# E-BOMB TECHNOLOGY

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## ABSTRACT

*High Power Electromagnetic Pulse generation techniques and High Power Microwave technology have matured to the point where practical E-bombs (Electromagnetic bombs) are becoming technically feasible, with new applications in both Strategic and Tactical Information Warfare. The development of conventional E-bomb devices allows their use in non-nuclear confrontations. This paper discusses aspects of the technology base, weapon delivery techniques and proposes a doctrinal foundation for the use of such devices in warhead and bomb applications.*

***Keywords –Conventional e-bombs, EMP effect, MHD generator, PFC Generator, Vircator***

## I INTRODUCTION

The prosecution of a successful Information Warfare (IW) campaign against an industrialized or post industrial opponent will require a suitable set of tools. As demonstrated in the Desert Storm air campaign, air power has proven to be a most effective means of inhibiting the functions of an opponent's vital information processing infrastructure. This is because air power allows concurrent or parallel engagement of a large number of targets over geographically significant areas.

While Desert Storm demonstrated that the application of air power was the most practical means of crushing an opponent's information processing and transmission nodes, the need to physically destroy these with guided munitions absorbed a substantial proportion of available air assets in the early phase of the air campaign. Indeed, the aircraft capable of delivery laser guided bombs were largely occupied with this very target set during the first nights of the air battle. Electromagnetic bombs built for this purpose can provide, where delivered by suitable means, a very effective tool for this purpose.

## II THE EMP EFFECT

The Electromagnetic Pulse (EMP) effect was first observed during the early testing of high altitude airburst nuclear weapons. The effect is characterized by the production of a very short (hundreds of nanoseconds) but intense electromagnetic pulse, which propagates away from its source with ever diminishing intensity, governed by the theory of electromagnetism. The Electromagnetic Pulse is in effect an electromagnetic shock wave.

This pulse of energy produces a powerful electromagnetic field, particularly within the vicinity of the weapon burst. The field can be sufficiently strong to produce short lived transient voltages of thousands of Volts (ie

kiloVolts) on exposed electrical conductors, such as wires, or conductive tracks on printed circuit boards, where exposed.

It is this aspect of the EMP effect which is of military significance, as it can result in irreversible damage to a wide range of electrical and electronic equipment, particularly computers and radio or radar receivers. Subject to the electromagnetic hardness of the electronics, a measure of the equipment's resilience to this effect, and the intensity of the field produced by the weapon, the equipment can be irreversibly damaged or in effect electrically destroyed. The damage inflicted is not unlike that experienced through exposure to close proximity lightning strikes, and may require complete replacement of the equipment, or at least substantial portions thereof.

Commercial computer equipment is particularly vulnerable to EMP effects, as it is largely built up of high density Metal Oxide Semiconductor (MOS) devices, which are very sensitive to exposure to high voltage transients. What is significant about MOS devices is that very little energy is required to permanently wound or destroy them, any voltage in typically in excess of tens of Volts can produce an effect termed gate breakdown which effectively destroys the device. Even if the pulse is not powerful enough to produce thermal damage, the power supply in the equipment will readily supply enough energy to complete the destructive process. Wounded devices may still function, but their reliability will be seriously impaired. Shielding electronics by equipment chassis provides only limited protection, as any cables running in and out of the equipment will behave very much like antennae, in effect guiding the high voltage transients into the equipment.

Computers used in data processing systems, communications systems, displays, industrial control applications, including road and rail signaling, and those embedded in military equipment, such as signal processors, electronic flight controls and digital engine control systems, are all potentially vulnerable to the EMP effect.

## III PUMPED FLUX COMPRESSION GENERATOR

The explosively pumped FCG is the most mature technology applicable to bomb designs. The FCG was first demonstrated by Clarence Fowler at Los Alamos National Laboratories (LANL) in the late fifties. Since that time a wide range of FCG configurations has been built and tested, both in the US and the USSR, and more recently CIS.

The central idea behind the construction of FCGs is that of using a fast explosive to rapidly compress a magnetic field, transferring much energy from the explosive into the magnetic field.

## IV MHD GENERATOR

The design of explosive and propellant driven Magneto-Hydrodynamic generators is a much less mature art that that of FCG design. Technical issues such as the size and weight of magnetic field generating devices required for the operation of MHD generators suggest that MHD devices will play a minor role in the near term. In the context of this paper, their potential lies in areas such as start current generation for FCG devices.

The fundamental principle behind the design of MHD devices is that a conductor moving through a magnetic field will produce an electrical current transverse to the direction of the field and the conductor motion. In an explosive or propellant driven MHD device, the conductor is a plasma of ionized explosive or propellant gas, which travels through the magnetic field. Current is collected by electrodes which are in contact with the plasma jet.

The electrical properties of the plasma are optimized by seeding the explosive or propellant with suitable additives, which ionize during the burn .Published experiments suggest that a typical arrangement uses a solid propellant gas generator, often using conventional ammunition propellant as a base. Cartridges of such propellant can be loaded much like artillery rounds, for multiple shot operation.

## V VIRCATOR

From the perspective of a bomb or warhead designer, the device of choice will be at this time the Vircator. This is because the Vircator is a one shot device capable of producing a very powerful single pulse of radiation, yet it is mechanically simple, small and robust, and can operate over a relatively broad band of microwave frequencies.

The physics of the Vircator tube are substantially more complex than those of the preceding devices. The fundamental idea behind the Vircator is that of accelerating a high current electron beam against a mesh (or foil) anode. Many electrons will pass through the anode, forming a bubble of space charge behind the anode. Under the proper conditions, this space charge region will oscillate at microwave frequencies. If the space charge region is placed into a resonant cavity which is appropriately tuned, very high peak powers may be achieved. Conventional microwave engineering techniques may then be used to extract microwave power from the resonant cavity. Because the frequency of oscillation is dependent upon the electron beam parameters, Vircators may be tuned or chirped in frequency, where the microwave cavity will support appropriate modes. Power levels achieved in Vircator experiments range from 170 kiloWatts to 40 GigaWatts over frequencies spanning the decimetric and centimetric bands.

## VI LETHALITY OF ELECTROMAGNETIC WARHEADS

The issue of electromagnetic weapon lethality is complex. Unlike the technology base for weapon construction, which has been widely published in the open literature, lethality related issues have been published much less frequently.

While the calculation of electromagnetic field strengths achievable at a given radius for a given device design is a straightforward task, determining a kill probability for a given class of target under such conditions is not.

This is for good reasons. The first is that target types are very diverse in their electromagnetic hardness, or ability to resist damage. Equipment which has been intentionally shielded and hardened against electromagnetic attack will withstand orders of magnitude greater field strengths than standard commercially rated equipment. Moreover, various manufacturer's implementations of like types of equipment may vary significantly in

hardness due the idiosyncrasies of specific electrical designs, cabling schemes and chassis/shielding designs used.The second major problem area in determining lethality is that of coupling efficiency, which is a measure of how much power is transferred from the field produced by the weapon into the target. Only power coupled into the target can cause useful damage.

### 6.1 Coupling Modes

**Front Door Coupling** occurs typically when power from a electromagnetic weapon is coupled into an antenna associated with radar or communications equipment. The antenna subsystem is designed to couple power in and out of the equipment, and thus provides an efficient path for the power flow from the electromagnetic weapon to enter the equipment and cause damage.

**Back Door Coupling** occurs when the electromagnetic field from a weapon produces large transient currents (termed spikes, when produced by a low frequency weapon ) or electrical standing waves (when produced by a HPM weapon) on fixed electrical wiring and cables interconnecting equipment, or providing connections to mains power or the telephone network.

## VII FIGURES

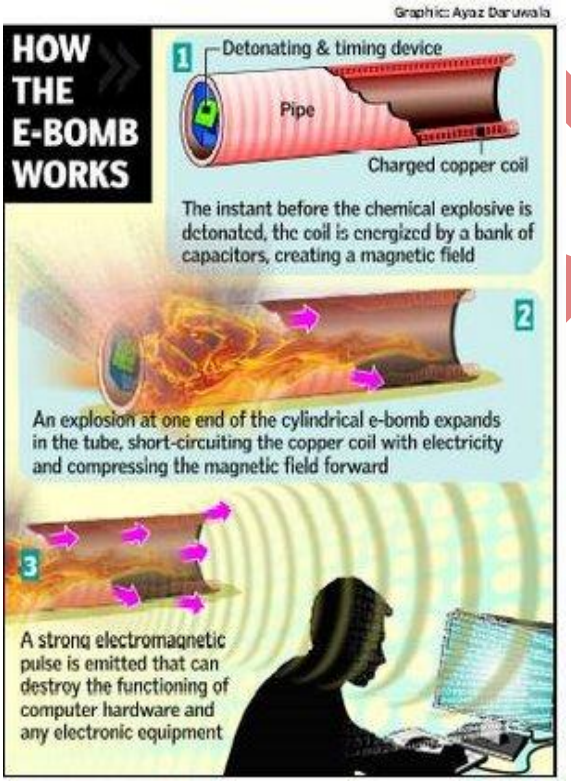


**Fig. 1 EMP effect**

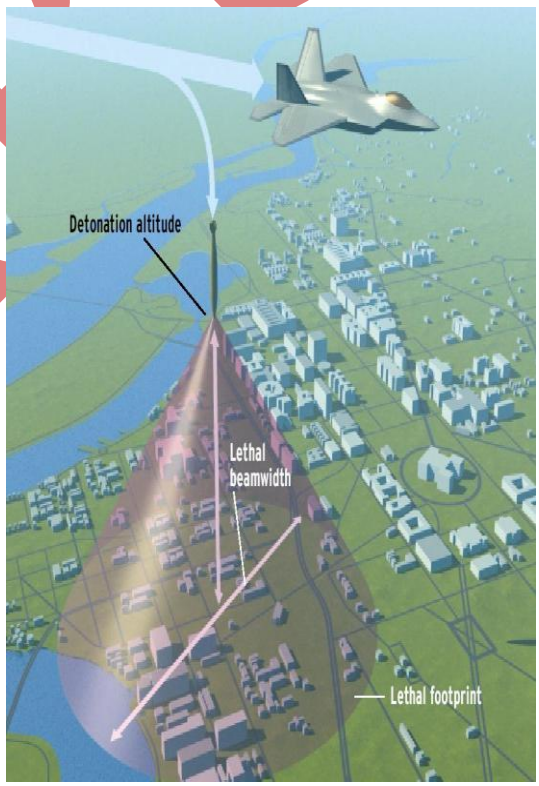


**Fig. 2 lethality of e-bomb**

## VIII CONCLUSION

Electromagnetic bombs are Weapons of Electrical Mass Destruction with applications across a broad spectrum of targets, spanning both the strategic and tactical. As such their use offers a very high payoff in attacking the fundamental information processing and communication facilities of a target system. The massed application of these weapons will produce substantial paralysis in any target system, thus providing a decisive advantage in the conduct of Electronic Combat, Offensive Counter Air and Strategic Air Attack.

Because E-bombs can cause hard electrical kills over larger areas than conventional explosive weapons of similar mass, they offer substantial economies in force size for a given level of inflicted damage, and are thus a potent force multiplier for appropriate target sets.

The non-lethal nature of electromagnetic weapons makes their use far less politically damaging than that of conventional munitions, and therefore broadens the range of military options available.

This paper has included a discussion of the technical, operational and targeting aspects of using such weapons, as no historical experience exists as yet upon which to build a doctrinal model. The immaturity of this weapons technology limits the scope of this discussion, and many potential areas of application have intentionally not been discussed. The ongoing technological evolution of this family of weapons will clarify the relationship between weapon size and lethality, thus producing further applications and areas for study.

E-bombs can be an affordable force multiplier for military forces which are under post Cold War pressures to reduce force sizes, increasing both their combat potential and political utility in resolving disputes. Given the potentially high payoff deriving from the use of these devices, it is incumbent upon such military forces to appreciate both the offensive and defensive implications of this technology. It is also incumbent upon governments and private industry to consider the implications of the proliferation of this technology, and take measures to safeguard their vital assets from possible future attack. Those who choose not to may become losers in any future wars.



## References

[1]. The "*Journal of Electronic Defence"[*JED96] speculate that the weapon will be a FCG driven microwave tube, which is most likely the case given the USAF's prior research activities in this area [REINOVSKY85]. An earlier report [JED95] indicated the existence of a related program which addresses command and control warfare and counter-air capabilities.