A Study on Developing a Framework for Sabotage Protection of Nuclear Facilities

Kilyoo Kim, WooSik Jung
Integrated Safety Assessment Center, Korea Atomic Research Institute, P.O. Box 105, Yuseong, Daejeon 305-600, South Korea, kykim@kaeri.re.kr

1. Introduction

A methodology related to physical protection of nuclear facilities against sabotage is preparing by IAEA[1]. However, the framework of IAEA is somewhat superficial and it seems not to reflect the risk concept since IAEA prefers a proven technology. In this paper, a framework for sabotage protection of nuclear facilities using risk assessment is described.

2. Methods and Results

2.1 Framework for Sabotage Protection

A proposed framework for sabotage protection is shown in Figure 1. Although the processes in the proposed framework is almost identical to those of the original IAEA framework for sabotage protection[1], Box 5, Box 15, and Box 16 of Figure 1 are different from the original IAEA framework. The brief explanation about important processes of Figure 1 is the followings;

- Box 2. Unacceptable radiological consequences

These unacceptable radiological consequences are generally defined in terms of dose or release limits, or in terms of design limits that specify unacceptable plant states such as core damage for NPPs.

- Box 4. Design Basis Threat(DBT)

A State may consider developing a DBT specific to sabotage.

- Box 7. Conservative Consequence Analysis

An estimate of the radiological consequences of sabotage is made to determine if the radionuclide inventory of the facility is sufficient to yield an unacceptable consequence as defined by the State. The consequence analysis is performed without considering sabotage protection. All commercial nuclear power plants are classified as category A, and very small research reactors are regarded as category C[1]. Sabotage protection is prepared according to the categories as a graded approach.

- Box 11. Vital Areas_Identification

It is only necessary to protect those minimum targets or areas that would ensure that every sequence of sabotage acts for every susceptible target set will be unsuccessful. A structured approach to define the minimum set of target areas to protect is defined as Vital Areas Identification(VAI)[1]. Probabilistic Safety Assessment(PSA) models which were used for design or risk-informed regulation(RIR) can be used in VAI[2].

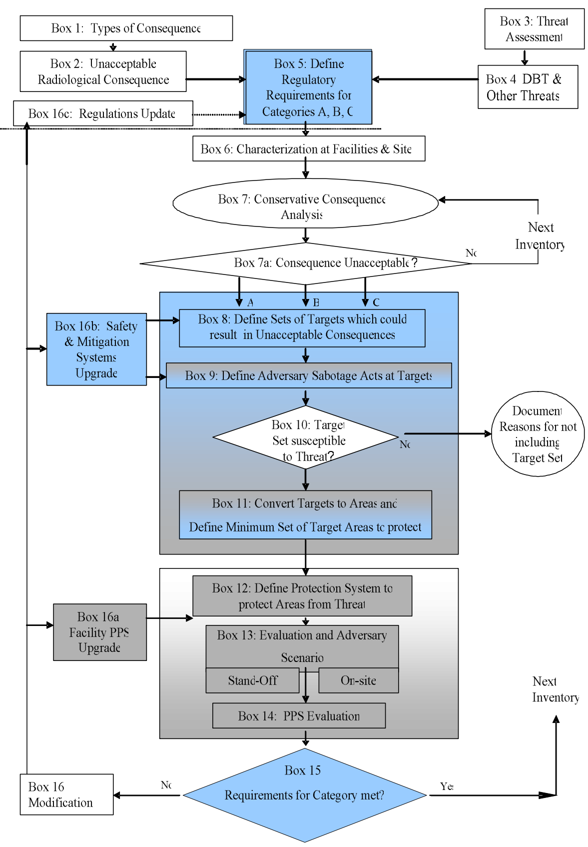

Figure 1. Proposed sabotage protection flow process.

2.2 Concept of Proposed Framework for Sabotage Protection

In the proposed framework for sabotage protection, as shown in Figure 1, Box 5, Box 15 and Box 16 processes are different from the original IAEA framework for sabotage protection[1].

- Box 5. Regulatory Requirements

Current IAEA framework does not consider the risk assessment because the risk assessment caused by sabotage is not matured. However, in the future framework, the risk assessment can be done, and the increased core damage frequency(CDF) given DBT is evaluated based on the criteria given in the regulatory requirements like Figure 2. The criteria of Figure 2 are adopted from RIR criteria[3], and it is example criteria for sabotage protection framework.

- Box 15. Regulatory Requirements Evaluation

In this process, risk assessment is performed as follows. Let's define the followings:

F_{DBT} :- DBT (frequency unit)
P_{PPS_fail} :- Likelihood that saboteur who attacked the nuclear facility can enter the buildings
P^{i}_{access} :- Likelihood that saboteur who entered the buildings can access compartment i
$F^{i}_{fail} = F_{DBT} * P_{PPS\_fail} * P^{i}_{access}$
= Destruction Frequency of Compartment i by sabotage

An illustrative example for the above definitions is shown in Figure 3. P^{i}_{access} may depend on the open/close status of fire or flood protection doors. Since the destruction frequency of each compartment can be derived, the CDF given sabotage can be calculated, because the calculation method in this case is very similar to the fire PSA.

The increased CDF given DBT is evaluated based on the criteria given in the regulatory requirements of Box 5.

- Box 16. Modification

When deficiencies are identified through Box 15 process, corrective actions should be undertaken by the operator and verified by the State. These actions could be either upgrade of physical protection, or mitigating system, or modification of the State's DBT.

3. Conclusions

A new framework for sabotage protection is proposed. In the new framework, the effectiveness of sabotage protection can be quantitatively evaluated and modified by checking the regulatory requirements. To find P_{PPS_fail} and P^{i}_{access}, more research should be done as a probabilistic security assessment.

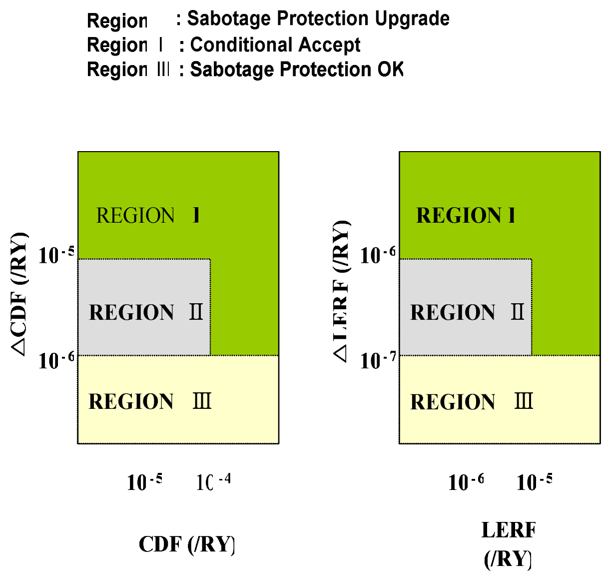

Figure 2. An example of regulatory requirements for sabotage protection

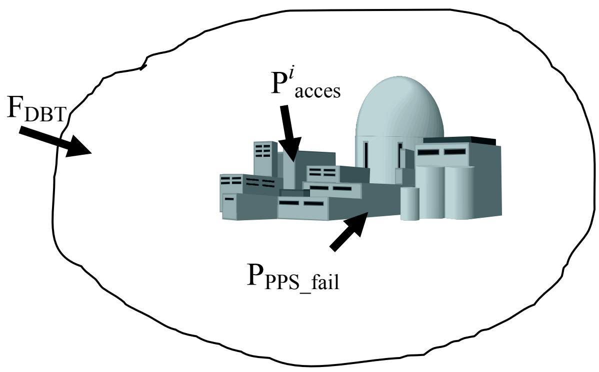

Figure 3. An illustrative example of F_{DBT}, P_{PPS_fail} and P^{i}_{access}

Acknowledgement

This project has been carried out under the Nuclear R&D Program by MOST.

REFERENCES

[1] IAEA, "Physical Protection of Nuclear Facilities and Nuclear Material against Sabotage", Nuclear Security Series, Vienna (in preparation)
[2] Chang-Kue Park, et. al., "A PSA-based vital area identification methodology development ", Reliability Engineering & System Safety 82 (2003)
[3] NRC, Reg. 1,174, "An Approach for Using PSA in Risk-informed Decisions On Plant-Specific Changes to the Licensing Basis", July 1998