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# Development of Safeguards Approach Considering Proliferation Resistance

Na Young Lee*, Hosik Yoo, Wan-Ki Yoo, Sung Yeon Jo, Jong-Kyu Jeon
*Korea Institute of Nuclear Non-Poliferation and Control, 103-6 Munji-dong, Yuseong-gu, Daejeon, 305-732, ROK*
**Corresponding author: leeny@kinac.re.kr*

## 1. Introduction

Under the Korean State System of Accounting for and Control of nuclear materials (SSAC), development of the safeguards approach for the pyroprocessing, which aims to recycle the spent fuel, is required. The SSAC denotes the domestic control of nuclear materials that can be diverted to a nuclear weapons program. Safeguards, however, should be considered within the framework of Proliferation Resistance (PR), which is the ultimate goal. In this regards, we reviewed how to evaluate PR and also how to apply it to the target system.

There are two major streams of research in evaluating proliferation resistance: the one is developed in the INPRO project and the other is by the GIF.

In the case of Korea, with its high level of nuclear technology and complicated environmental situation, it requires a higher level of transparency. This can only be achieved by self evaluation of its facilities and research plans.

In the evaluation of PR, safeguards, which is one of its extrinsic features, is an important factor affecting PR. It means that the level of a safeguards system affects the evaluation of PR. On the other hand, PR evaluation results can help identify the efficiency and appropriateness of an established safeguards system, therefore, we can determine whether we need to strengthen it.

In this research, we introduce the nuclear materials acquisition path, which is a high level state evaluation model. [1] Based on this, we define the acquisition path inside Korea. It can be defined in two ways: the first path includes existing nuclear facilities. The second path anticipates to be implemented after the pyroprocessing research results have been facilitated.

The first path is rather straightforward and, under the SSAC safeguards system, has been already established. The second path, however, is still under development. Therefore, we need to assume the anticipated path with safeguards refer to the safeguards research results for pyroprocessing.

There are two major approaches to evaluate PR: One is the GIF approach that can analyze PR quantitatively, and the other is the INPRO approach which is appropriate to qualitative analysis.

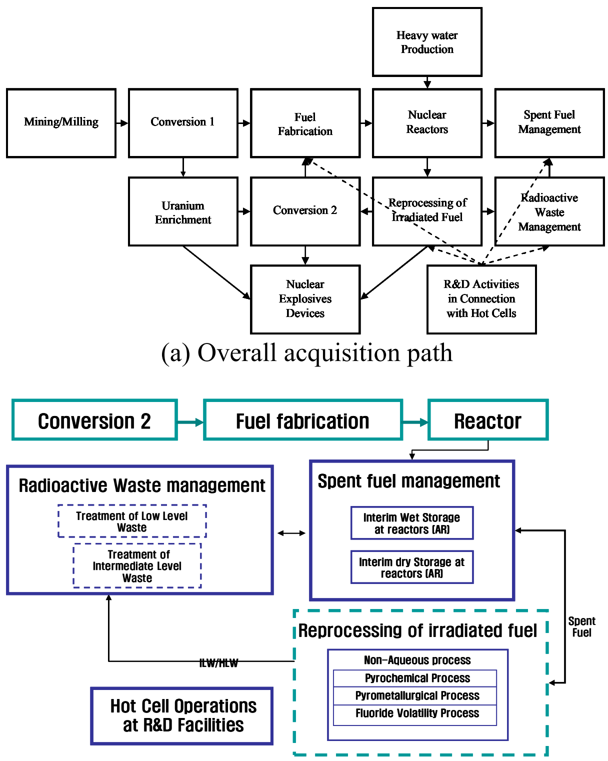
In this paper, we will address the preliminary PR evaluation strategy.

## 2. Identification and Application of a Physical Model

The term significant quantity (SQ) refers to the approximate amount of nuclear material needed for a nuclear explosive device can be manufactured. SQ is used in establishing the quantity component of the IAEA inspection goal. By considering the acquisition path to achieve 1 SQ, we can practically evaluate the PR of the target.

IAEA suggested Physical model of a nuclear fuel cycle which shows a detailed overview of the nuclear fuel cycle, identifying, describing and characterizing every known technical process for converting nuclear source material to weapon usable material, and identifying each process in terms of the equipment, nuclear material and non-nuclear material involved. It is useful for safeguards State evaluations by efficiently treating the increased information since Strengthened Safeguards System has been introduced [2].

In the evaluation of PR, we list up the entire path that nuclear materials flow. The path is similar to that in the physical model. Using the physical model, we identified the acquisition path in Korea. Once we identify the top level stage in the fuel cycle, we can go down from the facility level to the process level.




(a) Overall acquisition path

(b) Anticipated acquisition path

Figure 1. Physical Model

We showed the original physical model in the Figure 1(a) and the modified acquisition path applicable to Korea in Figure 1(b).

## 3. Two Approaches to Evaluate PR

PR is defined as the characteristic of a nuclear energy system that impedes the diversion or undeclared production, or misuse of technology [3]. To evaluate such a characteristic, research has been performed to define parameters that could be indicators used to evaluate PR.

Among them, the GIF approach and the INPRO approach are the most popular. The GIF approach introduces a probabilistic risk assessment to quantitatively evaluate PR. The INPRO approach utilizes a checklist format to confirm whether or not there is any item to improve PR. In the Table 1, we compared two approaches to identify what is the characteristic of these approaches.

Table 1. Comparison of PR Evaluation Approaches

| | INPRO methodology | GIF methodology |
|---|---|---|
| Purpose | Evaluation of system design against INPRO requirements | Quantitative assessment of the proliferation resistance of GEN IV nuclear systems |
| Analysis approach | Criteria/User requirement/ Basic principle | Threat/System response/outcome (Scenario approach) |
| Analysis input | State specific conditions System/ Safeguards design, Acquisition path Cost-effectiveness | System design Safeguards design Acquisition path |
| Output of analysis | Compliance/gaps to requirements Need for R&D | System assessment Pathway comparison Needs for R&D |

The INPRO approach defines ‘Basic Principle’, ‘User Requirement’ and ‘Criteria’. For ‘criteria’, indicators and acceptance limits are defined to check whether it satisfies a given criteria. It is comprehensive and easy to use in the early stages of development; but it defines only high level properties which require more detailed classification to apply to a real system.

The GIF approach requires input values to evaluate PR quantitatively. It defines 6 measures including both intrinsic and extrinsic features. Most of the parameters are converted to a reasonable number to be used in calculations. Therefore, it cannot be applied in the early development stage.

Considering these features, we need to apply each approach according to the development stage of the system. Based on the evaluation results, we can establish a safeguards system more efficiently. In the Figure 2, we showed which approach to apply in each stage of development.

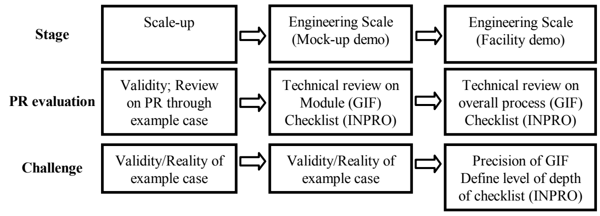



Figure 2. PR Evaluation Challenges According to the Technology Development Stage

## 4. Conclusion

In this paper, we tried to establish a framework to utilize PR evaluation results to set up a safeguards system.

To apply safeguards more efficiently, we need to identify which step is important. Therefore, in order to develop a safeguards approach, PR evaluation results a newly developed system must be considered.

Here, we suggested using a physical model to identify a nuclear materials acquisition path for PR evaluation purposes. Then, we suggested using two PR evaluation approaches in turn according to the development stage of the system.

In evaluation of the PR, we utilize existing PR evaluation approaches in each development stage of technology. Evaluation results will be used to complement the planned safeguards and thus provide feedback to establish an appropriate safeguards system.

We will identify the applicability of the GIF tool in a quantitative evaluation of PR.

## REFERENCES

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[2] LANL, “International safeguards for pyroprocessing: Options for Evaluation”, 2003

[3] GIF, “Evaluation methodology for PR and PP of GEN IV NES Rev.5”, 2006