Gauging the Threat of an Electromagnetic Pulse (EMP) Attack

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Over the past decade there has been an ongoing debate over the threat posed by electromagnetic pulse (EMP) to modern civilization. This debate has been the most heated perhaps in the United States, where the commission appointed by Congress to assess the threat to the United States warned of the dangers posed by EMP in reports released in 2004 and 2008. The commission also called for a national commitment to address the EMP threat by hardening the national infrastructure.

There is little doubt that efforts by the United States to harden infrastructure against EMP — and its ability to manage critical infrastructure manually in the event of an EMP attack — have been eroded in recent decades as the Cold War ended and the threat of nuclear conflict with Russia lessened. This is also true of the U.S. military, which has spent little time contemplating such scenarios in the years since the fall of the Soviet Union. The cost of remedying the situation, especially retrofitting older systems rather than simply regulating that new systems be better hardened, is immense. And as with any issue involving massive amounts of money, the debate over guarding against EMP has become quite politicized in recent years.

We have long avoided writing on this topic for precisely that reason. However, as the debate over the EMP threat has continued, a great deal of discussion about the threat has appeared in the media. Many STRATFOR readers have asked for our take on the threat, and we thought it might be helpful to dispassionately discuss the tactical elements involved in such an attack and the various actors that could conduct one. The following is our assessment of the likelihood of an EMP attack against the United States.

Defining Electromagnetic Pulse

EMP can be generated from natural sources such as lightning or solar storms interacting with the earth's atmosphere, ionosphere and magnetic field. It can also be artificially created using a nuclear weapon or a variety of non-nuclear devices. It has long been proven that EMP can disable electronics. Its ability to do so has been demonstrated by solar storms, lightning strikes and atmospheric nuclear explosions before the ban on such tests. The effect has also been recreated by EMP simulators designed to reproduce the electromagnetic pulse of a nuclear device and study how the phenomenon impacts various kinds of electrical and electronic devices such as power grids, telecommunications and computer systems, both civilian and military.

The effects of an EMP — both tactical and strategic — have the potential to be quite significant, but they are also quite uncertain. Such widespread effects can be created during a high-altitude nuclear detonation (generally above 30 kilometers, or about 18 miles). This widespread EMP effect is referred to as high-altitude EMP or HEMP. Test data from actual high-altitude nuclear explosions is extremely limited. Only the United States and the Soviet Union conducted atmospheric nuclear tests above 20 kilometers and, combined, they carried out fewer than 20 actual tests.

As late as 1962 — a year before the Partial Test Ban Treaty went into effect, prohibiting its signatories from conducting aboveground test detonations and ending atmospheric tests — scientists were surprised by the HEMP effect. During a July 1962 atmospheric nuclear test called "Starfish Prime," which took place 400 kilometers above Johnston Island in the Pacific, electrical and electronic systems were damaged in Hawaii, some 1,400 kilometers away. The Starfish Prime test was not designed to study HEMP, and the effect on Hawaii, which was so far from ground zero, startled U.S. scientists.

High-altitude nuclear testing effectively ended before the parameters and effects of HEMP were well understood. The limited body of knowledge that was gained from these tests remains a highly classified matter in both the United States and Russia. Consequently, it is difficult to speak intelligently about EMP or publicly debate the precise nature of its effects in the open-source arena.

The importance of the EMP threat should not be understated. There is no doubt that the impact of a HEMP attack would be significant. But any actor plotting such an attack would be dealing with immense uncertainties — not only about the ideal altitude at which to detonate the device based on its design and yield in order to maximize its effect but also about the nature of those effects and just how devastating they could be.

Non-nuclear devices that create an EMP-like effect, such as high-power microwave (HPM) devices, have been developed by several countries, including the United States. The most capable of these devices are thought to have

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significant tactical utility and more powerful variants may be able to achieve effects more than a kilometer away. But at the present time, such weapons do not appear to be able to create an EMP effect large enough to affect a city, much less an entire country. Because of this, we will confine our discussion of the EMP threat to HEMP caused by a nuclear detonation, which also happens to be the most prevalent scenario appearing in the media.

Attack Scenarios

In order to have the best chance of causing the type of immediate and certain EMP damage to the United States on a continent-wide scale, as discussed in many media reports, a nuclear weapon (probably in the megaton range) would need to be detonated well above 30 kilometers somewhere over the American Midwest. Modern commercial aircraft cruise at a third of this altitude. Only the United States, United Kingdom, France, Russia and China possess both the mature warhead design and intercontinental ballistic missile (ICBM) capability to conduct such an attack from their own territory, and these same countries have possessed that capability for decades. (Shorter range missiles can achieve this altitude, but the center of the United States is still 1,000 kilometers from the Eastern Seaboard and more than 3,000 kilometers from the Western Seaboard — so just any old Scud missile won't do.)

The HEMP threat is nothing new. It has existed since the early 1960s, when nuclear weapons were first mated with ballistic missiles, and grew to be an important component of nuclear strategy. Despite the necessarily limited understanding of its effects, both the United States and Soviet Union almost certainly included the use of weapons to create HEMPs in both defensive and especially offensive scenarios, and both post-Soviet Russia and China are still thought to include HEMP in some attack scenarios against the United States.

However, there are significant deterrents to the use of nuclear weapons in a HEMP attack against the United States, and nuclear weapons have not been used in an attack anywhere since 1945. Despite some theorizing that a HEMP attack might be somehow less destructive and therefore less likely to provoke a devastating retaliatory response, such an attack against the United States would inherently and necessarily represent a nuclear attack on the U.S. homeland and the idea that the United States would not respond in kind is absurd. The United States continues to maintain the most credible and survivable nuclear deterrent in the world, and any actor contemplating a HEMP attack would have to assume not that they might experience some limited reprisal but that the U.S. reprisal would be full, swift and devastating.

Countries that build nuclear weapons do so at great expense. This is not a minor point. Even today, a successful nuclear weapons program is the product of years — if not a decade or more — and the focused investment of a broad spectrum of national resources. Nuclear weapons also are developed as a deterrent to attack, not with the intention of immediately using them offensively. Once a design has achieved an initial capability, the focus shifts to establishing a survivable deterrent that can withstand first a conventional and then a nuclear first strike so that the nuclear arsenal can serve its primary purpose as a deterrent to attack. The coherency, skill and focus this requires are difficult to overstate and come at immense cost — including opportunity cost — to the developing country. The idea that Washington will interpret the use of a nuclear weapon to create a HEMP as somehow less hostile than the use of a nuclear weapon to physically destroy an American city is not something a country is likely to gamble on.

In other words, for the countries capable of carrying out a HEMP attack, the principles of nuclear deterrence and the threat of a full-scale retaliatory strike continue to hold and govern, just as they did during the most tension-filled days of the Cold War.

Rogue Actors

One scenario that has been widely put forth is that the EMP threat emanates not from a global or regional power like Russia or China but from a rogue state or a transnational terrorist group that does not possess ICBMs but will use subterfuge to accomplish its mission without leaving any fingerprints. In this scenario, the rogue state or terrorist group loads a nuclear warhead and missile launcher aboard a cargo ship or tanker and then launches the missile from just off the coast in order to get the warhead into position over the target for a HEMP strike. This scenario would involve either a short-range ballistic missile to achieve a localized metropolitan strike or a longer-range (but not intercontinental) ballistic missile to reach the necessary position over the Eastern or Western seaboard or the Midwest to achieve a key coastline or continental strike.

When we consider this scenario, we must first acknowledge that it faces the same obstacles as any other nuclear weapon employed in a terrorist attack. It is unlikely that a terrorist group like al Qaeda or Hezbollah can develop its own nuclear weapons program. It is also highly unlikely that a nation that has devoted significant effort and treasure to develop a nuclear weapon would entrust such a weapon to an outside organization. Any use of a nuclear weapon would be vigorously investigated and the nation that produced the weapon would be identified and would pay a heavy price for such an attack (there has been a large investment in the last decade in nuclear forensics). Lastly, as noted above, a nuclear weapon is seen as a deterrent by countries such as North Korea or Iran, which seek such weapons to protect themselves from invasion, not to use them offensively. While a group like al Qaeda would likely use a nuclear device if it could obtain one, we doubt that other groups such as Hezbollah would. Hezbollah has a known base of operations in Lebanon that could be hit in a counterstrike and would therefore be less willing to risk an attack that could be traced back to it.

Also, such a scenario would require not a crude nuclear device but a sophisticated nuclear warhead capable of being mated with a ballistic missile. There are considerable technical barriers that separate a crude nuclear device from a sophisticated nuclear warhead. The engineering expertise required to construct such a warhead is far greater than that required to construct a crude device. A warhead must be far more compact than a primitive device. It must also have a trigger mechanism and electronics and physics packages capable of withstanding the force of an ICBM launch, the journey into the cold vacuum of space and the heat and force of re-entering the atmosphere — and still function as designed. Designing a functional warhead takes considerable advances in several fields of science, including physics, electronics, engineering, metallurgy and explosives technology, and overseeing it all must be a high-end quality assurance capability. Because of this, it is our estimation that it would be far simpler for a terrorist group looking to conduct a nuclear attack to do so using a crude device than it would be using a sophisticated warhead — although we assess the risk of any non-state actor obtaining a nuclear capability of any kind, crude or sophisticated, as extraordinarily unlikely.

But even if a terrorist organization were somehow able to obtain a functional warhead and compatible fissile core, the challenges of mating the warhead to a missile it was not designed for and then getting it to launch and detonate properly

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would be far more daunting than it would appear at first glance. Additionally, the process of fueling a liquid-fueled ballistic missile at sea and then launching it from a ship using an improvised launcher would also be very challenging. (North Korea, Iran and Pakistan all rely heavily on Scud technology, which uses volatile, corrosive and toxic fuels.)

Such a scenario is challenging enough, even before the uncertainty of achieving the desired HEMP effect is taken into account. This is just the kind of complexity and uncertainty that well-trained terrorist operatives seek to avoid in an operation. Besides, a ground-level nuclear detonation in a city such as New York or Washington would be more likely to cause the type of terror, death and physical destruction that is sought in a terrorist attack than could be achieved by generally non-lethal EMP.

Make no mistake: EMP is real. Modern civilization depends heavily on electronics and the electrical grid for a wide range of vital functions, and this is truer in the United States than in most other countries. Because of this, a HEMP attack or a substantial geomagnetic storm could have a dramatic impact on modern life in the affected area. However, as we've discussed, the EMP threat has been around for more than half a century and there are a number of technical and practical variables that make a HEMP attack using a nuclear warhead highly unlikely.

When considering the EMP threat, it is important to recognize that it exists amid myriad other threats, including related threats such as nuclear warfare and targeted, small-scale HPM attacks. They also include threats posed by conventional warfare and conventional weapons such as man-portable air-defense systems, terrorism, cyberwarfare attacks against critical infrastructure, chemical and biological attacks — even natural disasters such as earthquakes, hurricanes, floods and tsunamis.

The world is a dangerous place, full of potential threats. Some things are more likely to occur than others, and there is only a limited amount of funding to monitor, harden against, and try to prevent, prepare for and manage them all. When one attempts to defend against everything, the practical result is that one defends against nothing. Clear-sighted, well-grounded and rational prioritization of threats is essential to the effective defense of the homeland.

Hardening national infrastructure against EMP and HPM is undoubtedly important, and there are very real weaknesses and critical vulnerabilities in America's critical infrastructure — not to mention civil society. But each dollar spent on these efforts must be balanced against a dollar not spent on, for example, port security, which we believe is a far more likely and far more consequential vector for nuclear attack by a rogue state or non-state actor.

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