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EMP - EFFECTS ON COMMUNICATIONS

by Lawrence I. Cotariu

The ABC-TV production, "The Day After" poignantly dramatized the vulnerability of a technological age to a nuclear exchange.

At the time of the blast, all electronically-controlled equipment--automobile ignitions, communications gear, radio and TV sets--were deactivated by the powerful electromagnetic pulse emanating from the fireball.

Let's take a closer look at this threat as addressed by MT author Larry Cotariu.

The detonation of a nuclear weapon produces intense transient electric and magnetic fields. These fields are called the electro-magnetic pulse (EMP). Any electrical conductor which is exposed to the EMP will have induced transient voltages and currents on it.

Whether or not these transients will cause damage or malfunction depends upon both their magnitude and the sensitivity of components connected to the conductor.

These in turn depend upon the location of the detonation point with respect to the equipment in question and upon the electrical and mechanical details of that equipment.

Research during the past few years concerning EMP effects on electrical and electronic equipment indicates that in many circumstances damage or malfunction can result. Further, this damage can occur at distances from the explosion great enough to be completely free from blast or other nuclear effects.

Areas affected by the EMP from a single detonation can encompass hundreds of thousands of square miles. This is true particularly for high altitude detonations - those at an altitude greater than about 50 kilometers.

During a high altitude detonation, high level but somewhat less intense waveforms than those which appear in the ionized sphere are radiated from the source. Various responses of surface equipment to EMP can be observed, ranging from static to burnout.

The most severe effects are associated with the more susceptible components which are connected to long exposed cables or antennas. One candidate for a severe effect would be a transistorized shortwave receiver connected to a large antenna.

The way in which the energy is collected is often complex but in general, the larger or more extensive the

conductor, the greater is the amount of energy collected. For example, the whip antenna of an automobile radio will collect far less energy than an AM broadcast transmitting antenna.

The orientation of the conductor with respect to the source of EMP also plays a role similar to the positioning of a small pocket transistor radio. Here, the orientation of the radio can be varied to increase or decrease the received signal.

Typical collectors of EMP include: long cable runs, piping or conduit, large antennas, antenna feed cables, metallic guy wires or metallic antenna support towers, overhead power or telephone lines, buried cables or pipes and long runs of electrical house wiring.

FUNCTIONAL DAMAGE

If sufficiently large electric transients are introduced, a component or subsystem may become permanently inoperative until some part or parts are replaced.

Other types of functional damage may occur wherein a particular device is rendered only partially capable of executing its entire range of functions. Another aspect of functional damage is the decrease in the lifetime of a particular component or subsystem.

OPERATIONAL UPSET

Small electrical transients may temporarily impair the performance of a system for only a few microseconds or hours. This temporary impairment of the system's operation is an operational upset.

Electronics components are often very sensitive to functional damage or burnout. These are listed in the order of decreasing sensitivity to damage effects: microwave semiconductor diodes, field-effect transistors, radio-frequency transistors, audio transistors, silicon-controlled rectifiers, power rectifiers semiconductor diodes, vacuum tubes.

Thus, systems employing vacuum tubes are far less susceptible to EMP effects than those employing transistors.

TESTS

A series of tests were performed on two FM receivers, one a standard size portable and the other shirt-pocket size. Both receivers, with whip antennas fully extended (19 and 25 inches in length) were subjected to 140 percent of threat level fields with no noticeable change in operating characteristics.

Both receiver chassis were next connected to the ground plane to maximize energy pickup and a series of 50 pulses were applied with no effect.

The receiver chassis were then connected to the top plane of the line with antennas pointing downward, and again, both receivers survived 50 pulse series.

For a final test they were placed in the tapered portion of the line and subjected to 50 pulses at approximately three times threat level. Both survived this test also.

With the exception of the tests at three times threat level, which were not feasible due to the length of its whip antenna (40 inches), similar tests were performed on a citizens band walkie-talkie. The unit was pulsed while in both transmit and receive modes with no observable damage.

Preamplifiers for the 14 and 144 MHz radio amateur

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bands were constructed, using junction field-effect transistors. Comparable results were obtained with both units. They survived 10 pulse tests with whip antennas up to 40 inches long.

However, a single pulse caused noticeable gain reduction when the whip was lengthened to 55 inches. After three pulses with the longer antenna, each ceased operating due to failure of the FET.

The results of the somewhat limited EMP susceptibility tests described above allow the following conclusions to be drawn regarding transistorized communications gear:

1) Typical receiving units with self-contained batteries and loopstick type antennas are not susceptible to direct damage from EMP. However, their antennas or circuits may pick up damaging amounts of energy if located too near conductors that might carry heavy EMP produced currents.
2) Equipment employing bipolar transistors can be safely operated with antennas up to 40 inches long.
3) Any receiving gear using an unprotected FET front end might suffer EMP damage if connected to an antenna exceeding 30 inches in length.

EFFECTS

Because of the broad and distributed coverage of this threat, unhardened (unprotected) telephone circuits and teletypewriter landlines, switching terminals and switchboards are not anticipated to survive and remain functional or to be re-established for some period of time following the threat.

Radio blackout effects would, depending on the number of high altitude bursts which occured, disrupt high frequency transmission of 3 to 30 MHz for several minutes and at 200 MHz for a few seconds.

For additional information read the following publications from the Federal Management Agency:

EMP Threat and Protective Measures - TR-61, August 1970

EMP Protective Systems - TR-61B, July 1976

EMP Protection for AM Radio Broadcast Stations - TR-61C, July 1976.

Logic Bomb in Nuclear Laboratory?

The scenario was reminiscent of the popular movie, "War Games." A Group of high-school computer hackers--compulsive hobbyists who thrill at breaking through private, and usually sensitive, password-protected data bases--got access to the Los Alamos National Laboratory computer system.

Cryptically called the "414 gang" (all shared the same area code during their on-line shenanigans), the persistent students managed to use up only $300 worth of telenet time, but created nearly four months of work for systems managers and security personnel at the top-secret nuclear facility to find out just what they had done.

According to Jim McClary, Security and Safeguards Division leader at Los Alamos, there is no way to determine whether or not a logic bomb has been entered into the massive computer installation.

A logic bomb is a programming command entered into a data base which could include instructions to alter or even destroy a computer's operating system and data files at a later time.

"I see no way to guarantee that there is not one," McClary told the House of Representatives Science and Technology Subcommittee investigating the security breach. "Software verification is a very difficult problem; no one knows how to do it now," he continued.

The incident, which happened in June, 1983 was not isolated. Other attempts have been made to access the computer without authorization, and at least one other was successful. The FBI is investigating.

How is such a vulnerability even possible? Continued McClary, "We were disappointed that certain system managers had not changed the passwords (that came from the manufacturer). The nature of open computing is such that things like this are going to happen occasionally."

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