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Security-by-Design Approach of the KALIMER-600 SFR Plant

Dongsup So, Yong Bum Lee
Korea Atomic Energy Research Institute
E-mail; dsso@kaeri.re.kr

1. Introduction

Security measures as well as safety and safeguards measures should be incorporated and addressed early in the design process to enhance the cost effectiveness of a PPS (Physical Protection System). Safety, security, operations, and safeguards design teams and regulators need to be flexible and perform "trade-studies" on the available options. In this paper, SBD (Security-by-Design) measures in the design phase of the KALIMER-600 SFR (Sodium Cooled Reactor) plant are identified and discussed qualitatively.

2. Design Approach of PPS in Nuclear Plants

2.1 PPS Measures and Scalability

A PPS have two types of measures: preventive and protective. Preventive measures are software-oriented and scalable. They can be put in place easily if the threat levels are deemed to rise after a threat assessment. Hardware-oriented measures, especially structural measures including a building and room layout, strong doors, wall thickness and materials, barriers, and systems that cannot be easily upgraded, are called non-scalable, and should be usually built for high threat levels during construction. Some hardware measures such as security devices can be retrofitted more easily than structural measures. A classification of PPS measures are shown in Table 1.

Fig. 1 shows a flow chart of the PPS design and evaluation against threat scenarios. The facility design, safety measures, and system design can affect the security design concept. These items should be considered at the design phase together with security measures to check their compatibility with each other.

Table 1. Classification of PPS measures

Aspects	Types	PPS Measures
Administrative aspects (Software)	Administrative measures	Policies and procedures Authorizations/delegations Quality assurance Confidentiality Emergency plans
	Personnel measures	Identity verification Trustworthiness assessment Escort and surveillance Activity sharing Response
	Information technology	Access accounts Passwords, screen savers
Technical aspects (Hardware)	Structural measures	Compartmentalization System-self protection Physical barriers
	Security devices	Security sensors Personnel surveillance Operation monitoring

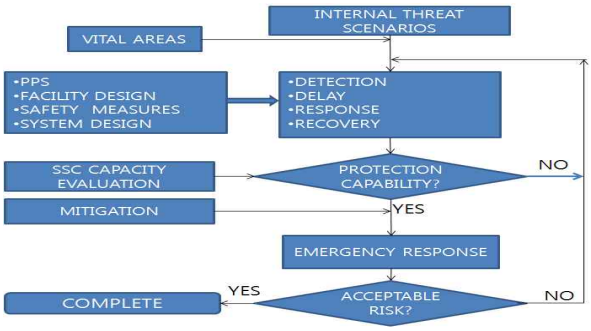


Fig.1 Flow chart of the physical protection system design and evaluation

2.2 Similarity of Nuclear Safety and Security Approaches in a Nuclear Facility Design

As a safety approach, we usually take the following steps: (a) elimination/minimization of hazards at the source, (b) engineering solutions by "defense in depth" such as diversity and redundancy, and (c) the implementation of administrative systems. The third step means that people have to do things for the desired goal to be achieved. Similarly, we can take the same procedures in a security design approach. Engineering solutions at the initial concept stage should be the principle means of providing security. It consists of site selection, a layout of structures, multiple physical barriers, delay mechanisms, detection, alarms, etc.. Some engineering solutions have a difficulty of retrofitting after construction. These security measures should be incorporated and addressed early in the design process to meet the acceptable risk levels without retrofitting.

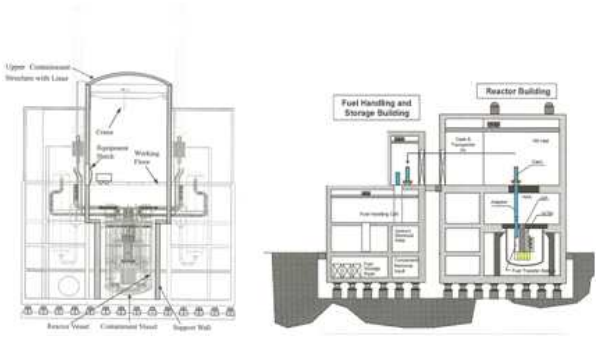
Safety and security measures have synergy. The "defense in depth" and "layout criteria" of safety can improve protection against malicious acts such as sabotage. Design criteria such as redundancy or diversity in safety systems and equipment, and layout criteria such as physical separation or segregation of these systems or equipment, can improve protection against sabotage by requiring more preparation, more means, and more time for an adversary to commit a malicious act.

Consequently, they can be of significant efficiency to deter, prevent, or delay acts of sabotage by insiders or to mitigate or minimize the radiological consequences.

2.3 PP Design Approach of KALIMER-600 PPS

During the PPS design stage, it is important to identify the following: (a) the location of the NM (Nuclear Material), (b) NM categorization/consequences of radiological release, and (c) an identification of the essential SSCs (Structures, Systems and Components) including these non-active SSCs required to maintain active SSCs. In the KALIMER-600, nuclear fuel is categorized as a 'Category II' material. The safety class system and components are mainly arranged inside the containment of the vital area. Some other SSCs outside the containment shown in Table 2 are also arranged inside the vital areas. Radioactive materials should be stored in the protected area.

Figs. 2(a) and (b) show a schematic drawing of the KALIMER-600 containment and KALIMER-600 layout, respectively.



(a) (b)

Fig.2 (a) Schematic drawing of KALIMER-600 containment, and (b) KALIMER-600 layout

Table 2. Safety class systems and components outside containment of KALIMER-600

Safety Class	Systems	Components& Equipment
1	Electrical power	Class 1E dc sub system Class 1E ac subsystem PHTS pump power supply
2	PHTS(Primary Heat Transport System)	Primary sodium storage tank
	IHTS(Intermediate Heat Transport System)	IHTS piping
	SGS(Steam Generation System)	Rupture disk
	RH RS(Residual Heat Removal System)	PDRC AHXs and inlet/outlet ducts PDRC loop piping
3	Auxiliary system	Piping of primary sodium processing system Piping of reactor cover gas system
	Reactor refueling system	In-vessel transfer machine
	Fuel transport system	Fuel transfer casks
	Buildings and structures	Seismic isolators
Others	Buildings and structures	Main control room Security control center Emergency control center

*PDRC: Passive Decay Heat Removal Circuit,
AHX: Sodium-to-Air Heat Exchanger

The components and equipment listed in Table 3 should be given special attention in view of nuclear safety and security. SSCs including safety class pipe lines and power supply lines should be arranged within vital areas, i.e., compartmentalized areas with surveillance, in the design phase to reduce the risks.

3. Conclusion

By incorporating security at a systems level early in the design process, an SBD can reduce the cost and raise the effectiveness of the PPS.

The SSCs and PPS systems of KALIMER-600 belonging to non-scalable security measures are identified.

Non-scalable security measures such as the site and building layout, physical compartmentalization of the areas, barriers, and system self-protection measures should be addressed early in design process to avoid expansive structural retrofitting.

A plant design can definitely affect both the detection and delay, facilitate a response, and act as a framework for recovery.

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