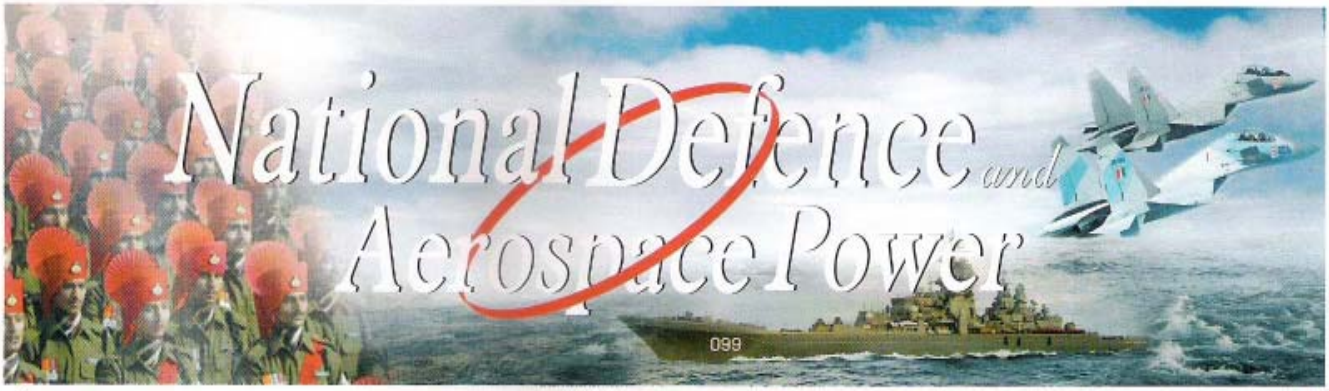
Robert Newton - See page 2 for excellent EMP information.



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EMP: THE NEXT WEAPON OF ELECTRONIC MASS DESTRUCTION ARE WE PREPARED?

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On April 6, 2010, a cyber-espionage Chinese group stole documents from the Indian Defence Ministry.[1] Unfortunately, this was not the first time. In December 2009, the Chinese cyber warriors had hacked into the computers of the PMO. Clearly, these incidences are a manifestation of the Chinese military doctrine, which pay significant attention to 'information warfare' ranging from computer attacks to a nuclear electromagnetic pulse (EMP) attack. Recently, the Assistant Secretary of Defense for Asian and Pacific Security Affairs, James J. Shinn disclosed that China's military is developing EMP weapons that can ravage electronic systems using an explosion of energy similar to that produced by a nuclear blast.[2] While China is busy building such capabilities, India continues to ignore the potential threat of an EMP attack.

In December 2009, the Chinese cyber warriors had hacked into the computers of the PMO. Clearly, these incidences are a manifestation of the Chinese military doctrine, which pay significant attention to 'information warfare' ranging from computer attacks to a nuclear electromagnetic pulse (EMP) attack.

An EMP is caused by the rapid release of gamma rays from a high altitude explosion (especially nuclear). Sreenath Bhat, in a paper on 'Emerging Trends in Airborne Defence Technologies', stated that the EMP bomb generates a broad band, high intensity, low duration burst of magnetic energy which disrupts or damages any electronic equipment miles away from the locus of explosion.[3] In simple words, a high-altitude nuclear explosion generates unrest of gamma rays, which in turn produces high energy free electrons (owing to the Compton scattering effect) ranging from 20 to 40 km. The electrons get entrapped in the Earth's magnetic field, creating oscillating electric current. The asymmetric currents breeds a radiated electromagnetic field termed as an EMP.[4]

As a result of the explosion, electrical and electronic systems get damaged, primarily due to overloading and thus, unhardened commercial computers would suffer the damage. The national infrastructures like electrical, transportation telecommunication and banking systems, emergency services, military equipment and space systems can also be potentially crippled. The effects of an EMP were first seen in 1962, when the US conducted tested a high-altitude atmospheric nuclear test, "Starfish Prime," (1.4 megaton nuclear weapon) in the Pacific Ocean, 800 miles from Hawaii.[5] This explosion caused an EMP that disrupted radio stations and electrical equipments throughout Hawaii and also damaged 7 satellites as radiations knocked out their solar arrays or electronics, including Telstar.

EMP attacks are not necessarily nuclear-oriented. Even though a nuclear high altitude electromagnetic pulse (HEMP) is created by nuclear means, there are non-nuclear weapons that can generate a similar pulse. Specifically, they are high power microwave (HPM) or electromagnetic bomb (E-bomb), coaxial flux compression generator (FCG) and the virtual cathode oscillator (Vircator). An EMP generated by nuclear weapons is the most lethal and effective. Presently, USA, UK, France, China, India, Israel and Pakistan have the capability to generate HEMP.

High power microwave (HPM) weapons contain a category of directed-energy devices that emit electromagnetic energy at high frequencies. It is important to note that these weapons can only thrive in a strong technological base and face major technical challenges, especially in terms of compactness, reliance and affordability. Another non-nuclear EMP weapon is the 'E-bombs'. The basics of the workings of an E-bomb are based on the elementary understanding of electromagnetic physics theory. An E-Bomb is different from HPM because it uses conventional explosives to destroy an already-charged electric circuit and

produce the desired EMP. The two versions of the E-bomb, are flux compression generator (FCG) and the virtual cathode oscillator (Vircator). A FCG comprises of an explosive-packed tube positioned inside a larger copper coil. The detonation of the chemical explosives energises the coil, producing a magnetic field. Further, the tube blazes outward, touching the edge of the coil, thereby generating a moving short circuit. FCG usually produce a frequency band below 1 MHz, therefore limiting its target focussing. Other version of an E-bomb, Vircator can generate a more lethal high frequency pulse, with field strength of 900v/m at a range of 1 mile, or 10 kV/m at 150 meters. A Vircator is capable of keeping a low physical profile imperative for packaging in a projectile or bomb and its output power can be easily focused, thereby making it a much effective weapon.[6] As pointed out by Major M. Cajon, 10 kV/m could induce electrical charges a billion times more powerful than systems were designed for, not just burning them out, but in some cases melting critical components.[7] Moreover, the higher the explosion takes place, the more damage it is bound to inflict.

As India continues to modernize, it is inevitably becoming dependent on electronic systems in almost all possible spheres, ranging from civil to military usage. While these developments have enhanced our capabilities and benefitted infrastructures, they have also increased the probability of an EMP strike in the future. Many analysts believe that future wars will not be fought on battle grounds but in 'control rooms'. Indian analysts have highlighted their fears about an EMP attack by Pakistan on the Indian Silicon Valley, Bangalore. While the validity of this possibility is disputed presently, it can well be likelihood in the coming decade. Keeping these aspects in mind, we need to develop our capabilities from today in order to tackle/challenge the threats of tomorrow. The impact of an EMP strike on India would lead to collective infrastructural failure, sending our country centuries back in time. Telecommunication systems, satellites, transportation (land and air traffic) systems can potentially collapse and so would the banking and financial services, hitting the metropolitan cities significantly heavily. Emergency services would become incapable of effectively responding to a disaster of this level, paralyzing us for years to come.

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Most importantly, such a strike would hamper the military arm of a country. With emerging IT technologies, the Indian armed forces are working towards Net-centric warfare (NCW) and evolving their C4I2SR capabilities. The essence of such systems lies in its ability to conduct network-enabled operations. The Indian Army's most ambitious project in this regard is the battle management system (BMS), which would provide a strong link between the headquarters and foot soldiers. Also, the Indian defence services wish to embark on projects that would integrate the Army, Air Force and Navy. The Indian Army's 'Shakti' artillery combat command and control system (ACCCS) is an example of a successful induction of such projects. Further, the Indian Air Force is working towards an Integrated Air Command and Control System (IACS) and the USA is considering the Indian navy's demand of the Aegis Combat System (ACS). These projects would comprise of sensors, digitally-enabled weapons and information grids, which rely heavily on technologies vulnerable to an EMP strike. Interestingly, military networking in India would employ fibre optic cables which are not susceptible to EMP. But it is important to note that switches and controls that depend on microelectronics combined with fibre optic cables would remain defenceless.

Air defence radar, satellites, missile complexes, troops and naval assets can be easy targets in this respect. The employment of 3G technology for networking would also be hampered impeding the communication systems. Additionally, systems like digital control systems (DCSs) and programmable logic controllers (PLCs) that are utilised in nuclear plants would also be severely affected, interrupting the nuclear strike-back capability. Fly-by-wire aircrafts such as the Mirage-2000 would crash (the ones of ground would become inoperable) due to the failure of their wire flight control systems. The proposed procurements of the IAF's aircraft (such as F-16 Super Viper, F-18 Hornet etc) are also fly-by-wire technology conversant, and therefore, would be equally affected by an EMP. It is believed that scientists working on EMP weapons intend to produce bombs that attack artillery shells, missiles and also intercept their trajectory in mid-flight.

E-bombs can be delivered by Surface-to-Surface missiles, cruise missiles (though it has certain limitations due to the size of the priming current and its battery). Conventional aircraft can also be employed to deliver an E-bomb, but would demand careful preparation lest the aircraft gets engulfed in the bombing. Therefore, it would involve delivery by toss bombing or delivering a glide bomb. Also, an adversary can use an unmanned aerial vehicle (UAV) armed with emission locator and E weapons.[8] As noted by W. J Broad, offshore HEMP would destroy an entire coast and regions hundreds of miles inland. Furthermore, a high altitude detonation can be positioned

over international waters launched from a ship. Pakistan possessed Scud-derived missiles of more than adequate capability.[9] Significantly, China continues to enhance its naval capacities and bases that encircle India. These developments or ability should not be ignored by India, purely because it is surrounded by water bodies, undoubtedly making the country vulnerable to such an attack in the future.

The degree of disaster an EMP bomb can inflict is massive. While presently, these weapons may not seem a probable choice for countries, they are likely to be used in future conflicts.

While there are no infallible measures for 100% protection against an EMP strike, there are few ways that can minimise the degree of damage. Primarily, it is important to protect the most critical civil and military infrastructures. Individual components such as radio, television etc can be protected by Faraday casing, a metallic mesh built around an electric circuit. Protection of key military assets is important to ensure its survival and strengthen the credibility of deterrence. While it may not be economically feasible to electro-magnetically harden present systems, it is important to concentrate on constructing EMP protection in upcoming systems, a move that is being encouraged in the armed forces. Interestingly, hardening of systems in defence of an EMP is usually between 1% and 5% of the system cost.[10] Another important consideration is the protection of satellites from system generated EMP (SGEMP) which can be done by focussing on the electrical interconnectivity of the system. Studies by the US Defense Special Weapons Agency assert that SGEMP and radiation hardened parts affixes 1% to 8% to the cost of a satellite.[11]

Apart from these deliberations, India should also replace solid-state technology with vacuum tube equipments that depend on thermionic technology and are durable against the EMP weapons. Our future efforts should be concentrated on procuring Fly-by-wire technology aircraft (that can withstand EMP), so that the damage to the IAF can be minimised and retain the capability to strike back.

As iterated above, the degree of disaster an EMP bomb can inflict is massive. While presently, these weapons may not seem a probable choice for countries, they are likely to be used in future conflicts. More so, considering the negligible collateral damage caused by an EMP weapon, countries would not shy away from employing them. Without doubt, the trends in warfare are changing, making it imperative to build capabilities to counter future threats which clearly demands time. EMP weapons would be the next weapons of electronic mass destruction, bearing the capability of paralysing one's adversary in no time. Urban warfare will undoubtly rely on such weapons to cripple a country's electrical infrastructure even before the arrival of the army. India is viewed as a potential regional power by its neighbours and the unbound infrastructural development makes it highly vulnerable to such an attack. In terms of military response, India has always maintained a reactionary stance, but now is the time to envisage our potential vulnerabilities and analyse our preparedness. With neighbours like China and Pakistan, India needs to take a futuristic approach and work towards the future threat, before it enhances to its full form.

Notes

[1] "Report: India targeted by spy network", CNET News, April 6, 2010.

[2] Dr. William R. Graham, "Commission to assess the threat to the United States from Electromagnetic Pulse (EMP) Attack" at http://www.empcommission.org/docs/GRAHAMtestimony10JULY2008.pdf.

[3] Sri Krishna, "Powering future warfare", at http://www.thestatesman.net/

[4] "Nuclear Weapon EMP Effects", athttp://www.fas.org/nuke/intro/nuke/emp.htm

[5] "High-altitude and in-space nuclear testing", at http://www.idealist.ws/hane.php

[6] The technical details about the EMP weapons has been adopted from Colin R. Miller, "Electromagnetic Pulse Threats in 2010", at http://www.au.af.mil/au/awc/awcgate/cst/bugs_ch12.pdf

[7] Major M. CaJohn, "Electromagnetic Pulse-From Chaos To A Manageable Solution", at http://www.globalsecurity.org/wmd/library/report/1988/CM2.htm

[8] C. N. Ghosh, "EMP weapons", athttp://www.informaworld.com/smpp/content~content=a792645638&db=all

[9] William J. Broad, "Nuclear pulse. II - Ensuring delivery of the doomsday signal", at http://www.jstor.org/pss/1685373

[10] Dr. Ullrich "Threats Posed by Electromagnetic Pulse to U.S. Military Systems and Civilian Infrastructure", p. 23 at, http://commdocs.house.gov/committees/security/has197010.000/has197010_1.HTM#18

[11] Klinger, "Threats Posed by Electromagnetic Pulse to U.S. Military Systems and Civilian Infrastructure", p. 92 at, http://commdocs.house.gov/committees/security/has197010.000/has197010_1.HTM#18

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