

When Things Go Dark...

*HEMP/Geomagnetic Storm Effects on All Things
Electronic*

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Principal/Owner



High-Altitude Electromagnetic Pulse (H-EMP)

- Scenario envisions a nominal nuclear device detonating between 40 and 130 miles above the earth, hence H-EMP.
- The effects on the US critical infrastructure discussed here can also be expected from a Geomagnetic storm caused by a significant Solar Storm event
 - Astrophysicists point to evidence that a very high level of severe solar activity will start in late 2011 and peaking about May 2013¹

“....a tendency in our planning is to confuse the unfamiliar with the improbable. The contingency we have not considered looks strange; what looks strange is therefore improbable; what seems improbable need not be considered.”

Thomas C. Schelling
Pearl Harbor: Warning & Decision
Stanford University Press, 1962

Solar Storm



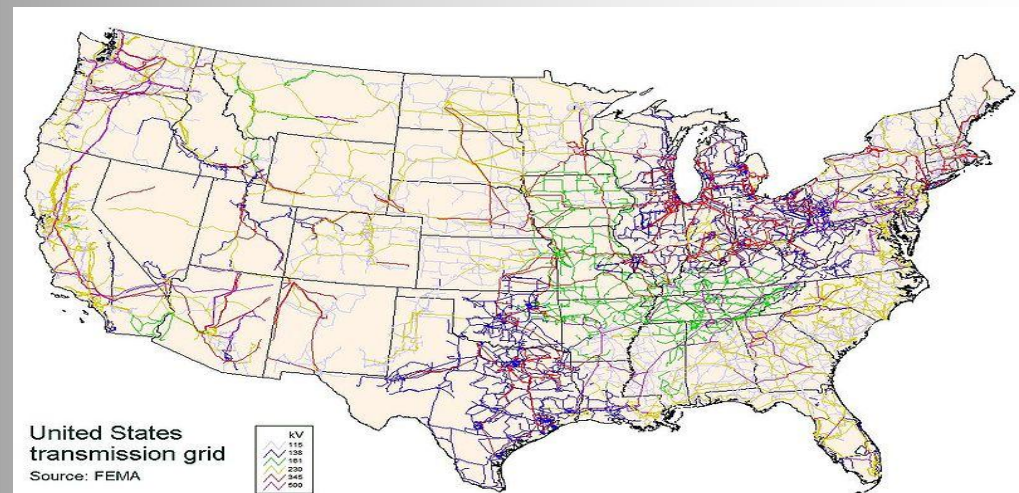
HEMP



Note ¹: *High-Energy Astrophysics Division attached to the Harvard-Smithsonian Center for Astrophysics.*

The Wave Plays Against Our Most Critical and Connected Infrastructure

- Gamma rays from a high-altitude nuclear detonation interact with the atmosphere to produce a radio-frequency wave of unique, spatially varying intensity that covers everything within line-of-sight...three distinct frequency waves which infiltrate from the free field or from antennae (cable connections) to compromised electromagnetic integrity.
- No direct effect on humans



The Shock to System

- **First EMP Component (E1); Electromagnetic Shock:**
 - A free field energy pulse with a rise-time measured in the range of a few nanoseconds.
 - E1 upsets protection/control systems, damages control and protective system components and causes critical infrastructure plants to initiate emergency shutdown – and controls that manage orderly shutdown are also damaged.
- **Second EMP Component (E2); “Lightning Strike”**
 - Covers roughly same geographic area as the E1, but far more geographically widespread in its character and lower amplitude.
 - Follows a small fraction of a second after E1 - take advantage of the damage already done by E1, and allow it to pass into/through and damage systems.
 - By the time E2 hits, many circuit and system safeguards will be ineffective
- **Third EMP Component (E3); Killer Punch**
 - Subsequent, slower-rising, longer duration pulse. -Creates currents in long electricity transmission lines, resulting in catastrophic damage to electrical supply and distribution systems.
 - Creates a cascading effect within US critical infrastructure - increasing damage as a result of earlier effects...all measured in billionths of a second.

Commission Findings

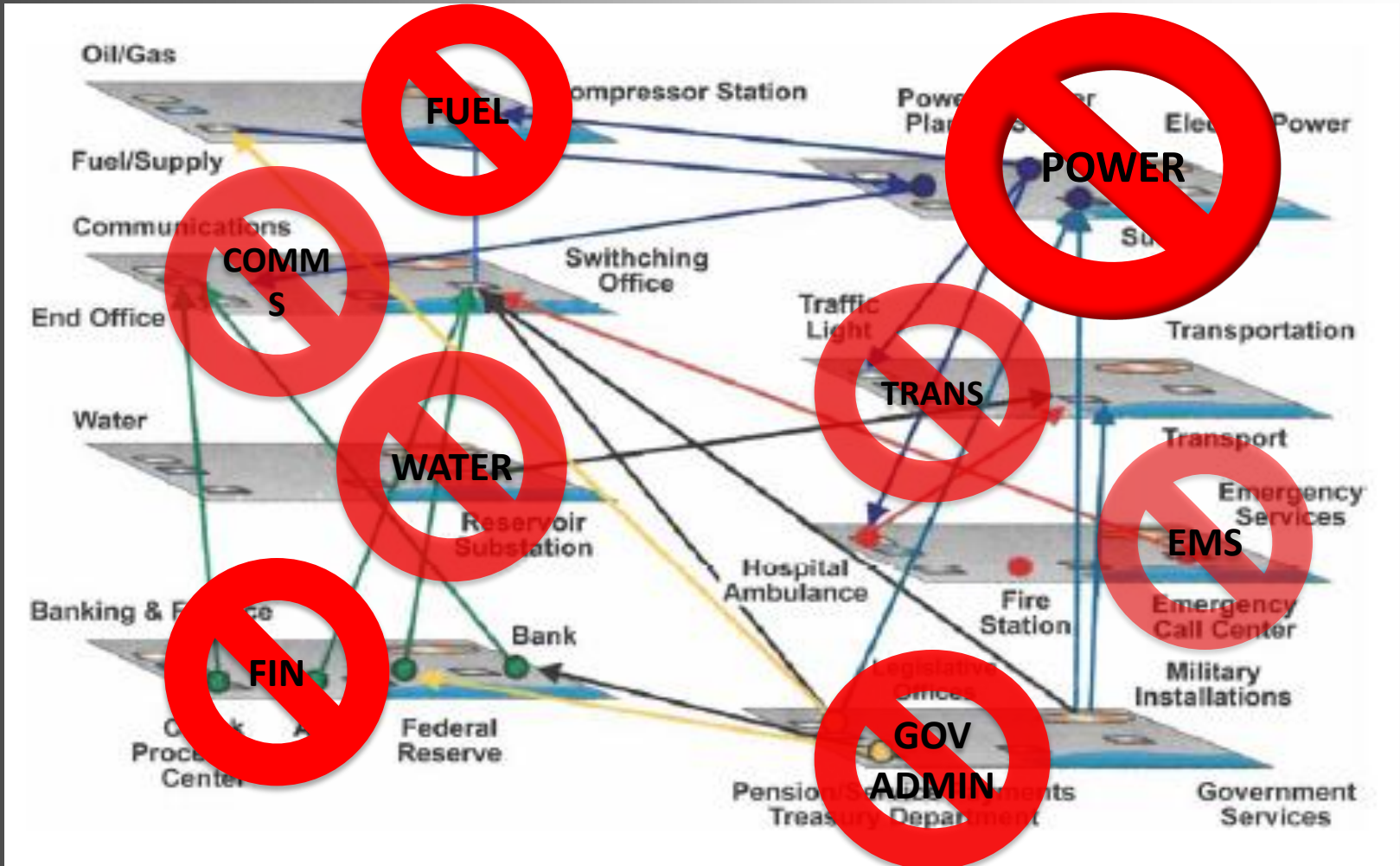
- *“Many of the control systems that we considered achieved operational connectivity through **Ethernet cabling**. EMP coupling of electrical transients to the cables proved to be an important vulnerability during threat illumination.”*
- *“The Commission has concluded that even a relatively modest-to-small yield weapon of particular characteristics, using design and fabrication information already disseminated through licit and illicit means, can produce a potentially **devastating E1 field strength over very large geographical regions.**”*



Figure 2-3. GIC Damage to Transformer During 1989 Geomagnetic Storm

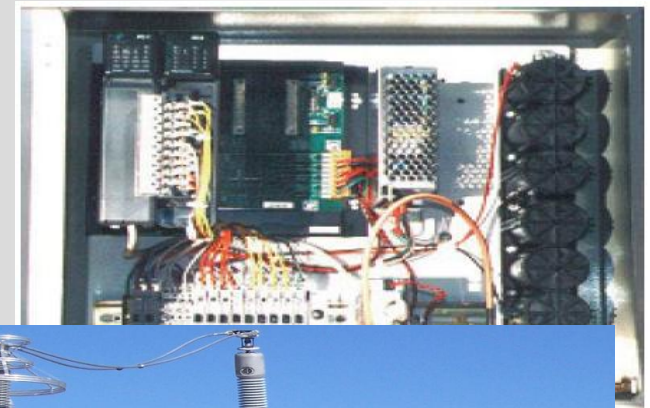
US Critical Infrastructure Interdependence

The So What



How HEMP Attacks Electrical Systems

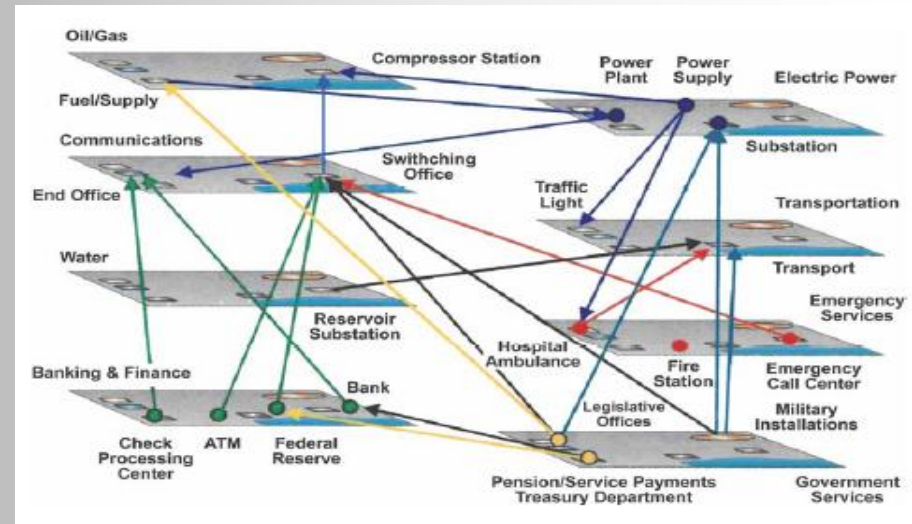
- Supervisory Control & Data Acquisition (SCADA) Systems – remotely monitor operating state of physical systems, working along interconnected digital control systems (DCS) and programmable logic circuits (PLC) **subject to flash-over.**
- Tests at North American Electric Reliability Corporation (NERC) proved that all systems exposed to EMP shock failed from the EMP **coupling of electrical transients** along cables.



~2,000 VHV Transformers in US
“Delivery of these systems under benign conditions is usually 2 years...” Ibid

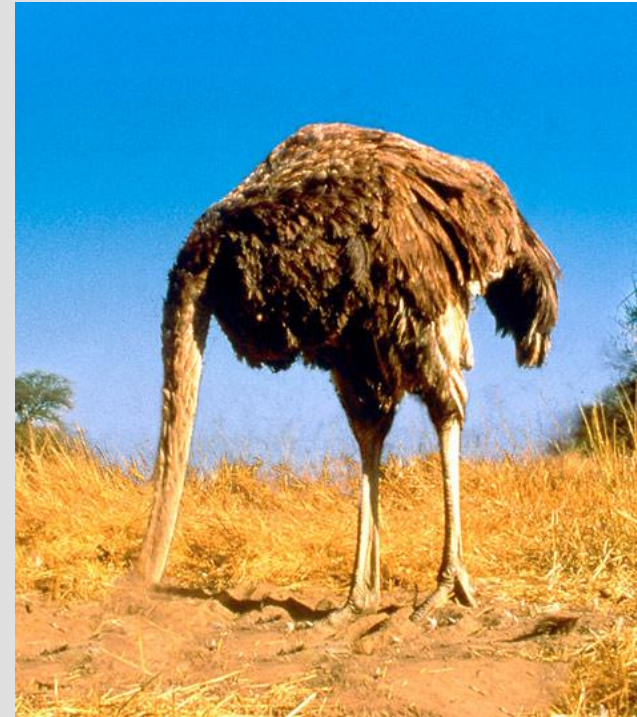
Potential Results...

- **Catastrophic loss of power grid**
- Limited communications
- Degrading or **loss of orbital communications/navigation**
- Transportation, utility, basic services cease
- Food production ceases; large scale starvation and death
- Breakdown in civil systems
- Long, long recovery cycle
- Police departments will be overwhelmed
- Estimated costs over DC alone = \$770 Billion (*James Zumwalt, Washington Times, October 2007*)



What US Strategy Looks Like

- National Mitigation
 - Some strategic US Defense assets have been hardened
 - Non-proliferation has been the main focus for Commission recommendations
 - Identifying critical infrastructure, especially within DoD to shape redundant, back-up technology packages has been discussed
 - The EMP Commission pointed to a more robust missile defense strategy



Mitigation Scheme

- Protection from the force of the EMP wave while using a device connected to the power grid is not easy
 - Reduce exposure to long-line transmission.
 - **Build back-up**, protected power source for critical systems.
- **Duplicate/redundant stand-by systems** can be protected by storing in insulated, metal containers (Faraday Cage).
- Some systems with little exposure to the power grid may survive (later generation automobiles, for instance).

Recovery Considerations

- Wargaming highly recommended to study your agency's particular exposure and requirements
 - Continuity of Operations Plan (COOP)
 - Business Continuity Plan (BCP)
 - Disaster Recovery Plan (DRP)
- Individual Family Disaster Plan



Probability

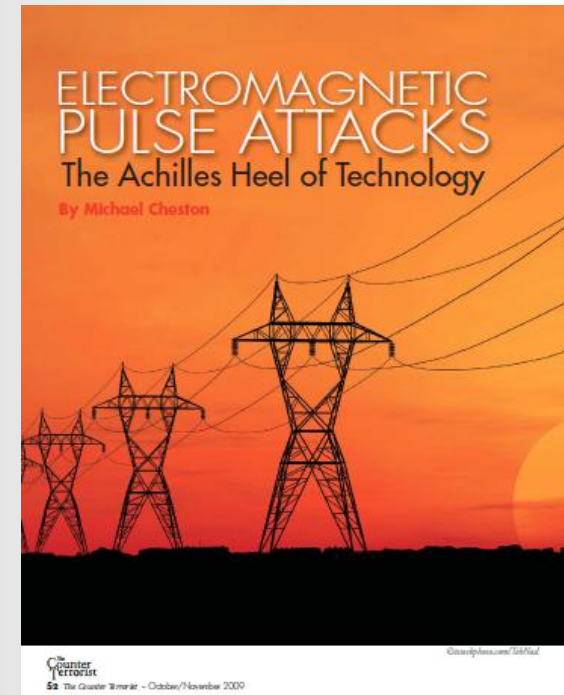
- The argument of probability of a HEMP is debatable.
 - Iran continues to develop a nuclear and missile capability/threat and has acknowledged EMP as a weapon.
 - North Korea, China, and others are capable, but will they exercise this capability?
- However, there is a 100% probability of a solar storm with enough magnitude to significantly damage strategic US critical infrastructure

“It is not a matter of *it*, it is a matter of *when*.” General Eugene Habiger, USAF (Ret)
Former Commander-in-Chief, USSTRATCOM, May 2002

“A solar storm’s power to threaten modern infrastructure is real and it’s on its way” Dr. Yousaf Butt, a physicist working at the High-Energy Astrophysics Division attached to the Harvard-Smithsonian Center for Astrophysics.

More Information

- Report of the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack, April 2008, <http://empcommission.org/>
- Institute for Science and International Security, <http://www.isis-online.org/>
- EMPact America, http://www.empactamerica.org/about_emp2.php
- Rick Adrian, EMP Resilience, 614-302-2393 <http://www.emp-resilience.com/>
- One Second After, William Forstchen, <http://www.onesecondafter.com/index.html>



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Naval Surface Warfare Center-Dahlgren,

Institute for Defense Analyses,

Mission Research Corporation,

Jaycor/Titan,

Metatech Corporation,

SAIC

SERAPH INC

Questions...

- Have a plan...
- BTW
 - Shelter in place may not be such a good idea...
- *Semper Paratus...*