The E-bomb - A Weapon of Electrical Mass Destruction

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Introduction:

. Desert Storm Counter-C3 operations relied on air

power and precision guided munitions

. Future campaigns will require more suitable weapons to achieve shock effect over large target sets with small attacking forces
. Electromagnetic bombs (E-bombs) can perform such a role

E-bomb Technology Base:

. Power source - explosively pumped Flux Compression Generator (FCG)

- FCG pioneered by Los Alamos Labs during the 1950s
- FCG can produce tens of MegaJoules in tens to hundreds of microseconds
- Peak current of an FCG is 1000 X that of a typical lightning stroke

The Physics of the FCG:

- Fast explosive compresses a magnetic field

- Compression transfers mechanical energy into the magnetic field
- Peak currents of MegaAmperes demonstrated in many experiments

FCG start current is provided by an external source:

- capacitor bank
- small FCG
- MHD device
- homopolar generator

FCG Internals:

- Armature - copper tube / fast explosive
- Stator - helical heavy wire coil
- Initiator - plane wave explosive lense
- Jacket - prevents disintegration due magnetic forces

FCG Operation:

- External power source pumps FCG winding with start current
- When start current peaks, explosive lense fired to initiate explosive burn
- Explosive pressure expands armature and creates moving short
- Moving armature compresses magnetic field

High Power Microwave (HPM) Sources:

Higher lethality than low frequency FCG fields, many device types:

- Relativistic Klystrons
- Magnetrons
- Slow Wave Devices
- Reflex Triodes
- Virtual Cathode Oscillators (vircators)

Vircator Physics:

- Relativistic electron beam punches through foil or mesh anode

- ”Virtual” cathode formed by space charge bubble behind anode
- Peak power of tens of GW for 100s of nsec
- Anode typically melts in about 1 usec
- Cheap and simple to manufacture
- Wide bandwidth allows chirping of oscillation

Lethality Issues in E-bomb Warheads:

- Diversity of target set makes prediction of lethality difficult
- Different implementations of like equipment have differing hardness
- Coupling efficiency is critical to lethality

Coupling Modes:

Front Door

Coupling through antennas.

- Destroys RF semiconductor devices in transmitters and receivers

Back Door

Coupling through power/data cabling, telephone wiring

- Destroys exposed semiconductor devices
- Punches through isolation transformers.

Semiconductor Vulnerability:

- Semiconductor components using CMOS, RF Bipolar, RF GaAs, NMOS DRAM processes are destroyed by exposure to volts to tens of volts of electrical voltage
- High speed - high density semiconductors are highly vulnerable due small junction sizes and low breakdown voltages

Damage Mechanisms:

. Low frequency pulses produced by FCG create high voltage spikes on fixed wiring infrastructure
. Microwave radiation from HPM devices creates high voltage standing waves on fixed wiring infrastructure
. Microwave radiation from HPM devices can couple directly through ventilation grilles, gaps between panels, poor interface shielding - producing a

spatial standing wave inside the equipment cavity

Example Scenario:

- 10 GigaWatt 5 GHz HPM E-bomb initiated at several hundred metres altitude
- Footprint has diameter of 400 - 500 metres with field strengths of kiloVolts/metre

Maximising Bomb Lethality:

Lethality is maximised by maximising the power coupled into the target set

- maximise peak power and duration of warhead emission (large FCG/Vircator)
- maximise efficiency of internal power transfer in weapon
- maximise coupling efficiency into target set

HPM E-bomb Lethality:

Microwave bombs are potentially more lethal due better coupling and more focussed effects

- chirping allows weapon to couple into any in-band resonances
- circular polarisation of antenna allows coupling with any aperture orientation
- reducing detonation altitude increases field

strength at the expense of footprint size

Targeting E-bombs:

- fixed installations (buildings, radar and comms sites) - conventional methods
- radiating mobile / hidden targets (ships, mobile SAMs) - use ESM or ELS
- non radiating mobile / hidden targets - use Unintentional Emissions (UE)

UE results from Van Eck radiation and LAN/comms wiring emissions, Characteristic signatures allow identification of target type and location

Delivery of E-bombs:

- Warhead comprises priming current source, FCG (cascade) and Vircator tube
- Missile installations must supply 100% of weapon

priming energy from own supply

. Bomb installations - weapon can be precharged before release from aircraft

A free fall E-bomb is more lethal than a missile borne HPM warhead as a larger proportion of the weapon is the warhead

Delivery Options:

. dumb bombs have a CEP of 100 - 1000 ft

(free fall delivery)

. GPS aided bombs have a CEP of 40 ft

(free fall but guided)

. Standoff missiles have a CEP of 40 ft

(GPS inertial with propulsion)

. Cruise Missiles have a CEP 10-40 ft

(eg USAF AGM-86 derivative)

Defences Against E-bombs:

- Destroy the delivery vehicle or launch platform
- Electromagnetically harden important assets
- Hide important assets

Vulnerability Reduction (Hardening):

- convert computer rooms in to Faraday cages

- use optical fibres for data
- isolate power feeds with transient arrestors
- use non-electrical power feed schemes
- use electromagnetic “air lock”
- shielding must be comprehensive

Susceptibility Reduction (Preventing Attack):

- redundant topology

- UE reduction - stringent electromagnetic control regime
- Low Probability of Intercept (LPI) Comms and Radar
- decoy emitters

Proliferation:

- E-bombs use non-strategic materials and manufacturing
- US and CIS capable of deploying E-bombs in next half decade

- possession of drawings and samples would allow Third World manufacture of E-bombs
- USAF estimated US$1,000-2,000 per round for FCG manufacture at US labour rates
- *Counterproliferation regimes will be ineffective*

Military Applications of the E-bomb

Doctrine and Strategy

1.Electronic Combat

- The objective is to paralyse the opponent’s C3I and IADS as quickly as possible
- The E-bomb enables rapid attrition of enemy electronic assets over large areas
- The E-bomb offers important force multiplication effects compared to the use of conventional weapons

The E-bomb is a Weapon of Electrical Mass Destruction

2.Strategic Warfare

The Warden "Five Rings" model was tested and proven during Desert Storm:

- Leadership and C3 targets highly vulnerable
- Economic vitals - finance, stock markets, manufacturing, petroleum, oil/gas are highly vulnerable

- Transport infrastructure - signalling, navaids, vehicle ignition systems vulnerable
- Population - radio and TV receivers
- Military forces in the field - eqpt vulnerable

E-bomb Advantages in Strategic Warfare

- Not lethal to humans
- Negligible collateral damage
- High tempo campaigns possible due the powerful

"shock" effect of using a WEMD

- No mass media coverage of bombing casualties (broadcast eqpt destroyed) will reduce the threshold for the use of strategic air power and missile forces

3.Theatre Warfare

- Offensive Counter Air operations - disable aircraft in flight, on the ground and destroy their supporting infrastructure

- Sea Control - disable surface combatants prior to attack with conventional weapons
- Battlefield Interdiction - disable mobile C3I and concentrations of tanks, armoured vehicles and helicopters

4.Punitive Missions

- The E-bomb is a useful punitive weapon as it can cause much economic and

military damage with no loss of civilian life

. E-bombs could be profitably used against countries which sponsor terrorism and info-terrorism

Conclusions:

. E-bomb is a WEMD

. High payoff in using E-bombs against fundamental infrastructure, resulting in substantial paralysis

. E-bombs will become a decisive capability in Strategic Warfare and Electronic Combat
. E-bombs are a non-lethal weapon
. The critical issues for the next decade are the deployment of E-bombs and the hardening of fundamental infrastructure