Development of Safeguardability Evaluation Process for Safeguards-by-Design

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1. Introduction

Safeguards-by-Design (SBD) process has been developed for timely and cost-effective safeguards activity for nuclear facilities in IAEA, Euratom and United States [1, 2]. The SBD process should be integrated into the national regulatory framework as standards of the licensing of nuclear facilities. In Republic of Korea, SBD process was stated in the second plan of Nuclear Safety Plan by Nuclear Safety and Security Commission in order to establish the regulatory framework and preemptive safeguards implementation system of future nuclear facilities [3].

Safeguardability is one of the extrinsic measures of Proliferation Resistance (PR). Several studies of Generation IV International Forum (GIF) and International Project on Nuclear Reactors and Fuel Cycles (INPRO) have been underway for enhancing the proliferation resistance. In 2006, Generation IV Forum Proliferation Resistance & Physical Protection Working Group (GIF/PR&PP WG) developed the preliminary checklist of safeguardability, comprised of three measures of implementation international safeguards. GIF defined that safeguardability was derived in terms of the degree of easiness with which a nuclear facility can be effectively put under international safeguards [5].

In this study, safeguardability evaluation process was suggested in the level of design of nuclear facilities. Iteration of the process have to be until safeguards system proposed is required before the construction.

2. Safeguardability Evaluation Process

2.1 Safeguards- by-Design

Safeguards-by-Design (SBD) is a structured approach which an international safeguards is fully integrated into the design process of a nuclear facility in order to enhance safeguardability [4]. Several studies on the safeguardability have been underway since the foundation of the IAEA. In the early 2000s, the preliminary list of safeguardability attributes were drafted by the Generation IV Forum Proliferation Resistance & Physical Protection Working Group (GIF/PR&PP WG) [5]. And the Joint Research Center (JRC) experts introduced additional attributes related to implement the Additional Protocol [6].

2.2 Safeguards Evaluation Process

The safeguardability evaluation process is based on Facility Safeguardability Analysis (FSA) process [7, 8]. The FSA process includes gap analysis in comparison with existing facilities by screening checklist [8]. Safeguards systems of existing facilities can be applicable for design of safeguards system of new facilities by screening. However, currently non-existing facilities, such as pyroprocessing facility, cannot apply to safeguards system of existing facilities. Safeguardability of new facilities reflects facility characteristics. Without existing facilities, the safeguards design should be developed for the level of unit process or material balance area (MBA).

The safeguards evaluation process is iteration process until satisfying safeguards requirements. The process is shown in Fig. 1.

In the first step, the process is that design information including process, material flow, and structure layout is received from an operator or a designer of a new nuclear facility. Based on the design information, the safeguards design concept (SDC) will be developed and diversion scenarios should be conducted in order to evaluate SDC.

After evaluation of SDC, we can determine whether the SDC satisfies the safeguards requirements or not. If the SDC does not satisfy requirements, the process return the development step of the SDC. If the SDC satisfies all requirements, lessons learned will be compiled about the proposed SDC and preliminary evaluation of the safeguardability of new facilities.

Screening for gap analysis between facilities is optional due to the non-existing future facilities before design the SDC. Brand-new facilities should be evaluated without screening. A checklist is developed for regulators to evaluate safegardability according to facility characteristics. Also, MUF calculation supports evaluation of safeguardability.

The process includes database of safeguards design of existing facilities and document of safeguards guideline in similar to evaluation toolkit in FSA process.

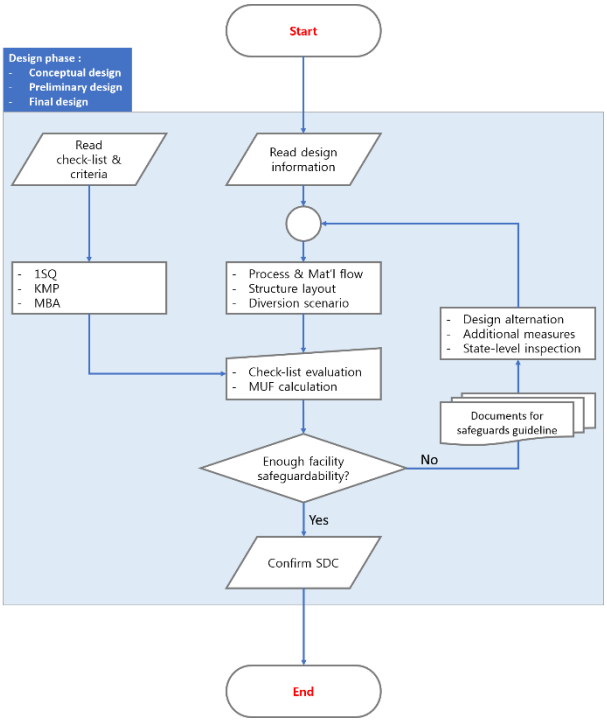

Fig. 1. Flow sheet of safeguardability evaluation process

2.3 Checklist of Safeguardability Evaluation

On top of screening in FSA process [8], the most of checklist focus on proliferation resistance for nuclear fuel cycle. For example, GIF, INPRO and KINAC developed evaluation parameters to evaluate total facility in view of proliferation resistance. Safeguardability evaluation checklist of a facility have to reflect characteristics of the facility, such as material characteristics, material flow, and characteristics of process. Finally, MUF calculation is one of the evaluation checklists.

2.4 Validity of Safeguardability Evaluation Process

For validation of the safeguardability evaluation of process, comparison is required for international guideline. The final SDC of facility will be evaluated by international guideline from International Atomic Energy Agency (IAEA). If the evaluation from international guideline be able to get the similar lesson learned or the report, the evaluation process has validity.

3. Conclusions

In this study, the safeguardability evaluation process was developed based on FSA process. This process is the first safeguards-by-design in Republic of Korea prior to construction of future nuclear facilities considering facility characteristics.

Following this study, future nuclear facilities, such as pyroprocessing facility and dry storage facility for spent fuels, will be evaluated by the safeguardability evaluation process.

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