A WEAPON OF ELECTRICAL MASS DESTRUCTION

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ABSTRACT

All the electrical and electronic appliances work under the influence of an electromagnetic field. When we increase the intensity of the signal / field (EM) , it would induce a much larger electrical current into the device. This intense fluctuating magnetic field induces a massive current in just about any other electrically conductive object that makes it disable. With a development in the technology, it is feasible to point any region by using EM Pulse or High Power Microwave signal. This is potentially non-lethal, but is still highly destructive that make is useful in military application. The non-lethal behavior makes it suitable for Information Warfare. In this paper we discuss the aspects of the basic technology, working and its effects.

Keywords: Conventional E- bomb, Vircator.

I INTRODUCTION

A low intensity transmission only induces sufficiently electrical current to pass on a signal to a receiver. When increase the intensity of the signal (the magnetic field), it would induce a much larger electrical current. The intense fluctuating magnetic field induces a massive current in just about any other electrically conductive object. Ex: phone lines, power lines, metal pipes. There are a number of possible ways of generating and "delivering" such a magnetic field.

An electromagnetic bomb, or e-bomb, is a weapon designed to take advantage of this dependency. But instead of simply cutting off power in an area, an e-bomb would actually destroy most machines that use electricity. Generators would be useless, cars wouldn't run, and there would be no chance of making a phone call. In a matter of seconds, a big enough e-bomb could thrust an entire city back 200 years or cripple a military unit.

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.

1.1 The Basic Idea

The basic idea of an e-bomb -- or more broadly, an electromagnetic pulse (EMP) weapon -- is pretty simple. These sorts of weapons are designed to overwhelm electrical circuitry with an intense electromagnetic field. If you've read How Radio Works or How Electromagnets Work, then you know an electromagnetic field in itself is nothing special. The radio signals that transmit AM, FM, television and cell phone calls are all electromagnetic energy, as is ordinary light, microwaves and x-rays.

For our purposes, the most important thing to understand about electromagnetism is that electric current generates magnetic fields and changing magnetic fields can induce electric current. This page from How Radio Works explains that a simple radio transmitter generates a magnetic field by fluctuating electrical current in a circuit. This magnetic field, in turn, can induce an electrical current in another conductor, such as a radio receiver antenna. If the fluctuating electrical signal represents particular information, the receiver can decode it. A low intensity radio transmission only induces sufficient electrical current to pass on a signal to a receiver. But if you greatly increased the intensity of the signal (the magnetic field), it would induce a much larger electrical current. A big enough current would fry the semiconductor components in the radio, disintegrating it beyond repair.

Picking up a new radio would be the least of your concerns, of course. The intense fluctuating magnetic field could induce a massive current in just about any other electrically conductive object -- for example phone lines, power lines and even metal pipes. These unintentional antennas would pass the current spike on to any other electrical components down the line (say, a network of computers hooked up to phone lines). A big enough surge could burn out semiconductor devices, melt wiring, fry batteries and even explode transformers. There are a number of possible ways of generating and "delivering" such a magnetic field. In the next section, we'll look at a few possible EMP weaponry concepts.

II THE TECHNOLOGY BASE FOR CONVENTIONAL E BOMBS

The technology base which may be applied to the design of electromagnetic bombs is both diverse, and in many areas quite mature. Key technologies which are extant in the area are explosively pumped Flux Compression Generators (FCG), explosive or propellant driven Magneto-Hydrodynamic (MHD) generators and a range of HPM devices, the foremost of which is the Virtual Cathode Oscillator or Vircator.

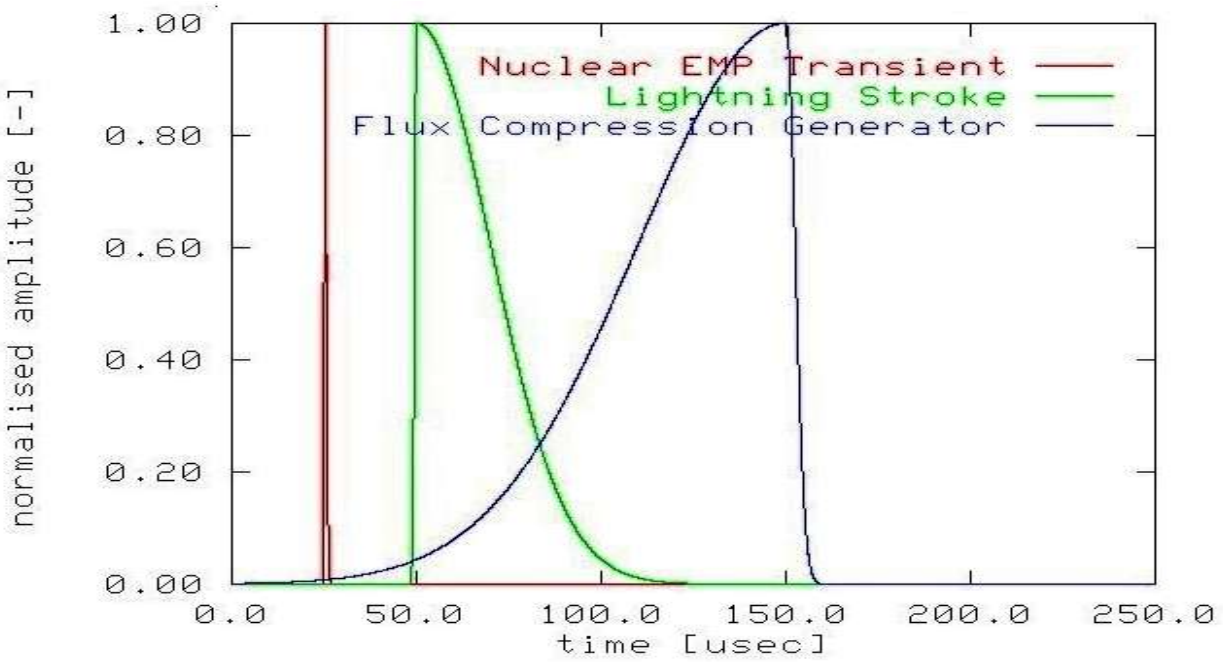


Fig 1: Typical Electromagnetic Pulse Shapes

III WORKING OF E-BOMB

The bomb consists of a metal cylinder (called the **armature**), which is surrounded by a coil of wire (the **stator winding**). The armature cylinder is filled with high explosive, and a sturdy **jacket** surrounds the entire device. The stator winding and the armature cylinder are separated by empty space. The bomb also has a power source, such as a bank of capacitors, which can be connected to the stator.

Here's the sequence of events when the bomb goes off:

- A switch connects the capacitors to the stator, sending an electrical current through the wires. This generates an intense magnetic field.
- A fuze mechanism ignites the explosive material. The explosion travels as a wave through the middle of the armature cylinder.
- As the explosion makes its way through the cylinder, the cylinder comes in contact with the stator winding. This creates a short circuit, cutting the stator off from its power supply.
- The moving short circuit compresses the magnetic field, generating an intense electromagnetic burst.

Most likely, this type of weapon would affect a relatively small area -- nothing on the order of a nuclear EMP attack but it could do some serious damage.

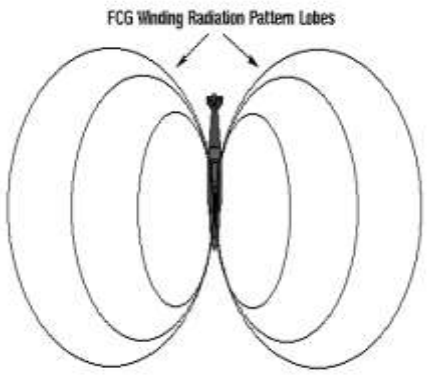
IV TARGETING E-BOMBS

The task of identifying targets for attack with electromagnetic bombs can be complex. Certain categories of target will be very easy to identify and engage. Buildings housing government offices and thus computer equipment, production facilities, military bases and known radar sites and communications nodes are all targets which can be readily identified through conventional photographic, satellite, imaging radar, electronic reconnaissance and humint operations. These targets are typically geographically fixed and thus may be attacked providing that the aircraft can penetrate to weapon release range. With the accuracy inherent in GPS/ initially guided weapons, the electromagnetic bomb can be programmed to detonate at the optimal position to inflict a maximum of electrical damage.

Mobile and camouflaged targets which radiate overtly can also be readily engaged. Mobile and re locatable air defense equipment, mobile communications nodes and naval vessels are all good examples of this category of target. While radiating, their positions can be precisely tracked with suitable Electronic Support Measures (ESM) and Emitter Locating Systems (ELS) carried either by the launch platform or a remote surveillance platform. In the latter instance target coordinates can be continuously data linked to the launch platform. As most such targets move relatively slowly, they are unlikely to escape the footprint of the electromagnetic bomb during the weapon's flight time.

V DELIVERY OF CONVENTIONAL E BOMBS

An “E-Bomb” is delivered by cruise missile. It can be fired from a long range 155mm artillery gun or MLRS rocket launcher, then its outer casing breaks open over the target. The shell or rocket unfolds its radio transmitter aerials, and then the transmitter sends a high powered radio pulse of billions of watts that lasts just a few nanoseconds. It would zap anything electronic on the ground. The high powered microwave (HPMs) are not emitted as a single beam but from side lobes. It’s for this reason that E-Bombs are dropped mainly by cruise missiles and not manned aircraft, since the microwaves can reflect off the ground and affect pilots.



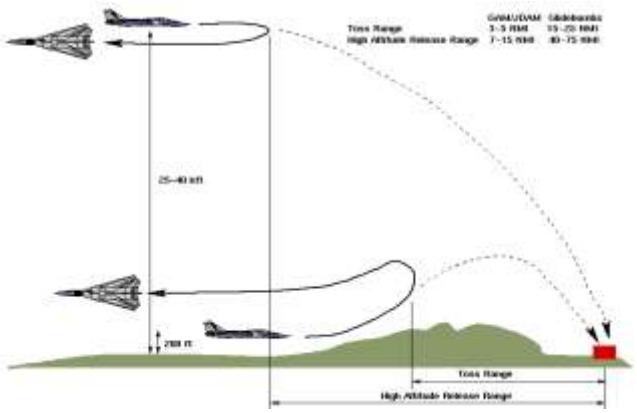


Fig 2: Low Frequency Electronic Bomb Warhead, Fig 3: Delivery profiles for GPS/Inertial guided weapon

VI DEFENCE AGAINST E-BOMBS

The most effective defense against e-bombs is to prevent their delivery by destroying the launch platform or delivery vehicle, as is the case with nuclear weapons. This however may not always be possible, and therefore systems which can be expected to suffer exposure to the electromagnetic weapons effects must be electromagnetically hardened.

Most effective method is to wholly contain the equipment in an electrically conductive enclosure, termed a Faraday cage, which prevents the electromagnetic field from gaining access to the protected equipment. However, most such equipment must communicate with and be fed with power from the outside world, and this can provide entry points via which electrical transients may enter the enclosure and effect damage. While optical fibers address this requirement for transferring data, electrical power feeds remain an ongoing vulnerability.

Where an electrically conductive channel must enter the enclosure, electromagnetic arresting devices must be fitted. A range of devices exist, however care must be taken in determining their parameters to ensure that they can deal with the rise time and strength of electrical transients produced by electromagnetic devices. Reports from the US indicate that hardening measures attuned to the behavior of nuclear EMP bombs do not perform well when dealing with some conventional microwave electromagnetic device designs.

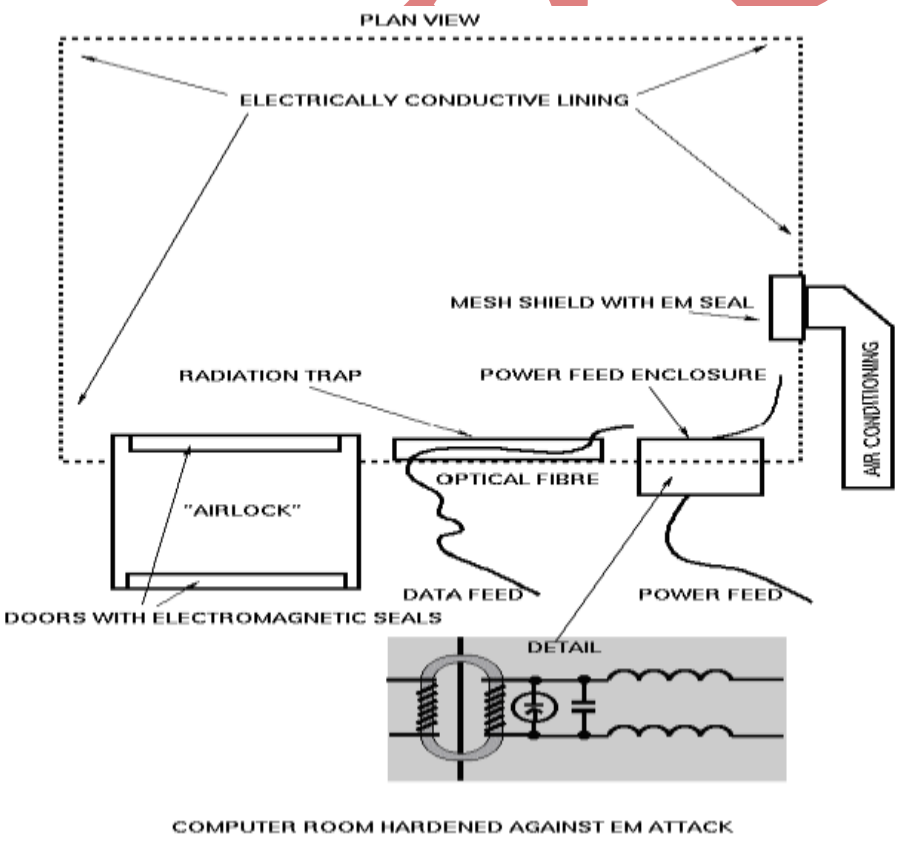


Fig 4: Microwave Electromagnetic Device Design

VII EFFECTS OF E- BOMB

The United States is drawn to EMP technology because it is potentially non-lethal, but is still highly destructive. An E-bomb attack would leave buildings standing and spare lives, but it could destroy a sizeable military. There is a range of possible attack scenarios. Low-level electromagnetic pulses would temporarily jam electronics systems, more intense pulses would corrupt important computer data and very powerful bursts would completely fry electric and electronic equipment. In modern warfare, the various levels of attack could accomplish a number of important combat missions without racking up many casualties. For example, an e-bomb could effectively neutralize: vehicle control systems targeting systems, on the ground and on missiles and bombs communications systems navigation systems long and short-range sensor systems .EMP weapons could be especially useful in an invasion of Iraq, because a pulse might effectively neutralize underground bunkers. Most of Iraq's underground bunkers are hard to reach with conventional bombs and missiles. A nuclear blast could effectively demolish many of these bunkers, but this would take a devastating toll on surrounding areas. An electromagnetic pulse could pass through the ground, knocking out the bunker's lights, ventilation systems, communications -- even electric doors. The bunker would be completely uninhabitable.

U.S. forces are also highly vulnerable to EMP attack, however. In recent years, the U.S. military has added sophisticated electronics to the full range of its arsenal. This electronic technology is largely built around consumer-grade semiconductor devices, which are highly sensitive to any power surge. More rudimentary vacuum tube technology would actually stand a better chance of surviving an e-bomb attack.

A widespread EMP attack in any country would compromise a military's ability to organize itself. Ground troops might have perfectly functioning non-electric weapons (like machine guns), but they wouldn't have the equipment to plan an attack or locate the enemy. Effectively, an EMP attack could reduce any military unit into a guerilla-type army.

While EMP weapons are generally considered non-lethal, they could easily kill people if they were directed towards particular targets. If an EMP knocked out a hospital's electricity, for example, any patient on life support would die immediately. An EMP weapon could also neutralize vehicles, including aircraft, causing catastrophic accidents.

In the end, the most far-reaching effect of an e-bomb could be psychological. A full-scale EMP attack in a developed country would instantly bring modern life to a screeching halt. There would be plenty of survivors, but they would find themselves in a very different world.

VIII LIMITATIONS OF E BOMBS

The limitations of electromagnetic weapons are determined by weapon implementation and means of delivery. Weapon implementation will determine the electromagnetic field strength achievable at a given radius, and its spectral distribution. Means of delivery will constrain the accuracy with which the weapon can be positioned in relation to the intended target. Both constrain lethality.

In the context of targeting military equipment, it must be noted that thermionic technology (i.e. vacuum tube equipment) is substantially more resilient to the electromagnetic weapons effects than solid state (i.e. transistor) technology. Therefore a weapon optimised to destroy solid state computers and receivers may cause little or no damage to a thermionic technology device, for instance early 1960s Soviet military equipment. Therefore a hard electrical kill may not be achieved against such targets unless a suitable weapon is used.

This underscores another limitation of electromagnetic weapons, which is the difficulty in kill assessment. Radiating targets such as radars or communications equipment may continue to radiate after an attack even though their receivers and data processing systems have been damaged or destroyed. This means that equipment which has been successfully attacked may still appear to operate. Conversely an opponent may shut down an emitter if attack is imminent and the absence of emissions means that the success or failure of the attack may not be immediately apparent.

An important factor in assessing the lethal coverage of an electromagnetic weapon is atmospheric propagation. While the relationship between electromagnetic field strength and distance from the weapon is one of an inverse square law in free space, the decay in lethal effect with increasing distance within the atmosphere will be greater due quantum physical absorption effects. This is particularly so at higher frequencies and significant absorption peaks due water vapour and oxygen exist at frequencies above 20 GHz. These will therefore contain the effect of HPM weapons to shorter radii than are ideally achievable in the K and L frequency bands.

Means of delivery will limit the lethality of an electromagnetic bomb by introducing limits to the weapon's size and the accuracy of its delivery. Should the delivery error be of the order of the weapon's lethal radius for a given detonation altitude, lethality will be significantly diminished. This is of particular importance when assessing the lethality of unguided electromagnetic bombs, as delivery errors will be more substantial than those experienced with guided weapons such as GPS guided bombs.

Therefore accuracy of delivery and achievable lethal radius must be considered against the allowable collateral damage for the chosen target. Where collateral electrical damage is a consideration, accuracy of delivery and lethal radius are key parameters. An inaccurately delivered weapon of large lethal radius may be unusable against a target should the likely collateral electrical damage be beyond acceptable limits. This can be a major issue for users constrained by treaty provisions on collateral damage.

IX THE PROLIFERATION OF E-BOMBS

The relative simplicity and thus low cost of such weapons can be considered of benefit to First World nations intending to build viable war stocks or maintain production in wartime, the possibility of less developed nations mass producing such weapons is alarming. The dependence of modern economies upon their information technology infrastructure makes them highly vulnerable to attack with such weapons, providing that these can be delivered to their targets.

X STRATEGIC AIR ATTACK OPERATIONS USING E-BOMBS

Modern strategic air attack theory is based upon Warden's Five Rings model [WARDEN95], which identifies five centres of gravity in a nation's war fighting capability. In descending order of importance, these are the nation's leadership and supporting C3 system, its essential economic infrastructure, its transportation network, its population and its fielded military forces.

The innermost ring in the Warden model essentially comprises government bureaucracies and civilian and military C3 systems. In any modern nation these are heavily dependent upon the use of computer equipment and communications equipment. What is of key importance at this time is an ongoing change in the structure of computing facilities used in such applications, as these are becoming increasingly decentralized. This decentralization and networking of information technology systems produces a major vulnerability to electromagnetic attack. Whilst the use of distributed computer networks reduces vulnerability to attack by conventional munitions, it increases vulnerability to attack by electromagnetic weapons.

The finance industry and stock markets are a special case in this context, as the destruction of their electronic infrastructure can yield, unlike manufacturing industries, much faster economic dislocation. This can in turn produce large systemic effects across a whole economy, including elements which are not vulnerable to direct electromagnetic attack. This may be of particular relevance when dealing with an opponent which does not have a large and thus vulnerable manufacturing economy. Nations which rely on agriculture, mining or trade for a large proportion of their gross domestic product are prime candidates for electromagnetic attack on their finance industry and stock markets. Since the latter are usually geographically concentrated and typically electromagnetically "soft" targets, they are highly vulnerable.

Transport infrastructure is the third ring in the Warden model, and also offers some useful opportunities for the application of electromagnetic weapons. Unlike the innermost rings, the concentration of electronic and computer equipment is typically much lower, and therefore considerable care must be taken in the selection of targets.

Railway and road signaling systems, where automated, are most vulnerable to electromagnetic attack on their control centres. This could be used to produce traffic congestion by preventing the proper scheduling of rail traffic, and disabling road traffic signaling, although the latter may not yield particularly useful results.

The population of the target nation is the fourth ring in the Warden model, and its morale is the object of attack. The morale of the population will be affected significantly by the quality and quantity of the government propaganda it is subjected to, as will it be affected by living conditions.

Using electromagnetic weapons against urban areas provides the opportunity to prevent government propaganda from reaching the population via means of mass media, through the damaging or destruction of all television and radio receivers within the footprint of the weapon.

The use of electromagnetic weapons against a target population is therefore an area which requires careful consideration in the context of the overall IW campaign strategy. If useful objectives can be achieved by isolating the population from government propaganda, then the population is a valid target for electromagnetic attack.

The outermost and last ring in the Warden model is the fielded military forces. These are by all means a target vulnerable to electromagnetic attack, and C3 nodes, fixed support bases as well as deployed forces should be attacked with electromagnetic devices.

XI CONCLUSION

The first EMP weapons are being tested right now, and their development is planned in the very near future. However, in my opinion none of these new weapons will be useful to create a better world to live in. I think if this huge amount of wasted energy were used in developing new machines to be used in digging for renewable sources of energy or to be used in creating new technologies used to treat fatal diseases, this energy will be more useful than building an army with EMP weapons. Finally, in this project I gave a general background about e-bombs and the electromagnetic pulse, what it does, it works the uses of e-bombs and the history of nuclear and non nuclear e-bombs and EMP weapons. Also I talked about the effects of such a weapon and what damages can it do to armies and people as well as countries. Moreover, I talked about the future and developments of EMP weapons and what advances are being made right now along with the simple process on e-bomb and the costs of such a weapon. Non-nuclear e-bombs could be an alternative weapon to nuclear weapons where nuclear weapons can cause an unrepaired damage to people instead of electronic devices

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