

A Study on the PP Evaluation Methodology for INS
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1. Introduction

With the potential danger of a terrorist attack against a nuclear facility, the international community is making efforts to adopt the concept of physical protection beginning at the initial stage design of a nuclear plant. Its purpose is to protect nuclear facilities from intrusion (both by outsiders and insiders) by eliminating security weak points through the evaluation of the physical protection regime at the design stage. Currently, three approaches have been developing for this purpose: the IAEA's INPRO[1], the Generation-IV project's PR&PP[2] and PP methodology developed by KINAC (hereafter PP-KINAC)[3]. These approaches have the same goal but are different in terms of evaluation procedure and measures. The INPRO methodology focuses on parameters related to the overall frame of a state such as the legislative and regulatory framework. The Gen-IV PP and PP-KINAC are more facility oriented evaluation methods. For this reason, the INPRO methodology is ideal for evaluating the state regime of physical protection, rather than a PPS of a nuclear facility. Therefore, the Gen-IV PP methodology and/or the PP-KINAC can complement the INPRO methodology. It is important to find what part of the Gen-IV and the PP-KINAC can be applied and complemented to the INPRO methodology. This can be accomplished through comparing and analyzing those methodologies. In this study, we explain the general concept of these three PP methodologies and try to seek ways to combine them to obtain a more efficient and practical methodology for PP evaluation. To do this, three methodologies are compared and the parts that can be complemented are derived.

2. PP evaluation methodology

2-1 INPRO methodology

The INPRO methodology for PP evaluation uses a set of Basic principles (BPs), User Requirement (URs) and Criteria including: Indicators and Acceptance limits. There is 1 BP, 12 URs and 27 CRs for PP evaluation. The BP of the INPRO area of PP is outlined in this statement: "A physical protection regime shall be effectively and efficiently implemented for the full lifecycle of an INS Innovative Nuclear System." The UR is similar to the 12 fundamental principles included in the amended CPPNM (Convention on Physical Protection of Nuclear Material) and contains one to four criteria. Table 1 shows an overview on UR and CR. Unlike the PR (Proliferation Resistance), the Evaluation Parameter (EP) and the Evaluation Scale (ES) are not

given in the INPRO manual. The EP and the ES for PP evaluation are being developed by KINAC.

Table 1. Overview on UR and CR of the INPRO

UR	CR	UR	CR
1.1	Roles and responsibilities of state	6.2	Graded approach
1.2	Regulation development	7.1	QA policy
1.3	Roles and responsibilities of license holder	8.1	Security culture
2.1	PP integration with PR, safety and operations	9.1	Terrain, topography and geography
2.2	PP consideration in all INPRO areas	9.2	Material transport and off-site response
2.3	PP consideration through all phases of INS	9.3	Future public encroachment
3.1	Trustworthiness program	10.1	INS design
4.1	Development of confidentiality program	10.2	INS layout
4.2	Implementation of confidentiality program	11.1	PPS an integrated system
5.1	Development of DBT	11.2	Insider adversary considerations in PPS
5.2	Periodic review of the threat	11.3	Defense in Depth
5.3	DBT as basis for PP	12.1	Responsibilities for contingency plans
5.4	Flexibility in PPS	12.2	Sabotage mitigation
6.1	Consequence limits	12.3	Recovery of material and facilities

2-2 Gen-IV methodology

The Gen-IV PR&PP group suggested three measures for PP evaluation; and they focused on the PPS of a facility. All the parameters related to the PPS are divided into three categories: probability of adversary success (PAS), consequences (C) and physical protection resources (PPR). The PAS is the probability that an adversary will successfully complete a pathway and generate a consequence. Consequences are the effects resulting from the successful completion of an adversary's intended action described by a pathway, including the effects of mitigation measures. The PPR is dependant upon staffing, capabilities, and costs required to provide PP, such as: background screening, detection, interruption, and neutralization, and the sensitivity of these resources to changes in threat sophistication and capability. The measures suggested in the Gen-IV PR&PP group are too simple and extensive to express all the parameters that may affect the PPS.

2-3 PP-KINAC methodology

The PP-KINAC methodology was developed to complement the Gen-V PP methodology; and it is comprised of five measures: probability of adversary interruption (PAI), probability of adversary neutralization (PAN), consequences (C), fissile material (MT) and effectiveness of physical protection resources (EPPR). The PAI measure assumes that an attack will be interrupted by a response force. It consists of

detection and delay functions. The PAN measure assumes that an adversary will be neutralized by facility's safeguards and offsite response force team. These two measures are combined in the Gen-IV PP methodology as the PAS. Consequences are the effect resulting from an attack and are composed of direct and indirect results. There is no difference from those of the Gen-IV. The fissile type that is stored or used in the facility is an important parameter for the evaluation of PP; but there is no mention about it in the Gen-IV. The MT is a categorization of material based on the degree to which its characteristics affect its utility for use in an attack, or its attractiveness for being a target. The EPPR makes the degree of how physical protection resources prove effective. Physical protection resources include: background checks on staff, MC&A activity and the PP staff's capability and education. Unlike the measure defined by the Gen-IV PR&PP group, it does not contain the activity related to detection, interruption and neutralization.

3. Comparison of the methodology

The three PP methodologies explained in the previous section are compared to find or derive the most effective ways for evaluation. As mentioned, the INPRO methodology is different from the other ones in terms of evaluation scope and measures. Therefore, it is not easy to compare directly the measures of the three methodologies. In this study, the PP measures of the Gen-IV and PP-KINAC that match each criterion of the INPRO are derived. The result of the comparison can be seen in Table 2.

Table 2. Comparison results of the PP methodology

INPRO(CR) ^o		Gen-IV ^o	PP-KINAC ^o	INPRO(CR) ^o		Gen-IV ^o	PP-KINAC ^o
1.1.	Roles and responsibilities of state	PPR ^o	EPPR ^o	6.2.	Graded approach ^o	PAS ^o	MT ^o / PAN ^o
1.2.	Regulation development	PPR ^o	EPPR ^o	7.1.	QA policy ^o	PPR ^o	EPPR ^o
1.3.	Roles and responsibilities of license holder	PPR ^o	EPPR ^o	8.1.	Security culture ^o	PPR ^o	EPPR ^o
2.1.	PP integration with PR, safety and operations	PPR ^o	EPPR ^o	9.1.	Terrain, topography and geography ^o	PAS ^o	PAN ^o
2.2.	PP consideration in all-INPRO areas	PPR ^o	EPPR ^o	9.2.	Material transport and off-site response ^o	PAS ^o	PAN ^o
2.3.	PP consideration through all phases of INS	PPR ^o	EPPR ^o	9.3.	Future public encroachment ^o	PPR ^o	EPPR ^o
3.1.	Trustworthiness program	PPR ^o	EPPR ^o	10.1.	INS design ^o	PAS ^o	PAI ^o
4.1.	Development of confidentiality program	PPR ^o	EPPR ^o	10.2.	INS layout ^o	PAS ^o	PAI ^o
4.2.	Implementation of confidentiality program	PPR ^o	EPPR ^o	11.1.	PPS an integrated system ^o	PAS ^o	PAI ^o
5.1.	Development of DBT	PAS ^o	PAI ^o	11.2.	Insider adversary considerations in PPS ^o	PPR ^o	MT ^o / PAN ^o
5.2.	Periodic review of the threat	PAS ^o	PAI ^o	11.3.	Defense in Depth	PAS ^o	MT ^o / PAN ^o
5.3.	DBT as basis for PP	PAS ^o	PAI ^o	12.1.	Responsibilities for contingency plans	PPR ^o	EPPR ^o
5.4.	Flexibility in PPS	PPR ^o	PAI ^o	12.2.	Sabotage mitigation ^o	C ^o	C ^o
6.1.	Consequence limits	C ^o	C ^o	12.3.	Recovery of material and facilities ^o	PPR ^o	EPPR ^o / PAN ^o

It was difficult to find the measures in the Gen-IV and PP-KINAC comparable to the parameters regarding the overall state of PP such as: legal & instrumental basis, confidentiality program, QA policy and security culture in the INPRO methodology. We have derived the PPR and the EPPR as a corresponding measure since they are

connected to the overall framework of the PP. The criteria related to the DBT, threat evaluation and defense in depth is a match for the measures of PAS in the Gen-IV, PAI and PAN in the PP-KINAC. The MT measure in the PP-KINAC can be comparable to the criteria such as graded approach and insider adversary consideration in PPS.

4. Result and Discussion

The three PP methodologies developed by different groups have been compared to find the effective ways for evaluation. The INPRO methodology deals with the PP regime from the perspective of a state; while the Gen-IV and PP-KINAC focus on the PPS of a facility. The results of this study showed that the measures of both Gen-IV and PP-KINAC can not exactly match to the criteria of the INPRO methodology. If the INPRO methodology adopts some measures of Gen-IV and PP-KINAC that can be calculated quantitatively, more reliable results can be attained. From this study, we can identify the possibility of combining these PP methodologies. To do this, further study is required, especially on the evaluation parameter for the INPRO methodology.

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