

# Articles

- QST November 2009
- QST August 1986
- QST September 1986
- QST October 1986
- QST November 1986
- TCSTIB 85-10
- NX6R Presentation

# EMP

- Electro-magnetic Pulse
- What causes an EMP
- Properties of an EMP
- What does an EMP do
- How can equipment be protected

# Causes

- Lightning
- Geomagnetic Storm
- Power Line Transient
- Thermonuclear Detonation
- E-Bomb

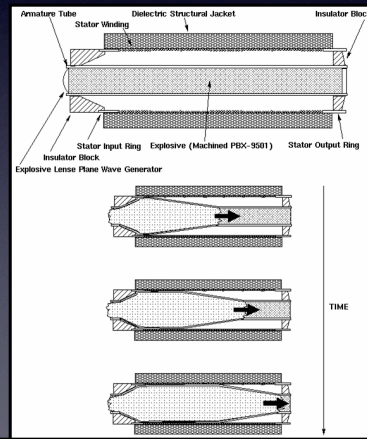
# E-Bomb

- Localized EMP effect
- Cheap to Make (\$1000 - \$2000)
- Commonly available materials
- Well known technology
- Multiple delivery methods
- Peak current of large device stronger than lightning stroke

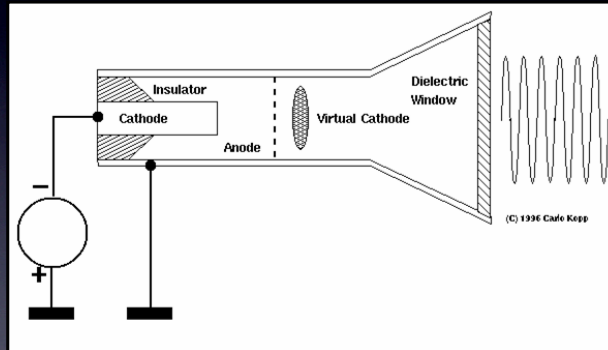
# Ideal Terrorist Weapon

- Highly disruptive
- Minimum collateral damage
- Conventional C-4 explosive
- Can't be detected
- Can be fitted in van and driven to site

# Coaxial Flux Compression Generator



# Virtual Cathode Oscillator



# EMP History

- Operation Starfish Prime
- Predicted by Enrico Fermi
- Street Lights burned out in Hawaii



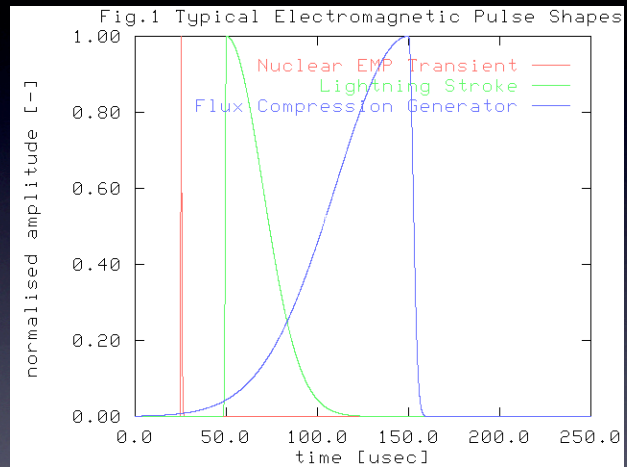
# Starfish Prime

- July 9, 1962
- Altitude of 250 miles
- 1.4 Mt - 6.0 Peta Joules
- Took out microwave link
- Street lights in Hawaii
- 900 miles away

# Compton Electron Scattering

- Intense short burst of gamma - 0.3%
- Collide with electrons in air molecules
- Energetic electrons knock out other electrons
- Cascade effect - 30,000 electrons for each gamma
- $10^{11}$  Joules of energy in EMP per megaton
- Magnetic field causes electrons to spiral

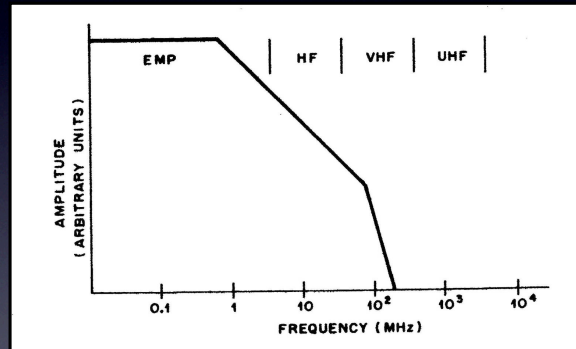
# Pulse Shapes



# EMP Induced Surges

Conductor Type	EMP Rise Time $\mu$ S	Peak Voltage (volts)	Peak Current
Long Unshielded Wires Power Lines	.01 - .1	100K - 5M	1K - 10K
Unshielded Telephone wires at outlet	.01 - 1	100 - 10k	1 - 100
AC power lines at wall outlet	.1 - 10	1k - 50k	10 - 100
HF Antennas	.01 - .1	10k - 1M	500 - 100k
VHF Antennas	.001 - .01	1K - 100K	100 - 1k
UHF Antennas	.001 - .01	100 - 10k	10 - 100
Shielded Cable	1 - 100	1 - 100	.1 - 50

# Spectrum



# Effects

- Transportation
- Access
- Communications

# Will we have access



# Transportation

- Most Vehicles have computers
- Also metal bodies
- Not grounded



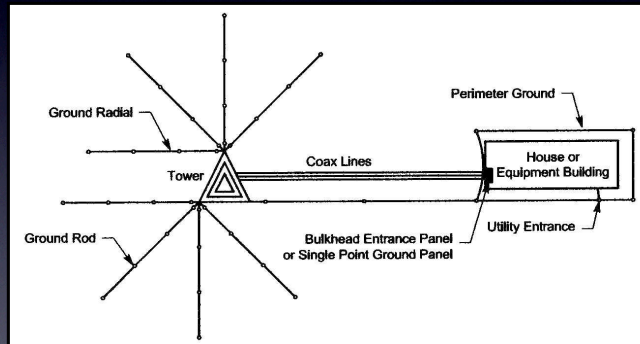
# How does it cause damage

- Conduction - Antennas, Power lines, Ground
- Induction - Cables and Wires
- Coils, chokes and transformers act as generators

# Protection

- Disconnect external cables
- Good grounding
- Transient suppressors
- Energy tolerant componets
- Faraday cage or shielding

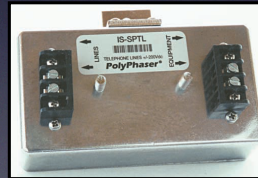
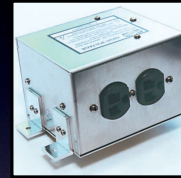
# Grounding



# Grounding Tips

- Common “bulkhead” ground point
- Single-point ground panel
- Suppressors external to building
- Multiple ground rods interconnected with #6 or larger wire

# Lightning Suppressors



# Modified Faraday Cage

- Steel file cabinet
- Add steel plate to close bottom
- Good shielding below 10 MHz
- Add shielding gaskets around drawers for protection to VHF / UHF
- Store spare equipment, microphones, coax cables

# Other measures

- Ground Vehicles
- Screen in garage walls and door
- Store data on optical media
- Metal garden sheads