Backgrounder

Published by The Heritage Foundation

No. 2491
November 17, 2010

EMP Attacks—What the U.S. Must Do *Now*

James Jay Carafano, Ph.D., and Richard Weitz, Ph.D.

Abstract: *Most Americans—whether members of the public or politicians in Congress—ignore or are unaware of the very real threat of an electromagnetic pulse (EMP) attack. A nuclear device detonated high in the atmosphere above the American mainland can easily disable the country's electrical grid—shutting down nearly all communications, transportation, and service systems. Overnight, daily life as Americans know it will be a thing of the past. There are ways to prevent devastation from an EMP — and the U.S. must invest in them now before it is too late. Two of the country's preeminent national security experts explain how to prevent the worst.*

An electromagnetic pulse (EMP) attack represents one of the greatest threats imaginable—to the United States and the world. An EMP occurs when a nuclear device is detonated high in the atmosphere—a phenomenon of which America's enemies are well aware. The electromagnetic discharge can permanently disable the electrical systems that run nearly all civilian and military infrastructures. A massive EMP attack on the United States would produce almost unimaginable devastation. Communications would collapse, transportation would halt, and electrical power would simply be non-existent. Not even a global humanitarian effort would be enough to keep hundreds of millions of Americans from death by starvation, exposure, or lack of medicine. Nor would the catastrophe stop at U.S. borders. Most of Canada would be devastated, too, as its infrastructure is inte-

Talking Points

- An electromagnetic pulse (EMP) attack represents one of the greatest threats imaginable—to the United States and the world.
- The largest vulnerability in the country's electrical grid is the power-transmission infrastructure, which will suffer significant damage under an EMP attack and is extremely difficult to repair.
- While the banking infrastructure was designed to withstand a wide range of threats, it was not designed to withstand a complete communications shutdown.
- An EMP attack would heavily damage the U.S. transportation sector, which would significantly impair recovery efforts in the wake of an attack.
- The delivery of aid in a chaotic post-strike environment will be impossible without robust pre-disaster planning that integrates federal, state, local, private-sector, non-governmental organizations, and international support.

This paper, in its entirety, can be found at:
http://report.heritage.org/bg2491

Produced by the Douglas and Sarah Allison Center for Foreign Policy Studies
of the
Kathryn and Shelby Cullom Davis Institute for International Studies

Published by The Heritage Foundation
214 Massachusetts Avenue, NE
Washington, DC 20002–4999
(202) 546-4400 • heritage.org

grated with the U.S. power grid. Without the American economic engine, the world economy would quickly collapse. Much of the world's intellectual brain power (half of it is in the United States) would be lost as well. Earth would most likely recede into the "new" Dark Ages.

All past calamities of the modern era would pale in comparison to the catastrophe caused by a successful high-altitude EMP strike. Still, recent disasters do offer insights into how to mitigate and respond to some aspects of this threat. Major urban blackouts, Hurricane Katrina, and the recent earthquake in Haiti illuminate the most daunting challenges. These disasters suggest that the most vital aspects of mitigating the effects of an EMP attack are: (1) a resilient U.S.–Canadian electrical grid; (2) integrated catastrophic planning; and (3) redundant means of global communication.

In the end, however, even with farsighted mitigation measures there is little question that a nationwide EMP attack would be crippling. Thus, while pursuing mitigation, the U.S. should take all possible measures to protect and defend the nation against a ballistic-missile attack that could be used to deliver an EMP strike, as well as pursue aggressive counter-proliferation measures against rogue states developing nuclear weapons.

Thinking the Unthinkable

In many respects, an EMP attack is a unique and unprecedented threat to the United States. EMP is a high-intensity burst of electromagnetic energy caused by the rapid acceleration of charged particles. EMP is most often created from gamma rays emitted during a nuclear explosion. At altitudes between 40 to 400 kilometers, these gamma rays produce high-energy free electrons that give rise to an oscillating electric current that destroys electronic equipment.[1]

After an EMP attack, Earth would most likely recede into the "new" Dark Ages.

The direct effects are due to electromagnetic "shocking" of electronics and the stressing of electrical systems. Indirect effects include the cascading damage that occurs because of these shocked, damaged, and destroyed electronics and electronic systems that are embedded in critical infrastructure. These indirect effects can be even more severe than the direct effects. For example, surges might simultaneously cause electrical fires and incapacitate traffic control and emergency dispatch systems. In turn, responders will be unable to respond to resulting mass fires.

An electromagnetic pulse consists of three components: E1 is a free-field energy pulse that occurs in a fraction of a second. The generated "electromagnetic shock" then damages, disrupts, and destroys electronics and electronic systems in a near simultaneous time frame over a very large area. Faraday cage protection and other mechanisms designed to defend against lighting strikes will not withstand this assault. Only specialized technology integrated into equipment can harden it against EMP. If the electromagnetic distortion is large enough, the E1 shock will even destroy lightly EMP-shielded equipment in addition to most consumer electronics.[2] Devices that incorporate antennas by nature accept electronic signals and cannot be shielded against E1, meaning trillions of dollars worth of electronics will fail after an EMP assault, regardless of protective measures. E1 is also particularly worrisome because it destroys Supervisory Control and Data Acquisition components that are critical to many of our national infrastructures.[3]

1. John S. Foster, Jr., *et al.*, "Report of the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack," Vol. 1: Executive Report, 2004, United States EMP Commission, p. 4, at *http://www.empcommission.org/docs/empc_exec_rpt.pdf* (November 9, 2010).
2. Clay Wilson, "High Altitude Electromagnetic Pulse (HEMP) and High Power Microwave (HPM) Devices: Threat Assessments," Congressional Research Service *Report for Congress*, July 21, 2008, p. 13, at *http://www.fas.org/sgp/crs/natsec/RL32544.pdf* (November 9, 2010).
3. Foster, *et al.*, "Report of the Commission to Assess the Threat to the United States from EMP Attack," p. 14.

E2 covers essentially the same area as E1 but is more geographically widespread and has lower amplitude than E1. The E2 component has similar effects as lightning. In general, it would not be a critical threat to infrastructure, since most systems have built-in protection against occasional lightning strikes. The E2 threat compounds that of the E1 component since it strikes a fraction of a second after the E1 has very likely damaged or destroyed the protective devices that would have prevented E2 damage. The syncretistic effects mean that E2 typically inflicts more damage than E1 since it bypasses traditional protective measures, vastly amplifying the damage inflicted by EMP.[4]

E3 is a longer duration pulse, lasting up to one minute. It disrupts long electricity transmission lines and subsequently causes damage to the electrical supply and distribution systems connected to these lines. This E3 element of EMP is not a freely propagating wave, but is a result of the electromagnetic distortion in the earth's atmosphere. In this regard, E3 is similar to a massive geomagnetic storm, and is particularly damaging to long-line infrastructure, such as electrical cables and transformers. A moderate blast of E3 reportedly could directly affect up to 70 percent of the U.S. power grid.[5]

The timing of the three components is an important part of the equation in relation to the damage that EMP generates. The damage from each strike amplifies the damage caused by each succeeding strike. The combination of the three components can cause irreversible damage to many electronic systems. With the combined damage from earlier E1 and E2 blasts, E3 has the potential to destroy the nation's electrical grid and thus inflict catastrophic damage on the United States.[6]

In practice, the precise EMP effects vary depending on many factors. One of the most important variables is altitude. The most effective altitude is above the visible horizon. If detonation is too low, most of the electro-magnetic force from the EMP will be driven into the ground, creating deadly nuclear fallout that deprives the weapon of its non-casualty appeal. Damage is inversely related to the target's distance from the epicenter of detonation. In general, the further from the epicenter, the weaker the EMP effects. Yield is another factor to consider. The higher the yield, the greater the effect. Even so, since the effects travel through electric lines and waterways, and have secondary spill-over impacts on other infrastructure, it is difficult to predict the possible extent of damage from a large-scale EMP attack.[7]

For the past decade, the Commission to Assess the Threat to the United States from Electromagnetic Pulse Attack, chaired by Dr. William R. Graham, has investigated the EMP threat to the United States and how it can be reduced. The commission's specific areas of analysis have included:

- "the nature and magnitude of potential high-altitude EMP threats to the United States from all potentially hostile states or non-state actors that have or could acquire nuclear weapons and ballistic missiles enabling them to perform a high-altitude EMP attack against the United States within the next 15 years;
- "the vulnerability of United States military and especially civilian systems to an EMP attack, giving special attention to vulnerability of the civilian infrastructure as a matter of emergency preparedness;
- "the capability of the United States to repair and recover from damage inflicted on United States military and civilian systems by an EMP attack"; and
- "the feasibility and cost of hardening select military and civilian systems against EMP attack."[8]

The Graham commission's bottom line is that an EMP attack will put an end to the functioning of the

4. *Ibid.*, p. 6.
5. *Ibid.*
6. *Ibid.*, pp. 1–12.
7. *Ibid.*, p. 18.
8. "Charter," in Foster, *et al.*, "Report of the Commission to Assess the Threat to the United States from EMP Attack," p. iii.

U.S. electrical infrastructure and much of the hardware that runs everyday life.

The multiple components of EMP are each highly damaging in their own right and combined have the potential to inflict catastrophic damage to the major infrastructures throughout the United States. Moreover, the sequential and nearly simultaneous delivery of E1, E2, and E3 pose a complicated threat that could destroy much of the electrical infrastructure and other critical services under current conditions. The United States has seen the rapid growth in its dependence on electronics, telecommunications, and information technology. This technology has infused itself into the nation's critical infrastructure and key resources (CIKR). These include the energy sector, banking and finance, petroleum and natural gas, transportation, food services, water, emergency services, and space systems. These technological innovations have brought great benefits, but also make the United States—and its component states and localities—vulnerable to an EMP attack.

Technological innovations have brought great benefits, but also make the United States vulnerable to an EMP attack.

Although the altitude necessary for an effective nuclear-based EMP minimizes the likely damage from the nuclear thermal blast and radiation, large numbers of casualties would most likely occur from the sheer loss of power. Airplanes would literally fall from the sky, cars and trucks would stop working, and water, sewer, and electrical networks would fail. Food would rot, medical services would collapse, and transportation would become almost non-existent. The United States and other highly developed countries are especially vulnerable to such attacks, given their dependence on extensive transportation networks and other electricity-driven infrastructures.[9]

One crucial commonality is the widespread use of automated monitoring and control systems, which the Graham commission has labeled the "ubiquitous robots of the modern age known as Supervisory Control and Data Acquisition (SCADA) systems." These SCADA systems, along with Digital Control Systems (DCS) and Programmable Logic Controllers (PLC) have penetrated into every critical area of the nation's CIKR. While these systems provide increased operational benefits and agility, they also increase vulnerability to an EMP attack. The fact that these systems have frequently replaced manual controls both on-site and at remote locations is one of the crucial factors that have intensified the possibility of cascading damage within and across the infrastructure sectors.[10]

Blackout Lessons

Lesson #1: Lights-Out Fall-Out. An EMP could destroy much of the electrical grid within the United States. The largest vulnerability in the country's electrical grid is the power-transmission infrastructure, which will suffer significant damage under an EMP attack and is extremely difficult to repair. The transmission grid is composed of substations and transformers that step power up and down as power lines are switched in order to transfer high-voltage long disaster power to a lower voltage more suitable for consumer use. This grid is essential to maintaining electrical distribution if some power generation is lost, as this system can reroute electricity to where it is needed most. Substations are exposed to both EMP and the elements while situated in remote areas, are full of cables which can act like antennas, and are dependent on telephone lines in order to function. Two high-value components of the transmission infrastructure, transformers and capacitors, are very sensitive to both E1 and E3.

The combination of these factors makes it highly unlikely that U.S. substations will remain unscathed after an EMP attack. The equipment used in the transmission grid is costly, specially produced, and has to be ordered from overseas before replacement

9. William R. Graham *et al.*, "Report of the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack: Critical National Infrastructures," April 2008, at *http://www.empcommission.org/docs/A2473-EMP_Commission-7MB.pdf* (November 13, 2010).
10. *Ibid.*, p. 1.

in the U.S. Those with the expertise to replace transformers and capacitors are likely to be overwhelmed if much of our infrastructure is damaged, only delaying the replacement of equipment that generally takes two years to be manufactured and delivered.[11] The severe deficiencies in America's ability to replace its transmission infrastructure must be addressed in order to reduce the catastrophic effect of a successful EMP attack.

A good model for this potential disorder is the New York City blackout of 1977. On July 13, 1977, two lighting strikes caused overloading in the electric power substations of the Con Edison power company. These lighting strikes, the equivalent of a minuscule fraction of E2, caused the Indian Point power plant north of the city to fail, as well as the subsequent failure of the Long Island interconnection—a regional, or larger, synchronized-frequency grid. Failure of the Linden–Goethals 230,000-volt interconnection with New Jersey resulted in the protective devices removing overloaded lines, transformers, and cables from service. As a result, a power failure spread throughout the New York area.[12] This blackout lasted only one day, yet resulted in widespread looting and the breakdown of the rule of law throughout many New York neighborhoods. The estimated cost of the blackout was approximately $346 million, and nearly 3,000 people were arrested through the 26-hour period.[13]

The blackout in New York City resulted in an immediate breakdown of the social order. The police were outmatched and had no chance of stopping such massive theft, largely having no choice but to stand by watching the looters from a distance. In North Brooklyn, a community of more than a million residents, only 189 police officers were on duty.[14] The New York Police Department was completely overwhelmed in its efforts to preserve order. The social order degenerated so quickly that *Time* magazine called it a "Night of Terror."[15]

There were many of explanations for the sudden violence in the aftermath of the blackout, with justifications ranging from racial animosities to culture, even to weather, but the simple fact is that during disaster, "'under stress' or 'exceptional circumstances,' the poor saw 'no reason to play by the rules.'"[16] This astounding amount of violence occurred in the course of a single day. After an EMP attack, cities will likely lose power for weeks and months, and the National Guard cannot occupy every major city, assuming it is able to mobilize at all. The historical evidence from the 1977 New York blackout bodes poorly for the prospect of maintaining order and the rule of law without electricity.

The August 2003 Northeast blackout that affected Ohio, New York, Maryland, Pennsylvania, Michigan, and parts of Canada—though marked by less social disorder—also demonstrated the potential effects of a wide-area EMP attack. During that incident, more than 200 power plants, including several nuclear plants, were shut down as a result of the electricity cutoff. Loss of water pressure led the local authorities to advise affected communities to boil water before drinking it due to contamination from the failure of sewage systems and other health threats. Many backup generators proved unable to manage the crisis. The initial day of the blackout brought massive traffic jams and gridlock when people tried to get home without traffic lights. Additional transportation problems arose when railways, airlines, gas stations, and oil refineries halted operations. Telephone lines were overwhelmed due to

11. *Ibid.*, p. 49.
12. "The New York City Blackout of July 13, 1977," Hearing before the Subcommittee on Energy and Power, Committee on Interstate and Foreign Commerce, U.S. House of Representatives, October 13, 1977, p. 5, at *http://blackout.gmu.edu/archive/pdf/hearing001_050.pdf* (November 9, 2010).
13. SCI Systems Control, Inc., "Impact Assessment of the 1977 New York Blackout," Energy Systems Division, July 1978, pp. 3, 14, at *http://blackout.gmu.edu/archive/pdf/impact_77.pdf* (November 9, 2010).
14. James Goodman, *Blackout* (New York: North Point Press, 2003), p. 51.
15. "The Blackout: Night of Terror," *Time*, July 25, 1977, pp. 12–22, at *http://www.time.com/time/magazine/article/0,9171,919089-1,00.html* (November 9, 2010).
16. Goodman, *Blackout*, p. 113.

the high volume of calls, while many radio and television stations went off-air. Overall, the blackout's economic cost was between $7 billion and $10 billion due to food spoilage, lost production, overtime wages, and other related costs inflicted on over one-seventh of the U.S. population.[17]

In the case of an EMP attack, the damage could prove even more severe. During the 1977 and 2003 blackouts, some communications systems remained intact, while motor vehicles and aircraft were not directly affected and rapidly resumed operation after the electrical system recovered a few days later. After an EMP attack, however, the damage to power lines, SCADA control systems, and commercial computers would likely be permanent due to fused power lines and lost data, which would necessitate replacing the entire electric system in the affected area.

The vast amounts of electronic and telecommunications systems supporting the financial industry have never been hardened against an EMP attack despite physical attacks posing one of the largest threats to operations. If these systems were damaged, consumers would be forced to operate a cash economy, or, since cash withdrawals would be impossible without financial records, a barter economy. The August 2003 Northeast blackout is considered a successful test of post–September 11 safeguards, but it happened under ideal conditions for the financial market. It occurred after the 4 p.m. closing time, was largely over by 9 a.m. the next day, and business was light as usual for a Thursday in August. Even then, some traders could not access the NASDAQ electronic exchange by telephone, ATMs failed all over New York City and elsewhere, transportation systems were interrupted regularly, power outages continued to randomly disrupt business, and many companies had trouble obtaining backup diesel fuel for their generators. Banks borrowed a total of $785 million from the Federal Reserve System to compensate for imbalances. This was the result of a disruption that lasted a matter of hours, and a few days at most, not the weeks or months that an EMP is likely to inflict.[18]

The banking and finance sector relies on one of the most advanced information-technology systems to transfer millions of transactions daily, and depends on the telecommunications networks to maintain critical voice and data transfers. Disruptions of these networks could result not only in disruptions of operations, but also a loss of confidence by the public in the national economy.[19] While the banking infrastructure was designed robustly against a wide range of threats, it was not designed to withstand a complete communications shut-

The vast amounts of electronic and telecommunications systems supporting the financial industry have never been hardened against an EMP attack.

down. The backup power generators and battery backup systems, while allowing for an organized shutdown of the electronic systems, were not designed to last for the amount of time that will likely be required to restore power. It could be weeks or months before services are restored and it remains to be seen what a national shutdown of this vital infrastructure sector would entail long term. Particularly in the direct aftermath of the EMP attack, banks will find it difficult to provide the public with the liquidity necessary to purchase essential goods. Indeed an EMP attack that shuts down the electronic data retrieval systems would render banking transactions virtually impossible. The inability of customers to access funding at such a critical time will certainly be a factor in maintaining a civil and orderly recovery.[20]

17. "Major Power Outage Hits New York, Other Large Cities," CNN, August 14, 2003, at *http://www.cnn.com/2003/US/08/14/power.outage* (November 9, 2010), and The Electricity Consumers Resource Council, "The Economic Impacts of the August 2003 Blackout," February 9, 2004, at *http://www.elcon.org/Documents/EconomicImpactsOfAugust2003Blackout.pdf* (November 9, 2010).
18. Foster, *et al.*, "Report of the Commission to Assess the Threat to the United States from EMP Attack," pp. 91–92.
19. "Banking and Finance: Critical Infrastructure and Key Resources Sector-Specific Plan as Input to the National Infrastructure Protection Plan," Departments of Homeland Security and the Treasury, May 2007, p. 22, at *http://www.dhs.gov/xlibrary/assets/nipp-ssp-banking.pdf* (November 9, 2010).

Many Americans have experienced the burdens of a short blackout. But the U.S. could not survive as a unified civil nation with the long-term loss of the electrical grid. Ensuring a resilient U.S.–Canadian power grid is vital.[21] An essential component of mitigating the threat must be an early warning system, system-situational awareness, and robust command and control to ensure cooperation between government agencies and private companies during a crisis.

Lesson #2: Losing Infrastructure. An EMP attack would heavily damage the U.S. transportation sector, which would significantly impair recovery efforts in the wake of an attack. Transportation networks are crucial for the supply of life-sustaining goods and services. These networks are increasingly incorporating electronics into their systems, so the transportation network is increasingly vulnerable to EMP. Any damage to the network has a significant impact on the distribution of goods and will significantly influence the nation's recovery after a disaster.

The effects of EMP will immediately disable a portion of the 130 million cars and some 90 million trucks. Since millions of vehicles are on the road at any given time, there will be accidents and congestion that will impede movement, particularly in large metropolitan areas. Stoplights and train crossing signals will shut down or malfunction. The longer-term effects on the automobile and trucking infrastructure will hinge on the ability to obtain fuel and the recovery of commercial power. Police may be needed to replace automated traffic controls at the same time that they are critically needed for other emergency services.[22]

The U.S. rail network depends directly on electricity. Though passenger rail is only lightly developed in this country, America depends heavily on rail for transportation of fuel, food, and unfinished products. Railroad freight traffic in 2003 totaled 1.8 billion tons, much of this coal for power plants.[23] The rail infrastructure is especially critical for the continued generation of power, and will hamper restoration of the electrical grid if the nation's railroad system is damaged. Though the rail lines themselves are unlikely to suffer destruction, the control computers onboard the locomotives, traffic signals, and control centers will most likely be disabled. These elements of the rail infrastructure must be hardened in order to ensure that power plants will have an adequate fuel supply if disaster strikes.

America's aviation industry will be destroyed after an EMP attack. Communication and tracking equipment will be devastated. New airline designs, such as the Boeing 777, may fail in flight due to the lack of a direct mechanical or hydraulic link for safety procedures.[24] Airline control towers as well will suffer significant damage, and likely will ground the aviation industry for a significant time. The airline industry is not crucial for national survival, but it will be needed for the shipment of international aid, yet all air traffic in and to the U.S. will likely be grounded after an EMP assault.

U.S. sea transportation will not be critical to recovery unless other transportation cannot recuperate within a week, and by that time the nation may have already irrecoverably collapsed. But sea transport will be essential to revitalization of the U.S. economy after critical recovery, and its resilience to EMP is therefore important. Many of the nation's seagoing vessels are likely to experience the effects of EMP, and if they do, they will lose communication as a result. More important, American dockyards may be significantly impaired by EMP. Cargo cranes contain upwards of 100 vulnerable computers and sensors, and the distribution centers linking shipping containers with the U.S. trucking industry may be destroyed.[25]

20. Foster, *et al.*, "Report of the Commission to Assess the Threat to the United States from EMP Attack," pp. 83–94.
21. "Energy: Critical Infrastructure and Key Resources Sector-Specific Plan as Input to the National Infrastructure Protection Plan," Departments of Homeland Security and Energy, May 2007, p. 24, at *http://www.dhs.gov/xlibrary/assets/nipp-ssp-energy-redacted.pdf* (November 9, 2010).
22. Foster, *et al.*, "Report of the Commission to Assess the Threat to the United States from EMP Attack," pp. 105–128.
23. *Ibid.*, p. 107.
24. *Ibid.*, p. 124.

The U.S. food infrastructure depends heavily on the transportation sector. The production of food in the U.S. is increasingly reliant on electronics in vehicles such as tractors and combines, which have similar EMP vulnerability to semi-trailer trucks. The storage of food is directly dependent on the electrical infrastructure to power refrigerated warehouses, yet the distribution of the nation's food supply is entirely at the mercy of the trucking industry. Without refrigerated warehouses and with increasing spoilage in supermarkets that have only three days of backup stock, the country's food infrastructure will be only more dependent on the trucking sector.[26] Transportation will be the key to the food infrastructure after an EMP attack, which increases the societal impact if the U.S. loses a significant portion of its transportation infrastructure, making it extremely important to harden these systems against the effects of an EMP assault.

On August 29, 2005, Hurricane Katrina struck the city of New Orleans. Katrina is currently the best model for an EMP attack, since the hurricane and subsequent flooding disabled and demolished the power and transportation infrastructure. Similar to an EMP attack, a large proportion of the population was not able to leave the disaster zone where power and transportation infrastructures had been completely destroyed.

Mayor Ray Nagin ordered the evacuation of the city too late to effectively mobilize those who did not have access to cars, and instead allowed 10,000 people to stay in the Superdome in order to ride out the hurricane. More stayed in the Ernest Morial Convention Center. In total, about a fifth of the city was unable to escape before the effects of the hurricane hit the city. Much of the city was unable to mobilize when disaster struck, deprived of food, water, power, and transportation. The direct impact of the hurricane on the city caused minimal damage, incurring a few casualties and destroying some buildings, such as part of the roof of the Superdome. True disaster struck when New Orleans's levees failed to contain a flooded Lake Pontchartrain from reaching the streets. The mayor did not fully realize the scope of the catastrophe, nor did the Louisiana governor or the President, which caused emergency response agencies to lag behind in mobilization to New Orleans. Immediately after the disaster, the Federal Emergency Management Agency (FEMA) allowed 1,000 rescue workers to take two days to arrive, while 2,000 more were given an entire week to mobilize to New Orleans.[27] Federal disaster response did not anticipate the near-immediate and complete breakdown of the social order, with looters and gunmen running rampant.

One day after the hurricane struck, flooding in neighborhoods developed into a massive outpouring that destroyed much of the city. The metro area lost power.[28] Katrina turned into a situation in which the resources of military, FEMA, and police forces had been devoted to a failed effort to restore order throughout the city while those displaced and in need of aid languished.

By Tuesday, September 6, more than a week after the landfall of Katrina, 10,000 people remained to be rescued from the city.[29] Moreover, much of the city was destroyed and order had not been restored. Katrina exposed many flaws in the national capacity to respond to a catastrophic event, and poor advance planning made an effective response nearly impossible. FEMA was prepared to respond to a normal disaster, but had not prepared for something as overpowering as Katrina. Overall, this hurricane cost $81 billion in damage and caused around 1,500 casualties.[30]

The failure of transportation in New Orleans exhausted emergency generators for use by cell

25. *Ibid.*, pp. 116–122.
26. Graham *et al.*, "Report of the Commission to Assess the Threat to the United States from EMP Attack: Critical National Infrastructures," p. 133.
27. Fred C. Pampel, *Disaster Response* (New York: Facts on File, 2008), p. 47.
28. Douglas Brinkle, *The Great Deluge: Hurricane Katrina, New Orleans, and the Mississippi Gulf Coast* (New York: Harper Perennial, 2007), p. 201.
29. Pampel, *Disaster Response*, p. 49.

phone towers, hospitals, and police forces because fuel could not be delivered.[31] Electrical failure resulted in widespread looting and the spoilage of food supplies throughout the city. This partial knockout of both power and transportation created a catastrophe of unprecedented proportions and threatened to destroy one of America's major cities. Federal, state, and local governments failed to adequately respond to Katrina during the first week of disaster; this lenience will not be possible with EMP, since the entire country's, not just a city's, disaster-response capacity may collapse. Relocation to the Houston Astrodome, the slow arrival of FEMA housing, or a massive nationwide recovery effort would be impossible after an EMP attack.

The delivery of aid in a chaotic post-strike environment will be impossible without robust pre-disaster planning.

In the aftermath of an EMP strike, the delivery of aid and restoration of order within the first week of catastrophe will be crucial in order to prevent the permanent collapse of the nation's cities. The delivery of aid in a chaotic post-strike environment will be impossible without robust pre-disaster planning that integrates federal, state, local, private-sector, non-governmental organizations, and international support.

Lesson #3: Delivering Assistance. The U.S. communications infrastructure will suffer severe disruption in an EMP assault. The crucial role that telecommunication plays in the health and well-being of modern society cannot be overstated. The loss of this infrastructure would seriously impede the routine communication between individuals, business, and government. The vital components that make telecommunications possible include send-and-receive devices for voice and data, such as standard and cellular phones and personal computers. They also include mediums such as fiber and copper, wireless and cellular transmission facilities, and monitoring and management systems that identify, mitigate, and repair problems that can impact the services that make modern communication possible. The major elements of the civilian communication equipment networks have electrical systems with circuit boards, integrated circuit chips, and switching equipment such as routers that are inherently susceptible to EMP attack. The good news is that fiber is resistant to E1 attacks and much of the backbone of communication networks are often located or housed in facilities that are designed to protect this equipment from EMP effects or lightning, so there is some built-in industry protection in these areas.[32]

A key factor in regard to communications in relation to EMP attack and other disaster situations for that matter is that the times when these assets are most needed for emergency services and recovery efforts is also when they are barraged with extra demand. At least four times the normal call traffic can be expected. In previous disasters, this higher level of traffic lasted through the first four to eight hours, and a slightly elevated level of traffic, for 12 to 24 hours after the event occurred.[33]

Telecommunications in America consists of four overlapping vital systems that allow the modern economy to function: wireline, wireless, satellite, and radio. They are of critical importance to society. The overlapping functions within this infrastructure allow the system to operate if one aspect of it has been completely wiped out. The use of electromagnetic waves for the transportation of communications signals reduces the amount of hardware that can be conceivably damaged by an EMP explosion. The communication infrastructure is only consid-

30. Richard D. Knabb, Jamie R. Rhome, and Daniel P. Brown, "Tropical Cyclone Report: Hurricane Katrina, August 23–30, 2005," National Hurricane Center, December 20, 2005, p. 12, at *http://www.nhc.noaa.gov/pdf/TCR-AL122005_Katrina.pdf* (November 9, 2010), and Louisiana Department of Health and Hospitals, "Hurricane Katrina: Deceased Reports, Reports of Missing and Deceased," August 2, 2006, at *http://www.dhh.louisiana.gov/offices/page.asp?ID=192&Detail=5248* (November 9, 2010).
31. Foster, *et al.*, "Report of the Commission to Assess the Threat to the United States from EMP Attack," p. 78.
32. *Ibid.*, pp. 62–82.
33. *Ibid.*

ered to be vulnerable to E1 pulse. A number of measures in place, such as grounding, bonding, shielding, and the use of surge protectors, are considered insufficient to protect against an electromagnetic attack.[34] Each of these infrastructures is unique in its ability to suffer injury from EMP, and should be considered a separate system with unique protection plans.

The recent transition from copper line to fiber optic cable as the backbone of the wireline infrastructure has given this industry significant protection from EMP shock. The EMP commission considers fiber optic cable "highly survivable" and has focused instead on the transmission infrastructure as the source for potential vulnerability to EMP threat.[35] The wireline communications sector is housed in windowless concrete buildings containing significant protective mechanisms. For these reasons, wireline communications are considered the most secure against EMP, but that does not mean wireline communications are safe. The centers directly affected by the blast will suffer some direct damage due to EMP and degrade communications within the area, but the larger issues are the certain loss of portions of the power grid and the lack of sufficient backup generation within the infrastructure. Most wireline sites carry up to 72 hours of generation capability; therefore, much of our communication grid will fail if the electrical infrastructure is not restored promptly.[36]

In the event of an EMP attack, the U.S. cellular phone network will suffer some direct damage, but may ultimately fail due to excessive call volume overloading the infrastructure. This phenomenon occurred after the September 11 terrorist attacks. It highlighted the success of the Government Emergency Telecommunications Service (GETS) that gives priority resources to emergency responders and government officials. This arrangement gives priority cellular service to officials and provides the administrative framework to operate the communications infrastructure in crisis. However, nationwide network stress coupled with significant infrastructure damage may result in the failure of this system. The immense proliferation of smartphones in the last few years may cause unprecedented stress for the system, as users try to download data in addition to making calls. There is a workable infrastructure in place in order to provide priority calling in the event of disaster—but the changing nature of wireless communication may cause unprecedented difficulty.

The U.S. satellite infrastructure may be significantly damaged by EMP. Not only may GPS and other satellite-dependent devices be damaged by EMP, but the satellites themselves may be affected. Both line-of-sight exposure and residual radiation will degrade satellite performance after an EMP attack. The x-rays, gamma rays, and UV radiation emitted during a nuclear explosion will propagate in outer space and affect the performance of satellites within line-of-sight exposure, which is a significant amount of Earth's orbit. Moreover, the Earth's magnetic field could act as a container to trap energetic electrons and form a radiation belt that would encircle the Earth.[37] Both of these effects will degrade satellite performance. It has been demonstrated that large EMP explosions will cause a significant portion of satellites to fail.[38] Generally, old satellites that have been exposed to previous cosmic radiation, satellites in low orbit, and new satellites that are faster and lighter are most at risk of failure. An EMP explosion will cause significant degradation of the U.S. satellite network, increasing the importance that other methods of communication are maintained.

The recent earthquake in Haiti can serve as a model for EMP catastrophe in the United States if the attack destroys a significant portion of the electrical, transportation, and communications infra-

34. *Ibid.*, p. 67.
35. *Ibid.*, p. 66.
36. *Ibid.*, p. 68.
37. J. A. Van Allen and L. A. Frank, "Radiation Around the Earth to a Radial Distance of 107,400 KM," *Nature*, Vol. 183 (February 14, 1959), p. 433.
38. Foster, Jr., *et al.*, "Report of the Commission to Assess the Threat to the United States from EMP Attack," p. 163.

structure. With the destruction of most of the nation's infrastructures, the U.S. will be plunged into a total catastrophe where the resources of the U.S. government alone will be insufficient to allow the country to recover. When dealing with a disaster of this scope, there must be serious collaboration with foreign entities in order to plan the delivery of emergency supplies and alleviate the crisis. The plight of Haiti demonstrates the need for an international disaster response coordination in which the U.S. may be the recipient, not the donor, of massive foreign aid. This will be impossible without effective communication to provide situational awareness, transmit needs assessments, and organize the delivery of assistance.

With the destruction of most of the nation's infrastructures, the U.S. will be plunged into a total catastrophe. The resources of the government will be insufficient to let the country recover.

A magnitude 7.0 earthquake struck Haiti on January 12, 2010. This earthquake destroyed much of the country, and nearly caused the collapse of leadership within the state. Between 100,000 and 230,000 died as a result of the earthquake.[39] It seems that 50 percent to 70 percent of the buildings in Port-au-Prince have collapsed, destroying nearly 250,000 homes and 30,000 businesses. More than a quarter of a million Haitians have been injured.[40] More worrisome for recovery efforts, "the country's new and only undersea fiber link…suffered major damage from the earthquake"[41] and will likely impede the ability to coordinate relief efforts. Haiti's infrastructure is in complete shambles, yet would be in a far worse state were it not for significant international aid.

As of September 2010, $3.3 billion in aid has been given to Haiti and another $1.1 billion has been pledged.[42] The United States, among other nations, has become heavily involved in Haitian disaster relief, sending troops and two medical ships to support the recovery effort, among other endeavors.[43] The U.S. even took over the Port-au-Prince airport in order to organize aid flights coming into the country and ease a bottleneck that has been slowing the arrival of supplies.[44] Foreign countries are heavily involved in the recovery efforts throughout Haiti and in a sense have taken over the country in order to prevent its collapse.

Even with heavy foreign involvement, the Haitian government is struggling to maintain its authority. Haitian President Rene Preval has to publicly insist that "Haiti will not die" in an attempt to maintain his authority as recovery efforts progress.[45] Protestors angry with the slow pace of recovery have marched on both the mayor's facilities and the U.S. embassy shouting "Down with Preval," who has spoken to the public only a few times since the disaster occurred.[46] Preval's government is in a precarious state, as much of the populace is in the streets and the country is in shambles.[47]

39. "Haiti Death Toll Rises to 230,000," BBC News, February 11, 2010, at *http://news.bbc.co.uk/2/hi/americas/8507531.stm* (November 9, 2010).
40. Clarens Renois, "Haitians Angry Over Slow Aid," *The Age*, February 5, 2010, at *http://www.theage.com.au/world/haitians-angry-over-slow-aid-20100204-ng2g.html* (November 9, 2010).
41. Christopher Rhoads, "Quake Sets Back Haiti's Efforts to Improve Telecommunications," *The Wall Street Journal*, January 15, 2010, at *http://online.wsj.com/article/SB10001424052748703657604575005453223257096.html* (November 9, 2010).
42. "Haiti-Earthquakes–January 2010," United Nations, Office for the Coordination of Humanitarian Affairs, September 29, 2010, at *http://fts.unocha.org/reports/daily/ocha_R10_E15797_asof___1009291517.pdf* (September 29, 2010).
43. FOX News, "US Spearheads Global Response to Haiti Earthquake," January 13, 2010, at *http://www.foxnews.com/politics/2010/01/13/spearheads-global-response-haiti-earthquake/* (September 29, 2010).
44. Reuters, "US Takes Control of Haiti Airport to Speed Aid," January 15, 2010, at *http://www.reuters.com/article/idUSN1513622820100116?type=marketsNews* (September 29, 2010).
45. "Haiti Will Not Die, President Preval Insists," BBC News, February 12, 2010, at *http://news.bbc.co.uk/2/hi/americas/8511997.stm* (November 9, 2010).
46. Renois, "Haitians Angry over Slow Aid."

The most critical capacity provided by government in the face of disaster is legitimacy, providing the reassurance that government is functioning. This capability is impossible without the ability to communicate both within the country and with nations providing external support.

The Haitian tragedy serves as a cautionary model for total catastrophe in the U.S. As Americans have never experienced nationwide disaster, they are completely unprepared for a catastrophe on the scale of an EMP attack. Indeed, the challenge for the U.S. is infinitely greater. In addition to taking care of its own citizens, the U.S. has global responsibilities, including military forces stationed worldwide, which will still require command and control from Washington.

Mustering a global response requires above all the capacity to communicate. Redundancy in communications will be vital. Radio communications, for example, are highly insulated from the EMP threat. The lack of a need for a transmissions infrastructure and the global scope of shortwave radio make it extremely likely that radio communications will continue to function. Ham radios and other communication devices themselves may be destroyed, but the infrastructure itself is nearly invulnerable. Using radio or other means-assured emergency broadcasts as well as interactive communications will be essential.

Time to Act

Recent disasters suggest an important to-do list for handling EMP threats:

- **Prevent the threat.** Regardless of the mitigation and response measures, a massive EMP impact could have a devastating impact on the United States. Washington must pursue an aggressive protect-and-defend strategy, including comprehensive missile defense; modernizing the U.S. nuclear deterrent; and adopting proactive nonproliferation and counterproliferation measures, both unilaterally and in partnership with allies.
- **Provide resilience.** Measures must be adopted to ensure the resilience of the U.S.–Canadian electrical grid and telecommunications systems, including developing limited redundancy and identifying means for the timely replacement of essential damaged parts or their rapid substitution.
- **Plan for the unthinkable.** The U.S. must have robust pre-disaster planning—with practical exercises that include top officials who rehearse a wide variety of contingency scenarios—that integrates federal, state, local, private-sector, nongovernmental organizations, and international support.
- **Protect the capacity to communicate.** The U.S. must have the means to establish assured emergency broadcast as well as interactive communications both within the U.S. and across the globe. An EMP strike can easily obliterate America's electrical, telecommunications, transportation, financial, food, and water infrastructures, rendering the United States helpless to coordinate actions and deliver services essential for daily life. In the words of Arizona Senator Jon Kyl, EMP "is one of only a few ways that the United States could be defeated by its enemies."[48] The time to prepare is *now.*

*—**James Jay Carafano, Ph.D.**, is Deputy Director of the Kathryn and Shelby Cullom Davis Institute for International Studies, and Director of the Douglas and Sarah Allison Center for Foreign Policy Studies, a division of the Davis Institute, at The Heritage Foundation; **Richard Weitz, Ph.D.**, is Senior Fellow and Director of the Center for Political–Military Analysis at the Hudson Institute.*

47. Simon Romero and Marc Lacey, "Government Struggles to Exhume Itself," *The New York Times*, January 15, 2010, at *http://www.nytimes.com/2010/01/16/world/americas/16preval.html?_r=3&hp* (November 9, 2010).
48. Jon Kyl, "Unready for This Attack," *The Washington Post*, April 16, 2005, at *http://www.washingtonpost.com/wp-dyn/articles/A57774-2005Apr15.html* (November 9, 2010).