**E-Bomb: The two faced Angel**

**Abstract**

**My paper is going to be focused towards**

**1.** **the mechanism that e-bombs work on**

**2.** **how can ebombs be made**

**3.** **may be some ways to make ebombs at home**

**4.** **the future of wars with ebombs**

**Introduction**

In the era of Nuclear energy and warfare, people tend to side track one of the most prominent and effective natural phenomena and energy system - the electromagnetic pulse. Originating from the most basic structure known to man, this source is the originator of electromagnetic energy and its subderivative nuclear energy. E-Bombs are the next generation advancement in nuclear bombs. A short term electromagnetic pulse at low level is capable of disabling electronic system, a medium level can corrupt computer data and the high range can completely destroy the circuitry of any electronic system. Given that the modern day human lives are completely based on electronic systems, this will cause a grave impact on day to day work and would cause immense loss. However, in a more positive light, the concepts of e-bomb have proven to be a great knowledge to the aid of mankind. This project is an attempt to understand, learn and know more about the “E - Bombs”.

This project report starts its journey along the timeline of development of the basic theory on which the study of electromagnetics is developed and takes us through the time when the concept of e-bomb was introduced. It also takes a step ahead to demonstrate how the e-bomb is being used in today’s world and various form it can be applied in. Furthermore, this report also helps its readers understand the process behind making of an e-bomb along with a small do-it-yourself (DIY) procedure and then summarizes with the future as predicted by author. This report in general proposes to educate and expand the understanding of non technical readers as well as technical readers. The countdown timer starts to tick towards realization of E-Bombs or EMP - Bombs in early 1700’s when no-one had proper understanding of electric fields, it was the time when the atomic models were being proposed, and we still had about a century when the trio - Ampere, Biot and Savart experimentally confirmed the existence of electromagnetic waves and their interactions. It is the year of 1820 when the journey of E-bombs actually begins.

**History**

The EMP bomb or Electromagnetic Pulse Bomb is nothing but yet another implication of electromagnetic waves and radiation, we must venture our journey through the development and experimental discoveries of evolution from light to Electromagnetic waves and radiation. However, first we need to start by understanding the study of light.

The very first attempt towards the understanding of light (which we today know as electromagnetic wave) was made by none other than Galileo Galilei. He attempted to measure the speed of light with the aid of lanterns approximately two kilometers away on two adjacent hills from each other. Galileo would uncover the lantern, and his assistant would then uncover his lantern when he saw the light from the other one. Unfortunately, because light is so fast, this experiment proved to be useless in determining the speed of light.

Next most prominent person who studied about light was Willebrord Snell. He was able to determine the relationship between angles of incidence, angles of refraction, wavelength, velocity and what is known as index of refraction (n) and the relation is given by:

The formulation of Snell’ Law, proved that the light evidently travelled as waves. However, this hypothesis wasn’t greeted by everyone equally well in scientific community. There were few scientists who believed that the light exhibit particle nature. This dispute has been on for centuries and now the duality has been accepted.

Another yet progressive scientist was finally able to calculate the speed of light. Olaus Roemer roughly determined the speed of light based off of Jupiter’s moon – Io, by measuring the time difference between the shortest time for Io’s revolution around the Jupiter and the shortest amount of time. He then estimated Earth’s orbital diameter, and from there was able to calculate approximately 2.3 \* 10 ^8 m/s as the speed of light, which was very close to the actual value according to that particular time period and technology.

Then came along the most important scientist in the history of humanity – Sir. Isaac Newton. He took a triangular Prism and shined white light through one side. On the other side, he saw that a complete spectrum of colors was produced as a result. This was clear evidence of the Wave Model of Light, because it meant that the dispersion of different colors of light consisted of different wavelengths and frequencies, leading to the different angles of refraction for the various colors. This helped us formulate various parameter of electromagnetic waves including but not limited to frequencies, wavelength and period.

In 1678 Huygens proposed a very important principle that would challenge the wave nature of light. He constructed Huygens’ Principle, whereby a wave front is not comprised of a single wave, rather it is made up of many smaller waves called ‘wavelets’ that propagate outward in a circular motion from a point source. These wavelets act in the same way that a single wave would, and account for the properties that waves exhibit such as reflection and refraction. This principle means that when a wave contacts a barrier, it will change its shape and direction via diffraction: a key part of the Wave Model of Light, as shown by Young’s Double Slit Experiment.

**Theoretical Concept of ebomb**

**Electromagnetic Pulse**

An electromagnetic pulse (EMP) is a short burst of electromagnetic energy or radiation. An electromagnetic pulse can be man-made or natural. The potential sources of an EMP are radiation, magnetic field, electric field or conducting electrical current. EMP interference is harmful for electronic equipment. An example of a very powerful and harmful EMP is a lightning strike which can damage buildings and bridges etc. Due to the immense power of damage, EMP is is used for creating weapons. These weapons can be both nuclear and non nuclear. An example of nuclear EMP is that when Atomic Weapons are detonated, an electromagnetic pulse is released. Moreover, the higher up in the atmosphere a weapon is detonated, the more widespread is the effect of EMP.

**Characteristics of EMP**

The EMP is generally described as a short burst of energy. The short burst refers to the small duration of the burst. As the EMP is for a short duration, it is spread over a range of frequencies. The electromagnetic pulses are characterized by:

1. The type of energy: The energy can be transferred in the following forms:
2. Electric field
3. Magnetic field
4. Electromagnetic radiation
5. Electrical Conduction

2. Frequency ranges: The energy pulse has a wide frequency range from 0Hz to an upper limit depending on the source of the pulse. However, these frequencies do not comprise of the optical or ionizing ranges.

3. Pulse Waveforms: The waveform of a pulse is used for describing the instantaneous amplitude change over a course of time. Electromagnetic pulse tends to induce a corresponding signal in the electrical equipment, due to coupling between the source of the EMP and the electrical equipment. Such equipments are often known as the victim equipments. This coupling occurs over a narrow frequency band which leads to a characteristic damped sine wave signal in the victim equipment. A damped sine wave has a lower energy and a narrower frequency spread than the original pulse, due to the transfer characteristic of the coupling mode.

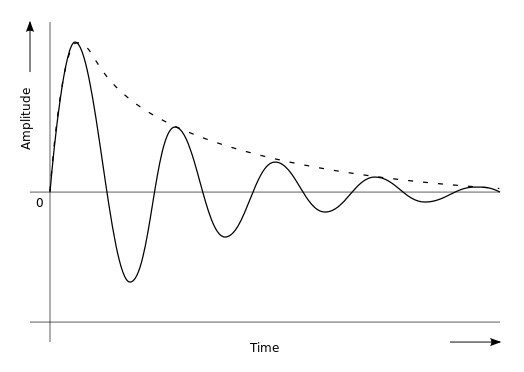


Figure 1: A damped sine wave

**Effects of EMP**

Small EMPs cause electrical noises or interference which can affect the operation of electrical devices. EMP was a common problem in the mid-twentieth century. It was emitted by the ignition systems of a gasoline engine and used to create crackle in radio or show stripes on TV screen. At a higher voltage level, an EMP can induce spark which can cause a fuel-air explosion. A larger EMP can induce currents and voltages high enough to damage the equipment. An extremely large EMP like a lightening strike can even damage objects like trees, buildings and bridges through heating effects or by cause a very large magnetic field generated by current. Due to the high heat, an electrical fire can also break out. Most bridges and engineering structures are designed to protect against lightning. These highly damaging characteristics of EMP are the cause for EMP weapons which range from a small range missile to nuclear bombs.

**Types of EMP**

Natural Electromagnetic Pulses

Lightening - It is a discharge of an initial high flow of current followed by a train of pulses of decreasing energy.

Electrostatic discharge - This is a result of two charged objects coming into close proximity or contact. Electrostatic discharge or ESD have high voltage but small current. ESD damages electronics through a high-voltage pulse and tends to give shocks as well. ESD can also create sparks which may result in fire. Moreover, technically, lighting is also an ESD, just a very large scale.

Meteoric EMP - The discharge due to the impact of meteoroid with a spacecraft or due to its explosive breakup while passing through the Earth’s surface.

Coronal Mass Ejection - This is caused to the a massive burst of gas and magnetic field arising from the solar corona and released into the solar wind.

Man-Made

Switching-action - The switching action in an electrical circuit tends to create a sharp change in the flow of electricity. The sharp change is the EMP. In most electrical sources such as relays and solenoids, the EMP is treated as noise or interference. However, the switching off event causes an abrupt change in the current which causes a large pulse in the electric field resulting in arcing and damage.

Nuclear and high altitude nuclear - The EMP resulting from a nuclear explosion is called N(Nuclear)EMP. The electric and magnetic fields produced due to the result of NEMP couples with electronic devices and damages them due to current and voltage surges. If the nuclear weapon is detonated high up in the air, it is called the H(high-altitude)EMP. There is a blast of gamma ray into the mid-stratosphere, which ionized and energetic free electrons interact with the Earth’s magnetic field to produce a much more stronger EMP than is normally produced in the denser air at lower altitudes.

Non-nuclear electromagnetic pulse - It is an EMP without the nuclear technology. Some of the devices which can be used to create a non-nuclear EMP are the following:

1. A large low-inductance capacitor discharged into a single-loop antenna
2. A microwave generator
3. An explosively pumped flux compression generator

To achieve the frequency characteristics of the pulse needed for optimal coupling into the target, wave-shaping circuits and/or microwave generators are added between the pulse source and the antenna.

The range of NNEMP is much less than NEMP. Hence, they need chemical explosives as their initial energy source. It is important to note that the nuclear weapons generate EMP as a secondary effect, whereas for NNEMP weapons, the EMP must come from within the weapon as their is no secondary effects. This also allows for finer target discrimination but does reduce the range of the weapon effect.

Electromagnetic forming - The large forces generated by EMP can be used to shape objects in manufacturing process.

**Initial Test On E-Bombs**

In July 1945, the first nuclear test was carried out in The United States of America. Most the electronic equipment and signal lines were shielded and yet the recording equipment was damaged at the time of the explosion. The shielding was done due to Enrico Fermi’s prediction of EMP.

The first observation of the high-altitude nuclear EMP occurred during the [helium balloon](https://en.wikipedia.org/wiki/Helium_balloon) lofted Yucca nuclear test of the [Hardtack I](https://en.wikipedia.org/wiki/Hardtack_I) series on 28 April 1958. There, the electric field measurements from the 1.7 kiloton weapon went off the scale of the test instruments and were estimated to be about 5 times the oscilloscope limits. The Yucca EMP was initially positive-going whereas low-altitude bursts were negative pulses. Also, the [polarization](https://en.wikipedia.org/wiki/Polarization_(waves)) of the Yucca EMP signal was horizontal, whereas low-altitude nuclear EMP was vertically polarized. In spite of these many differences, the unique EMP results were dismissed as a possible [wave propagation](https://en.wikipedia.org/wiki/Wave_propagation) anomaly.

However, in July 1962, the Starfish Prime test was carried out. It was a 1.44 [megaton](https://en.wikipedia.org/wiki/Nuclear_weapon_yield) nuclear test in space, 400 kilometres above the mid-Pacific Ocean which showed the nuclear scientists that the magnitude and effects of a [high-altitude nuclear explosion](https://en.wikipedia.org/wiki/High-altitude_nuclear_explosion) were much larger than any previous estimate. It was the first successful experiment in the series of Operation Fishbowl to carry out the high-altitude nuclear tests.

Starfish Prime made its effects public due to the electrical damage in Hawaii which was about 1,445 kilometres away from the detonation point. About 300 streetlights, numerous burglar alarms and microwave links were damaged.

The [Bluegill Triple Prime](https://en.wikipedia.org/wiki/Operation_Fishbowl#Bluegill_Triple_Prime) and [Kingfish](https://en.wikipedia.org/wiki/Operation_Fishbowl#Kingfish) high-altitude nuclear tests of October and November 1962 in Operation Fishbowl provided data that was clear enough to enable physicists to accurately identify the physical mechanisms behind the electromagnetic pulses.

The magnitude of damage caused by Starfish Prime EMP in Hawaii was relatively small and hence, the scientists did not see it as a big problem. However, further calculations showed that, if the bomb had been detonated over North America, then the magnitude of the damage would been about 5 to 6 times more due to the greater strength of the Earth's magnetic field over United States and the different orientation at high latitudes. These calculations, together with the increasing dependence on EMP-sensitive microelectronics made the scientists realise that EMP is a significant problem.

In 1962, the [Soviet Union](https://en.wikipedia.org/wiki/Soviet_Union) also performed three EMP-producing nuclear tests in space over Kazakhstan. Even though the weapons were smaller of about 300 kiloton, they were carried out in a large land mass with high Earth’s magnetic field. The resulting EMP was much greater than the Startfish Prime. The [geomagnetic storm](https://en.wikipedia.org/wiki/Geomagnetic_storm)–like E3 pulse from Test 184 induced a current surge in a long underground [power line](https://en.wikipedia.org/wiki/Power_line) that caused a fire in the [power plant](https://en.wikipedia.org/wiki/Power_plant) in the city of [Karaganda](https://en.wikipedia.org/wiki/Karaganda).

For one of the K Project tests, scientists instrumented a 570-kilometer section of telephone line in the area that they expected to be affected by the pulse. The monitored telephone line was divided into sub-lines of 40 to 80 kilometres in length and was separated by [repeaters](https://en.wikipedia.org/wiki/Repeater). Each sub-line was protected by [fuses](https://en.wikipedia.org/wiki/Fuse_(electrical)) and by [gas-filled](https://en.wikipedia.org/wiki/Gas-filled_tube) [over-voltage](https://en.wikipedia.org/wiki/Overvoltage) protectors. The EMP from the 22 October (K-3) nuclear test (also known as Test 184) blew all of the fuses and fired all of the overvoltage protectors in all of the sub-lines.

**Characteristics of a Nuclear EMP**

Nuclear EMP is a complex multi-pulse which is described in three components - E1, E2, E3 by the International Electrotechnical Commission.

**E1**

E1 is a extremely brief but intense electromagnetic field that induces very high voltages in electrical conductors. E1 causes most of its damage by causing electrical [breakdown voltages](https://en.wikipedia.org/wiki/Breakdown_voltage) to be exceeded. E1 can destroy computers and communications equipment. Moreover, it changes more quickly than an ordinary [surge protectors](https://en.wikipedia.org/wiki/Surge_protector) can protect against. Although there are special fast-acting surge protectors that will block the E1 pulse.

E1 is produced when [gamma radiation](https://en.wikipedia.org/wiki/Gamma_radiation) from the nuclear detonation [ionizes](https://en.wikipedia.org/wiki/Ionization) atoms in the upper atmosphere and is known as the [Compton effe](https://en.wikipedia.org/wiki/Compton_effect)ct. The resulting current is called the "Compton current". The electrons travel in a generally downward direction at [relativistic speeds](https://en.wikipedia.org/wiki/Special_relativity). In the absence of a magnetic field, this would produce a large, radial pulse of [electric current](https://en.wikipedia.org/wiki/Electric_current) propagating outward from the burst location confined to the source region (the region over which the gamma photons are attenuated). The Earth's magnetic field deflects the electron flow at a right angle to the field, leading to synchrotron radiation emitted by the electrons. Because the outward traveling gamma pulse is propagating at the speed of light, the synchrotron radiation of the Compton electrons adds coherently, leading to a radiated electromagnetic signal. This interaction produces a very large, but very brief, electromagnetic pulse over the affected area.

[Conrad Longmire](https://en.wikipedia.org/wiki/Conrad_Longmire) in 1963 detected the correct mechanism for E1 pulse produced in nuclear weapon detonation at high altitude. He gave numerical values for a typical case of E1 pulse produced by a nuclear weapons similar to the weapons used in the [Operation Fishbowl](https://en.wikipedia.org/wiki/Operation_Fishbowl) in 1962. The typical gamma rays given off by the weapon have an energy of about 2 [MeV](https://en.wikipedia.org/wiki/Electron_Volt). The gamma rays transfer about half of their energy to the ejected free electrons and gave an energy of about 1 MeV.

In a vacuum and absent a magnetic field, the electrons travelled with a [current density](https://en.wikipedia.org/wiki/Current_density) of tens of [amperes](https://en.wikipedia.org/wiki/Amperes) per square metre. Because of the downward tilt of the Earth's magnetic field at high [latitudes](https://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](https://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.

At geomagnetic field strengths typical of the central United States, central Europe or Australia, these initial electrons spiral around the magnetic field lines with a typical radius of about 85 metres (about 280 feet). These initial electrons are stopped by collisions with other air molecules at an average distance of about 170 metres (a little less than 580 feet). This means that most of the electrons are stopped by collisions with air molecules before completing a full spiral around the 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 some 5 nanoseconds. Its magnitude typically decays to half of its peak value within 200 nanoseconds. (By the IEC definition, this E1 pulse ends 1000 nanoseconds after it begins.) This process occurs simultaneously on about 1025 electrons.[[20]](https://en.wikipedia.org/wiki/Nuclear_electromagnetic_pulse#cite_note-longmire-20) The simultaneous action of the very large number of electrons causes the resulting electromagnetic pulses from each electron to radiate coherently, thus adding to produce a single very large amplitude, but very narrow, radiated electromagnetic pulse.

Secondary collisions cause 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 typically produce an E1 pulse near ground level at moderately high latitudes that peaks at about 50,000 volts per metre. This is a peak [power density](https://en.wikipedia.org/wiki/Surface_power_density) of 6.6 megawatts per square metre.

The ionization process in the mid-[stratosphere](https://en.wikipedia.org/wiki/Stratosphere) causes this region to become an electrical conductor, a process that 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 and upon the rapidity of the gamma ray burst. Strength is also somewhat dependent upon altitude.

There are reports of "super-EMP" nuclear weapons that are able to exceed the 50,000 volt per metre limit by the nearly instantaneous release of a burst of much higher gamma radiation levels than are known to be produced by second-generation nuclear weapons. The reality and possible construction details of these weapons are classified and unconfirmed in the open scientific literature.

### **E2**

The E2 component of the EMP is generated by scattering of gamma rays and inelastic gammas which are produced by the neutrons. This is an intermediate time pulse that lasts for about 1 microsecond to 1 second after the explosion occurs. Although E2 is similar to lightning but the E2 produced E2 is much larger than the nuclear E2. Due to its similarities to lightning, it is easy to protect against. However, as it is immediately followed by E1, the devices which protect against it might have been already damaged by E1.

### **E3**

Compared to E1 and E2, E2 is a very slow pulse which lasts a long time. E3 is caused by the temporary distortion of the Earth’s magnetic field which is caused due to the nuclear weapon detonation. Though E3 can be compared to the geomagnetic storm caused by a solar flare. This is because, E3 can produce geomagnetically induced currents in long electrical conductors, damaging components such as power line [transformers](https://en.wikipedia.org/wiki/Transformer).

**Impact**

**How can ebombs be made**

**Procedure**

**Making EBomb at home**

A Hand held EMP Bomb can be made with a disposable camera, insulated thick copper wire and an iron rod. Simply wrap the copper wire around the iron rod as tightly as possible. After that, solder the ends of the copper wire to the capacitor of the camera circuit. Put a battery inside the camera and push the switch. This EMP should have a blast radius of a few feet.

Another way to build EMP at home is with firecrackers, neodymium magnets, insulated thick copper wire and a hollow iron rod. Simply wrap the copper wire around the iron rod as tightly as possible. Fill the hollow space in the rod with a firecracker and connect the copper wires to the magnet. Light the fuse of the firecracker and get as far from it as possible. This EMP should again have a pretty good blast radius.

**Impact Area**

**How to increase the impact without having to increase the height of explosion**

**Future of ebombs**

<https://www.quora.com/How-do-I-make-a-small-EMP-bomb-for-a-college-project>

<http://whatis.techtarget.com/definition/e-bomb-electromagnetic-bomb>

<https://en.wikipedia.org/wiki/Electromagnetic_pulse>

https://en.wikipedia.org/wiki/Nuclear\_electromagnetic\_pulse

<http://www.ausairpower.net/ASPC-E-Bomb-Mirror.html>

<http://www.shtfplan.com/headline-news/flight-370-theory-e-bomb-a-non-nuclear-electro-magnetic-pulse-weapon-instantly-fried-the-planes-electronic-systems-videos_03112014>

<http://science.howstuffworks.com/e-bomb.htm>

<http://www.instructables.com/id/Make-a-cheap-electronic-detonator!/>

<https://in.rbth.com/blogs/2013/04/26/e-bomb_the_real_doomsday_weapon_24213>

<http://www.airpower.maxwell.af.mil/airchronicles/kopp/apjemp.html>

<http://www.salon.com/2015/05/06/a_president_for_the_tinfoil_hat_crowd_mike_huckabee_has_his_finger_on_the_electromagnetic_pulse/>

<http://www.slate.com/articles/technology/future_tense/2015/07/emp_threats_could_an_electro_magnetic_pulse_weapon_wipe_out_the_power_grid.html>

<http://dailysignal.com/2014/01/29/electromagnetic-pulse-emp-clock-ticking/>

<http://www.vice.com/read/we-asked-a-military-expert-how-scared-the-us-should-be-of-an-emp-attack-508>

<http://whatis.techtarget.com/definition/electromagnetic-pulse-EMP>

<http://www.extremetech.com/extreme/170563-north-korea-emp>

<http://www.zerohedge.com/news/2015-04-07/emp-threat-sending-america-back-1800s>

<http://www.electronicproducts.com/Power_Products/Power_Management/How_to_build_a_mini_EMP_generator_to_disrupt_electronics.aspx>

<http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.37.888>

<http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA529982>

<https://www.nas.org/articles/Ask_a_Scholar_Electromagnetic_Pulse_Attack>

<http://www.heritage.org/research/reports/2008/10/electromagnetic-pulse-emp-attack-a-preventable-homeland-security-catastrophe>

<http://www.livescience.com/38848-emp-solar-storm-danger.html>

<http://empbomb.blogspot.com/2008/10/history.html>

<http://science.howstuffworks.com/e-bomb.htm>

<http://whatis.techtarget.com/definition/e-bomb-electromagnetic-bomb>

<http://www.ausairpower.net/ASPC-E-Bomb-Mirror.html>