Derivation of Regulatory Elements for Target Sets Identification in Nuclear Facilities

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1. Introduction

International Atomic Energy Agency (IAEA) guided the Physical Protection System (PPS) of nuclear material and facilities [1]. PPS is a measure to protect nuclear facilities against the unauthorized removal of nuclear materials and sabotage. PPS detects adversary forces and delays and responds to malicious acts.

Threats and targets should be identified to protect nuclear materials and facilities effectively. In nuclear facilities, the target sets refer to the combination of operator actions or equipment that would lead to significant core damage or loss of coolant inventory [2]. PPS protects the target sets to prevent core damage and loss of coolant inventory.

In this paper, the elements are derived for identifying target sets and regulation about the target sets.

2. Regulatory Elements for Target Sets Identification

Target sets combine operator actions or equipment that would result in severe core damage. Identifying target sets is essential to prevent significant core damage and minimize the risk of accidents.

This paper shows elements that should be considered in the process of identification of target sets. These regulatory elements can help identify target sets.

2.1 Operational mode

Various safety assessments for nuclear power plants define the operational modes and apply one to the safety conditions that the nuclear power plants must reach after an accident. The operational modes correspond to the combination of core reactivity conditions, thermal power, and average reactor coolant system temperatures. Operational modes include power operation, startup, hot standby, hot shutdown, cold shutdown, and refueling [3].

In identifying target sets, the type and number of mitigating devices change widely depending on which operational mode is applied. For efficient and appropriate identification, it is essential to consider the operational mode. Currently, the Probabilistic Safety Assessment (PSA) is analyzed using hot standby as the operational mode [5]. Like the PSA, the use of hot standby as success criteria could be an option for regulation.

2.2 Mission time

Mission time refers to the period that a safety system is required to operate to perform its function successfully and maintain safety conditions after sabotage. Generally, a mission time of 24 hours is commonly applied in various safety analysis [4, 5].

As mission time decreases or increases, the duration for maintaining the safety state in nuclear facilities decreases or increases as well—consequently, the target sets of equipment changes. Consideration of mission time is essential for proper identification and regulation.

The mission time of 24 hours or the primary auxiliary feed water system maintenance time could be used to regulate.

2.3 Equipment on the yard

The physical protection system is designed to protect the target sets against sabotage. Among the equipment that may be included in the target sets, tanks are particularly crucial as they supply water for accident mitigation. Therefore, the protection of these thanks is of utmost importance.

However, since the condensate storage tanks (CST), or refueling water storage tanks (RWST) are mostly installed in yard (Table I), designing PPS becomes practically challenging. Therefore, when identifying the target sets, it is necessary to discuss this equipment.

Table I: Primary tanks and Auxiliary tanks according to plant type [6]

No	Type	Primary tank	Location	Aux. tank	Location
1	APR1400	IRWST	Containment	AFWST	Aux building
2	OPR+	RWST	Fuel building	AFWST	Aux building
3	OPR1000	RWST	Fuel building	CST	Yard
4	FR	RWST	Fuel building	AFWST	Yard
5	W900	RWST	Yard	CST	Yard

2.4 Portable accident mitigation equipment

The licensee of the nuclear facilities in Korea must submit the Accident Management Plan (AMP) to the regulatory body before operating. According to the

published AMP, portable accident mitigation equipment is designed to mitigate accidents [4].

In an accident, nuclear facilities utilize various cooling systems to maintain a safe state. Since the cooling system has limited capacities, portable accident mitigation equipment is helpful. This is because the portable equipment allows for cooling capabilities.

The portable equipment should be considered when identifying target sets and designing PPS. Efficient physical protection is possible by applying portable equipment.

2.5 Shared safety devices between units

Nuclear power plants in Korea are equipped with safety devices against sabotage. However, not all units of these safety devices exist. In the case of Alternate Alternating Current Diesel Generator (AAC DG), two units share one AAC DG. If an accident occurs in multiple units at the same time, the failure of AAC DG should be applied to the target set identification because it can only be used in one unit. Table II shows the AAC DG sharing situation by unit.

Table Ⅱ: The status of AAC DG sharing in the Korea unit [6]

No.	Site	Unit	AAC DG
1	Saeul	1, 2	1
2	Shin Kori	1, 2	1
3	Kori	3, 4	1
4		2	
5	Shin Hanul	1, 2	1
6	Hanul	5, 6	1
7		3, 4	
8		1, 2	1
9	Shin Wolsong	1, 2	1
10	Hanbit	5, 6	1
11		3, 4	
12		1, 2	1

3. Conclusions

This paper explains the connection between the target set and the PPS and presents various elements that can be considered in the target set identification and regulation.

These elements help the design of PPS to protect nuclear facilities effectively against unauthorized removal and sabotage. Also, the regulation on target sets is currently being prepared, and this paper can help with that regulation.

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