

Commission to Assess the Threat from High Altitude Electromagnetic Pulse (EMP): Overview

Dr. William R. Graham,
Chair

Dr. John S. Foster Jr.

Mr. Earl Gjelde

Dr. Robert J. Hermann

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GEN Richard L. Lawson

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Dr. Lowell L. Wood Jr.

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NASA Earthlights photographic montage of the world viewed from space at night with HEMP superimposed

EMP Commission Charter

EMP Commission
Public Law 106-398,
Title XIV

Duties of Commission

- **Assess the EMP Threat to the US:**
 - Nature and magnitude of EMP threats within the next 15 years
 - From all potentially hostile states or non-state actors
 - Vulnerability of US military and especially civilian systems
 - Capability of the US to repair and recover from damage to military and civilian systems
 - Feasibility and cost of EMP hardening select military and civilian systems
- **Recommend protection steps the US should take**

Commission considered:

- **Only EMP threats produced by high-altitude detonation of a nuclear weapon**
- **Threat assessment based on present and possible future capabilities of potential adversaries because of 15-year outlook**

Commissioners

- Dr. John S. Foster, Jr. (Director LLNL; Director DDR&E)
- Mr. Earl Gjelde (Chief Engineer and Acting Director, Bonneville Power Administration; Under Secretary Dept of Interior, COO, Dep of Energy)
- Dr. William R. Graham (Chairman) (Director, OSTP; Science Advisor to President Reagan)
- Dr. Robert J. Hermann (Director, NRO; Principal Dep Asst Sec USAF; Senior Vice President, United Technologies)
- Mr. Henry (Hank) M. Kluepfel (VP SAIC; Advisor to the President's NSTAC)
- GEN Richard L. Lawson, USAF (Ret.) (DCINC US European Command; Director Plans and Policy JCS)
- Dr. Gordon K. Soper (PDATSD NCB; Director Nuclear Forces C3; Chief Scientist DCA)
- Dr. Lowell L. Wood, Jr. (Director's Staff LLNL; Technical Advisor, SSCI & HASC, Visiting Fellow, Stanford U. and Hoover Institution)
- Dr. Joan B. Woodard (Exec VP & Deputy Director Sandia National Labs)

Seven Commissioners were appointed by the Secretary of Defense and two by the Director of the Federal Emergency Management Agency

Commission Products

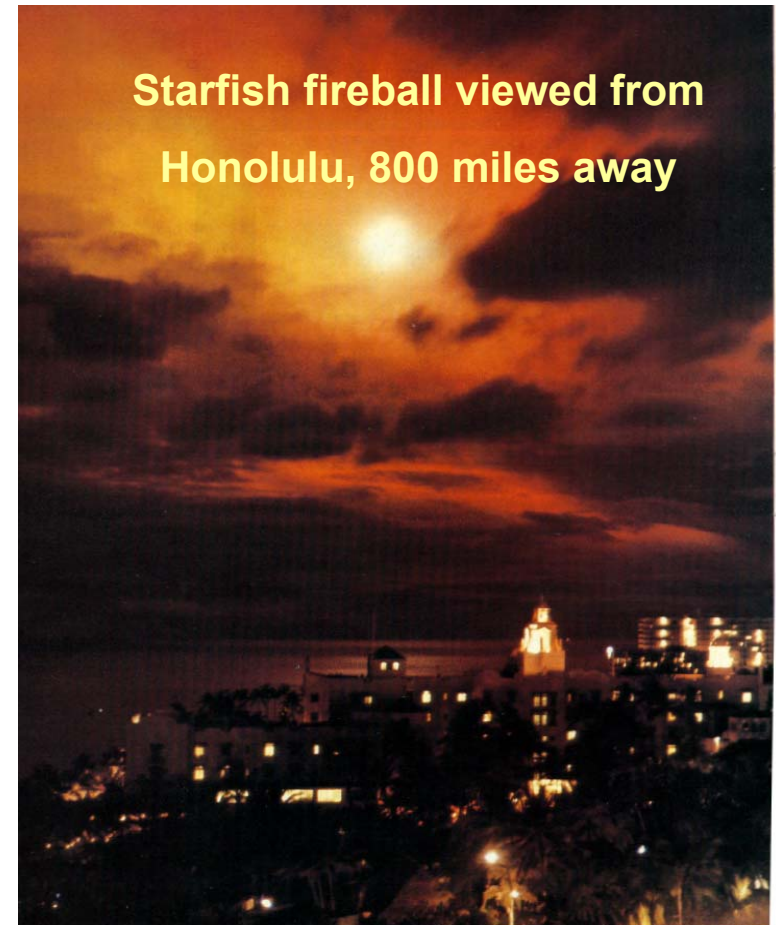
- Vol. 1 Executive Summary (UNCLASSIFIED)
 - Vol. 2 Threat Assessment (SECRET)
 - Vol. 3 Critical Infrastructure Assessments (UNCLASSIFIED)
 - Vol. 4 Military Topics (SECRET)
 - Vol. 5 Assessment of Potential Threats (TOP SECRET, SCI)
- Congressional testimony:
- Commission Chairman’s open session testimony (UNCLASSIFIED)
 - Commission Chairman’s closed session testimony (TOP SECRET,SCI)

Commission Products (continued)

- Staff papers and analyses
- Technical reports of sponsored research performed under contract to the Commission by government organizations and contractors
- Workshop proceedings
 - Critical Infrastructures Interdependency Modeling Workshop
 - Space Systems Workshop (CIA)
 - Seminar with former Russian military officers
- Report of foreign perspectives

EMP Threat: Historical Evidence

- STARFISH event, July 9, 1962
1.4 Megaton, 400 KM HOB,
Thor delivery vehicle, 800 nautical
miles from Honolulu
- EMP effects felt in Hawaii
 - coupling to Hawaiian electrical
transmission grid turns off nighttime
lights in Honolulu
 - Kanai telecom microwave outage
- Collateral effect: Sky swept clean of
of all commercial satellites within
six months



EMP Threat: Historical Evidence (continued)

- EMP observed during US and Russian atmospheric test programs
- EMP damages and disrupts electronics—does not directly harm people

Observed EMP Anomalies During USSR Atmospheric Testing (circa 1960)



Overhead Transmission Line and Telecommunications Disconnection and Damage

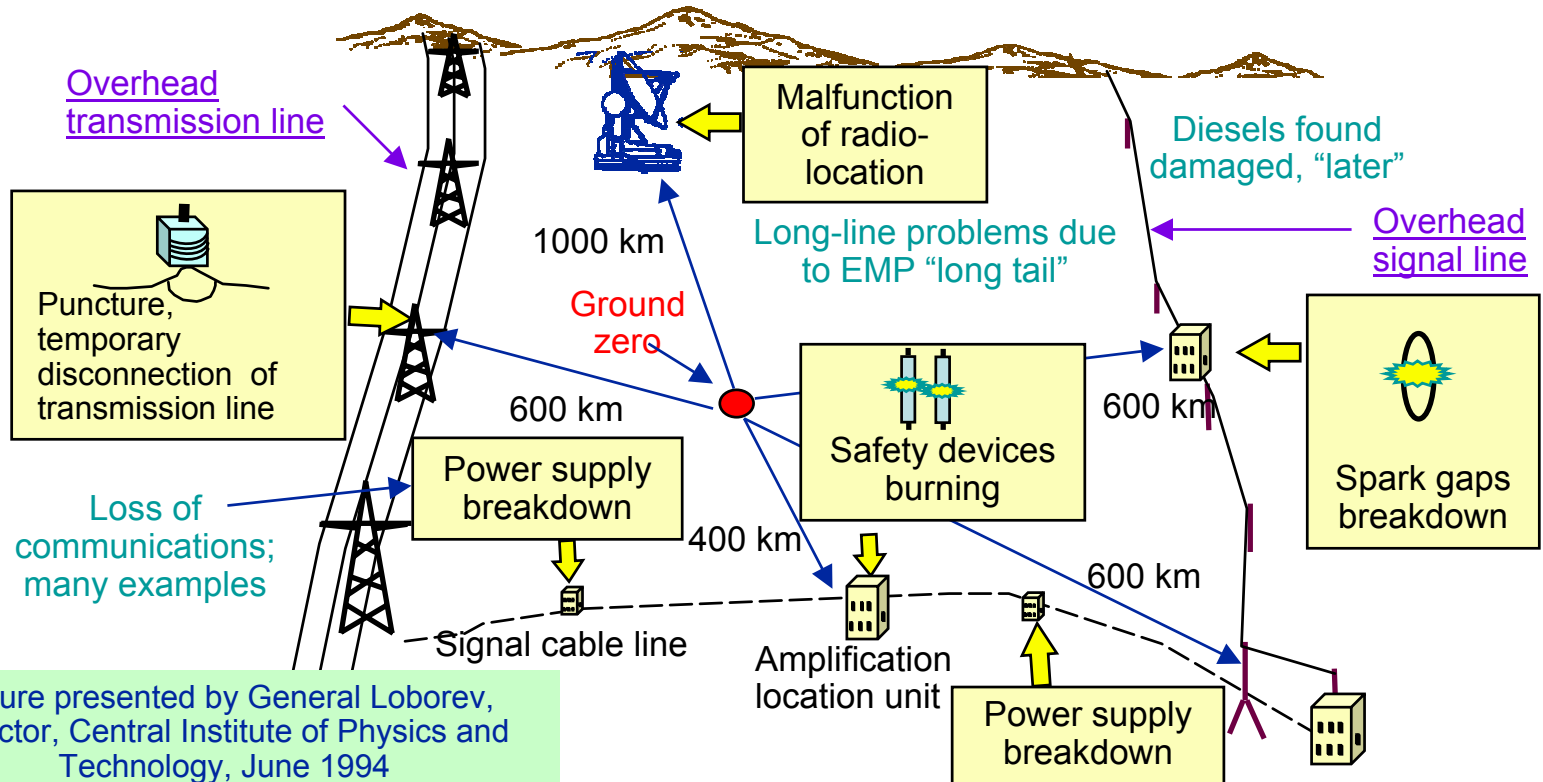


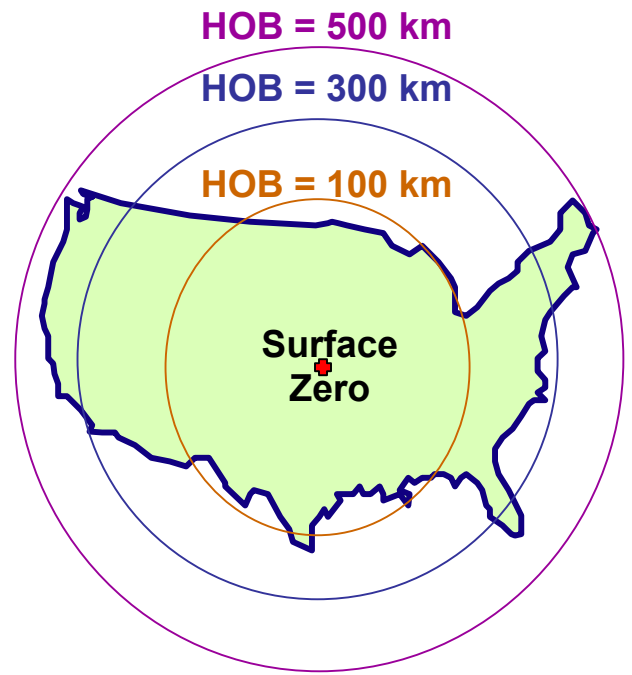
Figure presented by General Loborev, Director, Central Institute of Physics and Technology, June 1994

- Capability-based methodology for assessing potential EMP threats
- It is a mistake to focus on the relative likelihoods of various threats
 - Our ability to estimate such probabilities is questionable
 - The time between an accurate forecast and an attack could be small
- Prudent to focus on the threat capabilities over the next 15 years that can hold our society at risk or might result in defeat of our military forces
- Nuclear weapon expertise is mobile

Threat: Nature and Magnitude of EMP Threats Within the Next 15 Years

- EMP is one of a small number of threats that may
 - Hold at risk the continued existence of today's US civil society
 - Disrupt our military forces and our ability to project military power
- The number of US adversaries capable of EMP attack is greater than during the Cold War
- Potential adversaries are aware of the EMP strategic attack option
- Threat not adequately addressed in US national and homeland security programs

EMP Coverage for Bursts of Various Heights



- **Wide area coverage**
 - A million square miles
- **Intensity depends on:**
 - Weapon design
 - Height of burst
 - Location of burst
- **Broad frequency range**
- **Threat to all electronics in exposure**

Vulnerability may be an invitation to attack

Vulnerability of US Electric Power Infrastructure

- EMP induced functional collapse of the electrical power grid risks the continued existence of US civil society
 - Immediate EM transients likely to exceed capabilities of protective safety relays
 - Late time EMP could induce currents that create significant damage throughout the grid
- National electrical grid not designed to withstand near simultaneous functional collapse
- Procedures do not exist to perform “black start”
 - Restart would depend on telecom and energy transport which depend on power
- Restoration of the National power grid could take months to years
 - Typical 500kV transformer costs \$10M
 - Generally each is custom tailored to application
 - Spares do not exist
 - Manufacturing performed offshore



Substation Transformer



Melted 500kV transformer coil from EMP induced flux creating a hot spot

**EMP induced destruction of power grid components
could substantially delay recovery**

Capability of the US to Repair and Recover from Damage to Civilian Systems

Other Civilian Infrastructures Dependent Upon Availability of Power

- **Telecommunications:**
 - May be significantly impacted, at least at the outset
 - Recovery will be dependent on prompt restoration of power
- **Financial system:**
 - Vulnerable to an EMP induced disruption of telecommunications and computers
- **Remote controls** in infrastructures are at risk of disruption and damage
 - **Transportation** infrastructure is vulnerable to disruption.
 - **Oil and gas supplies** likely disrupted due to failures of pump and valve controls
 - **Potable water** likely disrupted in the region affected by the EMP
 - **Distribution of food** may be degraded
- US scientific and technical capability to address EMP and other nuclear weapon effects has diminished to the point where continued viability is questionable

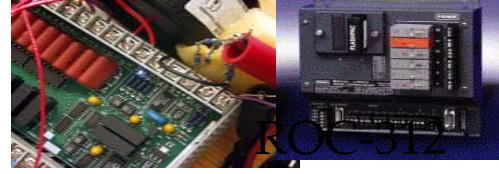


No credible capability exists to predict the full response of a single system (e.g., national power grid), let alone the highly interdependent US infrastructure

EMP Commission Infrastructure Test Activities

- Power

Electromechanical and electronic relays, generator controls, RTU/MTU/DSC/PLC control devices, ...



- Telecommunications

wireless cell tower, E911 switch equipment, routers, frame relay switch, modems, corded/cordless phones, IP Data Network elements, NOC equipment, ...

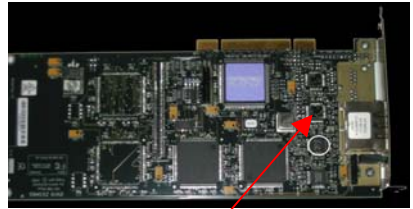


- Transportation

cars, trucks, traffic control systems, railroad switches,.

- Emergency Services

police/fire civilian communications devices, mobile command centers, medical equipment/pacemakers, radio/TV,...



Damaged Component

- Energy Distribution (Gas/Oil)

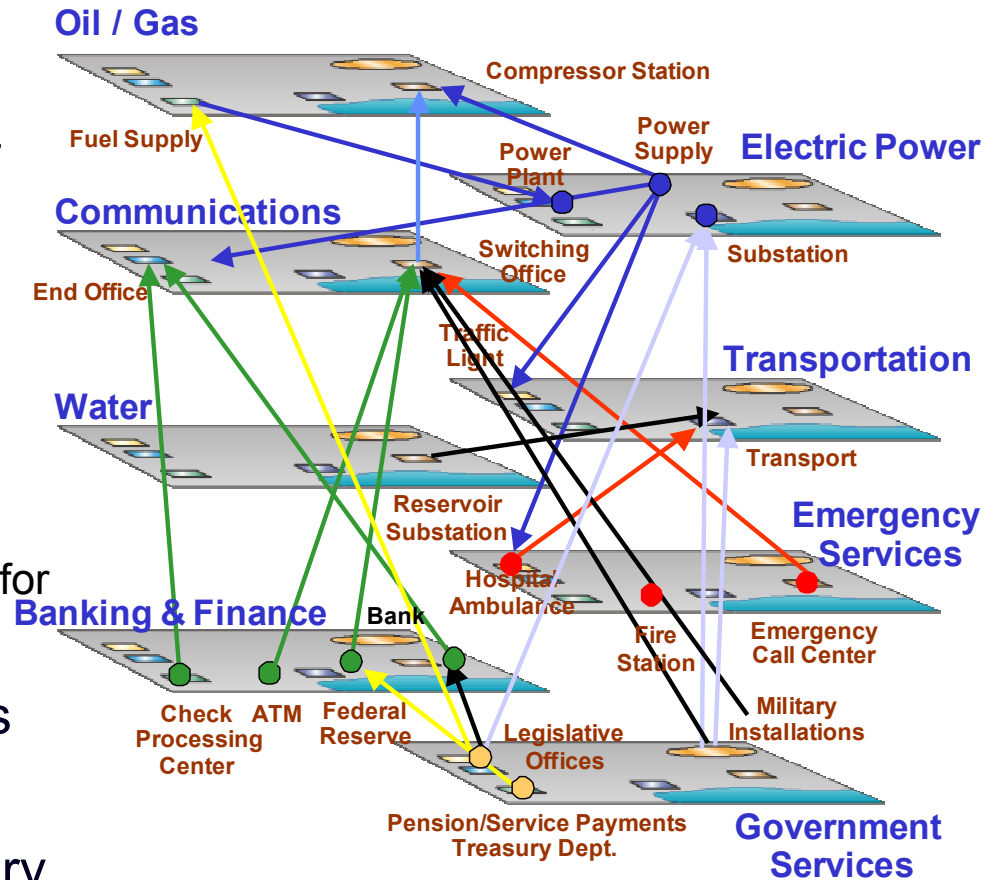
SCADA systems, pipeline/pump/valve control systems,...

- Food/Water

water distribution system controls, refrigerator/freezers...

Vulnerability of US Military and Civilian Systems

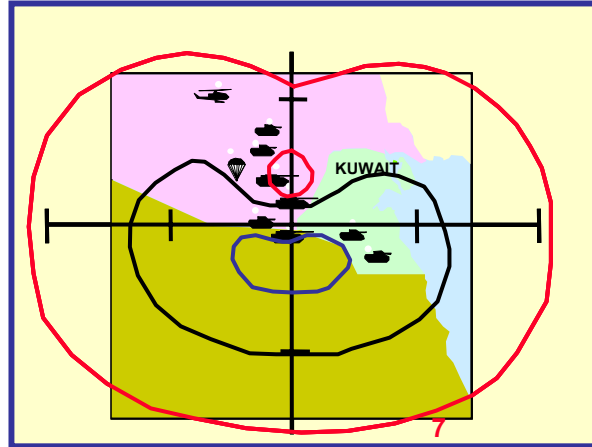
- One or a few high-altitude nuclear detonations can produce EMP, simultaneously, over wide geographical areas
- Unprecedented cascading failure of our electronics-dependent infrastructures could result
 - Power, energy transport, telecom, and financial systems are particularly vulnerable and interdependent
 - EMP disruption of these sectors could cause large scale infrastructure failures for all aspects of the Nation's life
- Both civilian and military capabilities depend on these infrastructures
- Without adequate protection recovery could be prolonged—months to years



Capability of the US to Repair and Recover From Damage to Military Systems

Military Systems:

- Our military forces are at risk from EMP attack
 - Proliferating threat heightens that risk
 - Asymmetric vulnerability invites EMP attack



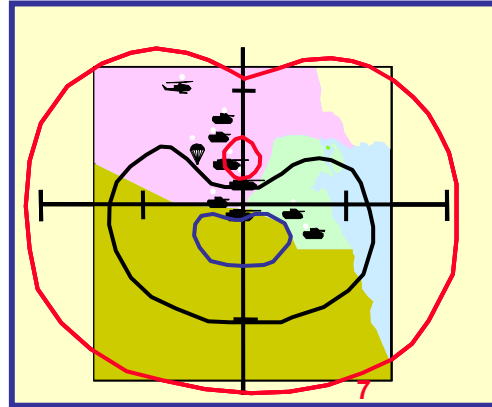
A single EMP weapon can cover
a large portion of an operation

A risk that on future battlefields our small technically superior fighting force
could be reduced to a small vulnerable force

Capability of the US to Repair and Recover From Damage to Military Systems - cont

Military Systems:

- Strategic Forces
 - EMP survivability remains essential for the New Triad
 - Offensive forces, Defensive forces, Responsive Infrastructure
 - End of Cold War relaxed discipline for meeting capability for EMP hardness

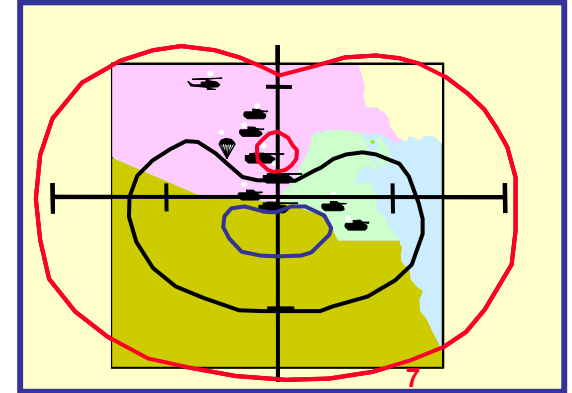


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Capability of the US to Repair and Recover From Damage to Military Systems - cont

Military Systems:



A single EMP weapon can cover
a large portion of an operation

- General Purpose Forces

- US policy to create EMP hardened tactical systems

- Strategy relies on DOD acquisition system resulting in hardened components
 - Does not provide confidence in fielded forces as a system – harder equipment embedded in softer system

A risk that on future battlefields our small technically superior fighting force
could be reduced to a small vulnerable force

Danger of EMP Attack Can Be Mitigated

- Our free, modern society has inherent vulnerabilities that cannot be completely eliminated
- Catastrophe can be averted by practical and affordable steps to
 - *Prevent* attacks,
 - *Prepare* to recognize and respond to an EMP attack
 - *Protect* critical infrastructure elements and strategic military capabilities, and
 - *Recover* following attack
- National security and homeland security are Federal responsibilities that should be funded by the Federal government

In just a few years we can make significant, affordable improvements to protect society even if an EMP attack is carried out against us

We Can Do Something About It: Strategy and Recommendations:

- Address threats by preventing attack and limiting damage
 - Prevention--the highest priority is to prevent attack
 - *Shape global environment to reduce incentive for antagonists to create weapons; pursue intelligence, interdiction and deterrence to discourage EMP attack*
 - *Suppress ability to create them by making it difficult and dangerous to try*
 - *Counter creation and use of EMP weapons by threatening military and other violent response,*
 - *Establish a coherent global force to intervene*
 - Limiting damage in the event prevention fails
 - *Demonstrate will and capability to protect our most critical infrastructures, protect critical components with particular emphasis on those requiring long time to replace or repair – **power and telecommunications are key***
 - *Demonstrate will and capability to recover from any attack*

Susceptibility invites attack, therefore:

- Prevent attack, while
- Planning and preparing to limit damage in the event prevention fails

Strategy and Recommendations –cont.

- Homeland Security Council
 - Prioritize government- and society-wide efforts to counter the small number of threats that can hold our society at risk
- Department of Homeland Security
 - Establish a senior leadership position and resourced program for protection of America against society-threatening attacks
 - *Recognize an EMP attack and understand how its effects differ from other disruptions*
 - *Develop metrics for assessing improvement in prevention, protection, recovery*
 - *Promulgate standards, conduct research, exemplify best practice, prioritize and coordinate protection for critical infrastructures*
 - *Train, evaluate, Red Team exercises, and periodic reports to Congress*
 - *Improve capability to monitor and evaluate condition of key infrastructures*
 - *Coordinate development of plans to carry out systematic recovery of critical infrastructures*

The achievable objective is to preclude catastrophic failure--
develop the capability to fail as gracefully as possible
to facilitate bringing networks back on line

Strategy and Recommendations –cont.

- **Congress**
 - Define the Federal Government’s responsibility and authority to act to protect critical infrastructures
 - *Governance distributed among Federal, State, regional, municipal, and a variety of non-governmental entities and associations*
 - *DHS has unique and sole responsibility to coordinate homeland response in face of threat*
 - *DOD has unique and sole responsibility to assure the survivability and continued operational effectiveness of our military forces in the face of an EMP threat*
 - Recognize the opportunities for shared benefits
 - Conduct research to better understand infrastructure system effects and develop cost effective solutions to manage these effects

Strategy and Recommendations –cont.

We will address further conclusions and recommendations
in the closed session

Conclusions

- The EMP threat is one of a few potentially catastrophic threats to the United States
- By taking action, the EMP threat can be reduced to manageable levels
- US strategy to address the EMP threat should balance prevention, preparation, protection, and recovery
- Critical military capabilities must be survivable and endurable to underwrite US strategy