EMP (ELECTROMAGNETIC PULSE)

Nuclear war has never been a more real threat to humanity. Should the inconceivable occur — and an exchange take place — how well prepared are we in Britain to survive? This disturbing article from Graham Packer points out what appears to be a major weakness in Britain's defensive thinking.

Relations between the super-powers are deteriorating rapidly and with the ever growing 'nuclear club' of nations the possibility of such weapons being used in anger in the not too distant future is very real indeed.

It would appear that one major effect of such use is largely unknown by the general public and is, to say the least, being dealt with too lightly by the authorities. It is an effect that has catastrophic consequences for solid state communications and computing equipment and which could reveal any well laid plans to cope with "the Bomb" to be futile and mis-guided.

I, the author, am a freelance writer, principly upon the topics of communications and amateur radio. All the information has been gleaned from normal technical publications and text books and can be freely obtained by any member of the public who cares to look.

Besides the well publicised phenomena associated with the detonation of a nuclear device (i.e. blast, heat and light) there is the ELECTROMAGNETIC PULSE (EMP) to contend with. Since the first weapon trials in 1945 the 'radio flash', as it was then known, has been obseved and documented. Only in recent years, however, have the full implications of the EMP become apparent. Damage to most radio, landline and computer equipment, up to a maximum range of 2500 k, from ground zero (the point of detonation), is not just possible, but *probable.*

Mechanisms That Produce EMP

There are three situations where an EMP can occur at high enough strengths (See Fig. 1.) to be deadly to electronic communications.

1. A WEAPON BURST AT GROUND LEVEL OR BELOW 100 m ABOVE GROUND LEVEL.
2. A VERY HIGH AIR-BURST AT THE TOP OF THE ATMOSPHERE.
3. AN EXO-ATMOSPHERIC BURST

In cases 1 & 2 the EMP appears to be caused by Compton electrons, produced by the initial, high energy, gamma flux radiating from the point of detonation. These cause a vast outward current flow — the pulse of energy known as EMP.

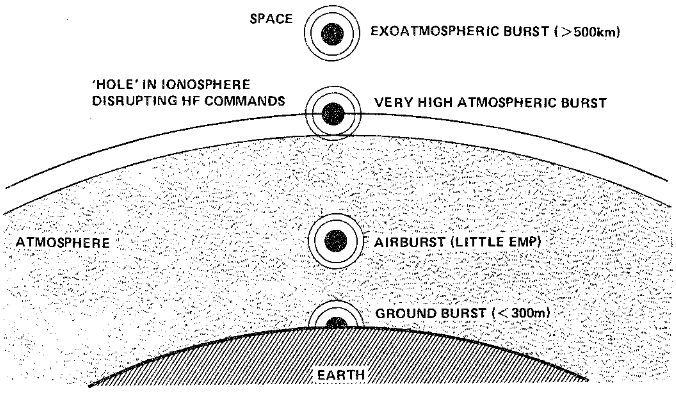

Fig. 1. The different methods of detonation of a nuclear device. Note that an airburst will maximise damage to surrounding environments physically but minimize EMP.

In the case of a ground burst an assymetric condition exists and the energy is radiated upwards in electromagnetic form, away from the ground.

If a very high air burst occurs the reverse happens (as there are electrons to be excited only in the atmosphere and not in space). In this case the electromagnetic energy is radiated downwards in a particularly crippling manner.

If the weapon is 'air-burst' however, (between 10 m & 10 km say) the outward current flow is symetrical and almost self cancelling. Fortunately, from an EMP point of view anyway, air bursts are the most efficient militarily, maximising heat and blast, and would probably consitute the majority of strikes in a major nuclear exchange.

An exo-atmospheric blast at, say, 1000 km altitude is the 'worst case'. With no absorbitive medium surrounding the device, the energy from the weapon, mainly in the form of gamma and X-rays, reaches the upper atmosphere over a wide area simultaneously. Interaction with the electrons there causes a vast pulse of energy to be radiated downward over a huge area. EMP with a vengeance.

Effects Of The EMP

Neither the 1950 or 1957 issues of 'Effects of Nuclear Weapons' contain any reference to EMP. It is first mentioned in 1962 where a fairly brief description mentions that EMP is "of considerable interest". The 'interest' shown was in the results of the Johnstone Island exo-atmospheric test in 1958. This test produced failures to street lighting systems (presumable fed via overhead wiring) in Hawaii *1000 km away.*

Unfortunately as the intensity of the effect was unexpected, no meaningfull measurements of field strength were made.

Further tests were carried out and Fig.2 shows the field strengths to be expected from a one Megaton ground burst weapon, at various distances from ground zero.

Detonating that same weapon as an exo-atmospheric burst produces several thousand volts per metre over an area limited only by the curvature of the Earth! Figure 3 shows the areas in Europe that such a blast over the North Sea would encompass - producing widespread disruption to Europe's communications.

Whilst not violating any particular country's territorial integrity, (there being no blast or fall out associated with an exo-atmospheric blast) such a strike could well be a final 'sabre-rattling' excercise prior to commencement of more direct hostilities.

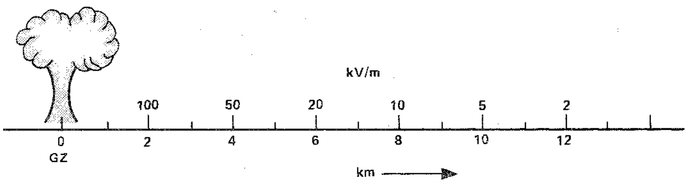

Fig. 2. The field strengths produced by detonating a one Megaton bomb. Remember too that a 20 Megaton warhead is very commonplace today — and to be expected in combat.

Of course Europe is not the only place that such a burst could be used and perusal of an atlas shows that there are other 'theatres' where an EMP could be generated such that 'innocent' countries (including perhaps the UK) would be subjected to its effect.

Rise Time

Figure 4 compares EMP to lightning. By comparison lightning can be seen as a very sluggish phenomena indeed! Rise times of 20 ns (20×10^{-9} seconds) have been reported, resulting in considerable energy up to several hundred of MHz. Radio amateurs and home computing enthusiasts need no reminding of the effects of large field strengths on their beloved electronics.

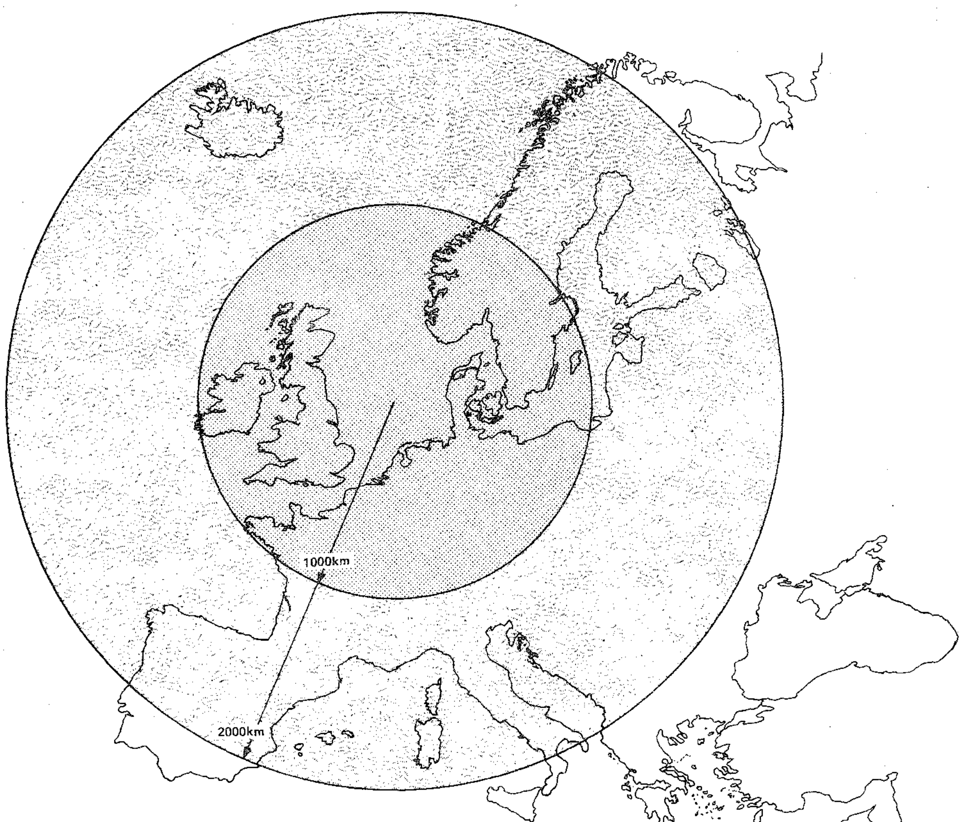

Fig. 3. A sketch of the European theatre, showing the level of effect from a one Megaton detonation over the North Sea. Such a blast does not actually infringe any single country's border intgegrity but affects all those shown.

The inner circle represents the radius of expected serg damage to equipment and the second circle is that within which some detrimental effect is to be expected.

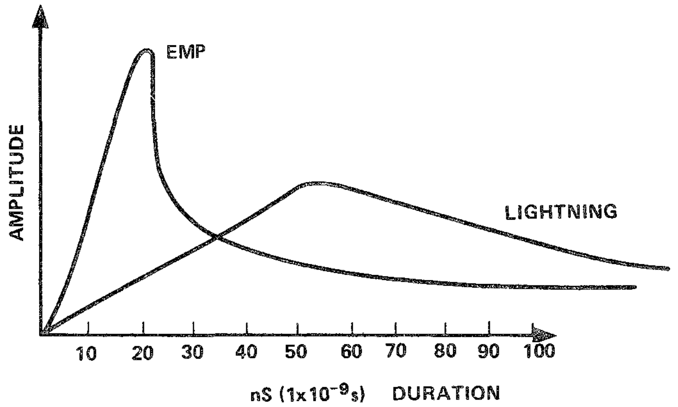

Fig. 4. Comparative rise-times of an EMP from a 1 Mt. bomb and an average lightning flash. Note that the EMP is many times faster.

Not for nothing do modern military receivers have POWER transistors and 2 W of local oscillator power present in the front ends! Don't entirely beleive the sales talk about "large signal handling characteristics" that's just a spin off!

The interest shown in professional computer circles in 'line conditioners', 'transorbs' and RFI sheilding has its roots in the military's requirements for protecting their data processing hardware.

EMP Collectors

HF aerials are of course text-book EMP 'collectors' and the increased use of broadband mixers and power output stages place this equipment especially at the risk from EMP.

However VALVE equipment is substantially immune to EMP — or can at least withstand levels of field strength orders of magnitude greater than solid state — rumour has it there could still be a place for '19' sets in World War III! (Russian and Warsaw Pact forces still employ valve equipment in quantity.)

Telephone lines, extending overhead for serveral kilometers at a time, are extremely vulnerable. They are being increasingly terminated in electronic exchanges, or transistor amplifiers WHICH ARE NOT EXPECTED to survive an EMP. Exit telephone communication.

Overhead power-lines are likewise excellent aerials and although the transient nature of EMP is unlikely to damage motors, tungsten lamps etc. etc, many pieces of electronic equipment, domestic, amateur and professional will be destroyed.

Table 1 gives items that are expected to survive or succumb to an EMP attack and should be carefully studied for the implicit effect upon Civil Defence communication after nuclear attack.

TABLE 1

EQUIPMENT NOT EXPECTED TO SURVIVE EMP ATTACK

1. Fluorescent lights.
2. HF transistor transmitters and receivers, especially broadband.
3. VHF mobile equipment with long whip aerials.
4. VHF broadcast-band recievers with aerials extended.
5. All landline communications, especially electronic telephone exchanges.
6. Land "repeaters", which account for 90% of radio communication.

RELATIVELY IMMUNE EQUIPMENT

1. Tungsten lamps (or other filament).
2. Valve transmitters and receivers.
3. Electronic motors (NOT solid-state speed control)
4. Medium Wave portable with ferrite rod aerials.
5. SHF link equipment, AS LONG AS the feeder or waveguide does not conduct EMP to other parts of the equipment.

Study the table above carefully. It has far reaching implications. Ask yourself if a stable society could be set up, given the destruction of all viable long distance communications as a starting point.

Radio Propagation

Little information seems to be available in the 'open' literature on radio propagation after a nuclear exchange. It is virtually certain that the ionosphere as we know it will be destroyed temporarily. The maximum usable frequency will probably be lowered dramatically (hence the vast low frequency, very low frequency and extremely low frequency military installations throughout the world) and it is assumed that most satellite communications will cease. This will come about either as a direct result of the nuclear exchange, the 'satellite - killing' capability of the super-powers, or the 'neutralisation' of the satellite ground stations.

Conversely highly ionised patches could well result in sporadic 'E' beyond the wildest dreams of 2 m DX enthusiasts.

Conclusions

From the preceding it may be seen that deliberate detonation of a nuclear weapon to maximise the EMP effect could and probably would occur in a future conflict. This could effect this country even if the U.K. was not directly involved in the conflict itself.

Some possible measures to counteract the effects of EMP are given in Table 2, although without concerted action at a high level, Britain will remain very vulnerable to this type of attack.

TABLE 2

1.	Disconnect all electronic equipment from aerials and power sources during that period.
2.	Use Radio equipment 'on sked' for the minimum possible time.
3.	Use high 'Q' ATU on HF or 'cavity' on VHF to reduce acceptance bandwidth to a minimum.
4.	Earth all screens, coax outers etc. Treat as for massive TVI case.
5.	Solder reverse parallel diodes across receiver front ends as for normal burnout protection.
6.	Keep a supply of spare vital components such as front end transistors, diodes etc. in a screened container.
7.	Consider the use of VALVE radios!

DEATH BY NEGLECT?

It seems strange that such a potentially crippling product of nuclear warfare has received such little exposure to the public eye. Much has been made of late, by both press and TV, of the Soviet superiority in conventional, and indeed nuclear, materials and the effect upon this country of employing such forces against the West. It is to be hoped that such debate will bring with it much needed increases in the defence spending of this country.

Our Civil Defense programme could be well described as minimal, with little or no interest until recently in improving it. Compared to countries such as Sweden, Switzerland and - more significantly -the USSR, our efforts are nothing short of laughable.

Picture now some highly probable effects of an EMP upon our already pitiful survival resources. Telephone communications will be knocked out in most, if not all, parts of the country. Landline and repeater equipment used for the majority of communications in Britain, will be destroyed or rendered inoperative. All double frequency radio communication (i.e. anything using repeaters) will be impossible. All VHF broadcast receivers, with aerials extended, and mobile VHF equipment will have their front-ends severely damaged. HF transistor and receiver units will no longer operate, especially the widely used broadband radio and radar equipment.

In essence then, electronic communication in this country will *cease to exist* in its present form once a blast which produces a significant EMP has taken place. This is not a temporary blackout - as popular opinion supposes - *but a widespread and immediate destruction of equipment*, which will take extensive repairs to correct. Difficulties such as this would normally cause will be compounded many times in a shattered and disjointed community desperately struggling to regain some cohesion in the face of hideous adversity.

Result? Small isolated groups will be unable to communicate effectively with each other. People alone in their houses, following government instructions - such as contained in the "Protect and Survive" leaflet, will be completely cut-off unless they have a *medium wave* portable, which was not in use at the time of the attack. VHF receivers will be dead and in need of extensive repair.

We have been through the government literature covering nuclear warfare and its effects. There is no reference anywhere to EMP. It seems from this angle as though this is yet another case of "head-in-the-sand" defense. If so, then it is simply not good enough and it will cost lives we can ill afford.

We have sent copies of this article to the Home Office, Ministry of Defense and even the Prime Minister's Office and await an answer to the vital questions posed herein. ETI will carry the full text of such a reply as soon as we receive it and a page is reserved in our next issue especially for this purpose. I have a cold certain feeling it will be blank.

Ron Harris
Editor

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