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Study on the Regulation Policy for the License Exempted Nuclear Material in aspect of Nuclear Nonproliferation

Ki Hyun KIM, Jae Bum PARK, Seong Youn JO, Wan Ki Yoon
Korea Institute of Nuclear Nonproliferation and Control
1534 Yuseongdae-Ro, Yuseong-Gu, Daejeon, Republic of Korea, 305-348

ABSTRACT

From a radiation safety point of view, License Exempted Nuclear Material (LENM) is approved when there is no radiation hazard to the public. LENM is controlled by the government under the Safeguards Agreements and Additional Protocol. However, there are few concerns regarding the management of LENM. Firstly, the level of safeguards awareness by firms and other institutions using LENM is not high, even though LENM management heavily depends upon user declaration. Secondly, after its use LENM tends to be thrown away with other industrial wastes. As a result, it earns a no-owner status because LENM is not under the control of radiation safety and physical protection regulation. Lastly, it is hard for a government to keep track of LENM transactions since these activities occur only in the private sector. A study on regulation policy was conducted. It focused on three areas of regulation. First, LENM criteria were re-evaluated. Next, characteristics of the nuclear material regulation system were analyzed by the SWOT-AHP method. Final, a system was created to develop strategies and optimized means to meet internal and external requirements of LENM. As a result, we were able to conclude that LENM regulation policy should be focused on anticipatory and cooperative management rather than the punishment or limitation of nuclear activities. We proposed the enhancement of the information management system to timely detect undeclared nuclear material and activities. In addition, we have to consider the education for LENM user and cooperation with private sector to inspire safeguards awareness.

INTRODUCTION

According to the 4th Comprehensive Nuclear Energy Promotion Plan (2012-2016), the government of the ROK had set out to enhance nuclear transparency and actively participate in the international nuclear non-proliferation regime. This was done as a strategic task in connection with the increase of the nuclear power supply ratio and the stabilization of the nuclear fuel supply [2]. Nuclear transparency is one of the most important issues facing the nation, because the ROK is heavily reliant on nuclear source materials from foreign nations. According to the long term strategic plan (2012-2030) of the IAEA, the Agency is planning to

enhance their safeguards system through the full use of their legal authority and the application of the state level safeguards approach. This means that the state is responsible for all events related to undeclared nuclear material and nuclear activities within the state itself, under the strengthened IAEA safeguards system even if these undeclared events were conducted at the individual or organizational level. The possibility of undeclared events is greatest during research activities using LENM. In this situation, nuclear material is used for industrial purposes such as small non destructive testing at a company rather than the large scale testing at a nuclear facility. Therefore it is necessary to evaluate whether or not the current LENM regulation system is able to cope with the undeclared events in private and small scale facilities sufficiently. In this study, LENM regulation policies which meet the strengthened IAEA safeguards system were suggested in order to minimize an unnecessary burden for the LENM user. Three main research activities were conducted and examine in this study. In the first study, the validity of the LENM criteria was re-evaluated, comparing it with the legal basis established in other countries. Then, SWOT (Strength, Weaknesses, Opportunities, Threats) analysis was conducted for the current LENM regulation system in ROK. Finally, we suggested LENM regulation policies based on the SWOT-AHP analysis result. The idea in utilizing the Analytic Hierarchy Process (Saaty, 1977, 2008) within a SWOT framework is to systematically evaluate SWOT factors and make them commensurable with regard to their intensities (Kurttila et al., 2001).

REGULATTION SYSTEM FOR THE LENM

LENM Regulatory Body

A person who intends to use or possess nuclear material must obtain a license to do so from the government--pursuant to the Atomic Energy Safety Act. Under the Act, LENM users still require a license to use material such as natural uranium which is not more than 300 grams and depleted uranium used as a shielding that constitutes part of shipping container. The Nuclear Safety and Security Commission (NSSC) is the body which regulates nuclear safety, security and non-proliferation. The NSSC has two affiliation institutes for the technical support. One is the Korea Institute of Nuclear non-proliferation and Control (KINAC) which is in charge of nuclear security and non-proliferation, and the other is the Korea Institute of Nuclear Safety (KINS) which oversees nuclear safety.

Legal obligation for LENM user

Licensees processing nuclear material have legal obligations with regard to radiation safety, physical protection, accountancy, and import/export control of nuclear material outlines by the Act. On the other hand, LENM users do not have those same obligations, except with the

requirement of reporting their import/export plan for authorization. The state has an obligation to report the quantity and location of LENM annually according to the additional protocol, although most of the LENM are exempted from IAEA safeguards. The state authority established a virtual Material Balance Area (MBA) which consists of 69 industrial organizations and 22 research institutes within the national territory to meet IAEA safeguards requirements. LENM users voluntarily declare their inventory changes not only domestic but also foreign on a web based system managed by KINAC called the Small Quantity Nuclear material Management (SQNM) system. KINAC conducts its IAEA safeguards obligations, such as accounting and additional protocol reporting on behalf of each company and research institute. KINAC also implements inspections for LENM users in order to verify the correctness of declarations every three years for each company and institute. Figure 1 shows the LENM regulation diagram.

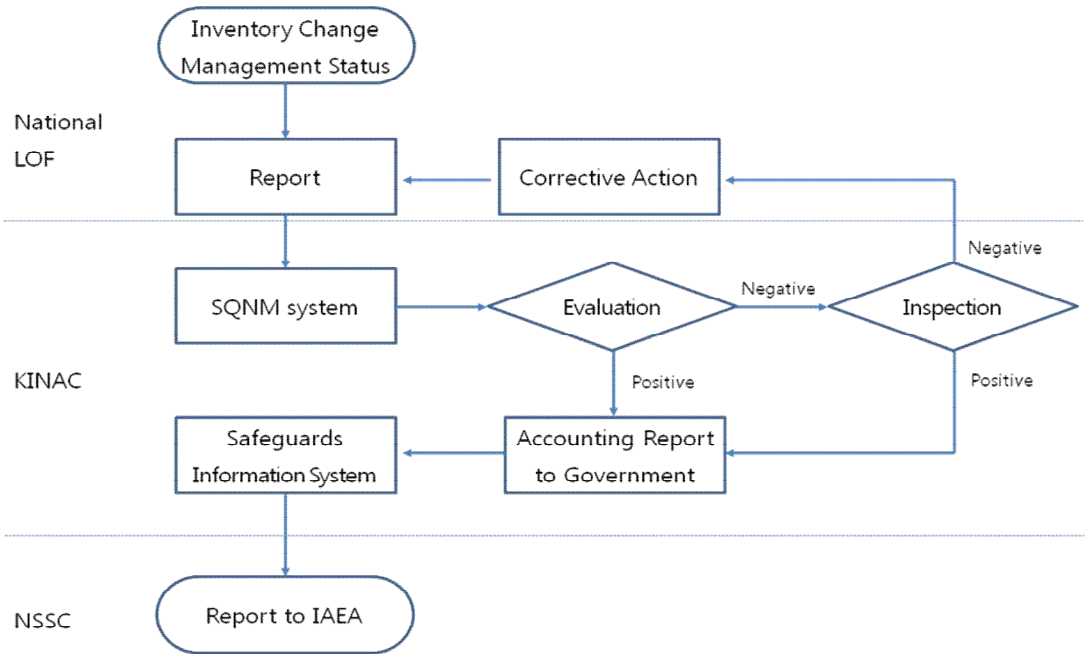

Figure 1. LENM regulation diagram

RE-EVALUATION OF LENM CRITERIA

In this study, the laws of other countries are compared with that of the ROK in order to evaluate the pertinence of the LENM criteria. Table 1 describes the legal basis of LENM. LENM criteria are regulated by the enforcement of the Act and public notification in the ROK. For example, natural uranium mixture below 300 grams and thorium compounds below 900 grams are defined as LENM according to the enforcement. We are able to find the same criteria on enforcement in Japan. Depleted uranium in shielding in containers, as an example, are categorized as LENM, according to public notification. In even more cases, we are also able to observe similar criteria

with regard to the Code of Federal Regulation part 40 in the US. The results, described above, suggest that the LENM criteria in the ROK have been properly regulated.

Table 1. Legal basis of the LENM criteria

Legal basis of ROK	LENM Criteria	Legal basis of Other country
Enforcement of Atomic Energy Safety Act Article 74	○ Uranium for which the ratio of uranium 235 to uranium 238 is the same as(or less than) the natural mixture and its compounds, the quantity of which is not more than 300 grams; ○ Thorium and its compounds, the quantity of which is not more than 900 grams;	Order for Enforcement of Regulation of Nuclear Source Material, Nuclear Fuel Material, and Nuclear Reactor in Japan, Article 39
Public notification of Nuclear Safety and Security Commission	○ Uranium contained in counterweights installed in aircraft ○ Natural or depleted uranium metal used as shielding constituting part of any shipping container ○ Any quantities of thorium contained in vacuum tubes, electric lamps for illuminating purposes : Provided, that each lamp does not contain more than 50 milligrams of thorium ○ Any quantities of thorium contained in germicidal lamps, sunlamps, and lamps for outdoor or industrial lighting: Provided, That each lamp does not contain more than 2 grams of thorium ○ Any finished product or part fabricated of, or containing tungsten or magnesium-thorium alloys, provided that the thorium content of the alloy does not exceed 4 percent by weight ○ Thorium contained in finished optical lenses, provided that each lens does not contain more than 30 percent by weight of thorium	10CFR40.13 Unimportant quantities of source material.

SWOT ANALYSIS OF THE LENM REGULATION SYSTEM

Currently, more attention has been paid to the nuclear security. Therefore, LENM regulation should be changed from passive management to active control to avoid nuclear non-proliferation and nuclear security problem, as well as to meet IAEA safeguards requirement. SWOT analysis was conducted so as to determine how well the current LENM regulation system is designed and operates with regard to nuclear non-proliferation and security. SWOT analysis is a strategic planning method used to evaluate the Strengths, Weaknesses, Opportunities, and Threats involved in a project. It involves specifying the objective of a project and identifying internal and external factors that are favorable and unfavorable in order to achieving an objective [6]. The scope of SWOT analysis in this study accounts for nuclear non-proliferation history, regulation experience, as well as internal and external environment factors in the ROK.

Historical Aspect of Nuclear Nonproliferation

The ROK joined the Treaty on the Non-Proliferation of Nuclear Weapons and signed a safeguards agreement with the IAEA in 1975. The additional protocol was ratified in 2004, and IAEA integrated safeguards had been applied in the ROK since 2008. IAEA Integrated Safeguards are implemented in a state only after the Agency has determined the absence of undeclared nuclear material and activities within that state. The Atomic Energy Act was initially established in 1958, but has been revised more than 25 times by 2012. During this time, the Ministry of Science and Technology had been in charge of nuclear promotion and regulation, until 2011. After the Fukushima Nuclear accident, the Atomic Energy Act was separated into the Atomic Energy Promotion Act and the Atomic Energy Safety Act. In addition, the NSSC was made independent from nuclear promotion related tasks. Since 2011 the NSSC has focused on nuclear regulation. This change enhanced competitiveness and made for greater efficiency in regulation.

Empirical Aspect of LENM Regulation

The LENM regulation system has three vulnerabilities. Firstly, the LENM user has no obligation to take the legal education program for nuclear non-proliferation. This exemption is one of the main reasons for low user awareness. Secondly, LENM related information is heavily reliant on user declaration. As a result, early detection of undeclared nuclear activities is hardly possible. Finally, the chance losing or have material stolen relatively high because most of the LENM are in small quantities and therefore can be easily moved without detection. Frequently moved item such as specimen, standard material, and depleted uranium in radiation projectors are also difficult to track.

Environmental Aspect

IAEA has empowered the state responsibility for the nuclear material and activities through the state level concept according to the IAEA long-term strategic plan. The state level concept means that the nuclear transparency of the state is evaluated comprehensively by diverse means such as industrial characteristics, technical capacity, and open source information. In other words, the nuclear activities not only in major group but the small scaled private company can affect the nuclear transparency in state level. This indicates that undeclared nuclear activities in private sector may cause the problem of state nuclear transparency. We have to consider that undeclared nuclear activities tend to be happened at small scale industrial or research firms rather than at large scale organization that are well designed and operated in a managerial context.

SWOT-AHP ANALYSIS AND SUGGESTION OF LENM REGULATION POLICY

Analytic Hierarchy Process (AHP) was used to carry out SWOT more analytically. The factor with the highest priority was chosen from each group, and these four factors were then compared pair-wise. Next, their relative and overall priorities were calculated on the basis of the comparisons. Finally, we were able to suggest the strategic alternatives by combining each highest priority factors (SW, SO, WO, OT). This analysis was based on the survey results of eight experts-five regulators and three LENM users. Each participant had conducted three pair-wise comparisons between factors within each SWOT group so that 96 pair comparisons had been implemented. Then, six more comparisons at a group level had been conducted, so that 48 pair comparisons had been implemented. Pair-wise comparison means that participants give priority to the factor by scoring from 1 to 9. The analysis results are based on the 117 valid survey results, excluding 27 invalid results which had more than a 0.3 inconsistency ratio.

Table 2. Priorities of the SWOT groups and factors, and consistency ratio of comparisons

SWOT group	Group priority	SWOT factors	Priority of factor within group	Overall priority of factor
Strengths	0.077	S1. Empirical knowledge	0.127	0.010
		S2. Efficient information management system	0.532	**0.041**
		S3. Efficient inspection system	0.341	0.026
Weak-nesses	0.358	W1. Vulnerability of loss, uncontrolled disposal	0.127	0.045
		W2. Less regulation in aspect of nuclear safety and security for LENM	0.267	0.095
		W3. High dependency upon the user notification but low user awareness	0.606	**0.217**
Oppor-tunities	0.154	O1. Increase of LENM use	0.103	0.016
		O2. Interface with nuclear safety, export control	0.326	0.050
		O3. Education for LENM user	0.571	**0.088**
Threats	0.412	T1. Strengthened IAEA Safeguards	0.257	0.106
		T2. Resistance against the enforcement	0.148	0.061
		T3. Social effect of LENM management failure	0.595	**0.245**

Note. Results are based on the survey by 8 experts using Expert Choice software ver. 11.5. The greatest weight score within the SWOT group in boldface. Overall weight scores are calculated by multiplying the local weight score within the SWOT group by the group weight score.

Strategic priority

The threats group turned out to be highest group priority followed by weaknesses, opportunities, and strengths. Table 2 shows the priorities for the SWOT groups and factors. An efficient information management system for LENM accounts for top priority in group S. Low user awareness despite high dependency upon user notification gets the highest score in group W. Education for LENM users has greatest significance in group O. We were aware that the social problem for LENM management failure had to be considered preferentially for group T.

SO, WO, ST, WT strategies and strategic alternatives

The strategies had been established by combining the top scoring factors in each group. The strategy is to enhance the quality of the information management system by improving education of the LENM user. Upgrading the SQNM system in a user-friendly manner and educating the user is considered a SO alternative. The WO strategy is used to raise user consciousness by improving the education system. Every LENM user has to take a legal education program for the radiation safety once a year. The LENM user has no obligation to take legal nuclear non-proliferation education. Therefore, curriculum modification can be made by adding a non-proliferation course in the radiation safety education program. This can be an effective and efficient alternative. Figure 3 show the strategies derived from the SWOT-AHP analysis

Internal Environment / External Environment		S	W
		S1(0.010) **S2(0.041)** S3(0.026)	W1(0.045) W2(0.095) **W3(0.217)**
O	O1(0.016) O2(0.050) **O3(0.088)**	**S2O3** SO	WO **W3O3**
T	T1(0.106) T2(0.061) **T3(0.245)**	ST **S2T3**	WT **W3T3**

Figure 3. LENM regulation strategies from SWOT-AHP analysis

The ST strategy is used to cope with the social problems associated with LENM failure by improving the information management system. The diversification of information sources by cooperation with industrial and academic associations enhances the system and lowers the possibility of LENM management failure. The WT strategy is used to prevent the management

failure by the LENM user. The LENM user is not only the victim but the primary stakeholder when management failure happened. Efforts mentioned in other strategies can be utilized as alternatives for this strategy. Figure 4 describes strategies and alternatives suggested.

Strategy		Alternatives
SO	o Enhance the education for LENM user to improve the quality of information management system	o Upgrading the SQNM system in a user-friendly and educating manner
WO	o Raise user consciousness by improving education system	o Curriculum modification adding a nonproliferation subject in the radiation safety education program
ST	o Prevent LENM management failure by improving the information management system in an operational manner	o Diversification of information source by enhancing cooperation with industrial and academic association
WT	o Prevent the management failure by LENM user's effort	o Implementation of SO, WO, ST alternatives

Figure 4. Strategy and Alternatives suggestion

CONCLUSION AND DISCUSSION

The key findings of this study are summarized here. First, LENM regulation policy, with respect to nuclear non-proliferation, should focus on raising user awareness and provide complete information in order to cope with potential internal and external difficulties or threats. Second, a LENM regulation policy should be implemented, not punish or restrict, but to education those involved and improve cooperation. These conclusions are based on the strategies and alternatives from the SWOT-AHP analysis. Improvement of the information management system and the LENM user education program is one of the key roles of the regulatory body. The LENM user has to comply and actively cooperate with the regulation policy program to prevent potential difficulties. Nuclear material management, including LENM, at a national level has important significance under strengthened IAEA safeguards-concentrated on detecting the absence of undeclared nuclear material and activities within the state. We are able to suggest that regulation policy for nuclear material is biased towards safety. So there is a need to consider the nuclear non-proliferation point of view to assure the peaceful use of nuclear energy. This study is expected to contribute to the preparation of LENM regulation policies for nuclear transparency and enhancement awareness of nuclear non-proliferation.

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