. . . . . AN AMERICAN JOURNAL OF CIVIL DEFENSE

SURVIVE

VOL. 2 NO.6 NOVEMBER—DECEMBER 1969

See: CAMILLE—An Adventure in Fury, page 11

CIVIL DEFENSE FORUM

OAK RIDGE CIVIL DEFENSE SOCIETY

ASSOCIATION FOR COMMUNITY-WIDE PROTECTION FROM NUCLEAR ATTACK

ALSO IN THIS ISSUE:

EMP IMPACT ON U.S. DEFENSES

SENATE SIDELIGHTS—ABM

WHATEVER HAPPENED TO THE LINCOLN STUDY?

"The need for an effective Civil Defense is surely beyond dispute . . . No city, no family nor any honorable man or woman can repudiate this duty . . ."

—Sir Winston Churchill

TABLE OF CONTENTS

Reader Comment . . . . . Page 1

EMP Impact on U. S. Defenses, by David B. Nelson . . . . . Page 2

Spotlight . . . . . Page 7

Senate Sidelights – ABM, by Arthur A. Broyles . . . . . Page 8

So Be It, "Whatever Happened to the Lincoln Study," by Don F. Guier . . . . Page 10

Camille – An Adventure in Fury . . . . . Page 11

Editorial, "Opposing Philosophies" . . . . Page 15

Book Reviews . . . . . Page 16

Effective Shelter . . . . . Back Cover

COVER PICTURE

The cover photo of Camille damages was furnished by Wade Guice, Civil Defense Director of Harrison County, Mississippi. Harrison County (County Seat: Gulfport) bore the brunt of Camille's charge into the Gulf Coast. The damage shown in the photo is evidence that Guice's exhaustive warning efforts and emergency evacuation measures saved thousands of lives. For further facts and more pictures, please turn to page 11.

SURVIVE

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The Civil Defense Forum
The Oak Ridge Civil Defense Society
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Survive presents authentic information relating to civil defense – to the survival of free government, the United States, and its people in the nuclear age. Its aim is public education in this field and service as a forum.

Authors are encouraged to submit manuscripts for consideration by the editorial board for publication. Articles (preferably illustrated) should be 1,000 to 1,500 words in length, slanted to the non-technical reader, and oriented toward the civil defense field. Views expressed in contributions to *Survive* are those of the authors and do not necessarily reflect *Survive* policy.

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READER COMMENT

Bensenville, Illinois

To: Survive

Your July-August 1969 issue presented several experts for and against the ABM proposal. How tragically irresponsible these so-called experts can be was made clear by their use of arguments favoring their position and detracting from the opposing point of view, arguments that they knew, most assuredly, were no arguments at all. Let me cite a few:

1. Seitz claims the Russians would consider development of our ABM system perfectly natural but he refrains from saying they would also consider it perfectly natural to develop counter-ABM techniques.
2. Broyles cites all the means by which the ABM system could be effective. All depend on radar yet he ignores the fact that the first enemy assault could consist of dummy warheads meant only to draw our ABM fire. The resulting ionized atmosphere would be a perfect shield from radar for the next lethal attack following seconds later.
3. Broyles argues with Packard on the protection of cities, yet every other author cites the economic factor behind the selection of missile sites as the location for ABMs.
4. Wigner chooses to play upon Kosygin's statement that defense measures are not provocative, yet he finds Russian evacuation plans frightening. What is frightening is the fact that he is willing to concede the life-saving value of evacuations for Russians yet disclaims any value for an American plan, even though this might be initiated during a period of international tension.
5. Teller claims to prefer defense to offense, yet both are forms of violence.
6. All writers claim negotiated peace must be pursued. This implies they want to win something somewhere. When will we awaken to the fact that if we are working together we will be much less likely to need either form of violence?

Suppose we had extended an invitation for a joint first landing on the moon? The shared pride would have made a powerful bond. So many areas for cooperation exist that to persist in the fabrication of devices of violence can be justified only by the further fabrications of man.

J. T. Sanecki

Let me try to answer the part of Mr. Sanecki's statement which refers to my own contribution to Survive. *Perhaps my article, written originally for physicists, was not sufficiently explicit. The reason for the Little Harbor group's opposition to evacuation plans was that evacuation, since it takes several hours' time, can be expected to be effective only if it is undertaken before the initiation of a confrontation. If it is undertaken during a period of severe tension, it is sure to aggravate that tension by degrading the opposing party's strategic position. Hence a crisis evacuation may induce an immediate attack and become thereby worthless. It can be useful to the party which wishes to initiate a confrontation by being a prelude thereto.*

Taking shelter is a different matter. Since, if the shelters have proper accessibility, people can reach them after the enemy missiles have been launched, taking shelter, even if it is done before the enemy launches its missiles, does not deteriorate his position and will not induce precipitate action on his part. It was for these reasons that the members of the Little Harbor study (myself included) were opposed to evacuation plans but in favor of shelter construction.

What I find frightening is not so much that Mr. Sanecki refuses to see this point. I find it even more frightening that he opposes the Safeguard system which would be useful for thwarting a first strike but quite useless for the party which wishes to initiate such a strike. As he brings this out most clearly in his 5th point, he sees no difference between aggression and defense against aggression.

Eugene P. Wigner

(See also Gregory Breit's letter in *Survive* for September-October 1969 – Ed.)

AMONG SURVIVE WRITERS

David B. Nelson

Dr. Nelson, author of "EMP Impact on U. S. Defenses", is a member of the Civil Defense Research Project at Oak Ridge National Laboratory. A mathematical physicist, he received his B. A. *cum laude* in Engineering Science from Harvard University and earned M. S. and Ph.D. degrees at New York University's Courant Institute of Mathematical Sciences.

Since he is a tinkerer at heart, Nelson's work on EMP alternates between theoretical analysis and experiments with self-designed equipment like the simulator described in his article. His chief hobby is music in its many facets: he especially enjoys playing the piano and a harpsichord which he and his wife built. He is presently assembling a "definitive" high fidelity system, and is building a large room acoustically designed for music production and reproduction – as well as for attenuation of the noise produced by his two small children.

EMP IMPACT ON U.S. DEFENSES

by David B. Nelson

A prominent research scientist—devoted to direct experimentation—unveils the mystery of the "electromagnetic pulse" (EMP) and explains the extent of the EMP danger and the manner in which it can be successfully countered.

To most people EMP could be the abbreviation for a new urban housing agency. Probably not one person in a hundred knows that these letters stand for "electromagnetic pulse," and fewer still know whether or not EMP has any relevance to them. Yet the electromagnetic pulse, one of the effects of a nuclear detonation, could degrade significantly the effectiveness of many unprotected civilian and military electrical systems during a nuclear attack by damaging components or causing them to malfunction. To devise and implement protection against this possibility many millions of dollars are spent yearly in research, development, and testing programs.

EMP does make the news occasionally. Last fall the New York Times reported that:

> "the possibility of communications, radar and missile systems being blacked out by electromagnetic pulses from nuclear explosions remains a serious problem despite five years of intensive research."[1]

This information came from a speech by Senator Henry Jackson, a member of the Joint Committee on Atomic Energy and the atomic weapons expert on the Senate Armed Services Committee. Also one sometimes sees pictures or descriptions of impressive testing facilities, which duplicate over a small volume the electromagnetic fields from a nuclear explosion.[2]

What is the electromagnetic pulse?

Everyone has heard sharp cracks of static when listening to a radio during a thunderstorm. This static is caused by

[1] *New York Times, September 26, 1968*

[2] *Electronic News, October 30, 1967 discussed a facility in New Mexico and Electronic Design, July 19, 1969 reported on a simulator in Florida.*

the electrical currents in lightning strokes and it is picked up by radios many miles-away. Such static is itself a radio signal and the lightning currents form the transmitter and antenna. Just like any other radio signal, the static can travel long distances.

Similarly the complicated processes which occur during a nuclear explosion generate a current of moving electrons. This, too, causes radio static, but because the currents are so intense, the signal is much stronger than that from a lightning stroke. This radio signal, or static, is called the electromagnetic pulse. The pulse lasts a very short time, only a small fraction of a second. Still it is intense enough that, when picked up by radio antennas or any other conductor such as electrical wires, it can actually damage electrical or electronic equipment.

Although the EMP is a form of radiation, it is *totally different* from the more familiar nuclear emissions, including neutrons, alpha and beta particles, and gamma rays. Theory and experiment have shown that generally the EMP is completely harmless to living tissue. Under unusual circumstances, such as a person touching a long electrical conductor, it is possible for electrocution to occur.

EMP and Blackout Contrasted

There is another effect of nuclear detonations which is called blackout. Since it and EMP are classed together as electromagnetic effects, the difference between them is sometimes unclear. Blackout refers to the disruption of radar and radio transmission caused by electrical "fog" produced by a nuclear detonation in the upper atmosphere. Extensive blackout does not occur with a low altitude or ground burst. The "fog" patches are regions of ionized air or weapon debris, and radio signals cannot penetrate them just as light cannot penetrate ordinary fog. This "fog" may persist for many minutes; however, it cannot damage or interfere directly with equipment. Generally, blackout will not be a serious problem for civilian systems, except in the few cases where uninterrupted radio communication is required during and immediately following an attack.

Pulse Characteristics for Surface and High Altitude Bursts

Like many other weapons effects the characteristics of the electromagnetic pulse vary greatly depending on the height of burst and the yield of the weapon. In the technical appendix on page 6 the reasons for this are discussed, along with a closer examination of the mechanisms responsible for the pulse. We may distinguish two limiting cases: the surface burst and the high altitude burst.

If the detonation is near the earth's surface, an intense pulse of electric and magnetic fields is produced to a distance of at most a few kilometers depending on the weapon yield. The region of strong fields is also highly ionized and there are large electrical currents flowing in the air and ground. Beyond this region the pulse strength drops fairly quickly, eventually as the inverse of the distance. A recent article[3] indicates that the fields may cause damage to electronic equipment at distances exceeding that for the 2 pounds per square inch level of overpressure. For a one megaton burst this is about 13 km (8.2 miles) from the detonation point.

A detonation above the earth's atmosphere – higher than 40 km (24.8 miles) – produces fields on the ground which are about one tenth as strong as the highest field for a surface burst (see the appendix). But since for a surface burst these fields coexist with a very high overpressure, for some unhardened equipment the fields from a high altitude burst may be the worse threat. (One wouldn't worry about EMP damage to equipment that is vaporized or crushed!) For a high altitude detonation the pulse occurring on the ground is created in a layer of air at an altitude of between twenty and forty kilometers (12.4 to 24.8 miles). This layer is sometimes called the interaction region. As explained in the appendix, it is here that the gamma rays from the detonation are converted into electromagnetic fields. Substantially the same field strength is maintained over a circle on the ground whose radius is many hundreds of kilometers. The EMP for a high altitude detonation is definitely not a localized phenomenon.

Trying to calculate the strength of these electromagnetic fields has provided many problems for physicists and engineers. Since so many processes are occurring at the same time, things are rather complicated. As with research on other weapons effects the test ban treaty has been an inconvenience.[4] Instead of devising new experiments to yield the most information, one must reinterpret old atmospheric test data or else try to use underground nuclear detonations. This has meant that in some areas the agreement between theory and the available experimental data is less than ideal.

EMP Damage and Protection

For most people the important question is: What can the EMP damage, and what can we do about such damage? The electric and magnetic fields which comprise the pulse are a form of energy. In principle any conductor can collect this energy and perhaps apply it in a destructive way. However, the amount of energy available in the pulse is not great enough to damage most components without a considerable amount of "focusing". Figure 1 shows that the energy on the ground from a high altitude burst is not more than 3 joules/meter^2. This is less than one calorie. (One calorie will heat one cubic centimeter of water one degree centigrade.)

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[3] *Foss and Mayo, Bell Laboratories Record, January 1969.*

[4] *The same New York Times article referred to above stated that one objection at the time of the test ban treaty debate was that not enough was yet known about EMP. The article also quoted Senator Jackson as saying that one of the prime objectives of a test program in the event of test ban treaty abrogation is to obtain realistic data on the electromagnetic fields created by nuclear detonations at high and low altitudes.*

A simple analogy may serve to make the focusing process clearer. Sunlight is a form of energy, and by focusing it with a magnifying lens one may ignite paper. However, it takes time to start the fire, and if only a short pulse of sunlight were available it would require a large lens focusing to a small spot to deliver the required amount of energy for ignition. Loosely speaking, the EMP is like a short pulse of sunlight in that it must be collected into a small volume to do any damage. The amount of focusing required depends on the sensitivity of the electrical components, just as the size of a lens required to burn a piece of paper depends on the ease of ignition.

The most common way that this focusing is accomplished is by connecting long electrical wires to sensitive equipment. A prime example here would be a radio receiver, connected to a long antenna and to the A.C. power line. The wires pick up the energy in the electromagnetic field over a large area and then deliver it in the form of current and voltage pulses to the attached equipment.

Some components are much more susceptible to the pulse than others. A recent OCD report[5] gives the following list of sensitive electronic components in order of decreasing sensitivity and damage effects:

Microwave Semiconductor Diodes
Field-effect Transistors
Radio-frequency Transistors
Audio Transistors
Silicon-controlled Rectifiers
Power Rectifier Semiconductor Diodes
Vacuum Tubes

One would be concerned about effects on systems which employ equipment using such components as these. However, not even the most sensitive of components can be damaged unless it is wired into a circuit that can collect pulse energy over an appreciable area (at least a large fraction of a square meter). And even then the details of a particular circuit can influence greatly how much energy is actually delivered to a component and whether it is damaged. So determining the vulnerability of a given system to EMP can be a very difficult task, and it is hard to estimate *a priori* the vulnerability of a system or of the equipment which it uses.

There are many ways of hardening (protecting) equipment against the EMP. Continuing with the sunlight analogy, one seeks to defocus or reflect the pulse energy away from the equipment. Shielding by metal cases blocks the fields. Surge arrestors, similar to lightning arrestors and electrical filters, stop pulses picked up on wires from getting to sensitive components. Often just careful choice of components and wiring practices can markedly reduce the vulnerability of equipment. A simple expedient for equipment not in use is to unplug all incoming cables such as power cords, control cables, and antennas. Of course, this would not be feasible for equipment which must be used during an attack. In fact, if one is to use this method of protection, either the equipment must always be disconnected, or one must be sure that attack warning is received in time to disconnect it.

Without considerable focusing the EMP energy is totally harmless to man. Standing in the open one would literally not feel a thing. (From EMP, that is. Blast and thermal radiation might be very noticeable). However, the energy collected in a long wire could easily cause electrocution, so it would be very inadvisable to touch conductors, even such otherwise harmless ones as conduits and pipes.

EMP Protective Measures

1. Metal shielding – blocks entry of EM fields.
2. Surge Arrestors and Filters – block voltage surges picked up on wires from sensitive components.
3. Good wiring practice – minimize the amount of EM energy coupled into circuits.
4. Choice of Components – eliminate most sensitive components where possible.
5. Operating Procedure and System Design – minimize the impact of component failure on system operation.

Although the test ban treaty, by prohibiting above ground nuclear testing, has precluded any new direct experiments on nuclear EMP damage, there are indirect methods of determining this. Knowing the expected electric and magnetic fields from theory, pre-treaty data, and underground tests, one can determine the effects either by calculation or experiment. The chief experimental tools are EMP simulators. These are electrical devices, each really a transmitter and antenna, which duplicate the EMP fields over a limited volume. An example is shown in Figure 2. Equipment placed within this volume presumably responds as it would to nuclear EMP. Even without the test ban treaty there would be advantages in the use of simulators. They are much cheaper and easier to operate than nuclear devices. If one wants certainty that a given component will not fail, he can test to a higher field strength than expected or run many tests in quick succession. The biggest disadvantages of simulators are the relatively small volume over which one can duplicate the EMP and the difficulty in testing installed equipment, especially in underground locations. Thus from simulator tests one can be confident of the survivability of a portable radio receiver or of the electrical components of a re-entry vehicle, rather less so of the vulnerability of an underground telephone switching

[5] *J. E. Bridges and J. Weyer, EMP Threat and Counter Measures for Civil Defense Systems, Office of Civil Defense, 1968. Obtainable for $3.00 from Clearinghouse (CFSTI), Springfield, Va. 22151 under document number AD-687-349.*

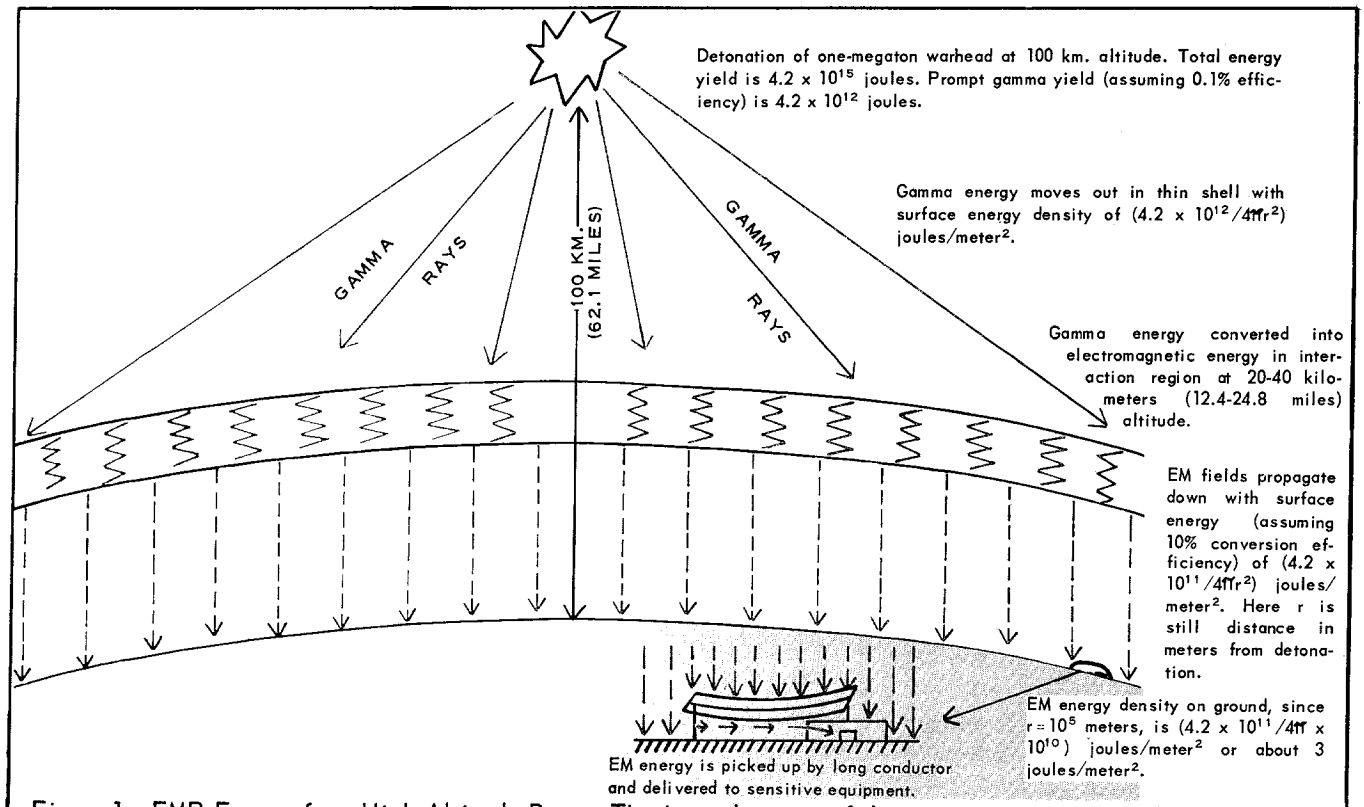


Figure 1. EMP Energy from High Altitude Burst. The lateral extent of the interaction region is limited only by the earth's curvature.

center. Combinations of other experimental techniques, calculation, and over-design of protective measures increase confidence in these other cases.

EMP Invulnerability Versus Vulnerability

There are really two problems in EMP analysis and protection. The difference may be made clear by an analogy. If you ask an aircraft engineer to design something that will fly he will present you with a very creditable airplane. But if you confront him with an object and ask: Will it fly? he may not know or may answer wrongly. For a while the bumble bee was just an object. According to aerodynamic theory, the bee couldn't fly.

Similarly we think we know how to design equipment to withstand EMP. This is the easy problem, and one which primarily the military has addressed. It may cost a little more or be slightly less convenient in other respects, but it will be invulnerable. The harder problem is to decide whether an existing component, or even worse a large, distributed, and redundant system, has a vulnerability to EMP which will degrade critically its effectiveness. Most civilian systems, including electrical power, communications, and transportation systems, fall into this latter category. They exist now, and backfitting high-confidence protective measures would be stupendously difficult. Using current knowledge, we think that individual components in these systems may be damaged by EMP. To know whether this damage will critically degrade system effectiveness we must answer the questions of system damage and system importance during and after a nuclear attack. The element of timing is of extreme importance here. Damage to the Emergency Broadcast System or the National Attack Warning System could be disastrous at or before the beginning of a heavy attack. After the attack it is of lesser consequence. The duration of system degradation is also important. A ten-second interruption of operations might be insignificant whereas a ten-hour outage could be critical. These questions are not unique to EMP analysis; they arise in every facet of civil defense damage assessment.

What is Being Done?

The military services have invested many millions of dollars to assure the survival of their systems. The Office of

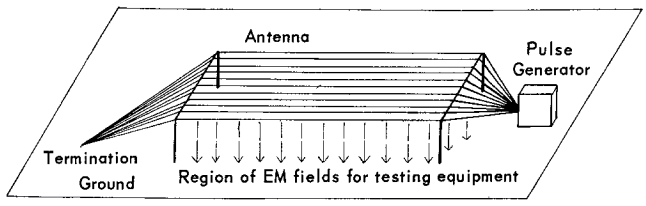


Figure 2. One example of an EMP simulator. A voltage pulse is produced in the pulse generator and travels along the wires forming the antenna to the termination. This pulse causes electric and magnetic fields within the region between antenna and ground like those from the nuclear EMP. The length of the simulator can be a few meters up to even hundreds of meters. This particular type is called a parallel plate transmission line.

Civil Defense, the Atomic Energy Commission and other agencies are conducting research on the vulnerability and protection of civilian systems. A recent publication by OCD[6] discusses EMP effects and protective measures. Using their military experience, Bell Telephone Laboratories is helping AT&T protect some of its most vital telephone equipment.[7] This protection includes the shielding of switching centers and filtering of incoming wires. For the individual householder the threat is not great. Small transistor radios and radiation monitoring equipment have been shown by experiment to be invulnerable to the EMP. It is unlikely that automotive electrical equipment would be damaged. The only source of significant electrical energy is the incoming power line. There might be reason to disconnect the main switch at the fuse box. This would have the additional advantage of avoiding fires due to short circuits occurring in the blast. However, the reader is cautioned that disconnecting of house power is not recommended by OCD officials; they point out that this makes unavailable non-battery television and radio sets, will cause spoilage of refrigerated foods, and could cause other harmful effects.

Research in EMP effects on civilian systems is still in the exploratory phase. Enough is known to arouse concern and require consideration of remedial measures. In many cases these measures are near at hand, but if they are expensive, economic factors must also be weighed. We have come to recognize EMP as a problem that defense planners must live with; the questions that remain concern damage to specific systems and the effects of that damage on our ability to withstand and recover from a nuclear attack.

Technical Appendix: Source of the Electromagnetic Pulse

Although one speaks of *the* EMP, there are many different types of pulse depending on the geometry of the detonation. In every case the pulse is composed of short duration electric and magnetic fields. The sources of these fields are free electrical charges and currents occasioned by the detonation. If we restrict the observation point (where one *measures* the fields) to the surface of the earth, then in every case gamma rays are the principal weapon output responsible for producing the charges and currents. Gamma rays are high energy photons. When such a photon strikes an atom it can knock free an electron and drive it outward in a process known as the Compton effect. These electrons and the ions left behind constitute the charges and currents which produce the EMP seen on the ground.

As we vary the height of the detonation point and its distance from the observation point, the characteristics of the EMP change. The first case which we discuss is where the detonation is within a few hundred meters of the ground (see Figure 3). Those gamma rays which do not strike the ground produce a Compton electron current in the air which travels radially from the detonation point leaving behind a highly ionized hemispherical region of air, sometimes called the ionized sphere. The gamma rays and electrons are all absorbed within a few hundred or thousand meters (depending on weapon yield), this being the radius of the ionized sphere. Within this sphere one observes initially a radial electric field whose rise time is the same order as the weapon gamma rise time (about 10^{-8} seconds) and whose peak magnitude can be 10^5 volts/meter or more. In addition, due to the anisotropy presented by the ground, there is an aximuthal magnetic field whose magnitude can reach 100 gauss. The fields will then oscillate in a manner similar to the classical conducting sphere, and radiated fields will extend beyond the ionized region. At longer distances from the burst point the source has the characteristics of vertical dipole, the net current being chiefly upwards due to the presence of the earth. Although the EMP has a complex frequency spectrum, an estimate of the principal frequency is available from the radius of the ionized sphere by means of the relation:

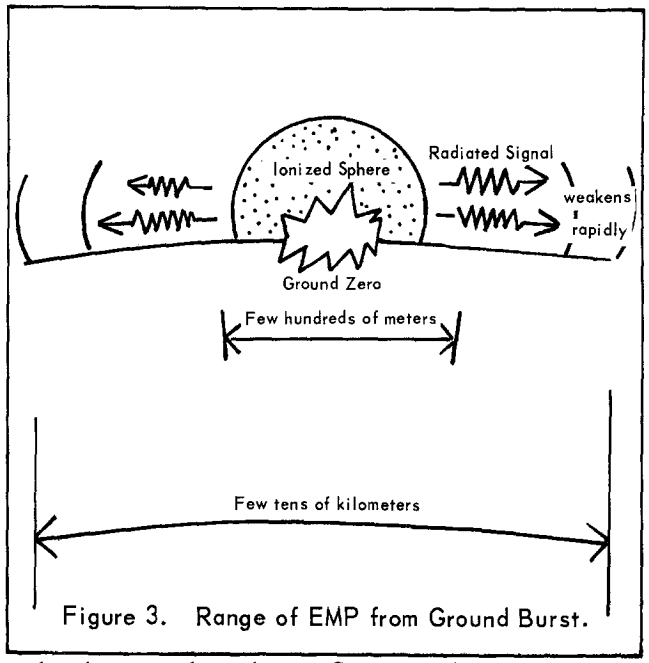


Figure 3. Range of EMP from Ground Burst.

Frequency (hz) = (speed of light) / (diameter of sphere)

For a one kilometer diameter this relation gives a principal frequency of about 300 kHz (kilocycles per second).

If the burst height is a few kilometers above the ground, the ionized sphere no longer extends to the earth's surface. Hence the peak fields observed on the ground are not as intense as for the case of a surface burst. Anisotropy is still present due to the atmospheric density gradient so that a radiated signal is present. This radiated signal comprises the observed pulse.

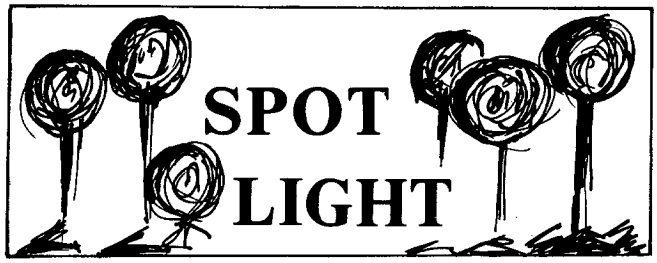
For burst heights above about fifty kilometers (31.0 miles) there is not enough atmosphere around the weapon to create large currents. Instead the gamma rays travel unimpeded until they strike the atmosphere. Thus only

[6] *Bridges and Weyer, op. cit.*

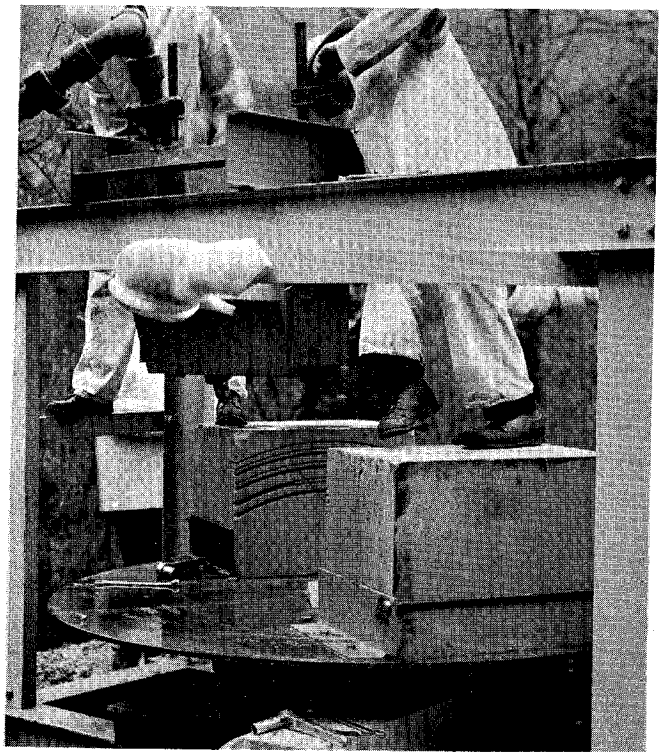
[7] *Foss and Mayo, op. cit.*

those gamma rays directed downwards will produce Compton electrons. The region of high current, called the interaction region, is then pancake shaped and centered between about twenty and forty kilometers above the earth. Its lateral extent depends somewhat upon the weapon yield, but for high enough yield it can be limited only by the earth's curvature.

Initially the Compton electrons are driven radially away from the burst point, but the geomagnetic field serves to bend their trajectories and effect a current transverse to the radius between detonation point and observer. It is this transverse current which is the chief source of the pulse observed on the ground. The pulse is a radiated signal, and because of the large spatial extent of the source region it is approximately a plane wave propagated downwards. The electric and magnetic fields therefore have the same time dependence, with a rise time on the order of the weapon's gamma rise time and a peak magnitude of a few times 10^4 volts/meter and about one gauss respectively. Pulse duration is shorter than for the surface burst. ■



Reduction of rock tunneling costs to one-tenth their present level is the goal of current water jet research at the Oak Ridge National Laboratory (Tennessee). Experiments conducted under contract with HUD (Department of Housing and Urban Development) show that pressures of 5,000 psi to 12,000 psi produce better results than higher pressures used in the intermittent "water cannon" devices now employed in the Soviet Union and elsewhere in the United States.



Technicians adjust water jet nozzle in Oak Ridge National Laboratory rock cutting experiments. Arched cuts in Berea sandstone bock show paths of nozzle. This new method opens up cheap rock-tunneling possibilities.

Project engineer G. A. Cristy indicated that the "water jet mole" could cut from 30 to 50 feet in rock per hour with a diameter of three to ten feet. The need for utility tunnels under large cities is acute according to J. C. Bresee, director of the laboratory's Civil Defense Research Project, under which the tunneling program is being carried out. Once installed, he claims, they would result in much improved safety, economy, and service. A vitally important by-product is the adaptation of such tunnels as very effective blast shelters. (see *Survive,* Vol. 2, No. 1, Vol. 2, No. 3.) ■

SENATE SIDELIGHTS–ABM

by Arthur A. Broyles

The Senate vote closing the great debate on the ABM (Anti-Ballistic Missile) system favored deployment by the narrowest of margins. Let us consider what can be learned on how public opinion made itself felt and on the aftermath of the debate.

The July-August issue of *Survive* noted (p. 20) the marked contrast between the relatively large quantity of anti-ABM mail received (9 to 1) by Senator Hugh Scott and an Opinion Research Corporation poll showing that 84% of the population favors the ABM. To shed some light on this apparent discrepancy, *Survive* wrote to the 100 U. S. Senators asking them the proportion of their mail that opposed deployment. Since that time the results of Gallup polls have been published in the press. Although the information from these sources is sketchy, the significance to the lawmaking process may be so great that it seems worthwhile to consider what has been revealed.

It is clear that at least some, and perhaps all, of the Senators recognize that the number of letters on each side of an issue may not correctly indicate the opinion of the majority of their constituents. One Senator reports, ". . . I have never made it a practice to keep score on my mail. . ." Senator George Murphy makes the comment, "As you know, there are groups organized both for and against the deployment and construction and research and development on the Safeguard and as such, they are capable of generating considerable quantities of mail." Senator Clinton P. Anderson remarks, "I might point out that my mail from New Mexico was not necessarily indicative of the feeling in the state. I almost always receive more mail from people who are opposed to an issue than from people who are in favor of it. Individuals who favor an issue that has been proposed are generally more apathetic than those who are opposed to it." Nevertheless, some Senators receive so much mail that the numbers on each side are used to indicate the opinions expressed. Some Senators also resort to their own opinion polls to get a more reliable count of constituent votes on an issue.

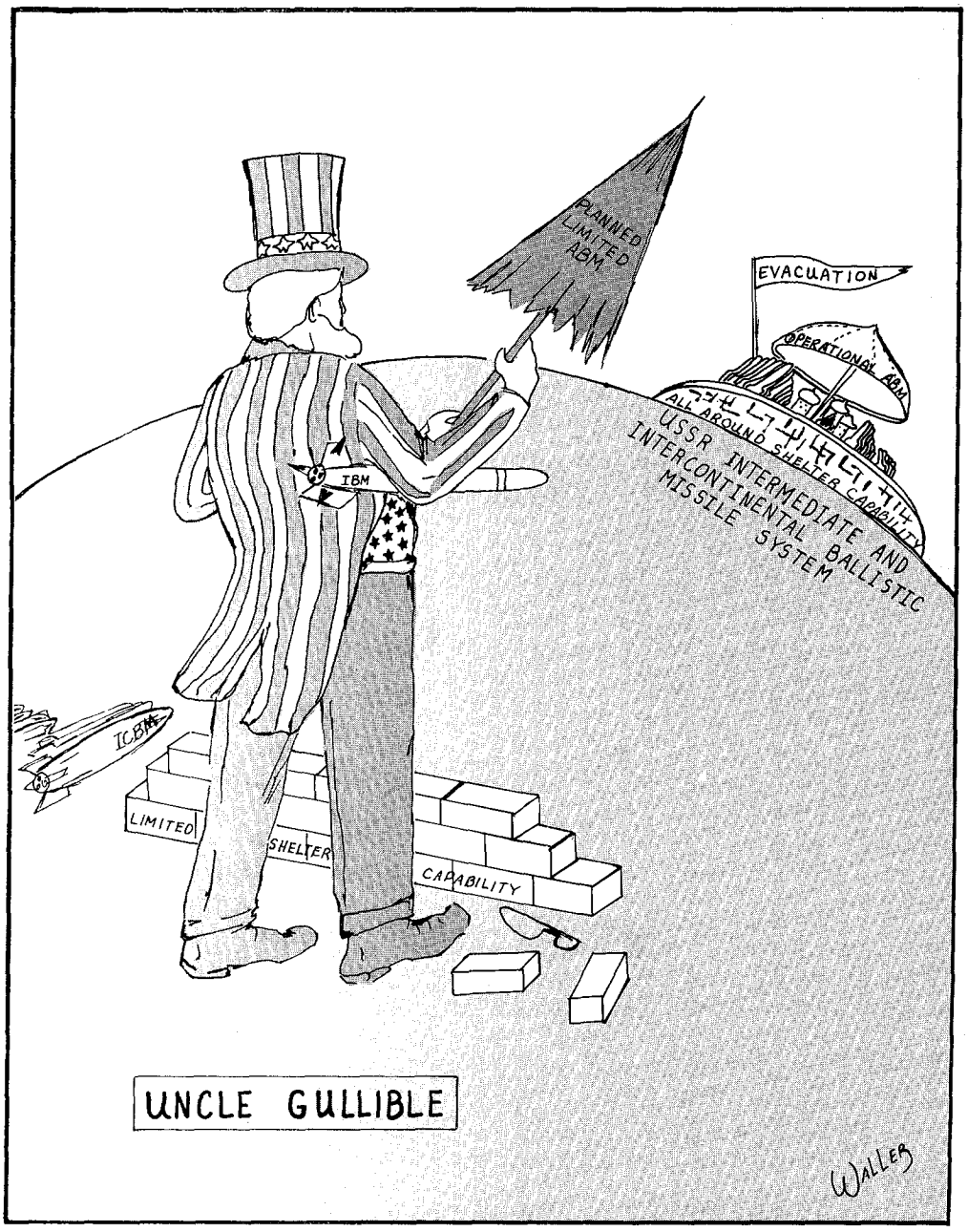
It is clear that the Senators were aware of the thought content of many of the letters that they received. This is indicated by Senator John Sherman Cooper's letter that states, "There were many strongly-worded ones calling upon me to stand by my country, my President and my party. There also were some carefully reasoned letters speaking in judicious tones of my opposition and urging me to reconsider. I was quite surprised at the great warmth of the letters written by those who thought I was right in being against deployment of ABM." Senator Cooper's comments reveal the intense emotions involved in this issue.

There is also evidence of confusion in the public mind on the ABM question. This confusion is not surprising since one of the issues raised was the effectiveness of the Safeguard system, a highly technical question. One of the Senators pointed out the problem by writing, ". . .I would be frank to say that few of my correspondents appear to have a very good grasp of the system's objectives." Confusion was also evident from the Gallup polls taken March 28-31, May 16-19, and July 11-14 which showed that approximately 60% of those polled were either unaware of the program or had not made up their minds about it.

The change with time in the pro-con ratio was one of the most remarkable features in the letters received by the Senators. This change is illustrated by Senator Peter Dominick's comment, "Until the end of June, the letters coming to my office stated views of 10 to 1 in opposition to the ABM. Since June 30, however, the opinions have been running about even in support and opposition, and I have received a greater number of letters in the latter period." This is consistent with the statements of a number of Senators. It is not consistent, however, with the Gallup polls indicating a rather steady 24% in favor of ABM deployment in March, May and on July 11-14 as well as 14% opposed in March and May and rising to 18% in the period July 11-14. It seems evident, then, that people and organizations opposed to ABM wrote first. The proponents realized what was happening and began to press their writing campaign. The numbers of letters prior to June

30 were a poor indication of the position of the population as a whole.

The strongest letter support for the ABM deployment seemed to come from the Southern states and from some Western states such as Colorado, Oklahoma, and Utah. The states of the Northeast were most strongly opposed, particularly Vermont, Pennsylvania, Connecticut, and Massachusetts. A notable exception to this was Maine where Senator Muskie, who opposed deployment, received 60% in favor and 40% opposed. Most of the rest of the country seemed to be about evenly divided in their letters to Senators.



One of the most interesting questions arising out of the ABM controversy was why, after the very close vote on ABM, the opposition to military spending declined so markedly by the time the votes on the C5-A transport plane, the new Air Force bomber, the nuclear aircraft carrier votes were taken. In an effort to shed light on this question, *Survive* contacted a member of the staff of one of the pivotal Senators. He listed the following reasons influencing those who shifted their votes. A large effort had been concentrated on the ABM issue by the opposition forces resulting in considerable exhaustion of human energy and financial resources. The loss of the ABM fight had a demoralizing effect on them. The issue had also raised such intense public interest that some Senators who had opposed ABM deployment feared that they would be tagged as opposed to the defense of the United States.

Some Senators opposed ABM but favored other weapons because the ABM differed from other military projects in that it appeared to them to be more marginal in technical feasibility. A second difference was that the deployment of the "thin" Safeguard ABM system might lead to a later thick system that could provide very substantial protection for the population of the United States. Such a system, it was feared, might disturb the delicate "balance of terror". The United States might then decide that it could launch a first strike at the Soviet Union without fear of intolerable destruction from the retaliatory attack. This could have the effect of frightening the Soviet Union into prodigious efforts to arm and could greatly accelerate the arms race. Those who subscribed to this position believe that the chances of nuclear war are reduced by maintaining the American people as hostages to the other nuclear powers to assure these powers that we do not intend to strike first.

The debate over ABM is over for this year. It may be renewed next year when the federal budget is reconsidered in Congress. Presumably the issues raised this year will again come to the fore next year. It is possible, however, that some new information on the question of technical feasibility of the ABM will become available, which may influence whether or not deployment is continued. ■

SO BE IT!

- by Don F. Guier

Q. *Mr. President, what effect, if any, will your Safeguard program have on the shelter program. Can you tell us anything about your long-range plans in this direction?*

A. *Congressman Holifield, in the meeting this morning, strongly urged that the Administration look over the shelter program and he made the point that he thought it has fallen somewhat into disarray, due to lack of attention over the past few years.*

I have directed that General Lincoln, the head of the Office of Emergency Preparedness, conduct such a survey – we're going to look at the shelter program to see what we can do there in order to minimize American casualties.

President Nixon's Press Conference March 14, 1969

There have been few public references to this project since March. More pressing concerns – at least, problems requiring immediate Congressional action – have drawn official and public attention. Those concerned with the state of U. S. civil defense have begun to wonder aloud what happened to the Lincoln study.

Discussing the anticipated thorough review of our national security problems in *Survive* last January, I noted that the historical precedents suggest that a new study is likely to again produce a *recommendation* for a strong civil defense system. The recommendations of prior study panels produced no action programs, in large part because the threat was not immediate while this country enjoyed a monopoly or overwhelming superiority in nuclear arms.

The Lincoln study is a specific look at civil defense, and the fact that General Lincoln is himself no stranger to such studies strengthens the likelihood of realistic recommendations. He was one of only two persons who took part in both the Gaither commission study and the Rockefeller Brothers review in 1957, both of which urged greatly increased civil defense efforts.

The Lincoln study has been carried forward quietly by at least one hundred individuals, representing various government offices, research contractors, quasi-official agencies, and groups working in civil defense. The deadline for submission of the basic draft to General Lincoln was November first. It is anticipated that the final version will be placed in the president's hands before January, although this target date could vary either way, depending on the number of disagreements that might emerge on specific topics and evaluations.

An encouraging feature of the current study is that many acknowledged experts in various phases of civil defense have been consulted. The input from these individuals may be only a repeat of what they have said before – in the Harbor reports, in *Survive*, and in books and technical papers. But this time their views have been considered, at least, in a high level official evaluation of the current threat to our survival and our current capabilities to meet any contingency.

Among the groups contributing were the National Association of State Civil Defense Directors, the U. S. Civil Defense Council and, indirectly, the advisory committees on both civil defense and emergency planning of the National Academy of Sciences.

We can assume the National Academy of Sciences advisory committees stressed two recommendations which their members have repeatedly included in earlier writings, reports, and discussions. First is the need for protection against direct effects of nuclear weapons. Second is the need to integrate civil defense into day-to-day operations of government at all levels. Peacetime utilization in disasters of all kinds strengthens public support and official backing for civil defense, and improves proficiency.

The position paper submitted by the NASCDD at General Lincoln's invitation also calls for federal recognition of the peacetime uses of civil defense, and for protection against direct effects. In addition, it calls for greater efforts to secure public acceptance of civil defense and for federal requirements to include defense considerations in construction, planning, and other federal grant supported actions.

A point made by the U. S. Civil Defense Council is worth repeating: although our nation spends about one thousand times more on military defenses than on civil defense, the civilian population remains hostage. Yet civil defense is officially described as an essential part of our national security establishment. It is obvious that a small increase in civil defense, in terms of the total defense budget, could greatly reduce our strategic vulnerability.

Not all who have contributed their views take an optimistic view of the potential effect of this study. One veteran of many study projects cautions that any recommendation for increased funding of civil defense will immediately face the problem of competing demands on national resources. Budget cutbacks have hit many federal programs hard. In assigning priorities, there is more political appeal in some of the programs to resolve economic or urban problems than in any kind of civil defense. But this

CONTINUED ON PAGE 4

The most powerful U. S. hurricane in recorded history packed the damage punch of a nuclear weapon. Well-defined types of construction which here and there survived the 200 mph winds and 20-foot tides point up one significant fact: Effective protective measures against these forces are available to rebuilders if they elect to use them.

A Survive Staff Study

CAMILLE—

Out of the shock and the agony and the rubble of Hurricane Camille last August came a sort of foggy realization that there exist forces and circumstances with which we are poorly equipped to contend. Bravery and charity, crossed fingers and luck go only so far. One hundred mile-an-hour winds have little respect for guts. Two hundred mile-an-hour winds much less.

The day following Camille's assault the Mississippi coast looked as though it had been the target of a wartime saturation bombing. Death spared not fish, foul, man, beast or plant. All were scrambled midst the ruins in an unholy, silent litter that stretched mile after mile.

Damages Reflect Nuclear Effects

If much of the waterfront resembled scenes of Hiroshima and Nagasaki in another August twenty-four years ago it was because the conspiring forces of wind and water during America's worst hurricane were similar in effect to blast. The devastation gave all appearances of that of nuclear attack. Just as in the "ground zero" area of a nuclear burst, along the waterfront – which bore the brunt of Camille's wild impact – a band of total destruction comparable to the "A Zone"[1] stretched for fifty miles. This band varied in width, sometimes limited to a few yards

[1] *Damages to common-type American buildings in the area presumed to be affected by a nuclear blast are divided into the following classifications for which appropriate circles are drawn to indicate the limits of each category of damage:*
A Zone – Total (or near-total) destruction;
B Zone – Severe damage to structures, non-repairable;
C Zone – Damage to structures requiring major repair;
D Zone – Light damage to structures requiring minor repair.
Factors such as (a) construction techniques (b) shielding by other structures (c) terrain irregularities and (d) structure orientation will cause varied responses to the blast wave within each zone.

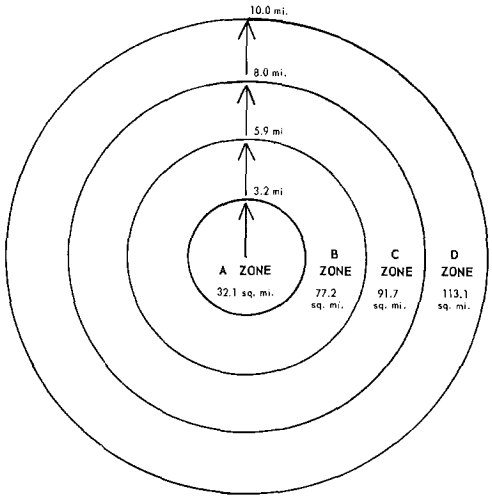


Figure 1. Although Camille damages were similar to those found in the area of a nuclear detonation, they are quite difficult to match with a specific nuclear burst size. For instance, Camille's "A Zone" damage area can be loosely compared to that of a 1-megaton air burst (above). Her "B Zone" was a bit smaller, however. Her "C Zone" was much smaller, and her "D Zone" was many times greater. Camille's damages were in "strips" of course and not circles.

and sometimes penetrating inland for an appreciable distance. Within this area all conventional construction was leveled. This included masonry, metal and wood structures. Where motels had once stood, for instance, there were only swimming pools and networks of paving leading to small cluttered spots that had been concrete block cabins. Where the destruction was not total most of the buildings were so badly damaged that they were irreparable. Although not completely distinct from the total destruction band this "major destruction" area was also extensive and roughly – qualitatively – approximated the "B Zone" of a nuclear detonation. These damages graduated into a third band where buildings, although severely damaged, were repairable – as in the "C Zone" of a weapon burst. Beyond this extended a very large area similar to that in the outer or "D Zone" of a nuclear detonation where minor damages were evident.

These "zones" or "bands" had no distinct boundaries, although it is convenient to designate them in this way. The damage zones of a nuclear detonation are of course found in a circular pattern. The estimates of damages inflicted by Hurricane Camille are somewhat unique in hurricane history. Figure 1 shows the idealized damage pattern of a 1-Megaton air burst.

Little is left of port facilities at Gulfport. Water tanks, however, still stand. Ships at left are high and dry and damaged but intact. .Photo by American Red Cross

What Survived?

Of significant interest in sizing up survival capabilities and the resistance offered by structures to the forces of wind and water is this question:

> What types of structures will withstand the terrific winds and tides which Hurricane Camille brought into play?

As noted, swimming pools and access roads were found intact after Camille. Roads and streets also fared well under the impact of a nuclear air burst. These features do not provide shelter, however. Structures which withstood the full force of Camille were:

a. Reinforced concrete buildings (and portions of buildings);

b. Rounded structures;

c. Ships and boats;

d. Water tanks;

e. Chimney stacks; and

f. Poles.

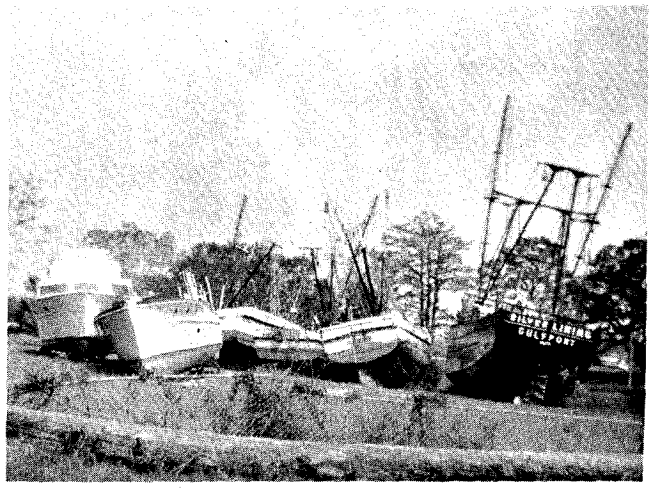
Ships were beached by the twenty-foot-plus tide, but they remained whole. Smaller pleasure and fishing craft were carried inland by the tide, but unless they were dashed against obstacles they too survived. The conclusion can be drawn from these observations (substantiated by engineering studies) that buildings can be designed to withstand the forces of a 200 mile-an-hour wind just as they can be designed to withstand the shock of an earthquake. The technique is much the same, and much of it is applied common sense. A very important item is roof design. The roof of a modern ranch-type house, for instance, overhangs two to three feet and has the characteristics of the leading edge of an aircraft wing. In a good storm it will tend to take off just like an aircraft. Spanish type houses, with no eaves, offer no such "wing" surfaces.

Houses normally will withstand winds of around 75 miles-an-hour. Even with the margins of safety incorporated in building codes, most house construction will suffer substantial damages in winds of 100 miles-an-hour, which are frequent in coastal areas when hurricanes hit. Very few are designed for winds of 200 miles-an-hour, which are possible in hurricanes and generously exceeded in tornadoes.

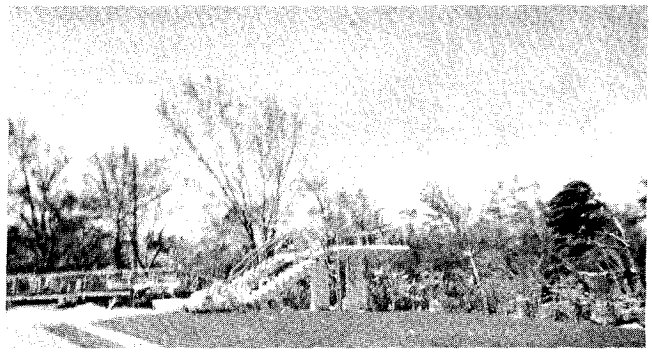
The predicament of Camille victims was greatly alleviated by help from outside the disaster area. The assistance organized by local government and local disaster agencies and that organized by the State of Mississippi, as well as that help which poured in from neighboring states and from across the country, did much to accelerate recovery.

Road to Remedies

It is realistic to note that in a nuclear attack population



Boats are "shaped" to shed wind. These boats were carried inland by the Camille tide and wind but suffered no major damages. Photo by Wayne McIntyre



A motel is gone, but reinforced concrete stairways remain. Photo by Fred Willis

Economy construction saves money (initially). It doesn't save lives. L. A. Dicks (right), a county civil defense director, who brought in convoy of *Jaycees* emergency supplies, surveys damages in disbelief with rescue worker.

Photo by Steve Knight

Along with the similarities between Camille and the Japanese nuclear experiences there are also some notable differences. Among them are these:

a. Warning was an important factor in holding Camille casualties to a minimum. Preparations and evacuation were possible.

b. No thermal radiation accompanied Camille.

c. No nuclear radiation accompanied Camille.

d. No flooding accompanied the Japanese nuclear bursts.

e. No pressure front* accompanied Camille.

f. The "dynamic" pressure of Camille's winds built up slowly and was more or less sustained for several hours. The "overpressure," dynamic pressure and winds of a nuclear burst come with a brutal suddenness but are of extremely short duration (a matter of seconds, the exact duration depending upon weapon yield and distance from ground zero).

**A "squeezing" type pressure is a feature of the blast wave of a nuclear explosion and is called "overpressure". This is a phenomenon peculiar to explosions. It is not present where there is a gradual build-up of winds, as in a hurricane. The "dynamic" pressure is defined as that pressure caused by the winds of a blast wave. This type of pressure does accompany the winds of a hurricane.*

centers affected will be so numerous that outside help will be most unlikely. With the present state of preparedness urban communities over the nation would suffer damages much worse than that of the Mississippi coast. Without substantial help from the outside, these communities would have to rely on preparations as inadequate as the preparations of Camille victims.

The official, country-wide planning for civil defense today does not accent general preparations for blast protection. In fact, most of the fallout shelters that are expected to support our urban population are located in areas that can be expected to be zones of blast damage. Most of these fallout shelters would survive blast about as well as the motels along the Mississippi waterfront survived Camille.

Could Camille be a lesson – finally? For what *can* survive in a hurricane of this intensity – along with the people inside – is construction with the well-known qualities of strength and ductility (and economy) designed to withstand earthquake shock. This same general type of construction will also survive in tornadoes – and in over 90% of the A-B-C-D area of the blast wave of a nuclear weapon. ■

Anyone for a hurricane party? This young lady accepted, then changed her mind and waded through mounting winds to shelter. Now, alive and alone, she sifts rubble for personal items. Note block-brick construction. Photo by Steve Knight

EDITORIAL

OPPOSING PHILOSOPHIES

The recent ABM controversy over military spending, and continuing pronouncements concerning the effectiveness and desirability of civil defense (see page 8 of this issue) presents a confusing array of "expert" opinions to the people of this country, who have a great deal at stake in these issues – both tax-wise and survival-wise. The person who accepts a responsibility to support those programs which will insure the perpetuation of this free society, preferably in peace, must understand the basic tenets which underlie most of the debate and furor over defense issues.

Aside from partisan alignments, which are usually transparent, controversies stem from opposing political philosophies concerning the intentions of other major world powers.

One side holds the opinion that disarmament agreements have not advanced sufficiently for us to trust our potential enemies not to become aggressive if their losses in conflict could be held to some acceptable minimum. This position calls for a superiority of armament, defense of our retaliatory capability, and a strong civil defense program.

Opposing this position is the philosophy that other nations (Russia and China in particular) are building nuclear capabilities and developing extensive civil defenses in response to our military strength. Fear of attack by the United States is, to follow this line of reasoning, the major deterrent to effective disarmament agreements. This philosophy calls for a reduction in our military strength and cessation of civil defense preparations against the effects of a nuclear war.

Man's history, and the recent actions of world powers must be considered in evaluating the validity of either of these beliefs. There is one criterion for deciding our course of action, however, which is more readily understandable. It is admittedly negative, and it rests in the answer to this question:

> After following the national policies advocated by either side – what would result if we had made the wrong choice?

(LBB)

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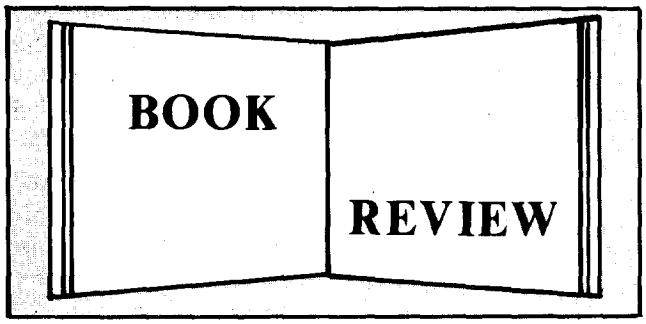

EMERGENCY AND DISASTER PLANNING

Emergency and Disaster Planning by Richard J. Healy. Published by John Wiley & Sons, Inc., New York, $12.95.

Detailed information to assist in planning for defense against the destructive forces of nature and man can be obtained from many sources. However, it is arduous and time consuming to extract the essentials from voluminous reports and texts, written to present only limited aspects of the broad field of civil defense. Healy has carried out this formidable task, extending to the reader the benefit of his wide experience in security and emergency planning both in government and in private enterprise. His book, *Emergency and Disaster Planning,* presents the elements of organizational emergency planning, describes the causes and characteristics of the forces which can wreak havoc with life and property, and discusses major disasters of history which vividly support the need to face realities and to be prepared.

The book begins with general disaster considerations, bringing out step-by-step analysis of the factors of emergency plans. This section of the book directs itself primarily toward planning for industry, the area in which the author is currently working. Following the chapter on planning procedures, the book is devoted to the development of the basic ingredient of any effective planning – a sound knowledge of the disaster which might occur. Nuclear war, nuclear accidents, hurricanes, tornadoes, floods, and riots are among the subjects covered. The psychological reactions brought on by disaster are also discussed, to round out a very thorough coverage of the many aspects of civil defense planning.

Healy has presented a wealth of information in interesting, readable style. His book will serve not only as a guide and reference for emergency planners, but also as a source of authoritative information for those who want to understand the workings of the great forces of nature. The contents yield an almost inexhaustable supply of topics for talks and discussions. It is not a book based on fear, but rather a reassuring treatise which carefully and unemotionally examines the forces which we may have to face, and provides the blueprint for survival.

(LBB)

NUCLEAR EXPLOSION CASUALTIES

Nuclear Explosion Casualties by Evert Schildt, Jr., M.D. Chas. C. Thomas, Springfield, Ill. (Almqvist & Wiksell/ Gebers Förlag A B, Stockholm, 1967.) $10.50.

Planning for the provision of treatment and staging of the handling of nuclear casualties can be effectively organized just as in conventional warfare if the variables of explosion characteristics, doses, terrain, protection, atmosphere and weather are evaluated. The casualty load will be greater than with conventional weapons; patients with burns will be present in far greater numbers; survivors with only blast injuries will be rare since almost all cases will have multiple kinds of disablements with almost all having radiation exposure as one kind of injury. Those with severe radiation exposure will expire soon in spite of treatment; those in the twilight zone of exposure will either die or recover with the best treatment, and those with light doses whether showing the acute radiation syndrome or no symptoms will require negligible care for recovery. The initial injury is always more important to medical planning than injury from residual radiation.

Guidelines for estimating and evaluating injury from the blast wave, thermal radiation, ionizing radiation and combined effects are formulated. The guidelines presented are based on nuclear tests, experience with nuclear bombs and supporting research. A plan is given for evaluating the extent of injury and for prognosis so that casualties can be quickly evaluated as to the severity of the course of their injuries.

For example those with thermal injury can be divided by area of burned surface, degree of burn on exposed parts of body, age of individual, and the part affected. Arguments are presented to justify this type of classification. Each type of injury is analysed according to the variables in the exposure and clinical experience with this injury. Reliable information is presented in proper perspective so that medical planning can proceed effectively.

Dr. Schildt has thoroughly evaluated the situation of nuclear casualties and presented plans which might allow medical units to function as effectively for nuclear attack as for conventional warfare.

(LEF)

"The past year has not seen any progress in the field of disarmament . . . only international nuclear escalation . . . The threat of nuclear war is increasing every day."

—UN Secretary-General U Thant
at September, 1969 press conference.

SO BE IT!

Continued from page 10.

scientist adds philosophically that if a compelling case for action is made, the civil defense problem is at least assured of a hearing at the right level – where action can be initiated.

The range of topics assigned the Lincoln study panels is broad: past, present, and potential future civil defense postures; relation of civil defense requirements to the ABM program; public acceptance; and other subjects of similar scope.

There is a special hazard in assigning so many technical topics to men of highly specialized competence for study. Their report could become too technical to achieve its purpose. The basic report will fail to achieve a political end – the establishment of a firm commitment to a sound civil defense policy – unless it is couched in terms the political leadership can understand and use.

Political underestimates of the popular support for such a policy, and of the vital need for it, have resulted in a steady decline of federal financial support for civil defense and emergency preparedness. Today, local government investments in construction and hardware projects cannot be fully matched by federal funds.

One unique feature of the Lincoln study is that it was requested by the president himself. It may be assumed that whatever report is produced will thus be laid before the president. A problem which bothered the authors of several earlier studies, such as the Harbor and Little Harbor reports, was that they were answers to questions no one had asked. They were acknowledged politely, and pigeonholed just as politely.

Whether the present study becomes merely another footnote to history or the basis for a vital policy decision will depend on many factors, some not susceptible to any objective analysis. But if it correctly assesses the last several years' record of community support and participation, the study would then have a better chance to make a political impact. ■

"Large-scale" civil defense preparations are reported as taking place in Kazakhstan, one of Russia's major missile launch areas. Kazakhstan's border with China has also been the scene of recent Soviet-Chinese skirmishing. Vitaly Titov, high-ranking Kazakhstan Communist Party official, announced that the civil defense activity was calculated to protect the population against "imperialist" nuclear, chemical and biological attacks.

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EFFECTIVE SHELTER

Since the federal activities related to urban affairs are concentrated in the Department of Housing and Urban Development (HUD), this department is the natural authority responsible for the passive defense of the cities [*i.e. should become so, in coordination with the Federal Office of Civil Defense–ed.*] New construction and urban renewal projects could incorporate shelters as such or as dual-use components . . . Urban planners may well keep in mind that nuclear weapons exist and that they are not likely to be abolished in the near future. New concepts and practices developed in the HUD programs may also contribute to the solution of some of the problems of postattack recovery.

. . .HUD and the General Services Administration could provide example and leadership for private builders to incorporate shelters into new buildings or at least to make later conversion into shelters possible. With such leadership and perhaps with other appropriate incentives, private construction, which will continue to exceed public construction by a wide margin, could add substantially to the realization of an effective passive defense.

– From the Civil Defense *Little Harbor Report,* 1969 (A Report to the Atomic Energy Commission by a Committee of the National Academy of Sciences).

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IN THE JANUARY-FEBRUARY ISSUE:

An American municipality looks at nuclear attack facts and votes for a blast-protected underground emergency operating center. John Causten Currey builds a story of survival pioneering around an Oklahoma City civil defense director who "means business".

Also: a Swedish report on "total defense" in Czechoslovakia.