**E-BOMB**

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***ABSTRACT***

The basic idea of an e-bomb or an electromagnetic pulse (EMP) weapon is to overwhelm electrical circuitry with an intense electromagnetism. The gist of e-bomb is to understand electromagnetism, that is electric current generates magnetic fields and changing magnetic field can induce electric current. The types of e-bomb are nuclear e-bomb and non nuclear e-bomb. The paper discusses e-bomb in detail. It deals with the construction and working of both the kinds of e-bomb. It also mentions the significance of e-bomb over bombs in warfare which includes nuclear EMP threat, non nuclear EMP threat and EMP threat to cause mass electric destruction.

**INTRODUCTION**

An **electromagnetic bomb**, or e-bomb, is a weapon designed to take advantage of electromagnetic dependency. An electromagnetic pulse (commonly abbreviated EMP) is a burst of [electromagnetic radiation](http://en.wikipedia.org/wiki/Electromagnetic_radiation). The abrupt pulse of electromagnetic radiation usually results from certain types of high energy explosions, especially a [nuclear explosion](http://en.wikipedia.org/wiki/Nuclear_explosion), or from a suddenly fluctuating [magnetic field](http://en.wikipedia.org/wiki/Magnetic_field). The resulting rapidly-changing [electric fields](http://en.wikipedia.org/wiki/Electric_fields) and magnetic fields may couple with electrical/electronic systems to produce damaging current and [voltage surges](http://en.wikipedia.org/wiki/Voltage_spike).

In military terminology, a nuclear warhead detonated hundreds of kilometers above the Earth's surface is known as a high-altitude electromagnetic pulse (HEMP) device. Effects of a HEMP device depend on a very large number of factors, including the altitude of the detonation, [energy yield](http://en.wikipedia.org/wiki/Nuclear_weapons_yield), [gamma ray](http://en.wikipedia.org/wiki/Gamma_ray) output, interactions with the [Earth's magnetic field](http://en.wikipedia.org/wiki/Earth%27s_magnetic_field), and [electromagnetic shielding](http://en.wikipedia.org/wiki/Electromagnetic_shielding) of targets.

This idea dates back to nuclear weapons research from the 1950s. In 1958, American tests of hydrogen bombs yielded some surprising results. A test blast over the Pacific Ocean ended up blowing out streetlights in parts of Hawaii, hundreds of miles away. The blast even disrupted radio equipment as far away as Australia .Researchers concluded that the electrical disturbance was due to the **Compton Effect**, theorized by physicist Arthur Compton in 1925. Compton's assertion was that photons of electromagnetic energy could knock loose electrons from atoms with low atomic numbers. In the 1958 test, researchers concluded, the photons from the blast's intense gamma radiation knocked a large number of electrons free from oxygen and nitrogen atoms in the atmosphere. This flood of electrons interacted with the Earth's magnetic field to create a fluctuating electric current, which induced a powerful magnetic field. The resulting electromagnetic pulse induced intense electrical currents in conductive materials over a wide area. This was the initialisation of idea of e-bomb.

**TYPES OF E-BOMB**

1. **Nuclear e-bomb:** The case of a nuclear electromagnetic pulse differs from other kinds of electromagnetic pulse (EMP) in being a complex electromagnetic multi-pulse. The complex multi-pulse is usually described in terms of three components, and these three components have been defined as such by the international standards commission called the [International Electro technical Commission](http://en.wikipedia.org/wiki/International_Electrotechnical_Commission) (IEC).

The three components of nuclear EMP, as defined by the IEC, are called E1, E2 and E3.

**E1:**The E1 pulse is the very fast component of nuclear EMP. The E1 component is a very brief but intense [electromagnetic field](http://en.wikipedia.org/wiki/Electromagnetic_field) that can quickly induce very high voltages in electrical conductors. The E1 component causes most of its damage by causing electrical [breakdown voltages](http://en.wikipedia.org/wiki/Breakdown_voltage) to be exceeded. E1 is the component that can destroy computers and communications equipment and it changes too quickly for ordinary lightning protectors to provide effective protection against it.





Fig. (1) principle of nuclear EMP

The E1 component is produced when [gamma radiation](http://en.wikipedia.org/wiki/Gamma_radiation) from the nuclear detonation knocks [electrons](http://en.wikipedia.org/wiki/Electrons) out of the atoms in the upper atmosphere. The electrons begin to travel in a generally downward direction at [relativistic speeds](http://en.wikipedia.org/wiki/Special_relativity) (more than 90 percent of the speed of light). In the absence of a magnetic field, this would produce a large pulse of [electric current](http://en.wikipedia.org/wiki/Electric_current) vertically in the upper atmosphere over the entire affected area. The Earth's magnetic field acts on these electrons to change the direction of electron flow to a right angle to the geomagnetic field. This interaction of the Earth's magnetic field and the downward electron flow produces a very large, but very brief, electromagnetic pulse over the affected area.

Physicist [Conrad Longmire](http://en.wikipedia.org/wiki/Conrad_Longmire) has given numerical values for a typical case of the E1 pulse produced by a second generation nuclear weapon such as those used in high altitude tests of [Operation Fishbowl](http://en.wikipedia.org/wiki/Operation_Fishbowl) in 1962. According to him, the typical gamma rays given off by the weapon have energy of about 2 [MeV](http://en.wikipedia.org/wiki/Electron_Volt) (million electron volts). When these gamma rays collide with atoms in the mid-stratosphere, the gamma rays knock out electrons. This is known as the [Compton Effect](http://en.wikipedia.org/wiki/Compton_effect), and the resulting electrons produce an electric current that is known as the Compton Current. The gamma rays transfer about half of their energy to the electrons, so these initial electrons have energy of about 1 MeV. This causes the electrons to begin to travel in a generally downward direction at about 94 percent of the speed of light. Relativistic effects cause the mass of these high energy electrons to increase to about 3 times their normal rest mass.

If there were no geomagnetic field and no additional atoms in the lower atmosphere for additional collisions, the electrons would continue to travel downward with an average [current density](http://en.wikipedia.org/wiki/Current_density) in the stratosphere of about 48 [amperes](http://en.wikipedia.org/wiki/Amperes) per square meter.

Because of the downward tilt of the Earth's magnetic field at high [latitudes](http://en.wikipedia.org/wiki/Latitudes), the area of peak field strength is a U-shaped region to the equatorial side of the nuclear detonation. As shown in the diagram at the right, for nuclear detonations over the continental United States, this U-shaped region is south of the detonation point. Near the [equator](http://en.wikipedia.org/wiki/Equator), where the Earth's magnetic field is more nearly horizontal, the E1 field strength is more nearly symmetrical around the burst location.

The Earth's magnetic field quickly deflects the electrons at right angles to the geomagnetic field, and the extent of the deflection depends upon the strength of the magnetic field. At geomagnetic field strengths typical of the central United States, central Europe or Australia, these initial electrons spiral around the magnetic field lines in a circle with a typical radius of about 85 meters (about 280 feet). These initial electrons are stopped by collisions with other air molecules at an average distance of about 170 meters (a little less than 580 feet). This means that most of the electrons are stopped by collisions with air molecules before they can complete one full circle of its spiral around the Earth's magnetic field lines.

This interaction of the very rapidly-moving negatively-charged electrons with the magnetic field radiates a pulse of electromagnetic energy. The pulse typically rises to its peak value in about 5 nanoseconds. The magnitude of this pulse typically decays to half of its peak value within 200 nanoseconds. (By the IEC definition, this E1 pulse is ended at one microsecond (1000 nanoseconds) after it begins.) This process occurs simultaneously with about 1025 other electrons.

There are a number of secondary collisions which cause the subsequent electrons to lose energy before they reach ground level. The electrons generated by these subsequent collisions have such reduced energy that they do not contribute significantly to the E1 pulse.

These 2 MeV gamma rays will normally produce an E1 pulse near ground level at moderately high latitudes that peaks at about 50,000 volts per meter. This is a peak [power density](http://en.wikipedia.org/wiki/Surface_power_density) of 6.6 megawatts per square meter.

The process of the gamma rays knocking electrons out of the atoms in the mid-[stratosphere](http://en.wikipedia.org/wiki/Stratosphere) causes this region of the atmosphere to become an electrical conductor due to ionization, a process which blocks the production of further electromagnetic signals and causes the field strength to saturate at about 50,000 volts per metre. The strength of the E1 pulse depends upon the number and intensity of the gamma rays produced by the weapon and upon the rapidity of the gamma ray burst from the weapon. The strength of the E1 pulse is also somewhat dependent upon the altitude of the detonation.

There are reports of "super-EMP" nuclear weapons that are able to overcome the 50,000 volt per metre limit by the very nearly instantaneous release of a burst of gamma radiation of much higher energy levels than are known to be produced by second generation nuclear weapons. The reality and possible construction details of these weapons are classified, and therefore cannot be confirmed by scientists in the open scientific literature.

**E2:** The E2 component is generated by scattered gamma rays and inelastic gammas produced by weapon [neutrons](http://en.wikipedia.org/wiki/Neutrons). This E2 component is an "intermediate time" pulse that, by the IEC definition, lasts from about 1 microsecond to 1 second after the beginning of the electromagnetic pulse. The E2 component of the pulse has many similarities to the electromagnetic pulses produced by lightning, although the electromagnetic pulse induced by a nearby lightning strike may be considerably larger than the E2 component of a nuclear EMP. Because of the similarities to lightning-caused pulses and the widespread use of lightning protection technology, the E2 pulse is generally considered to be the easiest to protect against.

According to the United States EMP Commission, the main potential problem with the E2 component is the fact that it immediately follows the E1 component, which may have damaged the devices that would normally protect against E2.

According to the EMP Commission Executive Report of 2004, "In general, it would not be an issue for critical infrastructure systems since they have existing protective measures for defense against occasional lightning strikes. The most significant risk is synergistic, because the E2 component follows a small fraction of a second after the first component's insult, which has the ability to impair or destroy many protective and control features. The energy associated with the second component thus may be allowed to pass into and damage systems."

**E3:** The E3 component is very different from the other two major components of nuclear EMP. The E3 component of the pulse is a very slow pulse, lasting tens to hundreds of seconds, that is caused by the nuclear detonation heaving the Earth's magnetic field out of the way, followed by the restoration of the magnetic field to its natural place. The E3 component has similarities to a [geomagnetic storm](http://en.wikipedia.org/wiki/Geomagnetic_storm) caused by a very severe solar flare. Like a geomagnetic storm, E3 can produce geomagnetically induced currents in long electrical conductors, which can then damage components such as power line transformers.

Because of the similarity between solar-induced geomagnetic storms and nuclear E3, it has become common to refer to solar-induced geomagnetic storms as "solar EMP." At ground level, however, "solar EMP" is not known to produce an E1 or E2 component.

**Generation of nuclear EMP:** Several major factors control the effectiveness of a nuclear EMP weapon. These are-

1. The altitude of the weapon when detonated;
2. The [yield](http://en.wikipedia.org/wiki/Nuclear_weapon_yield) and construction details of the weapon;
3. The distance from the weapon when detonated;
4. Geographical depth or intervening geographical features;
5. The local strength of the magnetic field of the Earth.

Beyond a certain altitude a nuclear weapon will not produce any EMP, as the gamma rays will have had sufficient distance to disperse. In deep space or on worlds with no magnetic field (the moon or Mars for example) there will be little or no EMP. This has implications for certain kinds of nuclear rocket engines, such as [Project Orion](http://en.wikipedia.org/wiki/Project_Orion_%28nuclear_propulsion%29).



Fig. (3) Graph stating the permissible weapon altitude

1. **Non-nuclear e-bomb:** Non-nuclear electromagnetic pulse (NNEMP) is an electromagnetic pulse generated without use of nuclear weapons. There are a number of devices that can achieve this objective, ranging from a large low-inductance [capacitor](http://en.wikipedia.org/wiki/Capacitor) bank discharged into a single-loop antenna or a microwave generator to an [explosively pumped flux compression generator](http://en.wikipedia.org/wiki/Explosively_pumped_flux_compression_generator). To achieve the frequency characteristics of the pulse needed for optimal [coupling](http://en.wikipedia.org/wiki/Coupling_%28electronics%29) into the target, [wave](http://en.wikipedia.org/wiki/Electromagnetic_wave)-shaping circuits and/or microwave generators are added between the pulse source and the [antenna](http://en.wikipedia.org/wiki/Antenna_%28radio%29). A vacuum tube particularly suitable for microwave conversion of high energy pulses is the [vircator](http://en.wikipedia.org/wiki/Vircator).



Fig. (2a) cross section of nuclear EMP



Fig. (2a) sequence of events in the working of non-nuclear EMP

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](http://electronics.howstuffworks.com/capacitor.htm), 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 fuse 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.

**E** **-BOMB WARFARE**

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. This technology is advanced and expensive and so would be inaccessible to military forces without considerable resources. But that's only one piece of the e-bomb story. Using inexpensive supplies and rudimentary engineering knowledge, a terrorist organization could easily construct a dangerous e-bomb device.

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](http://science.howstuffworks.com/machine-gun.htm)), 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 guerrilla-type army.

**FUTURE SCOPE OF STUDY**

In the coming years, significance of e-bomb will strongly be realised. The failure of habitable bunkers in wars, without loss of life, disruption and inaccessibility of mass media to restrict a human uprising, as for example could be worked upon most importantly; research is required in this field to restrict terrorist activities.

**CONCLUSION**

E-bomb is the device that works on the current-magnetism dependency. Working of nuclear and non-nuclear e-bomb is studied in detail. Other important facts about e-bomb are also discussed. From the above discussions, it is clear that in the next few years, modern warfare would include e-bomb as an important weapon to target the abrupt increase in technological dependency.

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