A Study on the Integrated Protection System against HEMP Threats with THIRA Process

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Abstract

With the advent of hybrid warfare in the 21st century, High-altitude Electromagnetic Pulse (HEMP) is seen as a more revolutionary and ultimate weapon than the German Blitzkrieg during World War II. The background of this assessment is the confidence that HEMP can easily destroy the host country’s infrastructure as a relatively low cost and high efficiency weapon system compared to existing WMDs. Domestic and foreign military experts estimate that North Korea and other major Northeast Asian countries have the capabilities to manufacture and launch EMP bullets. The damage from HEMP attacks is expected to reach catastrophic levels as the host country’s infrastructure becomes more scientific and advanced. However, the HEMP protection system is applied only to specific facilities and equipment, and the consequence management (CM) system that responds to the HEMP situation is considered to be ineffective because it is suspended in the extension of the WMD response system.

This study has been carried out by applying the THIRA process, a disaster management system used by the US Department of Homeland Security, in order to prepare for an integrated protection system that can minimize damage and recover quickly in an EMP situation. The research procedures and products are as follows: 1) based on time and cause of damage, HEMP damage phases are classified into 5 stages and realistic worst-case scenarios are presented phase by phase; 2) the risk assessment for the national infrastructures has been conducted using the metrics prepared based on the probability of HEMP attack and the intensity of damage; 3) goals for consequence management and National capability targets for HEMP protection have been identified; 4) and integrated protection measures against the HEMP threats have been developed based on the national disaster management system.

The products presented in this study are only the results of establishing research procedures and finding directions for the construction of the HEMP protection system. The research procedures and next research subjects proposed here by the researcher are expected to be the foundation for constructing a more effective HEMP protection system through subsequent studies.

[Keywords] Protection, High-Altitude Electromagnetic Pulse (HEMP), Threat & Hazard Identification & Risk Assessment (THIRA), Chemical–Biological–Radical and Nuclear (CBRN), Consequence Management (CM)

1. Introduction

Hybrid wars, also called ambiguous wars, nonlinear wars, and next-generation wars, are changing the patterns and rules of war in the 21st century[1]. The characteristics of the new-generation war, as defined by the “Gerasimov Doctrine”, are that in ambiguous situations, it destroys the national infrastructure and ultimately paralyzes the hostile country through the war called Cybergeddon or Black-out War, not only in the area of contact but also in deep areas.
Military experts[2][3] argue that the Hezbol-lah war against Israel’s regular troops, the Crimean Conflict, the Afghan war, and the Iraq war were all hybrid wars.

Some terrorist groups and so-called “rogue states” are waging this Black-Out War in the real world to achieve their political and military goals. Nuclear EMPs are considered the ultimate weapon for carrying out a Black-Out War, which is supposedly more revolutionary than Germany’s blitzkrieg during World War II[4]. North Korea has focused on bolstering its asymmetric forces which are currently centered on nuclear and ballistic missiles. They have been considered capable of manufacturing and firing EMP bombs since 2016[5].

HEMP (High-altitude Electromagnetic Pulse) attacks are expected to inflict even more damages as the hostile country’s infrastructure becomes more advanced and networked. This may eventually throw the 21st century back into the “stone age”. However, HEMP protection systems are equipped only at facilities that are essential at the national level because of scientific and technological limitations and astronomical protection costs. Moreover, the Consequence Management (CM) system for a HEMP situation is not integrated and developed at the national level, and even HEMP protection seems to be understood as part of the protection system for CBRN threats.

The purpose of this research is to find a framework for constructing a Consequence Management System to be carried out under the HEMP situations. This study has been conducted by applying the THIRA (Threat & Hazard Identification & Risk Assessment) process, which is used by the US Department of Homeland Security as a disaster management system. The results of this study suggest that the scenarios for HEMP damages, the HEMP risk assessment, the capability targets for HEMP protection, and the direction of HEMP integrated protection system be focused on prevention, preparedness, response and recovery. It is hoped that these findings will provide a useful framework for constructing a Consequence Management system in order to minimize damages and recover quickly under the HEMP attack situation.

2. Previous Researches

2.1. Characteristics and protection standards of HEMP

Types of EMP are classified into artificial EMP and natural EMP according to the cause of occurrence. Artificial EMP can be further classified into nuclear EMP (HEMP) and non-nuclear EMP according to the delivery system[6]. HEMP (High-altitude Electromagnetic Pulse) is a powerful electromagnetic wave generated into the magnetic field of the earth as gamma rays and X-rays generated by the nuclear explosion outside the atmosphere pass through the atmospheric layer[7].

HEMP cause a catastrophic damage on equipment and facilities in the wide frequency range, which can be classified into early, middle, and late phases depending on the time, and the types that causes the damage can be classified into conduction and radiation[8]. Methods of protecting facilities and equipment against radiated HEMP include shielding facilities and handling points of entry (POE) such as doors. On the other hand, methods for protecting against conductive intrusion are used to filter or ground electric wires and communication lines that enter the facility[6].

The HEMP protective action levels set by the US Department of Homeland Security are divided into four categories based on the ALARP (As Low As Reasonably Practicable) level. The agency also provides protection and resilience guidelines for critical infrastructure and equipment. According to this guidelines, military protection standards are applied at level 4, the highest level of protection, and civil protection standards are applied at level 3, which is one level below[9].
2.2. Disaster management system and THIRA process

Representative models for developing a disaster management system at the national level are the THIRA process in the United States, the National Risk Register (NRR) and the Community Risk Register (CRR) in the UK, and the All Hazard Risk Assessment (AHRA) in Canada[10]. The THIRA process is a system that results from the U.S. Department of Homeland Security’s redesigning of its disaster management system in the wake of the Sept. 11 terrorist attacks in the U.S. It has developed the concept of establishing a Capability-Based Plan (CBP) that the U.S. Department of Defense and the U.S. military used as a planning and management system to meet disaster management. THIRA is a system that sets out goals to be addressed in an uncertain environment in the event of a disaster. It prioritizes activities and resources to achieve them, and continually improves the capabilities required[11].

CBP is a system that has the following usefulness 1) it is possible to set mid-to-long-term disaster management goals in terms of strategic management; 2) capability analysis enables efficient budget investments for various disaster management projects; 3) interorganizational collaborations can more accurately reflect local risks; 4) and repetitive trainings and disaster experiences promote organizational learning[12]. CBP is not a panacea[13], however, it is important to make good use of the system while supplementing it to suit its own situation.

3. Research Methods and Procedures

The framework of analysis developed by the researcher to construct an integrated protection system against HEMP is shown in Figure 1. This study applied the THIRA process and proceeded as follows: 1) identification of realistic worst-case scenarios for damage prediction under the HEMP situation; 2) risk assessment of the subjects to be protected based on the likelihood and intensity of the HEMP attack; 3) identification of capability targets for HEMP protection; 4) and derivation of consequence management goals for the integrated protection against HEMP. The research mainly used analysis of the literature and discussion of experts.

4. Results

4.1. Identification of the worst-case scenarios for damage prediction

The first step in constructing an integrated protection system is to identify a time-based damage scenario that would be expected if a HEMP attack occurred. Damage phases caused by HEMPs can be classified into early-time, intermediate-time, and late-time HEMP depending on the time when the HEMP signal is conducted or radiated in the affected area or infrastructures. The descriptions of each HEMP are summarized in Figure 2.

<table>
<thead>
<tr>
<th>HEMP</th>
<th>Attribute</th>
<th>Description</th>
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<tbody>
<tr>
<td>Common Footprint</td>
<td>Cause</td>
<td>Adversarial threat; Strategic, unknown, Tactical, none to several minutes; Regional to continental depending on height of burst</td>
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<td>- E1 (Early-time HEMP)</td>
<td>Effects, Duration, Equipment at Risk</td>
<td>High peak field – Quick rise time; Telecommunications, electronics and control systems, relays, lightning arresters</td>
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<tr>
<td>- E2 (Intermediate-time HEMP)</td>
<td>Effects, Duration, Equipment at Risk</td>
<td>Medium peak field; Less than 10 millisecond; Lighting – power lines and tower structures – “Balloons”; Telecommunications, electronics, controls systems, transformers</td>
</tr>
<tr>
<td>- E3 (Late-time HEMP)</td>
<td>Effects, Duration, Equipment at Risk</td>
<td>High peak field – Quick rise time; Less than 1 microsecond; Transformers and protective relays – long run transmission and communication generator step-up transformers</td>
</tr>
</tbody>
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Note: Table above adapted from U.S. National Coordinating Center for Communications (NCC), Electromagnetic Pulse (EMP) protection and resilience guidelines for critical infrastructure and equipment[14].
The scenarios for damage prediction of HEMP as shown in <Figure 3> have been developed through expert discussions. The stages for HEMP damages have been divided into five in conjunction with the national disaster management system.

Figure 3. Scenarios for HEMP damage prediction.

Stage I(Preparedness against HEMP) refers to measures taken in the Theater Ballistic Missile Defense Posture just before the HEMP attack is launched. Stage II(Response to early-time HEMP), Stage III(Response to intermediate-time HEMP) and Stage IV(Response to late-time HEMP) correspond to the response phase of the national disaster management system. These phases are intended to implement the necessary protection measures according to the U.S. DHS’s “Electromagnetic Pulse(EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment”(2019)[14] against each type of HEMPs described in <Figure 2>. Stage V(Recovery from HEMP damage) is the recovery phase of the national disaster management and includes the process of taking steps to effectively respond to secondary damages such as fires, explosions and blackouts caused by HEMP, and to recover quickly from these situations.

4.2. Risk assessment

The second step for constructing a HEMP protection system is to assess the predicted risks in the event of a HEMP attack using the $5 \times 5$ matrix prepared in advance. The $5 \times 5$ matrix is a chart divided into five grades based on the probability of HEMP attack and the intensity of damage. The expert group identified the infrastructures or areas to be protected from the HEMP threat through qualitative evaluation. They were divided into 25 groups(grids) as shown in <Figure 4>.

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evaluated as the high-risk groups for HEMP attacks.

**Figure 4.** Risk assessment of HEMP threats.

4.3. Identification of capability targets (CTs) for HEMP protection

The next step is to identify the Capability Targets (CTs) for HEMP protection. Methods of identifying CTs include expert discussions and questionnaire surveys for workers in the relevant organizations or sectors. This study identified CTs by referring to the core capabilities in the government disaster and safety management and standardized targets in US FEMA, together with expert discussion results.

**Figure 5.** Goals for CM & national capability targets for HEMP protection.

The CTs for HEMP protection in **Figure 5** is a set of identified CTs in conjunction with the national missions and visions regarding HEMP protection. These targets may help relevant personnel better understand the correlation among the Capability Targets. They explain how sectoral activities for HEMP protection will play a role in securing their CTs.

4.4. Developing of Integrated protection measures against the HEMP threats

The final stage for constructing a protection system against HEMP threat using the THIRA model is to develop the civil-government-military integrated protection measures. Among the CTs identified in stage 3, the targets that are distinct from the already prepared WMD protection system selected in the first step of the stage 4. The measures to be taken exclusively in the preventive and preparedness phases to achieve the targets developed in the following step. The integrated protection measures for consequence management against HEMP threats are presented in **Figure 6**.

**Figure 6.** The integrated protection measures for consequence management against HEMP threats.
5. Conclusions

With the advent of the concept of hybrid war in the 21st century, the HEMP is recognized as the ultimate and most revolutionary weapon. This study has attempted to construct an integrated national protection system against HEMP threats. The study has been conducted according to the model developed by researchers based on the THIRA process used by the U.S. Department of Homeland Security as a disaster management model.

The results of the research are only a suggestion of the research procedure and direction for constructing HEMP protection systems. Therefore, it is expected that the following studies will be conducted to establish a more theoretical and practical HEMP protection system: 1) threat analysis of HEMPs differentiated from WMD; 2) case studies concerning the recent massive blackout events or battlefields with HEMPs; 3) identification and verification of realistic worst-case scenarios under HEMP situations; 4) identification and verification of CTSs for HEMP protection; 5) development of risk assessment techniques for HEMP; 6) and development of HEMP protection criteria and ALARP, etc.

Subsequent studies and practical protection measures related to HEMP are expected to mitigate the current vulnerabilities: optimism concerning HEMP attacks; constraints on HEMP protection technologies; high costs of HEMP protection systems; blanket application of full protection criteria; and consequence management without HEMP characteristics being considered.

6. References

6.1. Journal articles


6.2. Thesis degree

6.3. Books


6.4. Additional references


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