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About the cover: 2ID Soldiers moving through a simulated CWMD contaminated environment. Picture from Joint Program Executive Office for Chemical, Biological, Radiological and Nuclear Defense-JPEO-CBRND

Electromagnetic Pulse Preparedness – Homeland Security Challenges and DoD Opportunities

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The threat from high-intensity, electromagnetic disturbances – commonly referred to as electromagnetic pulses (EMP) – is not new. Modern observations of naturally occurring EMPs date as far back to the so-called “Carrington Event” of 1859 when a naturally occurring coronal mass ejection (CME) induced intense terrestrial electromagnetic fields and disrupted what little electrical devices existed – telegraphs.¹ Manmade EMPs are also not new. The 1962 U.S. nuclear test known as Starfish Prime illuminated the phenomenon by unanticipatedly disrupting civilian and military electronics in Hawaii, over 1,300 kilometers away.² However, what has changed since these events is the ubiquity of civilian and government dependence on electronics. To this end, the U.S. military has assessed the threat of EMP effects against military targets for several decades.³ Overlooked in this analysis is the U.S. military’s increasing dependence on civilian infrastructure which presents new EMP related homeland security challenges. Therefore, while an EMP poses a clear homeland security threat, it is in the interest of the Department of Defense (DoD) to promote homeland EMP resiliency to preserve its own strategic readiness. Put another way, a domestic EMP event presents an imminent homeland security threat whose second and third order effects may compromise the DoD’s ability to execute national defense at home and abroad.

Background

Though all nuclear weapon detonations produce EMPs, security researchers largely classify a high-altitude nuclear detonation, also called a high-altitude EMP (HEMP), as the most pervasive means to weaponize an EMP.⁴ EMP effects are mostly line-of-sight; therefore, as a nuclear weapon’s detonation altitude increases above the earth’s surface, so too does the ground footprint of EMP effects.⁵ Correspondingly, a nuclear detonation with an approximate 500 kilometer height of burst (HOB) could propagate effects across the entire continental United States, albeit, the energy of the electromagnetic field still decays exponentially with its propagation distance.⁶ Similarly, a HEMP’s high-altitude burst mitigates the casualty producing effects of the nuclear weapon (blast, thermal, and ionizing radiation) reaching the earth’s surface, which largely isolates the EMP effects of the weapon. However, security researchers are also pointing to a possibility of alternative EMP weaponization via conventional explosives or microwave emitters.⁷ Therefore,

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while possible ballistic missile-delivered EMP threats by China, Russia, North Korea, and Iran may be dissuaded by nuclear deterrence strategy, a directed energy EMP strike may be seen as an increasingly viable alternative to a nuclear weapon.⁸

Alternatively, CMEs are sources for natural geomagnetic disturbances (GMD) that also produce EMP effects. While scientists generally categorize GMD-induced EMPs as potentially less destructive than HEMPs, CMEs are effectively unavoidable, with the question rather being 'when and how strong?'⁹ Electricity-era society has witnessed many GMDs, with notable events occurring in 1859, 1921, and more recently in 1989 which left over 6 million customers without electricity in North America.¹⁰

In either case (man-made or natural), EMP's primarily affect electrical devices by coupling potentially destructive electromagnetic field energy into circuits, which may damage or destroy components incapable of contending with the induced currents. EMPs particularly affect long-line power distribution, but can also destroy sensitive electronics such as computers, telecommunications equipment, and Supervisory Control and Data Acquisition (SCADA) systems, among others.¹¹ The impact to electronics is typically sustained within minutes, if not near instantaneous to the onset of an EMP.¹² While the impact to electrical devices is quick, the second and third order consequences of widespread electronic failure on the economy, basic necessities, and healthcare give rise to long-term casualty estimates as high as nine out of ten Americans dead in the years following a serious EMP event.¹³ As a result, while EMP events present imminent security threats, their prolonged impact present long term strategic challenges for homeland security.

Homeland Security Challenges

In the United States, an EMP event uniquely challenges the DoD and its partners

across the spectrum of homeland security operations. Considering the similarities in delivery of an intercontinental surface strike nuclear weapon and a HEMP, the DoD's homeland defense mission of missile warning is largely similar. However, because effective HEMPs do not require significant reentry, adversaries have lower technical barriers for employment when compared to surface strike missiles; missile defense warning systems have comparatively shorter warning times; and missile warning can be further challenged by the possibility of a satellite-borne delivery.¹⁴ Following an EMP, homeland security responses also differ from surface nuclear weapon strikes. CBRN consequence management is less concentrated while the potential for widespread communications failure makes initial response difficult. Communication failures will complicate local, state, and national leadership efforts to develop the situation and coordinate a response thus straining resourcing and unity of effort. Furthermore, beyond first response, consequence management faces a protracted reconstruction period. Former White House science and technology advisor Dr. John Holdren estimated reconstruction from a significant GMD to be on the order of trillions of U.S. dollars with recovery spanning upwards of four to ten years.¹⁵ As a result, even if critical defense infrastructure is EMP hardened, the public burden may challenge the DoD to sustain protracted Defense Support to Civil Authorities (DSCA) missions during recovery.

Likewise, while tactical military equipment may or may not be EMP hardened, the civilian infrastructure the DoD relies on is largely vulnerable.¹⁶ The DoD's dependence on civilian infrastructure in the continental U.S. (CONUS) can be inferred by considering the DoD's reliance on the civilian power grid for nearly 99% of its electrical power.¹⁷ Perhaps more concerning, a domestic EMP event could disrupt food distribution, trans-

portation, water infrastructure, emergency services, fossil fuels industries, and space systems regionally or even globally.¹⁸ While disruptions of these industries immediately impact the U.S. civilian population, the DoD is largely reliant on these industries' prosperity for strategic level logistics and maintaining force readiness.¹⁹ As a result, widespread disruptions to basic necessities within CONUS have the potential to degrade the U.S. military's sustained readiness and their ability to conduct overseas operations, whether that be for a contingency response to an EMP strike or to carry out enduring national strategy abroad. Therefore, it is in the DoD's interest to not just consider EMP resiliency from a standpoint of preserving short-term combat power, but equally as important that the DoD support homeland security initiatives to harden civilian infrastructure to sustain strategic readiness. Nonetheless, several challenges exist that may inhibit homeland security preparedness for an EMP event.

The U.S. government's contemporary understanding of EMP vulnerabilities forms one challenge to homeland security. While the DoD and Department of Energy (DoE) have conducted EMP analyses for several decades, rapid changes in technology challenge the inference of these studies to emerging electronics and security classifications further limit the ability to share classified findings through all levels of government partners.²⁰ Recently, Executive Order 13865 – Coordinating National Resilience to Electromagnetic Pulses – has renewed national security focus to assess EMP vulnerabilities and attempts to achieve unity of effort with tasks to the Departments of State, Commerce, Defense, and Homeland Security to conduct vulnerability assessments.²¹ However, the effectiveness of such measures remains uncertain, particularly when considering the failure of larger national legislation to effectuate EMP preparedness, such as the 2013 Secure High-Voltage In-

frastructure for Electricity from Lethal Damage (SHIELD) and 2014 Grid Reliability and Infrastructure Defense (GRID) Acts which Congress did not pass into law.²² Nonetheless, the DoD should consider how to share its current understanding with government and private partners to build national EMP resilience.

Public and private partnership pose another challenge to EMP homeland security preparedness. Up front, public-private partnerships are critical for hardening power distribution due to large private investment in the U.S. power grid.²³ Additionally, second order effects to the agriculture, financial, telecommunications, energy, and transportation industries require effective unity of effort to mitigate EMP effects beyond government regulated critical infrastructure. Therefore, while such documents like the 2017 National Security Strategy outline the importance of hardening key infrastructure to weapons of mass destruction, it also underscores the importance of preparing resilient communities that are capable of coping with disaster.²⁴

DoD Opportunities

The challenges mentioned above bring unique opportunities for the DoD to support EMP homeland security preparedness prior to executing missile defense and DSCA responses. On a larger scale, the DoD has decades of research analyzing its own Command and Control (C2) systems that can be applied toward assessing vulnerabilities to SCADA and telecommunications industries.²⁵ But all opportunities may not require significant technical partnership. The DoD can offer unique tactical experiences to Federal Emergency Management Agency (FEMA) responders. While the National Response Framework identifies unique technical skills that the U.S. military can provide to homeland security responses, such as communications skills, the U.S. military's frequent training in degraded, "analog" en-

vironments could provide additional valuable lessons for civilian partners in homeland security conducting EMP responses without significant electronic support.²⁶ As a result, the DoD should not just consider large-scale, high-dollar collaboration to enable homeland security partners, but it should also consider sharing tactics, techniques, and procedures that may enable homeland security partners to operate in degraded environments.

Conclusion

EMPs pose a unique homeland security threat. Manmade EMPs hold large destructive power but may be considered of limited viability for an adversary, while natural EMP-causing events are potentially less destructive, but effectively unavoidable. In either case, the homeland security response could be protracted and wide reaching. As a result, an EMP event has the potential to challenge the nation's homeland security apparatus across the continuum of operations from missile defense to consequence management. However, the DoD must also consider its role beyond preparing itself by working with homeland security partners to harden national infrastructure and to train for operations following an EMP event. By seeking these opportunities to prepare civilian infrastructure, the DoD can mutually support its role in homeland security while also investing in preserving its readiness for defense abroad.

Notes

1. Tony Phillips Trudy E. Bell, "A Super Solar Flare," National Aeronautics and Space Administration, last modified May 6, 2008, accessed July 14, 2020. https://science.nasa.gov/science-news/science-at-nasa/2008/06may_carringtonflare.
2. "9 JULY 1962 'STARFISH PRIME', OUTER SPACE," Comprehensive Nuclear-Test-Ban Treaty Organization, accessed July 14, 2020. <https://www.ctbto.org/specials/testing-times/9-july-1962starfish-prime-outer-space>.
3. U.S. Department of Energy, Electromagnetic Pulse Resilience Action Plan (Washington, DC: DOE, January 10, 2017), 6, 14.
4. National Research Council, Evaluation of Methodologies for Estimating Vulnerability to Electromagnetic Pulse Effects: A Report, by Committee on Harnessing Light (Washington DC: The National Academies Press, 1984), 10 - 11, 59 - 60.
5. Threat Posed by Electromagnetic Pulse (EMP) to U.S. Military Systems and Civil Infrastructure, Committee on National Security, Military Research and Development Subcommittee (Washington, DC: 1997), 14 - 16.
6. Ibid.
7. Electromagnetic Pulse (EMP): Threat to Critical Infrastructure, 2nd ed., Subcommittee on Cybersecurity, Infrastructure Protection, and Security Technologies of the Committee on Homeland Security (Washington DC: U.S. Government Printing Office, 2014), 17.
8. Strategic Primer: Electromagnetic Threats (Washington DC: American Foreign Policy Council, 2018), 10 - 17.
9. "Electromagnetic Pulse (EMP): Threat to Critical Infrastructure," 10 - 11.
10. John Kappenman, "A Perfect Storm of Planetary Proportions," IEEE Spectrum, last modified January 24, accessed July 15, 2020. <https://spectrum.ieee.org/energy/the->

smarter-grid/a-perfect-storm-of-planetary-proportions.

11. Earl Gjelde John S. Foster, William R. Graham, Robert J. Hermann, Henry M. Kluepfel, Richard L. Lawson, Gordon K. Soper, Lowell L. Wood, Joan B. Woodard, Report of the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack: Critical National Infrastructures (2008), 15, 29 - 37, 64.
12. U.S. Department of Energy, Electromagnetic Pulse Resilience Action Plan (Washington, DC: DOE, January 10, 2017), 1.
13. "Electromagnetic Pulse (EMP): Threat to Critical Infrastructure," 12.
14. Strategic Primer: Electromagnetic Threats, 15.
15. John Beddington John P. Holdren, "Celestial Storm Warnings," New York Times, last modified March 10, 2011, accessed 6 July, 2020. <https://www.nytimes.com/2011/03/11/opinion/11iht-edholdren11.html>.
16. Strategic Primer: Electromagnetic Threats, 18 - 20.
17. "Electromagnetic Pulse (EMP): Threat to Critical Infrastructure," 4.
18. Ibid., 12.
19. Department of Defense, JP 4-0, Joint Logistics (Washington, DC: Government Printing Office, 8 May 2019), I-2 - I-3.
20. U.S. Department of Energy, Electromagnetic Pulse Resilience Action Plan (Washington, DC: DOE, January 10, 2017), 6.
21. President of the U.S., Executive Order 13865: Coordinating National Resilience to Electromagnetic Pulses (Washington DC: White House, 2019).
22. Strategic Primer: Electromagnetic Threats, 24.
23. "Electromagnetic Pulse (EMP): Threat to Critical Infrastructure," 4.
24. President of the U.S., National Security Strategy of the United States of America (Washington, DC: The White House, 2017), 7, 8, 14.
25. U.S. Department of Energy, Electromagnetic Pulse Resilience Action Plan (Washington, DC: DOE, January 10, 2017), 7.
26. Department of Homeland Security, 4th Edition, National Response Framework (Washington, DC: October 28, 2013), 32.

References

"9 JULY 1962 'STARFISH PRIME', OUTER SPACE." Comprehensive Nuclear-Test-Ban Treaty Organization. Last modified Accessed July 14, 2020. <https://www.ctbto.org/specials/testing-times/9-july-1962starfish-prime-outer-space>.

Threat Posed by Electromagnetic Pulse (EMP) to U.S. Military Systems and Civil Infrastructure. Committee on National Security, Military Research and Development Subcommittee. Washington, DC, 1997.

U.S., Department of Homeland Security. 4th Edition, National Response Framework. Washington, DC: October 28, 2013.

Electromagnetic Pulse (EMP): Threat to Critical Infrastructure. 2nd ed. Subcommittee on

Cybersecurity, Infrastructure Protection, and Security Technologies of the Committee on Homeland Security. Washington DC: U.S. Government Printing Office, 2014.

U.S., U.S. Department of Energy. Electromagnetic Pulse Resilience Action Plan. Washington, DC: DOE, January 10, 2017.

Strategic Primer: Electromagnetic Threats. Washington DC: American Foreign Policy Council, 2018.

U.S., Department of Defense. JP 4-0, Joint Logistics. Washington, DC: Government Printing Office, 8 May 2019.

National Research Council. Evaluation of Methodologies for Estimating Vulnerability to Electromagnetic Pulse Effects: A Report, Committee on Harnessing Light, 1984.

John P. Holdren, John Beddington. "Celestial Storm Warnings." New York Times. Last modified March 10, 2011, 2011. Accessed 6 July, 2020. <https://www.nytimes.com/2011/03/11/opinion/11iht-edholdren11.html>.

John S. Foster, Earl Gjelde, William R. Graham, Robert J. Hermann, Henry M. Kluepfel, Richard L. Lawson, Gordon K. Soper, Lowell L. Wood, Joan B. Woodard. Report of the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack: Critical National Infrastructures. 2008.

Kappenman, John. "A Perfect Storm of Planetary Proportions." IEEE Spectrum. Last modified January 24, 2012. Accessed July 15, 2020. <https://spectrum.ieee.org/energy/the-smarter-grid/a-perfect-storm-of-planetary-proportions>.

President of the U.S. National Security Strategy of the United States of America. Washington, DC: The White House, 2017.

President of the U.S. Executive Order 13865: Coordinating National Resilience to Electromagnetic Pulses. Washington DC: White House, 2019.

Trudy E. Bell, Tony Phillips. "A Super Solar Flare." National Aeronautics and Space Administration. Last modified May 6, 2008, 2016. Accessed July 14, 2020. https://science.nasa.gov/science-news/science-at-nasa/2008/06may_carringtonflare.