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TO THE UNITED STATES FROM
ELECTROMAGNETIC PULSE (EMP) ATTACK

STATEMENT BEFORE

The House Committee on Homeland Security's Subcommittee on Emerging Threats, Cybersecurity, and Science and Technology

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Mr. Chairman, Members of the Committee, thank you for the opportunity to testify today on the matter of the Nuclear Electromagnetic Pulse (EMP) threat to the United States, its forces, its allies, and its friends worldwide.

Abstract

Several potential adversaries have or can acquire the capability to attack the United States with a high-altitude nuclear weapon-generated electromagnetic pulse (EMP). A determined adversary can achieve an EMP attack capability without having a high level of sophistication.

EMP is one of a small number of threats that can hold our society at risk of catastrophic consequences. EMP will cover the wide geographic region within line of sight to the nuclear weapon. It has the capability to produce significant damage to critical infrastructures and thus to the very fabric of US society, as well as to the ability of the US and Western nations to project influence and military power.

The common element that can produce such an impact from EMP is primarily electronics, so pervasive in all aspects of our society and military, coupled through critical infrastructures. Our vulnerability is increasing daily as our use of and dependence on electronics continues to grow. The impact of EMP is asymmetric in relation to potential protagonists who are not as dependent on modern electronics.

The current vulnerability of our critical infrastructures can both invite and reward attack if not corrected. Correction is feasible and well within the Nation's means and resources to accomplish.

Background

I am an Electrical engineer and physicist who has served as a junior officer in the Air Force, as Director of the Office of Science and Technology Policy in the Executive Office of the President, and in the aerospace industry, together for over 45 years. I have also served on several government advisory boards, including as Chairman of the President's General Advisory Committee, and a member of the Defense Science Board, the Department of State's International Security Advisory Board, The National Academies Board on Army Science and Technology, and from 2001 to 2009 as Chairman of the statutorily established Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack. While now retired, I have worked on problems related to EMP during much of my career, beginning with my service in the Air Force at the Air Force Weapons Laboratory in 1962.

The Commission requested and received information from a number of Federal agencies and National Laboratories. We received information from the North American Electric Reliability Corporation, the President's National Security Telecommunications Advisory Committee, the National Communications System (since absorbed by the Department of Homeland Security), the Federal Reserve Board, and the Department of Homeland Security.

Introduction

A high-altitude electromagnetic pulse results from the detonation of a nuclear warhead at altitudes of about 40 to 400 kilometers above the Earth's surface. The immediate effects of EMP are disruption of, and damage to, electronic systems and electrical infrastructure. EMP is not reported in the scientific literature to have direct effects on people.

EMP and its effects were observed during the U.S. and Soviet atmospheric test programs in 1962. During the U.S. STARFISH nuclear test at an altitude of about 400 kilometers above Johnston Island,, some electrical systems in the Hawaiian Islands, 1400 kilometers distant, were affected, causing the failure of street lighting systems, tripping of circuit breakers, triggering burglar alarms, and damage to a telecommunications relay facility.

In their testing that year, the Soviets executed a series of nuclear detonations in which they exploded 300 kiloton weapons at approximately 300, 150, and 60 kilometers above their test site in South Central Asia. They report that on each shot they observed damage to overhead and underground buried cables at distances of 600 kilometers. They also observed surge arrestor burnout, spark-gap breakdown, blown fuses, and power supply breakdowns.

The physical and social fabric of the United States is sustained by a system of systems; a complex dynamic network of interlocking and interdependent infrastructures

("critical national infrastructures") whose harmonious functioning enables the myriad services, transactions, and information flows that make possible the orderly conduct of civil society in this country while also supporting our economic strength and national security. The vulnerability of these infrastructures to threats — deliberate, accidental, and acts of nature — is the focus of significant concern in the current era, a concern heightened by the events of 9/11, major hurricanes, recent wide-area power grid failures, and large-scale cyber attacks to date directed at other countries.

In November 2008, the Commission released an unclassified assessment of the effects of a high altitude electromagnetic pulse (EMP) attack on our critical national infrastructures and provides recommendations for their mitigation. The assessment entitled *Critical National Infrastructures* was informed by analytic and test activities executed under Commission sponsorship, as discussed in the report. An earlier executive report: *Report of the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) — Volume 1: Executive Report* (2004), provided an earlier unclassified overview of the subject. The Commission also prepared and submitted to the Congress and the Administration several classified reports addressing military, nuclear weapon, and intelligence aspects of the subject.

The electromagnetic pulse generated by a high altitude nuclear explosion is one of a small number of threats that can hold our society at risk of catastrophic consequences. The increasingly pervasive use of electronics of all forms represents the greatest source of vulnerability to attack by EMP. Electronics are used to control, communicate, compute, store, manage, and implement nearly every aspect of United States (U.S.) civilian systems. When a nuclear explosion occurs at high altitude, the electromagnetic fields it produces will cover the geographic region within the line of sight of the detonation[1]. This intense electromagnetic phenomena, when coupled into sensitive electronics through any connected wires or other electrical conductors, has the capability to produce widespread and long lasting disruption and damage to the critical infrastructures that underpin the fabric of U.S. society. Because of the ubiquitous dependence of U.S. society on the electrical power system, its vulnerability to an EMP attack, together with power grids increasing dependence on electronics for efficiency, control, and safety, as reflected for example in increasing national interest in "Smart Grid" design and implementation, creates the possibility of long-term, catastrophic consequences.

The Implicit Invitation

Some in government have taken the position that EMP attack and geomagnetic storm disruption are low-probability events. Of course, we know that geomagnetic storms will occur, and large ones can seriously damage very long-lead components of the electrical system – it is only a question of when, not if. Concerning EMP, the logic of their position is upside down. By ignoring large scale, catastrophic EMP vulnerability, we invite such

[1] For example, a nuclear explosion at an altitude of 100 kilometers would expose 4 million square kilometers, about 1.5 million square miles, of Earth surface beneath the burst to a range of EMP field intensities.

attack on our infrastructure by adversaries looking to attack us where we are weak, not where we are strong. Our adversaries know how to take advantage of this vulnerability, and when coupled with increasing nuclear weapon and ballistic missile proliferation, it is a serious concern. A single EMP attack may effectively instantaneously degrade or shut down a large part of the electric power grid in the geographic area of EMP exposure. There is also a possibility of functional collapse of grids beyond the exposed area, as electrical effects propagate from one region to another, as has happened in power grid failures over the last forty years.

The time required for full recovery of electrical power service would depend on both the disruption and damage to the electrical power infrastructure and to other national infrastructures. Larger affected areas and stronger EMP field strengths would prolong the time to recover. Adding to the recovery time, some critical electrical power infrastructure components, such as large high-voltage transformers, are no longer manufactured in the United States, and even in routine circumstances their acquisition requires up to a year of lead time.

Damage to or loss of these components could leave significant parts of the electrical infrastructure out of service for periods measured in months to a year or more. There is a point in time at which the shortage or exhaustion of sustaining backup systems, including emergency power supplies, batteries, standby fuel supplies, communications, and manpower resources that can be mobilized, coordinated, and dispatched, together would lead to a continuing degradation of critical infrastructures for a prolonged period of time.

Electrical power is necessary to support other critical infrastructures, including supply and distribution of fuel, communications, transport, financial transactions, water, food, emergency services, government services, and all other infrastructures supporting the national welfare, economy, and security. Should significant parts of the electrical power infrastructure be lost for any substantial period of time, the Commission believes that the consequences are likely to be catastrophic, and many people may ultimately die for lack of the basic elements necessary to sustain life in dense urban and suburban communities. In fact, the Commission is deeply concerned that such impacts are likely in the event of an EMP attack unless practical steps are taken to provide protection for critical elements of the electric system and for rapid restoration of electric power, particularly to essential services.

A Plan of Action

It is the consensus of the EMP Commission that the Nation need not be vulnerable to the catastrophic consequences of an EMP attack. As detailed in the Commission reports provided to the Congress, the Nation's vulnerability to EMP that gives rise to potentially large-scale, long-term consequences can be reasonably and readily reduced below the level of a potentially catastrophic national problem by coordinated and focused effort between the private and public sectors of our country. The cost for such improved security in the next 3 to 5 years is modest by any standard—and extremely so in relation

to both the war on terror and the value of the national infrastructures threatened. In fact, electromagnetic protection of the critical national infrastructures may over time provide a net saving of money through the more reliable and robust operation of the systems involved.

The appropriate response to the EMP threat is a balance of prevention, protection, planning, and preparations for recovery. Such actions are both feasible and well within the Nation's means and resources to accomplish. A number of these actions also reduce vulnerabilities to other serious threats to our infrastructures, thus giving multiple benefits.

It is not feasible to reduce the consequences of an EMP attack to an acceptable level of risk by any single measure. However, in the view of the EMP Commission, it is possible to achieve an acceptable level of risk and reduced invitation to an EMP attack with a strategy that integrates several significant measures:

- Pursuing intelligence, interdiction, and deterrence to discourage EMP attack against the US and its interests;
- Protecting critical components of the infrastructure, with particular emphasis on those that, if damaged, would require long periods of time to repair or replace;
- Maintaining the capability to monitor and evaluate the condition of critical infrastructures;
- Recognizing an EMP attack and understanding how its effects differ from other forms of infrastructure disruption and damage;
- Planning to carry out a systematic recovery of critical infrastructures;
- Training, evaluating, "Red Teaming," and periodically reporting to the Congress;
- Defining the Federal Government's responsibility and authority to act;
- Recognizing the opportunities for shared benefits;
- Conducting research to better understand infrastructure system effects and developing cost-effective solutions to manage these effects;

Finally, I would like to state for the record that I support HR 2195, a Bill to amend the Federal Power Act to provide additional authorities to adequately protect the critical electric infrastructure against cyber attack, and for other purposes. At the same time, I strongly recommend that electromagnetic threats to the critical electric infrastructure, both from nuclear EMP attack and from naturally occurring, large scale geomagnetic storms, be addressed in the bill in a manner explicitly comparable to and in parallel with cyber threats as now contained in the Bill. It is important to do this because an integrated approach to protecting critical electrical infrastructure will be much less expensive and more effective and expedient than any fragmented approach to the problem, and unlike

the Department of Defense, the Department of Homeland Security, from its establishment forward, has shown neither an understanding nor a willingness to consider the problem of electromagnetic threats to our country.

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