



Risk Mitigation Consulting Inc.

Intelligence and Analysis Division

WHITE PAPER SERIES

The Electromagnetic Pulse (EMP) Threat to the DoD

INTENT

This white paper is designed to provide an in-depth analysis of relevant, publicly available information on threat and hazard events/trends and their potential impacts to the interests of the United States, both at home and abroad. This product is not intended to be an all-encompassing assessment of the subject, rather, it provides a brief overview to provide the reader with situational awareness regarding topics with which they may not be familiar.



The Electromagnetic Pulse (EMP) Threat to the DoD

Introduction

On 26 March 2019, U.S. President Donald Trump signed an executive order instructing federal agencies to identify electromagnetic pulse (EMP) threats to the U.S. and develop strategies to ensure resilience from such threats.¹ Though the executive order was not the first U.S. government action taken to mitigate the threat from EMP, it serves as a reminder that the U.S. is largely unprepared for the potential impacts of an EMP event. EMPs can originate through a number of sources, although this paper will primarily focus on three of the most concerning scenarios for the Department of Defense (DoD); an EMP originating from space weather, an EMP originating from nuclear weapons, or an EMP originating from a non-nuclear weapon (it is important to note that these weapons are largely still in development, but proof-of-concept and other technological demonstrations have occurred).

EMPs can vary widely based on whether they are natural or manmade; the particular mechanism of action; frequencies present/affected; and a variety of other variables. However, all EMPs have the potential to interfere with (or disable) electronic systems, which increases their desirability for weaponized purposes. These impacts on electronic systems could seriously affect DoD assets, installations, supporting infrastructure, and personnel. This paper will examine three primary sources of EMP that could affect the DoD, the as well as the potential impacts (both direct and indirect) on the DoD and its interests.

Primary Sources of EMP Threats to the DoD

Space Weather

EMPs can occur naturally as a result of a coronal mass ejection (CME) from the sun. According to Montana State University's Solar Physics Group, CMEs are "an ejection of a large amount of matter from the Sun's outer atmosphere" that may or may not affect earth depending on whether they are directed toward earth, and can vary in severity based on factors to include "the amount of material ejected, the speed at which it travels, and the strength and direction of the magnetic field carried by the cloud of charged particles."² These events can be predicted to some degree using satellite data, but many scientific questions regarding solar activities remain, so the current state of space weather forecasts has room for improvement.³ Because CMEs are a naturally-occurring phenomenon, their potential to affect the DoD is more of a matter of random chance when compared to the potential for deliberate targeting with EMP weapons (both nuclear and non-nuclear) by U.S. adversaries.

Nuclear Weapons

Per the U.S. Department of Energy, when compared to solar-caused EMPs or non-nuclear EMPs, "nuclear EMP has the most ubiquitous effects because of the combination of its broadband nature and large area coverage."⁴ The large area coverage can be achieved via high-altitude electromagnetic pulse (HEMP). HEMP "is produced when a nuclear weapon is detonated high

above the Earth's surface, creating gamma radiation that interacts with the atmosphere to create an instantaneous electromagnetic energy field that is harmless to people as it radiates outward, but which can overload computer circuitry with effects similar to, but causing damage much more swiftly than, a lightning strike." Additionally, it should be noted that a single low-yield nuclear detonation at a high altitude may not result in any direct fatalities from the heat or blast because of the distance from the Earth's surface.⁵ HEMP's effects can vary based on the altitude of detonation, as seen in the figure below.

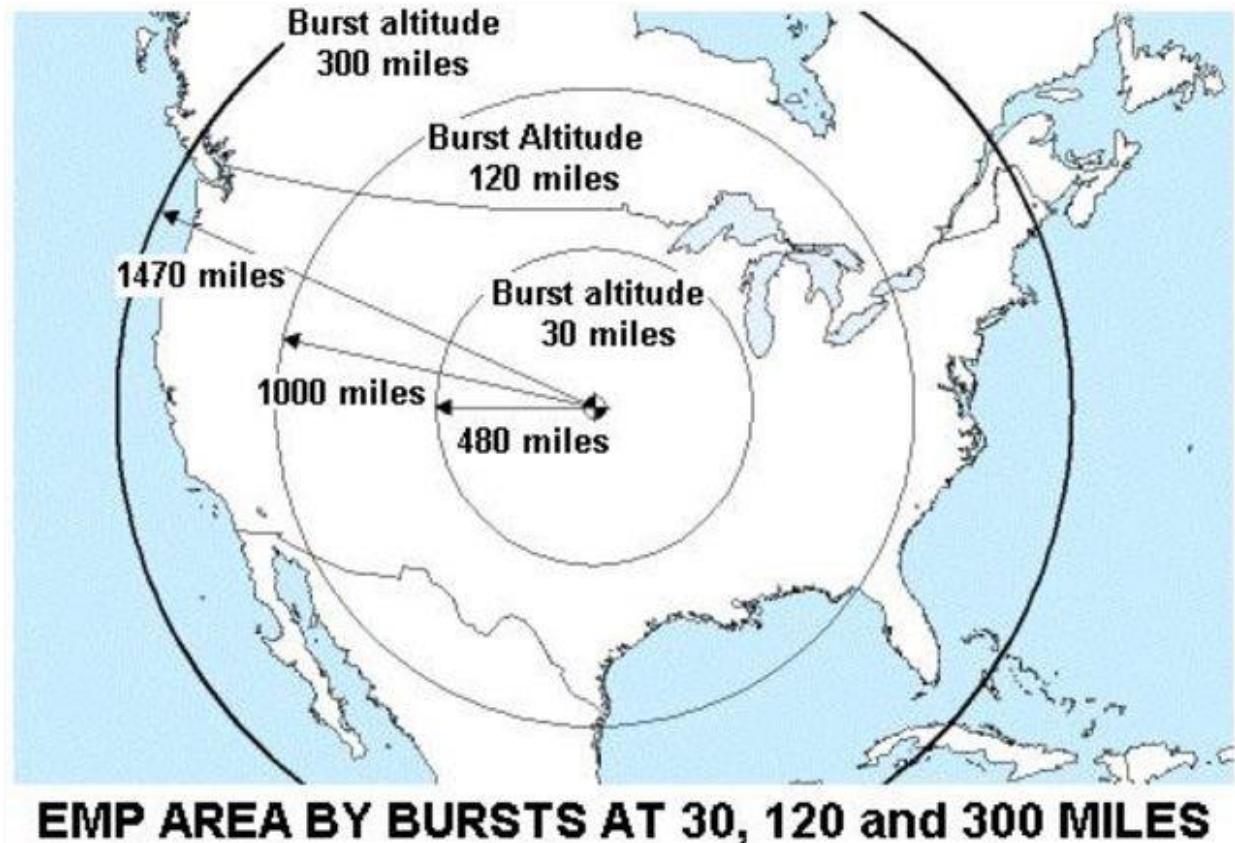


Figure 1
HEMP-Affected Area by Burst Altitude (Using CONUS for Reference)⁶

Non-Nuclear EMP Weapons

An EMP can also be created through the use of non-nuclear weapons utilizing high-power microwave (HPM) technology. HPM technology consists of "special electrical equipment that transforms battery power, or powerful chemical reaction or explosion, into intense microwaves that are also very damaging to electronics, but within a much smaller area." The Congressional Research Service assesses that "a mechanically simple, suitcase-sized [HPM] device might theoretically produce a one-time, instantaneous HPM shockwave that could disrupt many computers within a 1-mile range" and also assesses that such technology may be within the capabilities of some extremist groups.⁵



Military-grade HPM devices are a relatively recent phenomenon, and the U.S. military is actively developing such devices for weaponized use. Defense contractor Boeing and the Air Force Research Laboratory have recently partnered on such a program, known as the Counter-electronics High-powered Microwave Advanced Missile Project (CHAMP). According to Boeing, a missile outfitted with HPM technology successfully “navigated a pre-programmed flight plan and emitted bursts of high-powered energy, effectively knocking out the target's data and electronic subsystems” during a 2012 test.⁷ This proof-of-concept shows the potential for HPM to be used in targeted military strikes, particularly against command-and-control facilities, air defense batteries, or other appealing military targets that are dependent on electronic systems.

Potential Impacts to DoD

Because EMP events can vary widely in source, scope, and severity, the sections below are not intended to serve as an all-encompassing assessment of the potential impacts of such events. Rather, they are intended to provide a baseline exploration of how different types of EMP events may affect DoD interests, both directly and indirectly. EMP events can range from minor disruptions of certain systems (for example, due to a CME event), to more serious localized effects (perhaps from an extremist group utilizing a crude HPM device), all the way up to a nuclear HEMP event affecting all of CONUS (which, at this time could likely only be carried out by capable nation-state adversaries such as China and Russia). The reader is invited to critically examine the various ways in that electronic systems are utilized throughout the DoD, critical infrastructure sectors, and civilian applications (often in an interconnected fashion) in order to explore the ways that our dependence on various technologies presents a range of potential vulnerabilities.

Direct Effects on DoD Assets and Infrastructure

Due to the crippling effect that EMPs can have on electronic systems, many of DoD’s assets and infrastructure remain at risk to the effects of both natural and manmade EMPs. Command, control and communications could be affected or disabled entirely, and complex, expensive weapons systems that provide the DoD with a warfighting advantage (such as advanced fighter jets or naval vessels) could have their electronic systems rendered useless by the effects of EMPs. While the effects may vary between the type of EMP, some mission degradation could be expected. A space weather event may result in impacts such as communications issues in a particular geographic region, while a non-nuclear EMP could target a single DoD installation (bringing down a localized computer network or a squadron of fighter jets). However, a nuclear EMP event would be most concerning, as it could disable massive amounts of DoD assets and infrastructure across an area as large as CONUS.

Effects on Supporting Infrastructure

Even if DoD assets and infrastructure were adequately hardened in order to mitigate the threat from EMPs, an EMP event could affect infrastructure that directly or indirectly supports DoD installations. Civilian infrastructure is largely interconnected with the DoD, to include the electrical grid and other systems. This infrastructure is heavily dependent on electronic systems, particularly supervisory control and data acquisition (SCADA) systems, which has increasingly replaced more traditional, analog control systems in recent years. The shift from analog controls to SCADA has resulted in a variety of safety and efficiency improvements but has also rendered



numerous pieces of infrastructure vulnerable to EMP events (as well as malicious cyber activity and other threats).

An EMP event affecting the power grid could cripple the ability to operate critical systems at DoD installations in a particular region, while an event affecting the SCADA systems of utilities services could render water/sewage systems unusable, resulting in a tangible mission impact. For just one specific example of a potential scenario involving critical infrastructure, suppose that a SCADA system used to operate a dam system near a DoD installation was affected by an EMP event. With the dam's control system inoperable, water levels in the region could rise inadvertently following serious storms, resulting in riverine flooding. If the installation were an airfield, perhaps the runways could be affected, or alternatively, at an infantry-focused installation, live-fire training could be halted. These are just a few potential scenarios in which the importance of the DoD's supporting infrastructure can be highlighted.

Other Impacts on Readiness

Indirect effects associated with EMP events could also affect DoD personnel, assets, or infrastructure to varying degrees depending on the severity and scope of such events. Space weather events could affect civilian infrastructure to include banking, telecommunications, or air travel for personnel, which could create financial, personal, or logistical issues (respectively) that affect military readiness. For example, a CME event temporarily affecting air travel into a particular region (such as a basic training hub) could affect the arrival of new recruits and therefore impact military readiness. While these types of incidents may seem minor in scope, they could create cascading effects that result in financial, logistical, or personnel issues directly tied to readiness.

Outlook

As mentioned previously, EMP events can vary widely in nature, but share a common thread in that they affect (or in some cases, can disable) electronic systems, which could seriously affect DoD interests. The threat from a nuclear HEMP is ominous and almost apocalyptic in nature, but such a threat remains unlikely at this time absent a major nation-state conflict. Conversely, CME events occur regularly as part of space weather, although the effects of such events are typically less pronounced. Moreover, HPM devices continue to be developed by the U.S. military (and likely other adversarial nations), while crude versions of such technology could likely be constructed by non-state actors and used in targeted attacks (perhaps against a particular installation). These potential scenarios should not be blown out of proportion, nor should they be ignored. The DoD must continue to carefully evaluate the threat from EMP events (both natural and manmade) and develop mitigation strategies in order to ensure that such events do not affect national security.

Source List

1. Business Insider. *Trump Signs Executive Order to Protect the U.S. from a 'Debilitating' EMP Attack*. 26 March 2019.
2. Montana State University. Solar Physics Group. *Coronal Mass Ejection Prediction Page – Frequently Asked Questions*. 25 May 2007.



3. NBC News. *How We'll Safeguard Earth from a Solar Storm Catastrophe*. 14 June 2017.
4. U.S. Department of Energy. *Electromagnetic Pulse Resilience Action Plan*. January 2017.
5. Congressional Research Service. *High Altitude Electromagnetic Pulse (HEMP) and High Power Microwave (HPM) Devices: Threat Assessments*. 21 July 2008.
6. Gary Smith. "Electromagnetic Pulse Threats" *Testimony to House National Security Committee*. 16 July 1997.
7. Boeing. *CHAMP – Lights Out*. 22 October 2012.