NUCLEAR ELECTROMAGNETIC PULSE

AND POST EMP COMMISSION ISSUES

Presented by
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Most of the Phenomenology Data Supplied by
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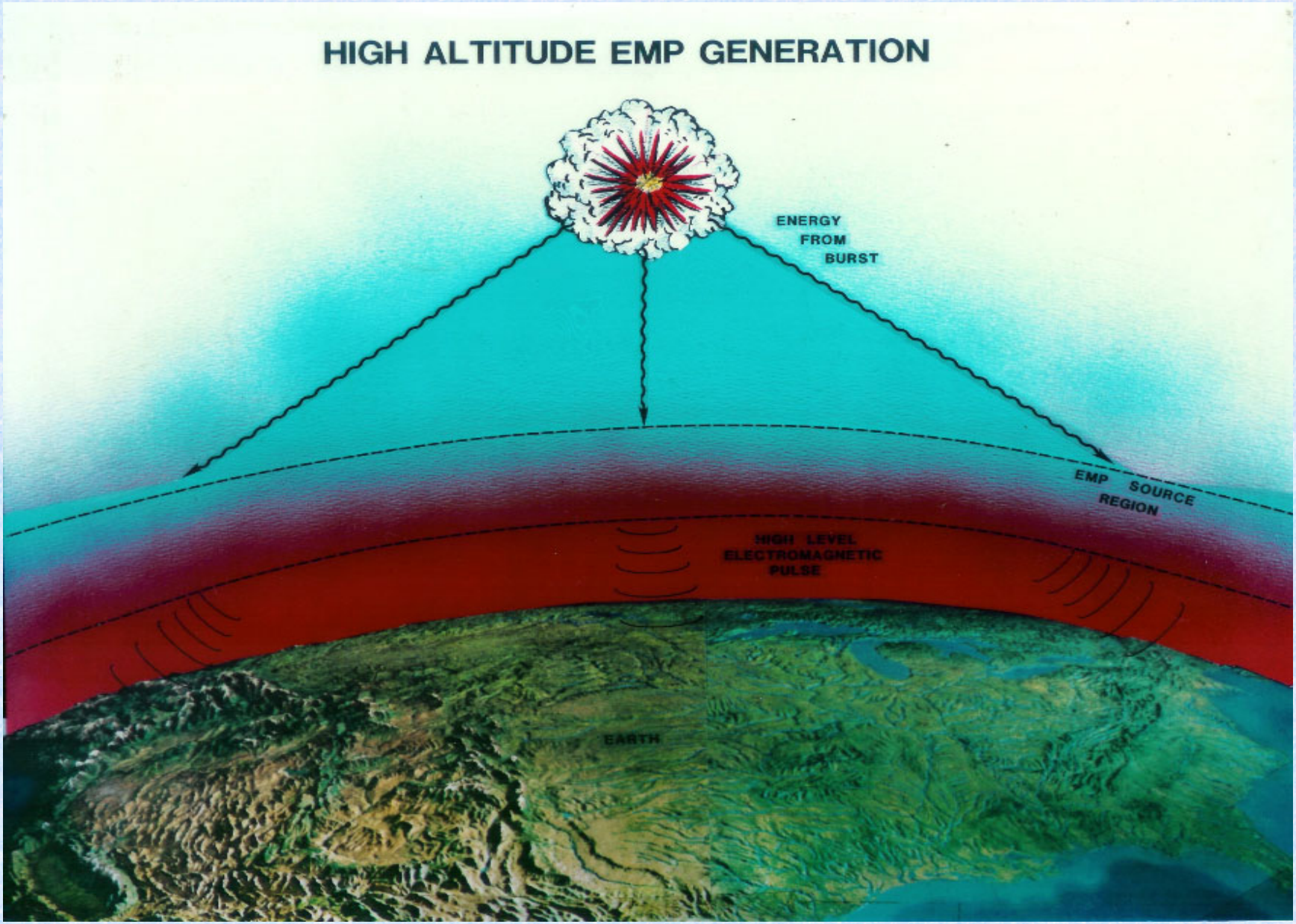
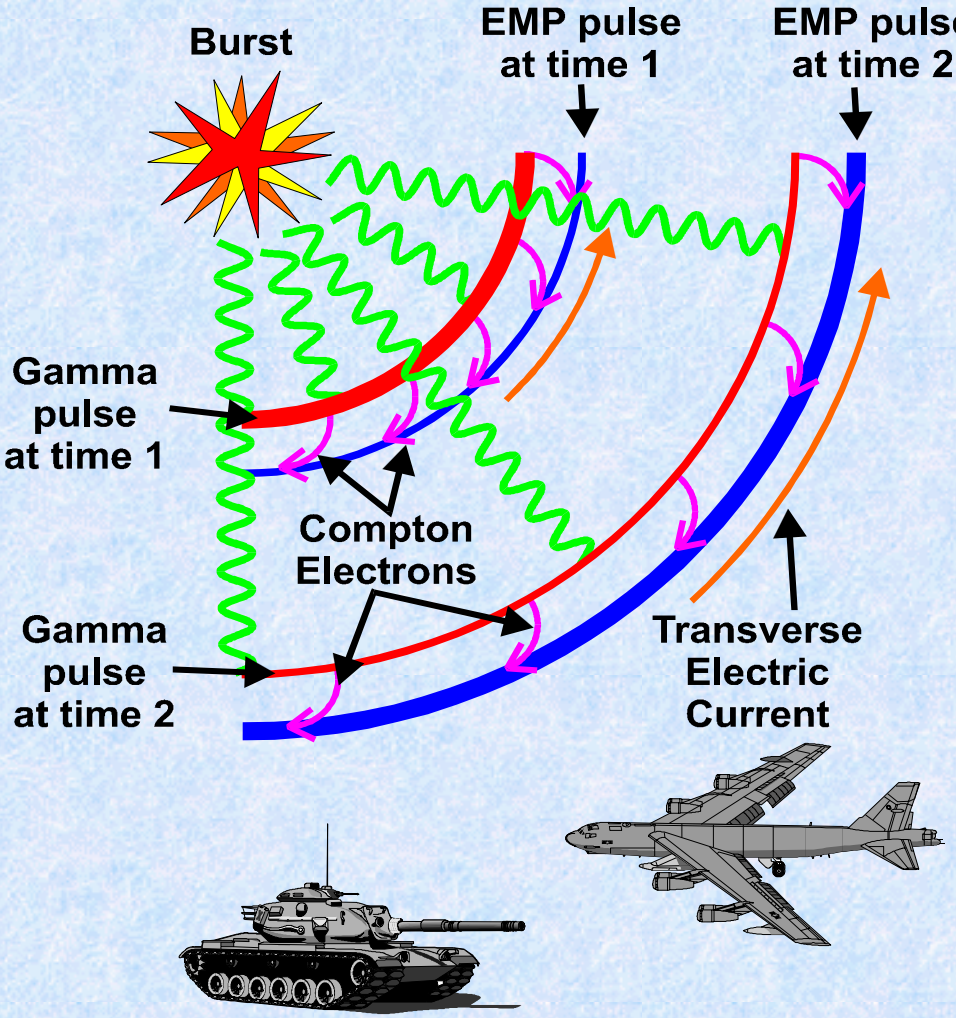
Outline

- **High Altitude EMP**
- **Threat Delivery Capabilities**
- **US EMP Commission**
- **Infrastructure Vulnerabilities**
- **Consequences**
- **Post EMP Commission Issues**
- **Recommendations**

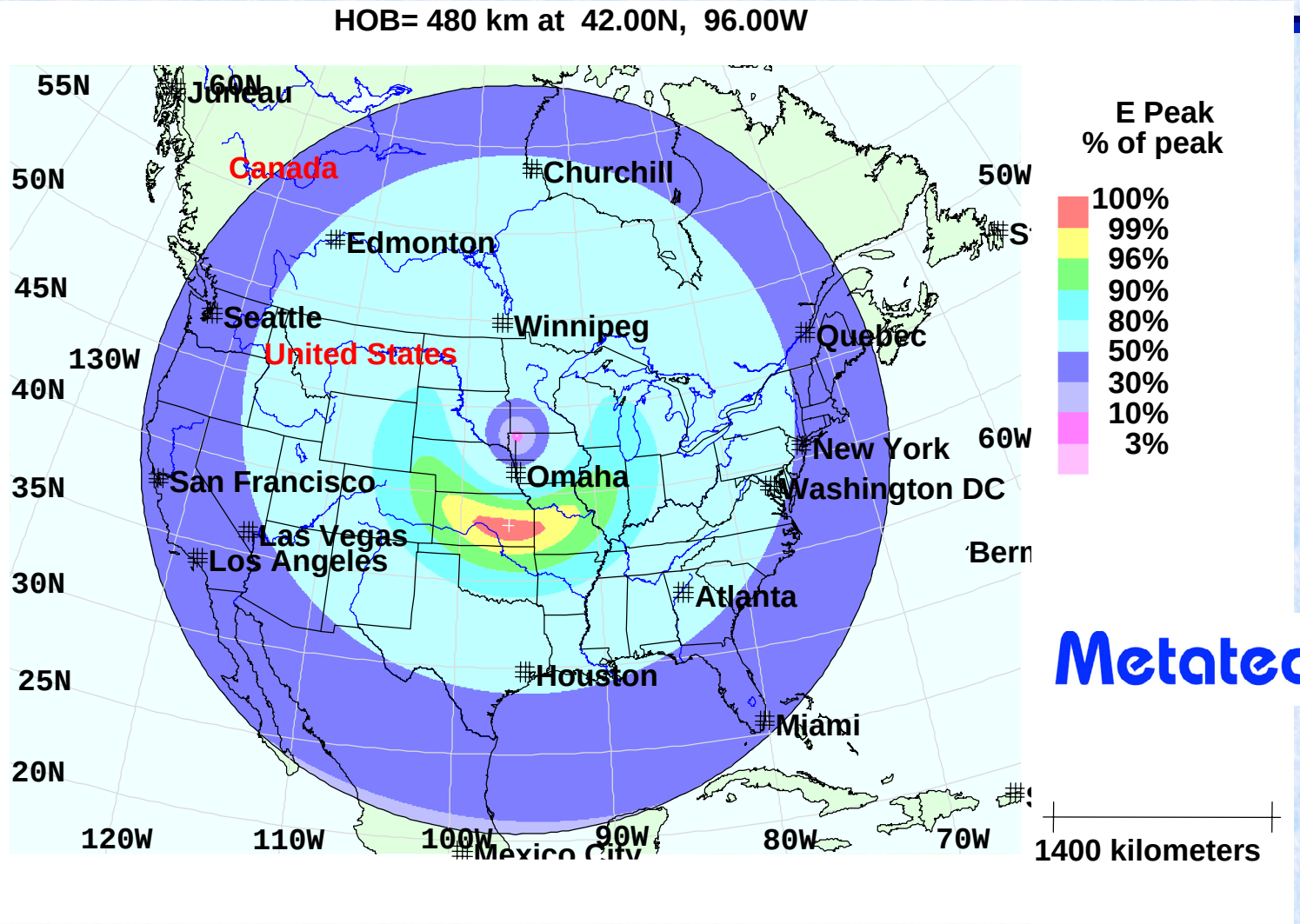

HIGH ALTITUDE EMP GENERATION
ENERGY
FROM
BURST
EMP SOURCE
REGION
HIGH LEVEL
ELECTROMAGNETIC
PULSE
EARTH

High-Altitude EMP (HEMP)



- Gamma-ray pulse emitted by burst propagates radially outward at speed of light.
- Gammas scatter off of air atoms and generate energetic Compton electrons, primarily between ~ 20 to 40 km altitude.
- Compton electrons are turned by Earth's magnetic field. Turning action generates transverse current that radiates EMP pulse.
- Gamma pulse and EMP pulse both propagate at speed of light, so they stay in phase.
  - EMP pulse grows as gamma pulse weakens.
- Scattered gammas and neutrons also contribute to HEMP signal.

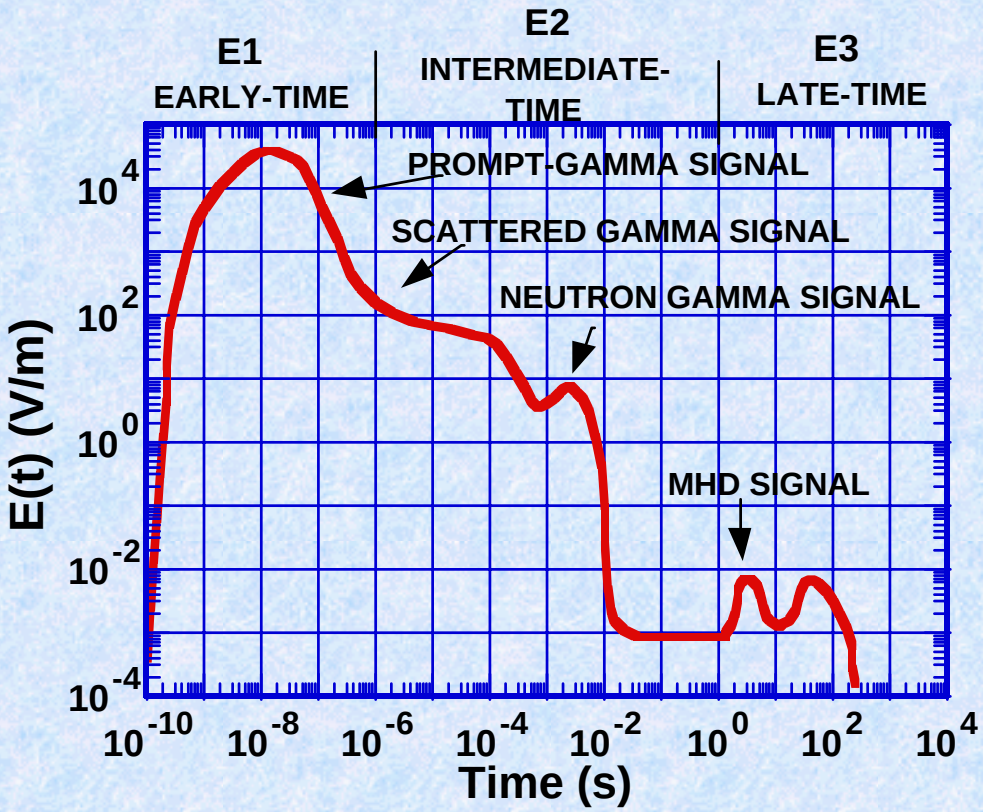
Large Yield HEMP E1 Detonation



HEMP Characteristics

- **Given the high altitude of detonation and the fact that the EM signals typically are line of sight, the area coverage is large**
  - **A 100 km burst will produce significant HEMP fields over a ground radius of 1100 km**
  - **A 500 km burst will produce HEMP over the entire U.S.**
- **While the HEMP terminology implies a single pulse, in fact there are a series of pulses that last from microseconds to hundreds of seconds**

Different Time Phases of HEMP



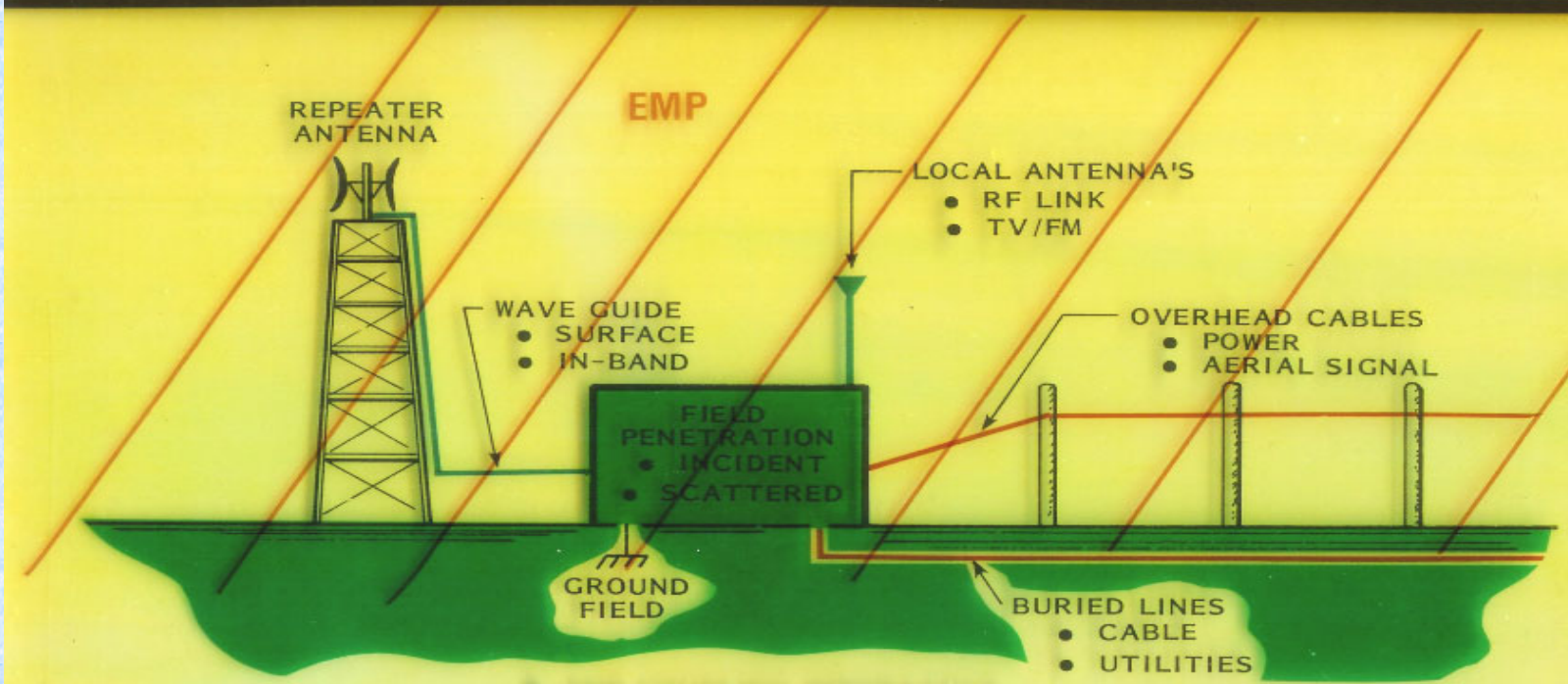
HEMP Threat Discussion - E1

- **The early-time HEMP rises on the order of a few ns and decays between 0.1 and 1 microseconds**
- **Strongest frequency content is between 1 and 1000 MHz**
- **Peak fields vary between a few and many 10s of kV/m**
- **Former Russian General officers meeting with the US EMP Commission in 2003 indicated the EMP threat levels up to 200 kilovolts per meter should be considered for the EMP threat.* That is significantly above the levels we have been working with**
- **Coupling is efficient to any metallic conductor**
  - **Peak currents vary between tens and thousands of amperes**
  - **High frequency fields can be shielded, however non-metallic buildings offer little protection**

E1 HEMP Network Coupling Issues

- **Power network**
  - **E1 can create flashover on the distribution power line insulators which can produce grid failure**
  - **E1 can also impact the power system control electronics leading to grid failure**
- **Telecom network**
  - **E1 can affect switching equipment in Central Offices leading to loss of connectivity for extended periods of time**

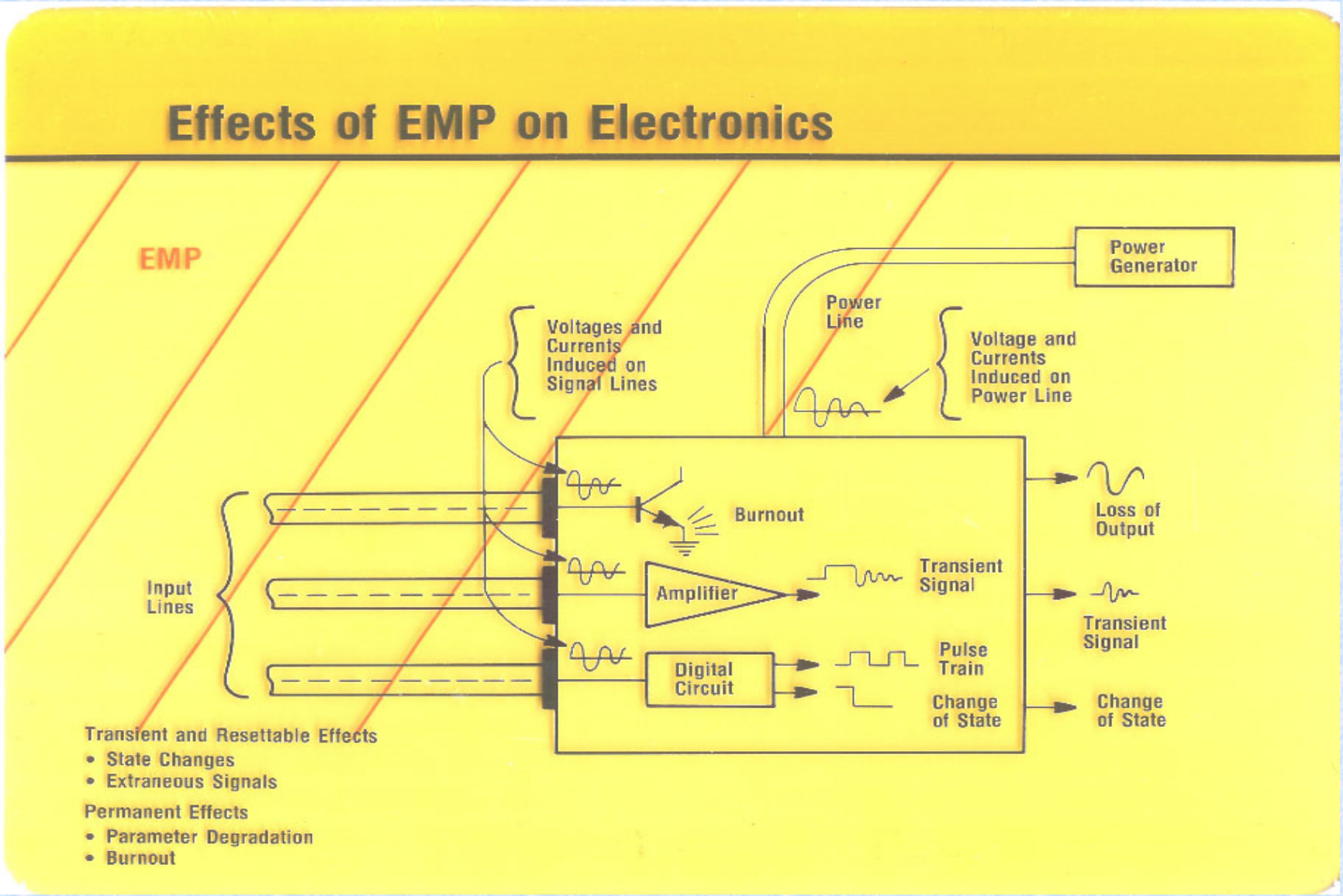
HEMP Coupling to Typical "Landline" Facility



- EMP COUPLING IMPORTANCE
  - LONG LINE PENETRATORS (UP TO 1000s AMPS)
  - SHORTER PENETRATIONS (UP TO 100s AMPS)
  - FIELD BUILDING DIFFUSION (UP TO 10s AMPS)

UNCLASSIFIED

Effects of EMP on Electronics



HEMP Threat Discussion - E3

- **Late-time HEMP rises in a few seconds and decays in hundreds of seconds**
- **Frequency content is below 1 Hz (quasi-DC)**
- **Peak fields vary from a few to many 10s of V/km**
- **Coupling is very efficient to long conductors**
  - **Main concern is distribution and transmission power systems and long metallic telecom lines (> 1 km)**
  - **“DC” currents of hundreds of amperes may flow in power system lines and tens of amperes in telecom lines**
  - **Under severe threat-level conditions, possible loss of power and telecom services within large regions of the U.S.**

Geomagnetic Storms vs. E3 HEMP

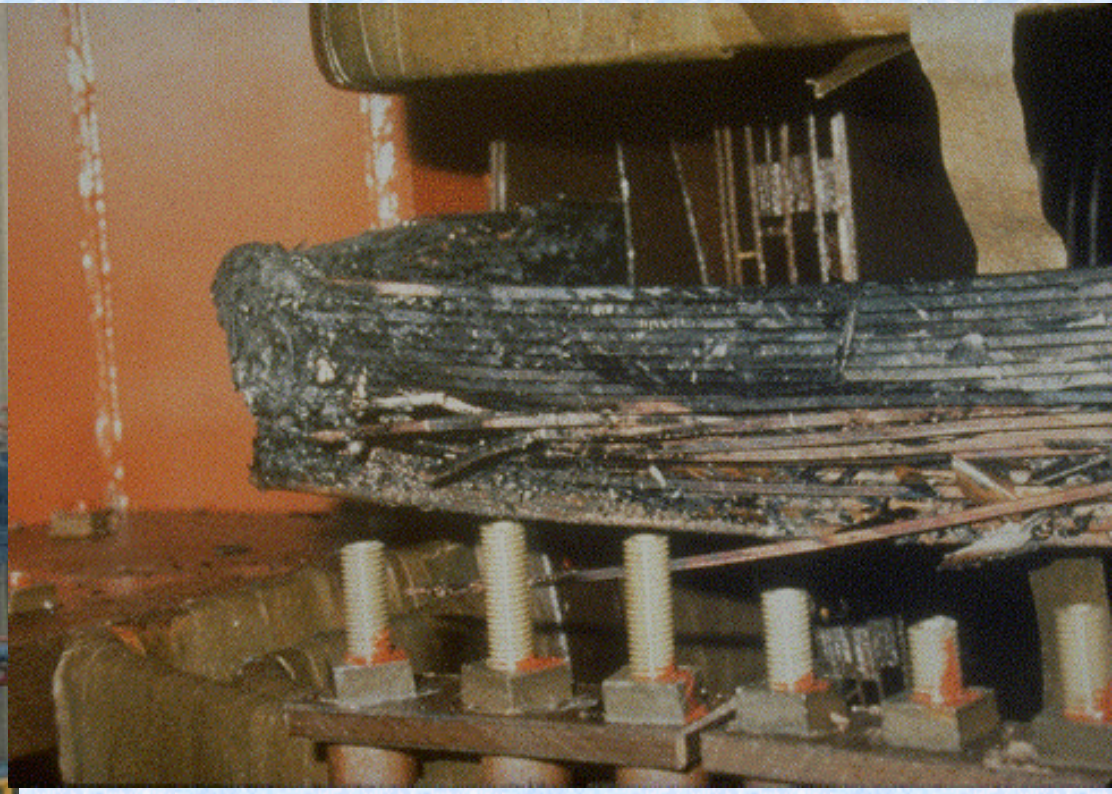
- **Recent studies by Metatech have indicated a strong similarity between geomagnetic storms (produced by solar activity) and the late-time HEMP**
  - **Similar rise and decay times for geomagnetic field disturbances and E3 HEMP**
  - **Lower levels of peak fields from geomagnetic disturbances**
  - **The EMP Commission found that the 100 year storm can have peak fields equivalent to E3 HEMP**

- **Some dramatic effects have occurred on the transmission power grids due to geomagnetic storms**
  - **Collapse of power grid (Hydro-Quebec in March 1989)**
  - **Damage to large transformers**

Salem Nuclear Plant GSU Transformer Failure

Great Geomagnetic Storm of March 13, 1989

External - Single Phase



Internal Damage - Hot Enough to Melt Large Copper Secondary Winding Leads

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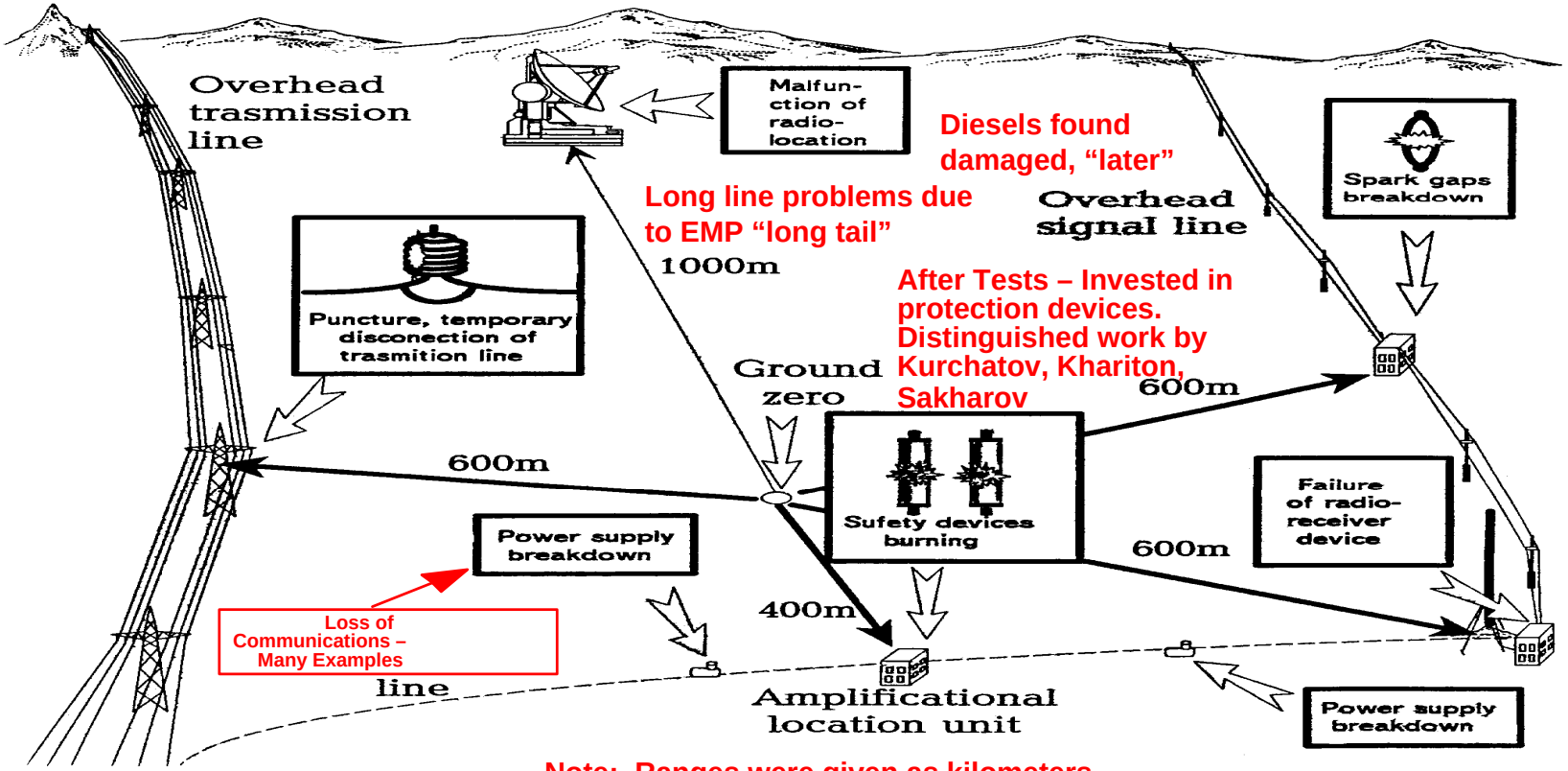
FSU Example of HEMP Effects on Systems

- **The Soviet Union performed 3 high-altitude nuclear tests in 1962 over Kazakhstan**
- **In June 1994 at the EUROEM Conference in Bordeaux, France, a summary briefing of HEMP effects was provided by General Vladimir Loborev, Director of the Central Institute of Physics and Technology (CIPT) near Moscow**
  - **Following chart annotated by Radasky in June 1994 summarizes the HEMP effects discussed**
- **Former Russian General officers meeting with the US EMP Commission indicated the EMP threat levels up to 200 kilovolts per meter should be considered for the EMP threat.* That is significantly above the levels that we have been working with**

HIGH ALTITUDE ELECTROMAGNETIC PULSE EFFECT (June 1994)

Overhead Transmission Line and Telecommunications – Disconnection and Damage



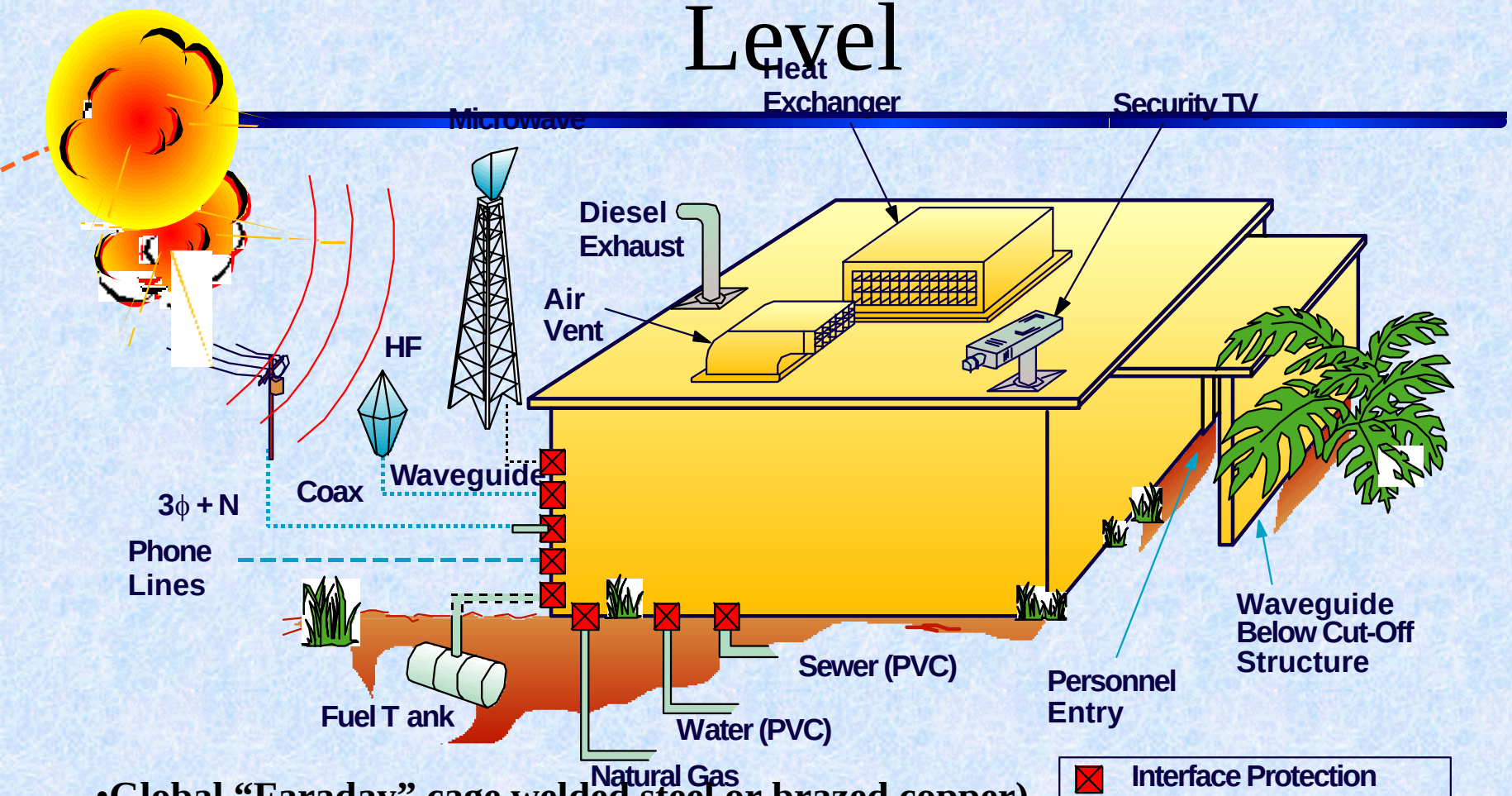
Note: Ranges were given as kilometers

Note: Red text based on Loborev's spoken words as documented by Radasky

Examples of Observed System Anomalies During Testing

- **Aircraft**
  - **Upset of on-board computers and weapon launch control systems**
  - **Garbled messages**
  - **Permanent damage to electronics**
  - **Inadequate EMP hardening protection (high frequency coupling through shields, filters and isolation devices, arcing across filters and isolation devices)**
- **Ground-Based Systems**
  - **Communication component failures (upsets and permanent damage of ICs)**
  - **False fault indications**
  - **Telephone handset failure (permanent damage)**
  - **Printer failures (permanent damage and upset)**
  - **Data terminal failures**
  - **Power supply failures**
  - **Vehicle ignition system failures**
  - **Damage of power grid distribution components (Transformers, generators, relays, insulators)**
- **Missiles**
  - **Catastrophic Upset**
  - **Permanent damage of discrete semiconductors and ICs**
  - **Capacitor and resistor damage**
  - **Premature firing of EEDS**

Global Shield: Hardening at Facility Level



- Global "Faraday" cage welded steel or brazed copper)
- Electrical penetration treatments
- Personnel entrance and aperture control

Threat Delivery

- **Russia and China have the capability to launch a HEMP attack against the US**
- **A SCUD launch off our coasts from a trawler/other that could cover a significant part of either coast with HEMP must be considered and evaluated as a threat**
- **The development of North Korea and Iran as credible threats to CONUS for in-country ICBM launches depends largely on the progress of their programs and the effectiveness of US NMD program**

Third World Nuclear Capabilities
(Notional only, unofficial sources)

Country	Nuclear Weapons	Ballistic Missile Systems	RANGE (km)	APOGEE (km) (Minimum Energy)
China	290 Strategic Weapons	JL-2 (SLBM) DF-31	8000 8000	--- ---
Israel	70-200 Weapons	Jericho 1 Jericho 2	500 1500	120 320
North Korea	Possibly material for 2 Weapons	Taepo Dong 1 Nodong 1 / 2 Scud C	2000 1000 / 1500 550	450 230 / 320 127
India	60-125 Weapons	Agni 2	2500	600
South Africa	Had 6 Weapons	Arniston	1500	320
Pakistan	10-25 Weapons	Hatf2 and M11 Ghauri Ghauri 2	300 1300 2300	70 300 530
Iran	Actively Seeking	CSS-8 Scud C Shahab-3	160 500 1300	37 120 300
Iraq	Had Active Program	Scud B Al Hussein Badr 2000	300 650 900	70 150 210

SOURCES: Center for Defence and International Security Studies (website (5/11/2000); Center for Strategic and International Studies (website 9/5/2000); Arms Control Association website Jun 2001); Jane's Defence Weekly, 8 Sep. '99; Carnegie Endowment for Int'l Peace (website 2/27/02); Federation of American Scientists (website 12/20/2001); "Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions (Jan - Jun 2001)," CIA, 30 Jun 02

The US EMP Commission

- **Formed in 2002 by Congress to assess the EMP threat, its effects on the nation's DoD and civilian infrastructures**
- **Estimate the resultant effects on the population, national security, and economy**
- **Recommend options to deal with the threat**
- **Executive summary published**
- **Report on critical infrastructures has not been released for publication**

Quote from US EMP Commission Executive Report

"EMP is one of a small number of threats that can hold our society at risk of catastrophic consequences. It has the capability to produce significant damage to critical infrastructures and thus to the very fabric of our US society as well as to the ability of the United States and Western nations to project influence and military power."

House Armed Services Committee Hearing July 2004

- **Congressman Kurt Weldon Vice Chairman of the HASC: Summarized the hearing with the statement "The EMP threat is real, it is significant and we are largely unprepared."**

Critical National Infrastructures - PDD-63

- **Acknowledges and raises national concern about the vulnerability and interdependencies of our infrastructures**
- **Acknowledges the severity of the threat and the difficulty of threat containment, elimination or defense against it**
- **Directs selected government agencies to address government infrastructure protection and to present a plan of implementation**
- **Requires selected government agencies to work with the private sector to motivate the private sector to address their infrastructure vulnerabilities and protection**

THE PROBLEM

- **Even after 9-11, the concept that the survival of our infrastructures, our society and our way of life can be threatened by nation states or hidden external forces, and that its protection to a large extent against these threats is dependent on the private sector and not on the government has not been understood The government (federal, state and local) owns less than 10% of critical infrastructures the private sector more than 90%**

THE PROBLEM (Continued)

- **Until this concept is understood and the responsibility accepted by the private sector, no effort by the government, short of legislative action is going to significantly move the private sector to act to protect our critical infrastructures beyond their financial interests. Liability is not a driver against major threats like nuclear war or EMP. After all who is going to be there to pay or collect?**

INFRASTRUCTURE DEPENDENCIES/INTERDEPENDENCIES

- **Transportation needs fuel, fuel needs transportation, power needs both and everything/everyone needs power, water, food, fuel telecommunications, etc.**
- **Because of interdependencies and resultant cascading effects, we need to ask what are the interdependencies and what are the elements within critical infrastructures that can cause them to spiral out of control bringing other infrastructures down with it.**
- **There is a common assumption that our infrastructures are so vast and robust that there is no way, short of a direct nuclear attack, to take them down – EMP or a 100 year solar storm can do it.**

Just in Time Manufacturing Delivery and Use

- **The competitive market has driven many industries throughout the world to just in time operations, pushing many infrastructures to operate close to the edge with minimal backup**
- **It is not something that can be changed without affecting our competitive edge amongst our industries and on the world market**
- **As a result, I believe that the burden/cost of protecting our critical infrastructures, public and private will fall on the government. A way will need to be found to get the private sector and the government to protect critical infrastructures**

CHALLENGES

- **To a large extent both the government and private sector do not adequately understand the EMP vulnerability, the interdependencies of our critical infrastructures and the potential cascading effects, which can result from an EMP attack. This understanding is necessary for planning and allocation of resources for infrastructure protection, as well as consequence management.**

- **Major education effort needs to be initiated by the government for the public and the private sector on the severity of the threat, its implications to the nation, the international community and the need for joint private sector and government planning to deal with it**

Infrastructure Vulnerabilities

- **Power**
- **Telecommunications**
- **Transportation**
- **Fuel**
- **Water**
- **Food**

CONSEQUENCES

- **YOU DO NOT WANT TO KNOW AND ESPECIALLY YOU DO NOT WANT TO EXPERIENCE IT**

Post EMP Commission Issues

- **EMP a newly realized threat to civilian infrastructures**
- **EMP a "new" threat to national security (DoD dependence on civilian infrastructures)**
- **Threat basically not understood or recognized by Congress or the public**
- **Significant commitment and 10's of Billions needed to protect the population and our way of life**
- **Both attack prevention and consequence management/life sustainment need to be primary goals**

Post EMP Commission Issues Cont.

- **We are vulnerable and so is Europe, Japan and the rest of the modern world and they appear not to appreciate the severity of the threat**
- **Prevalent false perception that EMP is a relatively benign threat that could be used as a show of intent, intimidation, economic/political attack and would result in minimal casualties.**
- **An EMP attack on the US is an attack on the world. It would sink the US economy and world economies would follow with major consequences for the modern and third world countries indirectly resulting in significant loss of life.**

Recommendations

- **Most Important – Attack prevention and consequence management planning and implementation**
- **Planning should include hardening of selected sectors of critical infrastructures, reallocation of and pre-positioning of critical resources (i.e. food, water, fuel, generation capacity etc.). Assigning organizational responsibilities for preparation, emergency operations, recovery, training and exercises**
- **Continue the EMP Commission to provide assistance, guidance and oversight in dealing with the EMP threat**

Recommendations Continued

- **Initiate programs to understand critical infrastructure dependencies, interdependencies and resource needs for extended operations and recovery.**

- **Initiate R&D programs in EMP hardening to optimize hardening efficiency and costs particularly in light of emerging technologies in electronics miniaturization, optics, distributed power generation, materials etc.**

Recommendations Continued

- **Expand the National Missile Defense program to deal with surprise launches from close in to our coasts and borders to include terrorist launches from within CONUS**
- **Share threat consequence information, planning and resources with our allies for world wide attack prevention and consequence management**
- **Initiate treaty agreements with allies for consequence management and assistance in case of HEMP attack.**