



Review Article

The regulatory system for imported-cargo radiation monitoring in Korea and a proposal for its improvement



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ABSTRACT

To protect people and the environment from environmental radiation, the Act on Protective Action Guidelines against Radiation in the Natural Environment was formulated in Korea in 2011. This law regulates matters related to radiation safety that can be encountered in life. In accordance with this law, radiation monitoring equipment is operated at major airports and ports across the country, ensuring radiation monitoring of imported cargo. Currently, six ministries conduct radiation monitoring of imported cargo: the Nuclear Safety and Security Commission; the Korea Customs Service; the Ministry of Food and Drug Safety; the Ministry of Environment; the Ministry of Agriculture, Food and Rural Affairs; and the Korea Forest Service. Each ministry designates the relevant cargo items for radiation monitoring. The objective of this study was to comprehensively review the Korean radiation monitoring system for imported cargo and identify the areas and scopes of improvement. This paper also proposes a new law and an integrated supervision plan, which involves establishing a dedicated department to enhance the efficiency and professionalism of the national radiation monitoring system for imported cargo. The review will contribute to the development of a more sophisticated national radiation monitoring system for imported cargo.

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1. Introduction

Safety implies that there is no risk of accidents. Radiation safety refers to protecting people and the environment from radiation by eliminating radiation risks and preventing radiation accidents and incidents. Because there is no absolute standard for distinguishing between safety and unsafety, as society evolves, efforts are made to build a safer environment. Likewise, there is no definite standard for separating the safe and unsafe from the risks of radiation. However, considerable effort is directed toward protecting people and the environment from radiation, which is referred to as

“radiation protection.” Radiation protection comprises both technical and philosophical aspects, involving not only the use of the advanced technology to reduce radiation exposure but also the application of philosophical standards to keep the radiation exposure as low as reasonably achievable (ALARA), with consideration of economic and societal factors.

Several laws for monitoring environmental radiation have been enacted in Korea to provide radiation protection more actively to the public from the perspective of the ALARA approach, and various measures have been taken to reduce radiation risk. In particular, the Fukushima nuclear accident in neighboring Japan raised concern about radiation safety in Korea, and the Japanese government's recent decision to release contaminated liquid waste from the Fukushima nuclear power plant to the sea has exacerbated this worry. The Korean government conducts radiation monitoring of imported cargo from countries where nuclear accidents may have occurred, to dispel concerns regarding high radiation levels. Various departments conduct radiation

Abbreviations: ALARA, As Low As Reasonably Achievable; KCS, Korea Customs Service; KFS, Korea Forest Service; MAFRA, Ministry of Agriculture, Food and Rural Affairs; ME, Ministry of Environment; MFDS, Ministry of Food and Drug Safety; NSSC, Nuclear Safety and Security Commission.

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monitoring of imported cargo in accordance with the relevant laws and regulations, and considerable effort is directed toward preventing contaminated cargo by radioactive materials from being imported into Korea.

The objective of this paper was to comprehensively review the radiation monitoring system of the Korean government and propose sustainable improvements. The legal system and the legal basis for radiation monitoring of imported cargo conducted by each department were investigated by analyzing the laws and regulations of radiation monitoring for the relevant cargo items. In addition, the current status of radiation monitoring by the government departments was examined to determine how radiation monitoring for imported cargo is performed within the legal system. The investigation of the current radiation monitoring system for imported cargo in Korea confirmed that radiation monitoring is conducted by classifying cargo items under the jurisdiction of each government department for all imported cargo. An improvement based on legal grounds is proposed in this paper to enhance the efficiency and expertise of Korea's current radiation monitoring system.

2. Legal background of imported-cargo radiation monitoring system in Korea

After the Fukushima nuclear accident in Japan in March 2011, many Koreans were concerned that products exposed to radioactive materials released from the nuclear power plant would be imported into Korea. In particular, the National Assembly and civic groups demanded systematic radiation monitoring of food and daily necessities imported from the nuclear accident areas. They criticized the absence of a legal system for radiation monitoring. Furthermore, in 2012, a paved road in the residential area of Nowon District, Seoul contained radioactively contaminated materials, which had social repercussions, including increased public concern about the safety of environmental radiation exposure.

To resolve concerns regarding environmental radiation in Korea, the Act on Protective Action Guidelines against Radiation in the Natural Environment was enacted in July 2011 and has been in effect since January 2013. This law aims to protect the public's health and the environment from environmental radiation. For this purpose, it regulates matters concerning the safety of radiation that can be encountered in life. For enforcement of this law, radiation monitoring equipment has been installed and operated at major airports and ports across the country, ensuring radiation monitoring of imported cargo [1].

Because the cargo imported into Korea is diverse and has different applications, not all imported cargo is included in the radiation monitoring target of the Act on Protective Action Guidelines against Radiation in the Natural Environment. Many government departments, including the Korea Customs Service (KCS); the

Ministry of Food and Drug Safety (MFDS); the Ministry of Environment (ME); the Ministry of Agriculture, Food and Rural Affairs (MAFRA); the Korea Forest Service (KFS); and the Nuclear Safety and Security Commission (NSSC), which is the department responsible for enforcing the Act on Protective Action Guidelines against Radiation in the Natural Environment, conduct radiation monitoring on imported cargo items under their jurisdictions. Table 1 presents the cargo items under the jurisdiction of radiation monitoring for each department and their legal basis.

2.1. Nuclear Safety and Security Commission

The Act on Protective Action Guidelines against Radiation in the Natural Environment provides the definition of environmental radiation and the monitoring scope [1]. According to the law, environmental radiation in the natural environment can be classified into four types. The first type of environmental radiation is the radiation emitted from natural radionuclides in the source material, byproducts from processing, and processed products. The source materials indicate natural nuclides, including uranium-235, uranium-238, thorium-232, radon-220, radon-222, nuclides in their radioactive decay series, and natural radionuclides such as potassium-40, which exceed the radioactivity concentration and quantity specified by the NSSC. Byproducts from processing are incidentally produced in facilities that treat source materials or other substances containing natural radionuclides whose radioactivity concentrations exceed the level specified by the NSSC. The term "processed products" refers to products manufactured by processing source materials or byproducts from processing or using source materials or byproducts as raw materials. The second type of environmental radiation is the cosmic rays that enter the Earth's atmosphere from the sun or space. The third is the terrestrial radiation emitted from rocks or soil on the Earth's surface. Terrestrial radiation is also included in the natural nuclides; thus, the nuclides categorized as natural nuclides and terrestrial radiation overlap. The fourth is the radiation emitted from radioactive materials contained in scrap metal sold or recycled in Korea or imported from abroad. The Act on Protective Action Guidelines against Radiation in the Natural Environment regulates radiation emitted from natural radionuclides, cosmic rays, terrestrial radiation, and radiation emitted from scrap metal.

Article 19 of the Act on Protective Action Guidelines against Radiation in the Natural Environment requires the installation and operation of radiation monitors at airports and ports to monitor radiation emitted from natural radionuclides contained in source materials, byproducts from processing, and processed products and radiation emitted from scrap metal. Paragraph 2 of Article 20 of the Act requires air transport operators, port facility operators, and all people handling recycling scrap metal to operate radiation monitors [1]. In particular, the Act designates a suspected substance as

Table 1
Cargo items and legal basis for radiation monitoring of imported cargo by Korean government departments.

Department	Monitoring cargo items	Legal basis
Nuclear Safety and Security Commission	Source materials, byproducts from processing, processed products, and recycled scrap metals	Act on Protective Action Guidelines against Radiation in the Natural Environment
Korea Customs Service	Industrial products	Working Manual for the Emergency Response to Radioactive Leakage Accidents in Neighboring Countries
Ministry of Environment	Wastes	Act on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal
Ministry of Food and Drug Safety	Agricultural products, marine products, livestock products, processed foods, food additives, and functional health food	Korean Food Standards Codex
Ministry of Agriculture, Food and Rural Affairs	Feed	Control of Livestock and Fish Feed Act, Feed Inspection Standards, Standards and Specifications for Feeds, etc.
Korea Forest Service	Timber	Act on the Sustainable Use of Timbers

one whose radioactivity concentration exceeds the level specified by the NSSC. It is also required that a radiation monitor operator report to the NSSC after detecting a suspected substance. In practice, radiation monitoring is performed on all imported cargo, in addition to source materials, byproducts from processing, and processed products, which are subject to legal monitoring, because cargo imported through airports and ports usually passes through the radiation portal monitor.

Because the amount of cargo imported into Korea is large and various types of radiation are emitted from these substances, it is essential to establish an information system to manage the radiation emitted from cargo effectively. Article 25 of the Act on Protective Action Guidelines against Radiation in the Natural Environment requires the establishment and operation of a comprehensive information system to systematically manage information on the safety management of environmental radiation, such as the distribution status of raw materials or byproducts from processing, the status of manufacturing or import and export of processed products, and the status of safety management of cosmic radiation. In addition, the system operator may request the head of the relevant administrative agency to provide the necessary data for the efficient operation of the information system. The head of the relevant administrative agency should comply with the request unless there is a valid reason not to comply [1].

Article 27 of the Act on Protective Action Guidelines against Radiation in the Natural Environment stipulates that a specialized institution that can professionally conduct research and investigation about the safety management of environmental radiation should be designated [1]. This specialized institution is equipped with facilities, equipment, and a workforce that meet the standards set by the Enforcement Decree of the Act on Protective Action Guidelines against Radiation in the Natural Environment and can provide technical support such as the measurement of the radioactivity concentration [2]. The specialized agency is the Korea Institute of Nuclear Safety.

2.2. Korea Customs Service

The practical basis for the KCS to conduct radiation monitoring on Japanese industrial products is specified not in the Customs Act but in the working manual for the emergency response to radioactive leakage accidents in neighboring countries [3,4]. This manual aims to protect people's health and preserve the environment through early detection and emergency-level response activities when radioactive materials flow into Korea from neighboring countries. It concerns detailed matters related to rapid delivery of emergency news and updates and cooperation and response in the government departments in charge and the relevant organizations. In the event of a radiological accident in a neighboring country, such as the Fukushima nuclear power plant accident in Japan, the NSSC will play the role of the response headquarters for the accident and will establish a response system for sharing information and cooperation with the related organizations. According to this manual, emergency alerts are classified into four levels: concern, caution, alert, and serious [3]. The KCS is required to perform radioactive contamination inspection of imported industrial products under customs clearance. Therefore, the radiation monitoring of imported cargo by the KCS is not based on the law but rather is based on the inter-ministerial cooperation system for emergency response; if such emergency factors disappear in the future, the need and justification for the customs office to conduct radiation monitoring on imported goods will disappear. Thus, the KCS does not have a legal duty or role in radiation monitoring of imported cargo.

2.3. Ministry of Environment

The ME conducts radiation monitoring of import and export waste based on the Act on the Transboundary Movements of Hazardous Wastes and Their Disposal [5]. The term "waste" is defined in Article 2 of the Waste Control Act, and the attached table of the Enforcement Regulations of the Waste Control Act stipulates that wastes include metals, such as scrap and non-ferrous metals, clean timber, and paint [6,7]. However, the radiation monitoring of scrap metal falls under the jurisdiction of the NSSC according to the Act on Protective Action Guidelines against Radiation in the Natural Environment, and the radiation monitoring of timber falls under the jurisdiction of the KFS according to the Act on the Sustainable Use of Timbers; thus, the monitoring targets of the departments overlap [1,9].

Article 19 of the Act on the Transboundary Movements of Hazardous Wastes and Their Disposal stipulates that the import of waste may be prohibited or restricted for a specified period when emergency measures are necessary to protect public health and the environment from hazardous waste. It is applied to cases where the waste is imported from areas for which imports are prohibited or restricted by the Minister of the Environment, such as areas where a nuclear accident has occurred. Accordingly, waste imported from the Fukushima nuclear power plant accident site in Japan or the area of the Chernobyl nuclear power plant accident in Ukraine could be restricted or banned. To restrict and prohibit the import of radioactively contaminated waste, the ME has issued the Guideline on the Radioactive Contamination-free Certification for Imported Wastes, providing specific import standards [9]. This guideline details the documents that must be submitted to indicate whether the imported waste applies to radioactive material or radioactively contaminated material specified in Article 2, paragraph 5 of the Nuclear Safety Act [9,10]. According to Article 2 of the Notice on the Radioactive Contamination-free Certification for Imported Wastes, a person who intends to import waste potentially contaminated with radioactive materials from a country where a nuclear accident has occurred must submit a radioactive inspection report for cesium-134, cesium-137, and iodine-131 issued by the national or Korean authorized institutions to prove that import wastes are not radioactively contaminated before import [9]. In addition, even if the waste has been approved for import or has been reported by submitting a radioactive inspection report, the results of the simple radiation measurement for importing waste must be submitted to the electronic information processing program at every customs clearance [9].

A large amount of different types of waste is imported into Korea. Therefore, to effectively manage imported waste, it is important to keep a record of the transfer and acquisition of this waste so that this information can be processed electronically. Article 18, paragraph 4 of the Act on the Transboundary Movements of Hazardous Wastes and Their Disposal stipulates that waste exports and imports records must be stored in the electronic information processing program for three years. In addition, Article 18, paragraph 5 of the same law requires that additional waste information, such as the weight, destination information, and images of the waste, must be recorded in the electronic information processing program [5]. This information processing system is similar to the comprehensive information system for environmental radiation specified in Article 25 of the Act on Protective Action Guidelines against Radiation in the Natural Environment. Thus, both the Act on Protective Action Guidelines against Radiation in the Natural Environment and the Act on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal recognize the importance of information processing systems and require computerized tracking management of imported goods.

Similar to the NSSC, the ME has designated a specialized institution to manage waste exports and imports. Article 22, paragraph 5 of the Act on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal stipulates that a waste export and import safety management center must be designated to support waste export and import businesses. This institution performs safety management for waste exports and imports; the establishment and operation of the electronic information processing program; the review of waste export and import documents, facilities, and equipment; the verification of permits and approvals; and safety inspections. The Korea Environment Corporation has been designated as the waste export and import safety management center. The Allbaro System—the electronic information processing program—is in operation [11].

2.4. Ministry of Food and Drug Safety

The Special Act on Imported Food Safety Control, which was enacted in February 2015 and enforced in February 2016, aims to ensure the safety of imported food [12]. The MFDS is responsible for enforcing this act. Article 21 of the Special Act on Imported Food Safety Control stipulates that the inspection for food safety should be performed during every customs clearance for imported food. However, radiation monitoring of imported foods is not included in this special act. The MFDS provides the general safety standards and specifications through a notice called the Korean Food Standards Codex, which requires imported food to comply with these standards and specifications [13]. According to the radioactivity standard for the types of food specified in the Korean Food Standards Codex, all foods must have $\leq 100 \text{ Bq kg}^{-1}$ of iodine-131. When cesium-134 and cesium-137 are mixed, food for infants must have $\leq 50 \text{ Bq kg}^{-1}$, and otherwise, foods must have $\leq 100 \text{ Bq kg}^{-1}$ [13].

In addition to the Special Act on Imported Food Safety Control, the working manual for the emergency response to radioactive leakage accidents in neighboring countries provides the basis for the MFDS to conduct radiation monitoring on imported foods [3]. As mentioned previously, this manual was created to protect public health and environmental conservation through early detection of radioactive materials imported from neighboring countries and response activities based on risk levels. The manual describes matters concerning cooperation and operation of the response system between the government departments in charge and other related government departments and organizations. The Fukushima nuclear power plant accident in Japan belongs to the category of emergencies specified in the manual. The information about the accident should be shared for cooperation with the related organizations. The emergency alerts are classified into four levels: concern, caution, alert, and serious. The MFDS conducts radioactive contamination inspections on agricultural products, marine products, livestock products and processed foods imported from countries where nuclear accidents may have occurred, and takes measures such as import restrictions, if necessary.

2.5. Ministry of Agriculture, Food and Rural Affairs

The MAFRA is conducting radiation monitoring of imported feed in accordance with the Control of Livestock and Fish Feed Act [14]. Article 19 of the Control of Livestock and Fish Feed Act stipulates that the safety of imported feed must be ensured and that inspections are to be performed during customs clearance. More specific inspection standards are provided by the notice on the Feed Inspection Standards announced by the MAFRA [15]. In particular, the Standards and Specifications for Feeds, etc. issued by the MAFRA specify the acceptance criteria for the radioactivity of iodine and cesium in compound feed, single-ingredient feed, and

feed supplements for each livestock type [16].

2.6. Korea Forest Service

The KFS conducts radiation monitoring of imported timber in accordance with the Act on the Sustainable Use of Timbers [8]. Article 17 of the Act on the Sustainable Use of Timbers stipulates that a safety evaluation of timber products should be performed to prevent physical or chemical harm to people and the environment when the timber products are produced, sold or used. More specific standards for this safety evaluation are included in the guideline on Safety Evaluation Criteria for Timber Products issued by the KFS [17]. The types and contents of hazardous substances specified in this guideline are from the attached table listing safety evaluation items and contents for timber products. With regard to radiation monitoring, this standard requires that the specific radioactivity, i.e., the radioactivity per unit mass, of cesium-134 and cesium-137 be maintained below a certain level, depending on the type of timber.

3. Radiation monitoring for imported cargo by government departments

The previous section provides the legal background of radiation monitoring for imported cargo by each government department in Korea. This section clarifies the practical operation of the radiation monitoring system for imported cargo. Table 2 presents the imported-cargo radiation monitoring standards of the NSSC, KCS, ME, MFDS, MAFRA, and KFS [1,3–8,13–17]. The ME does not provide specific acceptance criteria, because imported wastes are monitored via document inspection, e.g., a radioactive inspection report, and the results of the simple radiation measurement for importing waste, which prove that it is not contaminated with radioactivity. In addition, the KCS does not disclose its standards for radiation monitoring of imported cargo.

3.1. Nuclear Safety and Security Commission

In accordance with Articles 19 and 20 of the Act on Protective Action Guidelines against Radiation in the Natural Environment, the NSSC has installed and operated 134 monitors at two airports and 15 ports to block the domestic inflow and distribution of source materials, byproducts from processing, processed products, and recycled scrap metal contaminated with radioactive materials, considering the analysis results for the cargo volume and types of cargo handled at airports and ports. The number of radiation portal monitors in operation at each airport and port is presented in Table 3. Figs. 1 and 2 show the radiation portal monitors installed at an airport and a port, respectively. The operation of these radiation portal monitors is entrusted to air traffic operators or airport and port facility operators according to Article 19, paragraph 3 of the Act on Protective Action Guidelines against Radiation in the Natural Environment. The Korea Institute of Nuclear Safety supervises the installation, maintenance, regular checks, etc. of these radiation portal monitors [1].

An inspection and analysis of the actual conditions of safety control of radiation in the natural environment are performed every year according to Article 23 of the same act for protecting workers handling materials containing natural radionuclides and members of the public using products containing natural radionuclides by blocking the inflow of radioactive materials into the country through radiation monitoring of imported cargo and recycled scrap metals and preventing the spread of radioactively contaminated materials into the environment. The Korea Institute of Nuclear Safety is entrusted with conducting inspections and

Table 2
Standards for radiation monitoring of imported cargo by Korean government departments.

Department	Monitoring cargo items	Nuclide	Monitoring standards
Nuclear Safety and Security Commission	Source materials, byproducts from processing	Potassium-40	10 Bq g ⁻¹
		Other natural radionuclides	1 Bq g ⁻¹
Korea Customs Service	Processed products	Natural nuclides	1 mSv y ⁻¹
		Recycled scrap metals	Different values for different radionuclides
Ministry of Environment	Industrial products	- ^a	- ^a
		Waste	- ^b
Ministry of Food and Drug Safety	All food	Iodine-131	≤100 (Bq kg ⁻¹ or Bq l ⁻¹)
		Cesium-134	≤50 (Bq kg ⁻¹ or Bq l ⁻¹)
		Cesium-137	≤100 (Bq kg ⁻¹ or Bq l ⁻¹)
Ministry of Agriculture, Food and Rural Affairs	Manufactured food and milk for infants, milk and processed milk products, ice cream	Cesium (Cesium-134 + Cesium-137)	≤100 (Bq kg ⁻¹ or Bq l ⁻¹)
		Other food	40–160 (Bq kg ⁻¹ or Bq l ⁻¹) ^c
Ministry of Agriculture, Food and Rural Affairs	Compound feed, single-ingredient feed, feed supplements	Cesium (Cesium-134 + Cesium-137)	40–160 (Bq kg ⁻¹ or Bq l ⁻¹) ^c
		Iodine-131	300 (Bq kg ⁻¹ or Bq l ⁻¹)
Korea Forest Service	Lumber, preserved wood, flame-retardant wood, laminate, plywood, particleboard, oil plates, oriented strand boards, wood flooring, wood-plastic composites	Cesium (Cesium-134 + Cesium-137)	≤300 Bq kg ⁻¹
		Wood pellets, wood chips, wood briquettes	≤30 Bq kg ⁻¹
		Molded wood, charcoal	≤100 Bq kg ⁻¹

^a Nondisclosure.

^b A radioactive inspection report and the results of the simple radiation measurement, which prove that they are not contaminated with radioactivity.

^c Cow and horse: 100; pig: 80; poultry: 160; aquaculture animals: 40; others: 100.

Table 3
The number of radiation portal monitors in operation at Korean ports and airports.

Classification	Location	Number of radiation portal monitors
Port	Gyeongin	1
	Gwangyang	8
	Gunsan	11
	Daesan	1
	Donghaemukho	4
	Masan	1
	Mokpo	3
	Busan	39
	Samcheonpo	1
	Ulsan	7
	Incheon	30
	Janghang	1
	Jinhae	1
	Pyeongtaek Dangjin	8
	Pohang	3
Airport	Incheon	13
	Gimpo	2

analyses of the actual conditions of safety control of radiation in the natural environment and issuing annual reports, including the inspection and analysis results [18].

After customs clearance, the NSSC conducts radiation monitoring of all source materials, byproducts from processing, processed products, and recycled scrap metals. The radiation inspection is performed in such a way that the vehicle loaded with

cargo is automatically monitored as it passes through the portal monitoring system. Thus, if a radiation alarm is triggered when the level of radioactivity exceeds the acceptance criteria, the operator of the portal monitoring system screens the information on the cargo and conducts an additional inspection to determine the location of radioactive materials in the alerted cargo, to measure its radiation dose rate, and to identify the nuclide using radiation detectors, including a fixed radiation monitor, dose-rate meter, and multichannel analyzer.

The follow-up process for the substances that are suspected to have radioactivity concentrations exceeding the level specified by the NSSC is as follows. First, the airport or port monitor operator conducts additional monitoring and inputs alarm information to the operating system of the airport or port radiation portal monitor, which is called RPMnet. Subsequently, the Korea Institute of Nuclear Safety accesses RPMnet in real time to confirm the alarm occurrence date and time, airport or port location, vehicle number, container number, cargo details, etc. Additionally, the Korea Institute of Nuclear Safety prepares and submits an investigation and analysis report to the NSSC, which reviews it and takes measures, such as returning the suspected cargo.

3.2. Korea Customs Service

The KCS does not have a legal basis for radiation monitoring of imported cargo but conducts radioactive contamination

Table 4
Radiation inspection certificates issued by Korean government departments for customs clearance.

Department	Monitoring items	Certificates
Nuclear Safety and Security Commission	Source materials, byproducts from processing, processed products, and recycled scrap metals	Radiation contamination-free certification
Korea Customs Service	Industrial products	-
Ministry of Environment	Waste	Waste import certificates, radioactive inspection certificates, the simple radiation measurement result
Ministry of Food and Drug Safety	Agricultural products, marine products, livestock products, processed foods, food additives, and functional health food	Food certificate
Ministry of Agriculture, Food and Rural Affairs	Feed	-
Korea Forest Service	Timber	-



Fig. 1. Radiation portal monitor at a Korean port.



Fig. 2. Radiation portal monitor at a Korean airport.

inspections on industrial products according to the decision from the 76th National Policy Coordination Conference held on March 25, 2011, after the Fukushima nuclear power plant accident. According to the responsibilities and roles specified in the working manual for the emergency response to radioactive leakage accidents in neighboring countries issued by the NSSC, the KCS implements radiation monitoring for imported cargo [3]. The KCS conducts a selective radiation inspection of industrial products imported from and near the nuclear accident area in Japan. It reviews the radioactive inspection certificates issued by other government departments to verify customs clearance.

In the KCS, the Customs Information Division and Customs Inspection Division, which are offices for import and export hazardous cargo selectivity, provide monitoring standards, including screening

and inspection methods for industrial products, and the customs offices perform the actual radiation inspection at airports or ports before customs clearance. The equipment used for radiation inspection includes a fixed radiation monitor, multichannel analyzer, portable radiation detector, and vehicle-mounted mobile radiation monitor. If radioactivity is detected or suspected during the inspection, the KCS provides the monitoring results to the NSSC and the Korea Institute of Nuclear Safety. However, the criteria of cargo selectivity for radiation monitoring and more specific radiation inspection guidelines have not been disclosed, for security reasons.

The KCS implements customs processes for the cargo, which is assured to be radiation-free, after the customs inspection department in each airport or port customs office examines the radiation inspection certificates. Table 4 presents the radiation inspection

certificates issued by government departments for customs clearance. If there is no responsible department for certain imported cargo or a government department does not issue the radiation inspection certificates for imported cargo, the KCS performs the radiation inspection for that cargo.

3.3. Ministry of Environment

After the Fukushima nuclear power plant accident, concerns were continuously raised regarding the radioactive contamination of waste imported from Japan during the 2014 and 2015 parliamentary inspections of the government offices for the ME. Consequently, a person who intends to import waste, such as coal materials, from Japan and Ukraine must submit a radioactive inspection certificate (cesium-134, cesium-137, iodine-131) to comply with Article 2 of the Notice on the Radioactive Contamination-free Certification for Imported Wastes [9]. This document, which is issued by the authorized institution in the exporting country or Korea, confirms that the imported wastes are not contaminated with radioactive materials at each customs clearance. In addition, the radioactive inspection certificates must be attached to both the application for import permission and the import declaration to import and export controlled wastes according to Article 9, paragraph 1 and Article 17–2, paragraph 2 of the Enforcement Decree of Act on the Transboundary Movements of Hazardous Wastes and Their Disposal, respectively [19]. Furthermore, a person who intends to bring in waste that has been approved for import or that has been reported and accepted by submitting a radioactive inspection certificate, must submit the results of the simple radiation measurement to the electronic information processing program called the import-export waste portal system at every customs clearance [9]. The Municipal Waste Management Division of the Resources Circulation Bureau in the ME is currently in charge of establishing policies and enacting and revising laws related to the radiation monitoring system for imported waste. The institutions authorized to issue radioactive inspection certificates include four measurement institutions in Japan, i.e., the Measurement and Calibration Center, Oarai Laboratory, the Institute of Radiation Measurements, and the National Metrology Institute of Japan, and two measurement institutions in Korea, i.e., the Korea Atomic Energy Research Institute and Korea Research Institute of Standards and Science. In general, radiation monitoring is performed only on waste imported from countries where nuclear accidents may have occurred, such as Japan and Ukraine [9].

The submitted radioactive inspection certificates and the results of the simple radiation measurement are reviewed by the local branch offices of the ME. The local branch offices selectively take samples of imported waste in the field once a quarter and conduct the post-inspection using a simple radiation measuring instrument. In the case of imported coal materials, a cement manufacturer installs a fixed-type radiation monitor to conduct radiation monitoring which a bulk cement trailer vehicle passes through, and the monitoring records are automatically transmitted to the local branch offices of the ME.

3.4. Ministry of Food and Drug Safety

Since the Chernobyl nuclear power plant accident, the MFDS has performed radioactive contamination inspections on imported food. The target nuclides of these inspections include cesium and iodine in agricultural products, marine products, livestock products, processed foods, food additives, and functional health foods. The inspections are based on the general safety standards and specifications, in accordance with a notice called the Korean Food

Standards Codex [13]. The processes for the distribution, disposal, or return of imported food in Korea are as follows. First, when imported food arrives in Korea, it is transferred to a bonded warehouse after an import declaration is made in the electronic customs clearance system of the KCS. Next, the local branch offices of the MFDS conduct document inspection to determine the adequacy of the food by reviewing the raw material constituents, the food additive usage, and the manufacturing process according to documents such as a certificate of origin or radioactive inspection certificates issued by the exporting country after receiving an import declaration. In addition to document inspection, the local branch offices conduct sensory inspections using the five human senses to determine the suitability of the imported product by examining its nature, condition, taste, smell, color, packaging condition, and inspection history. After document and sensory inspections, a close inspection is performed by selecting samples from food that has been identified in Korea or foreign countries as containing harmful substances and food that has been re-imported after being disqualified for importation in the past. Random-sample inspection is also conducted on food that is not included in a close inspection by the sampling plan of the Minister of Food and Drug Safety. The close and random-sample inspections adopt the same method; high-purity germanium (HPGe) gamma detectors are used to identify the nuclides with a high energy resolution. If the results of the document inspection, sensory inspection, close inspection, and random-sample inspection pass the safety standards and specifications, the imported products are distributed in Korea. If the inspection results are unacceptable, the customs office and importer are notified by the MFDS, and the products are discarded or returned to the exporting country [20].

The inspection targets are selected using the Observation and Prediction by Endless Risk Analysis (OPERA) system, i.e., the information system that automatically selects the target of intensive monitoring in real time. OPERA plays a role in preventing the import of illegal, defective, or violating food by analyzing the customs clearance history, importers, and manufacturer information. The local branch offices use this system actively in the field to implement stricter imported food safety monitoring. After the Fukushima nuclear power plant accident, an import ban was imposed on marine products from eight prefectures near Fukushima nuclear power plants (Fukushima, Gunma, Tochigi, Chiba, Abaraki, Miyagi, Iwate, and Aomori) and on 27 agricultural products from 14 other prefectures. Additionally, radioactive contamination inspections are conducted on all food imported from Japan, and additional radioactive inspection certificates are required if radioactivity is detected (even below the standard). Radioactively contaminated food is not allowed through customs clearance. The radiation measurement time has been increased from 1800 to 10000 s since January 2021 to increase the inspection accuracy. In October 2020, a website for radiation safety information on imported food was established to provide the public with transparent and accurate radiation inspection information for imported food [20].

3.5. Ministry of Agriculture, Food and Rural Affairs

The MAFRA conducts radiation monitoring of imported feed based on the Control of Livestock and Fish Feed Act and the notices on the Feed Inspection Standards and the Standards and Specifications for Feeds, etc. [14–16]. As public concern about radioactive leakage from the Fukushima nuclear power plant has increased, the MAFRA has been conducting radiation monitoring using its monitoring manual for Japanese feed since March 2011 [21]. Radiation monitoring is performed for feed imported from all countries; however, the feed imported from 43 prefectures of Japan is monitored regardless of whether it is contaminated by cesium or iodine

nuclides every import owing to the Fukushima nuclear power plant accident. In particular, feed imports from four prefectures in Japan—Ibaraki, Tochigi, Gunma, and Fukushima—are prohibited. The MAFRA has entrusted two organizations—the Korea Feed Association and the Korea Feed Ingredient Association—to inspect imported feed for radioactive contamination. The method for radiation monitoring of imported feed is similar to that of the MFDS and includes document inspection, close inspection, and random-sample inspection.

3.6. Korea Forest Service

The KFS performs safety evaluations on 15 timber products, including lumber, preserved wood, flame-retardant wood, laminate, plywood, particleboard, oil plates, oriented strand boards, wood flooring, wood-plastic composites, wood pellets, wood chips, wood briquettes, molded wood, and charcoal, according to Article 17, paragraph 1 of the Enforcement Decree of the Act on the Sustainable Use of Timbers [22]. If an imported timber product is identified as a suspected substance by the radiation portal monitor installed at ports by the NSSC, the timber product is transferred to the KFS. The KFS requests the Korea Forestry Promotion Institute, an affiliated organization, to perform the radiation monitoring of the suspected timber products. The Korea Forestry Promotion Institute takes samples of the suspected timber products from the field and then requests the Korea Atomic Energy Research Institute to perform a radiation inspection. The results of the radiation inspection are reported to the KFS, which calls for a committee meeting to determine restrictions and disposal measures.

4. Proposal for improvement of the imported-cargo radiation monitoring system

4.1. Problems with current radiation monitoring system

Herein, improvements to the current radiation monitoring system are proposed according to an analysis of the current status of the monitoring system for imported cargo implemented by each government department in Korea. It was found that the current monitoring system provides customized radiation monitoring by classifying imported items under the jurisdiction of each department for all imported cargo. However, problems were also found, such as the inadequate legal basis for radiation monitoring of some imported cargo and the overlapping radiation inspection of specific cargo by departments. The details of these problems are as follows.

1 Reduced efficiency of radiation monitoring of imported cargo due to the monitoring of items under the jurisdiction of each government department

Currently, six ministries conduct radiation monitoring on imported cargo. Radiation-monitoring items are designated for each department, and monitoring is performed according to the inspection standards for each department. It may be advantageous that customized radiation monitoring of imported cargo is conducted depending on the characteristics of each department; however, from the perspective of control and supervision of the entire imported cargo, there is a concern that the monitoring efficiency is reduced by spreading the imported cargo across various departments to conduct radiation monitoring. In the case of the ME, radiation monitoring of imported waste is biased toward document inspection, such as the review of radioactive inspection certificates and simple radiation measurement results issued by accredited institutions in export countries or Korea. Therefore, the ME does not perform actual radiation inspections on imported

waste but conducts radiation monitoring through document reviews. The MFDS performs various radioactive contamination inspections on imported food according to the systematic legal basis and monitoring standards. However, for imported drugs, the monitoring standards and methods are unclear; thus, there are concerns about the relative imbalance in radiation monitoring between food and drugs. Regarding timber products, the NSSC notifies the KFS when an imported timber product is identified as a suspected substance by the radiation portal monitor installed by the NSSC at ports. Then, the KFS performs radiation inspections on the timber products specified by the NSSC. The Korea Forestry Promotion Institute, which is affiliated with the KFS, does not perform radiation measurement directly but requests a specialized organization to conduct radiation monitoring.

2 Inadequate legal basis for radiation monitoring of imported cargo

The implementation of radiation monitoring for imported cargo has a legal basis. However, the KCS does not have a legal basis for radiation monitoring of industrial products. The Customs Act does not mandate the radiation monitoring of imported cargo [4]. The KCS conducts radiation monitoring on Japanese industrial products according to the responsibilities and roles stipulated in the working manual for the emergency response to radioactive leakage accidents in neighboring countries [3]. Therefore, the radiation monitoring of imported cargo implemented by the KCS is based on the inter-departmental cooperation system for emergency response rather than on laws. Furthermore, the scope of industrial products is not clear and specific enough, which can cause confusion in the field regarding the radiation-monitoring items of the KCS.

3 Overlapping radiation monitoring of imported cargo by individual departments

The radiation monitoring system for national imported cargo comprises government departmental units. Each department designates monitoring cargo items: source materials, byproducts from processing, processed products, and recycled scrap metals for the NSSC; industrial products for the KCS; wastes for the ME; agricultural products, marine products, livestock products, processed foods, food additives, and functional health food for the MFDS; feed for the MAFRA; and timber for the KFS. However, in the current radiation monitoring system, the distinction between processed products and industrial products is unclear; therefore, the NSSC and the KCS implement overlapping inspections of the items. In addition, for imported scrap metals, the NSSC and the ME conduct duplicate radiation inspections. For example, non-ferrous metals are items to be monitored by the ME; however, the NSSC takes measures such as returning products to the export country when non-ferrous metals are detected by the radiation portal monitor installed at the airport or port by the NSSC.

4 Radioactive inspection certificates required for customs clearance

Customs offices in airports and ports implement the customs clearance process for the imported cargo after checking the radioactive inspection certificates submitted by the shipper of the imported cargo to the Customs Inspection Division of each customs office. The radioactive inspection certificates confirmed by the KCS include the radioactive contamination-free certification from the NSSC, the waste import certificates (including radioactive inspection certificates and the simple measurement results) from the ME,

and food certificates from the MFDS. However, there is no regulation in the laws or guidelines for the departments that requires an importer to submit these radioactive inspection certificates separately to the customs office at the time of customs clearance; therefore, the KCS requests a certificate directly from the shipper of the imported cargo.

5 Lack of information on imported cargo when operating a radiation portal monitor

The Customs Act stipulates that general information about shippers, cargo details, etc. for loaded cargo must be submitted to the head of the customs office before entering the port in Korea. If an alarm is triggered while the imported cargo passes through the radiation portal monitoring system at the airport or port after customs clearance, the monitor operator queries the cargo driver to obtain the general cargo information, and the Korea Institute of Nuclear Safety verifies additional information through the UNI-PASS system, which is the customs information network of the KCS. However, information regarding the shipper is not disclosed through the customs system, for privacy protection; thus, the Korea Institute of Nuclear Safety tracks the shipper individually when imported cargo with suspected substances leaves the airport or port without additional radiation monitoring.

4.2. Enactment of integrated radiation monitoring act for imported cargo and establishment of a dedicated department

A robust legal basis is important for implementing the radiation monitoring of imported cargo. The legal basis is central for establishing a systematic and sustainable radiation monitoring system for imported cargo. This paper proposes enacting a new law for integrated radiation monitoring of imported cargo and establishing a new dedicated department to supervise the whole process of radiation monitoring of imported cargo as an improvement to the current radiation monitoring system used in Korea. The improvement proposal aims to break away from the existing radiation monitoring system for imported cargo used by individual departments and enact an integrated imported-cargo radiation monitoring act that enforces radiation monitoring of all imported cargo. In addition, a dedicated radiation monitoring government department or organization should be established to enforce this act. The newly established radiation monitoring department will oversee the primary and secondary radiation monitoring of all imported cargo. Primary radiation monitoring is carried out outside the imported cargo container using a radiation portal monitor installed at the airports and ports. In secondary radiation monitoring, an opening inspection of cargo containers is conducted for cargo that radiation alarm occurred during primary monitoring, has a radiation detection history upon import, or is of high interest to the general public, such as daily necessities. After radiation monitoring, the customs clearance process, which is the last step, is performed by the KCS for radiation-free cargo. Thus, a new dedicated radiation monitoring department implements primary and secondary inspections of imported cargo, and the KCS handles the final customs clearance process. The improvement proposal for the integrated radiation monitoring of imported cargo is shown in Fig. 3. The following actions must be taken to implement this proposal.

1 Enactment of the integrated radiation monitoring act for imported cargo and establishment of a dedicated department

In the current radiation monitoring system for imported cargo, monitoring items are classified by different departments, and

individual radiation monitoring is performed on items under their jurisdiction. Under the current system, radiation monitoring of imported cargo appears to be effective; however, to conduct radiation monitoring more efficiently and systematically, it is necessary to establish a new dedicated department or organization that can perform radiation monitoring for all imported cargo and enact a new law that can serve as the legal basis for this integrated monitoring. If the new law is enacted, the provisions related to radiation monitoring of imported cargo from the current related laws and regulations, including the Act on Protective Action Guidelines against Radiation in the Natural Environment, the Act on the Transboundary Movements of Hazardous Wastes and Their Disposal, the Korean Food Standards Codex, the Control of Livestock and Fish Feed Act, and the Act on the Sustainable Use of Timbers, should be transferred to the integrated radiation monitoring act.

2 Implementation of radiation monitoring on all imported cargo by the dedicated department

The newly established department or organization will perform the radiation monitoring of all imported cargo instead of the current six ministries, i.e., the NSSC, the KCS, the ME, the MFDS, the KFS, and the MAFRA.

3 Provision of radiation monitoring information for all imported cargo by the new department

Currently, the NSSC and the MFDS provide radiation monitoring information, such as monitoring methods, procedures, standards, and results, on the website for radiation in the natural environment and the website for radiation safety information on imported food, respectively. According to the improvement proposal, the new department will provide radiation monitoring information for all imported cargo.

4 Issuance of radioactive inspection certificates required for customs clearance

The KCS determines customs clearance or returns after examining the radioactive inspection certificates for the imported cargo. However, under the current system, the KCS directly requests radioactive inspection certificates or waste import certificates, including radioactive inspection certificates and simple measurement results from the shipper, which is cumbersome. If a dedicated radiation monitoring department for imported cargo is established, the newly established department will issue radioactive inspection certificates and send them to the KCS directly to accelerate the process of customs clearance.

5 Sharing a real-time imported-cargo information system with the Korea Customs Service

According to the improvement proposal, the newly established department will be responsible for radiation monitoring of imported cargo until the customs clearance by the KCS. To increase the efficiency and speed of radiation monitoring, it is necessary to share cargo information between the newly established department and the KCS. Currently, it is impossible for government departments other than the KCS to obtain detailed information on imported cargo in real time; therefore, it is difficult to respond quickly when radioactively contaminated cargo is found. To solve this problem, a real-time imported-cargo information sharing system between the newly dedicated department and the KCS should be established to allow faster identification and response when suspected substances are detected in the cargo. In addition, the imported-cargo

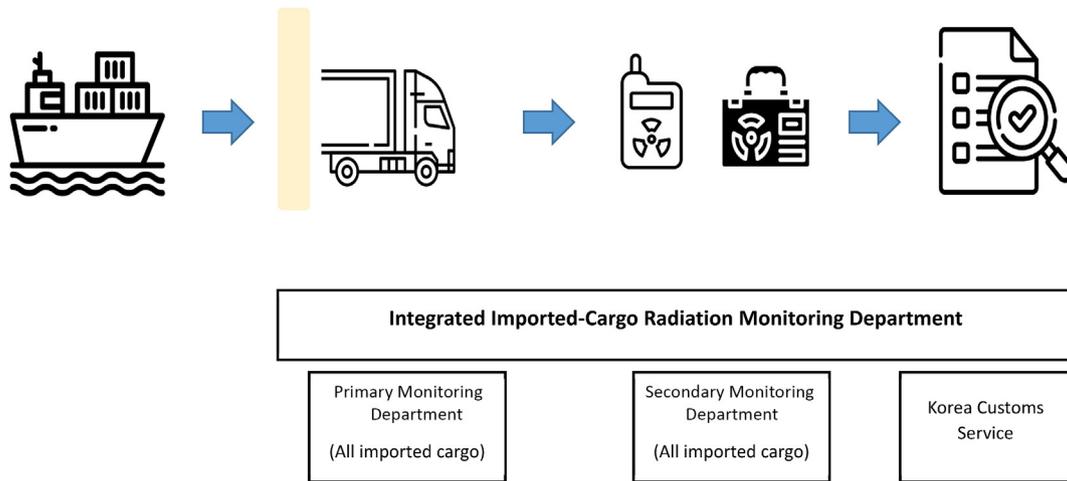


Fig. 3. Improvement of the imported-cargo radiation monitoring system.

information sharing system will make it possible to increase the accuracy of radiation monitoring by selecting the cargo to be monitored with a high probability of radioactive contamination according to the radiation inspection history and by performing an additional opening inspection.

The advantage of the integrated radiation monitoring act for imported cargo and that of having a dedicated department is that the primary and secondary inspections can be performed more professionally, which is an improvement over the existing monitoring system where each department performed inspections. In other words, establishing a new law and a dedicated department ensures that radiation monitoring of imported cargo conducts professionally. This can solve the problems of overlapping inspections due to the unclear classification of radiation-monitoring items by each department, the lack of expertise in radiation monitoring due to the outsourcing of radiation measurement, and the issuance of radiation inspection certificates for customs clearance. However, consultations must be made among the current six radiation monitoring ministries to implement this improvement proposal. This process is expected to take a long time, as it involves securing the budget and workforce, revising laws, and designing an organizational system. It appears that the reform should be pursued from a long-term perspective. In addition, it is necessary to reorganize the radiation monitoring methods, procedures, and standards applied in the existing radiation monitoring system for imported cargo according to the new laws.

5. Conclusion

The Act on Protective Action Guidelines against Radiation in the Natural Environment was enacted in Korea in 2011 to protect the health of people and the environment from environmental radiation and has been in effect since 2013. This act stipulates the safety of radiation that can be encountered in daily life. For enforcement of this act, radiation portal monitors have been installed and operated at major airports and ports across the country for the radiation monitoring of imported cargo. However, not all imported cargo is included in the radiation monitoring target of this act. In this study, to identify the ministries conducting radiation monitoring for imported goods, all 45 government departments in Korea were investigated by requesting the release of information. It was found that six departments, i.e., the NSSC, the KCS, the ME, the MFDS, the MAFRA, and the KFS, perform radiation monitoring for imported cargo under their jurisdiction.

To understand the national radiation monitoring system for imported cargo, the relevant laws, monitoring standards, and methods implemented by individual departments were investigated. The results indicated that the current monitoring system provides customized radiation monitoring by classifying imported items under the jurisdiction of each department for all imported cargo. However, weaknesses were found, such as the reduced efficiency of monitoring, the inadequate legal basis, and overlapping radiation inspection. First, there are concerns regarding a reduction in the efficiency of radiation monitoring of imported cargo due to monitoring by different departments. Currently, six ministries conduct radiation monitoring of national imported cargo, and regarding diversity, it may be beneficial that customized radiation monitoring is performed on items under the jurisdiction of imported cargo depending on the characteristics of each department. However, from the perspective of control and supervision of all the imported cargo, there is a concern that the monitoring efficiency is reduced by distributing imported cargo to various ministries for radiation monitoring. Second, a certain department implements radiation monitoring for imported cargo with an inadequate legal basis. The KCS conducts radiation monitoring based on the working manual for the emergency response to radioactive leakage accidents in neighboring countries rather than authentic laws. Third, government departments implement overlapping radiation monitoring of imported cargo. In the current radiation monitoring system, the distinction between processed products and industrial products is unclear; therefore, the NSSC and the KCS implement overlapping inspections on the items. In addition, for imported scrap metals, the NSSC and the ME conduct duplicate radiation inspections.

To enhance the current radiation monitoring system used in Korea, this paper proposes enacting a new law for integrated radiation monitoring of imported cargo and establishing a new dedicated department to supervise the whole process of radiation monitoring of imported cargo. The improvement proposal aims to break away from the existing system of radiation monitoring of imported cargo by individual departments and enact an integrated imported-cargo radiation monitoring act that enforces radiation monitoring of all imported cargo. A dedicated radiation monitoring government department or organization should be established to enforce this act. This improvement proposal allows more professional and efficient radiation monitoring of imported cargo. In addition, it can solve the following problems: overlapping inspections due to the unclear classification of radiation-monitoring

items by different departments, the lack of expertise in radiation monitoring due to the outsourcing of radiation measurement, and the issuance of radiation inspection certificates for customs clearance.

The objective of this study was to comprehensively review the Korean radiation monitoring system for imported cargo and seek improvements from a long-term perspective. The improvement proposal for the national radiation monitoring system for imported cargo presented in this paper is expected to contribute to the establishment of a more sophisticated national radiation monitoring system for imported cargo.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

- [1] Act on Protective Action Guidelines against Radiation in the Natural Environment, Act No. 17638, Republic of Korea, 2021.
- [2] Enforcement Decree of the Act on Protective Action Guidelines against Radiation in the Natural Environment, Presidential Decree No. 32220, Republic of Korea, 2021.
- [3] Ministry of Food and Drug Safety, Working Manual for the Emergency Response to Radioactive Leakage Accidents in Neighboring Countries, Republic of Korea, 2017.
- [4] Customs Act, Act No. 16838, Republic of Korea, 2019.
- [5] Act on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, Republic of Korea, 2021. Act No. 17984.
- [6] Waste Control Act, Act No. 17851, Republic of Korea, 2021.
- [7] Ministry of Environment, Enforcement Regulations of the Waste Control Act, Ministry of Environment Ordinance No. 965, Republic of Korea, 2022.
- [8] Act on the Sustainable Use of Timbers, Act No. 16711, Republic of Korea, 2019.
- [9] Ministry of Environment, Notice on the Radioactive Contamination-free Certification for Imported Wastes, Republic of Korea, 2017. Notice No. 2017-218.
- [10] Nuclear Safety Act, Act No. 17755, Republic of Korea, 2020.
- [11] Korea Environment Corporation. Allbaro system, Available at <https://www.allbaro.or.kr/index.jsp>, [cited June 12, 2021].
- [12] Special Act on Imported Food Safety Control, Act No. 17807, Republic of Korea, 2020.
- [13] Ministry of Food and Drug Safety, Korean Food Standards Codex, Notice No. 2021-54, Republic of Korea, 2021.
- [14] Control of Livestock and Fish Feed Act, Act No. 17091, Republic of Korea, 2020.
- [15] Ministry of Agriculture, Food and Rural Affairs. Feed Inspection Standards, Republic of Korea, 2019. Notice No. 2019-59.
- [16] Ministry of Agriculture, Food and Rural Affairs, Standards and Specifications for Feed, Etc., Republic of Korea, 2022. Notice No. 2022-28.
- [17] Korea Forest Service, Safety Evaluation Criteria for Timber Products, Republic of Korea, 2017. Notice No. 2017-80.
- [18] Korea Institute of Nuclear Safety, Report on the Inspection and Analysis of Actual Conditions of Safety Control of Radiation in the Natural Environment, 2020.
- [19] Enforcement Decree of the Act on the Transboundary Movements of Hazardous Wastes and Their Disposal, Presidential Decree No. 32528, Republic of Korea, 2022.
- [20] Ministry of Food and Drug Safety. Radiation safety information on imported food, Available at <https://impfood.mfds.go.kr/CFQCC01F01>, cited January 12, 2021.
- [21] Ministry of Agriculture, Food and Rural Affairs, Casebook of Key Questions and Answers Related to Feed, Republic of Korea, 2014.
- [22] Enforcement Decree of the Act on the Sustainable Use of Timbers, Presidential Decree No. 32528, Republic of Korea, 2022.