

letters

paleontologists ten million years from now they will characterize our period (the present) as the "age of extinction."

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More on civil defense

The "debate" on civil defense by Arthur Broyles and Eugene Wigner versus Sidney Drell (April, page 45) ignored the major role that fire will play in any nuclear war, be it large or small. The tendency of the physicist to assign the most familiar effect the greatest importance was apparent in this article. Thus, the electromagnetic pulse, thermal radiation, blast and fallout were given major roles, whereas fire was relegated to two short sentences in the section on shelter design.

The effectiveness of the incendiary air raids on Japan and Germany in which firestorms developed far exceeded that from the high-explosive air raids in terms of damage and casualties.^{1,2,3} Even in the attacks of Nagasaki and Hiroshima, between 50 and 65 percent of the deaths and casualties are attributable to fire. There were 68 000 killed at Hiroshima and 38 000 killed at Nagasaki. The interesting comparison can be made, that a firestorm developed at Hiroshima and not at Nagasaki. However, even in Nagasaki, fire played an important role in inflicting damage and casualties.

As a further basis for comparison, the great Tokyo air raid of 9-10 March 1945 killed 83 793, the Dresden fire raids of 13-14 February 1945 created a firestorm in which 135 000 died, and the Hamburg fire raids from 24 July to 3 August 1943 generated firestorms that killed more than 43 000. These fires created firestorm winds^{1,3} over areas up to 16 km². The Dresden firestorms were the most severe, and they probably most nearly approximate the fire that will develop from the large-area ignitions generated by a thermonuclear weapon. In this raid, the shelter ventilation systems, in many cases, collapsed and there is evidence that the intense fire whirls associated with the

firestorm generated pressure differential fluctuations that caused injected lethal concentrations of carbon monoxide into some of the shelters.

Theoretical studies^{4,5,6} of the fires generated by a five-megaton thermonuclear weapon, clearly indicate that almost all buildings from ground zero out to 8 km will be destroyed by fire. Many of these will start as a result of events other than thermal radiation. The rate of postulated destruction decreases to near zero at a range of 17.5 km; however, these studies largely ignore the spread of fire due to fire fronts and firebrands. These studies also show that the use of fallout shelters in large public buildings will result in the death by fire of large numbers of people, if the shelters are not especially designed to withstand the burning of the building. Even in this case, if there is a full-fledged firestorm development, the probability of survival is small. In the large, experimental fires of Project Flambeau, some were designed to produce firestorm-firewhirls. The areas in which they occurred were scoured clean, down to rocks the size of pebbles (about 1 cm) and all combustibles were burned off flush to the ground. It is possible to generate such large firewhirls by igniting 27 hectares or more⁷ simultaneously with a fuel loading of dry fuel greater than about 35 kg/m².

It has been indicated that as much as 10% of the United States would be destroyed by fire, even in the most modest nuclear exchange. Some areas are more vulnerable than others; for instance a modest nuclear attack in Southern California during a Santa Ana wind would effectively destroy much of the area.

It is probable that nuclear weapons will be used again against civilian populations. It behooves the planners of strategy to make realistic analyses of the impact of even limited use of nuclear weapons and to provide for the protection and preservation of the population. Otherwise, the destruction of our major cities by bomb and fire is highly probable.

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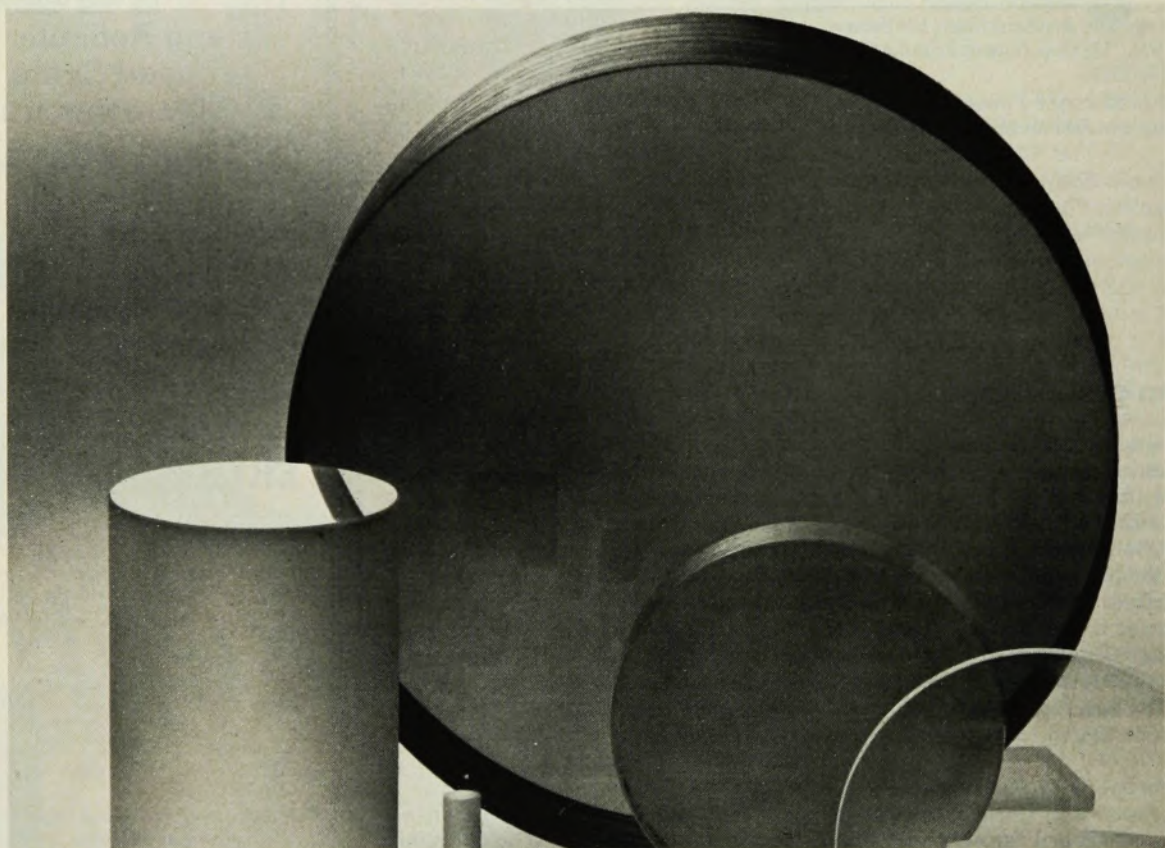
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THOMAS Y. PALMER
Fallbrook, California

Some of the points raised by Broyles and Wigner are misleading or erroneous. First, the use of numbers implying precision (that is, 11% and 5.5% casualties) conceals the extreme uncertainty in any estimates of human loss in a nuclear conflagration. Second, there is a gross misstatement (page 46) of the US annual welfare cost (\$500 million a day would be \$182 billion annually). One could hope that such a distinguished physicist and mathematician as Nobel Laureate Wigner would honestly state his political bias, which is implicit in, for instance, his comparison of the dollar cost of "counter-evacuation" with that of the welfare program. The authors' political bias also is apparent in the comparison of Soviet World War II casualties (page 47) with projected losses in a nuclear holocaust, which seems to imply that somehow the losses which the Soviets suffered then were acceptable or tolerable.

To those of us who recall the civil-defense hysteria of the early 1960's, which was fueled by the Berlin and Cuba crises, such political abuse of the weight of scientific authority is unacceptable. Drell, in his reply, has done an excellent job of presenting a rational analysis of a complex problem, which must be viewed in a global political context.

CARL E. FRIEDBERG
Berkeley, California

THE AUTHORS COMMENT: Thomas Palmer is quite right; our analysis of the fires that may be caused by nuclear explosions is quite incomplete. The same applies, of course, to the rest of the discussion, which had to be short also. We did quote two more elaborate discussions: those of the Russian handbook on civil defense and Glasstone's *The Effects of Nuclear Weapons*.

As to the ratio of fire-caused fatalities to those caused by the other effects of nuclear weapons, we disagree with Palmer. The cases he cites apply to unprotected people. Surely, if the people are removed to distances around 50 miles from the explosions, the chances of fires at their new locations become very small. If good shelters are used, even close to the nuclear explosions, the lives of the people in these shelters are not severely endangered by fires. One can easily calculate

the temperature increase in a shelter under a two-foot earth cover, as caused by a fire storm: it is around 2 degrees. In conformity with this, it was found that the Second World War's bombardments caused no fatalities in the well constructed shelters of Germany, called "bunkers." We repeat, no fatalities in the bunkers. The claim of the USSR handbook that their subway stations are "safe against nuclear weapons" may be exaggerated, but points in the same direction. Let us repeat; fires can have disastrous effects on unprotected people. However, the protection provided by the shelters is even greater against the life-endangering effects of fires than against other effects of nuclear weapons.

What has been said above applies to the lives of the people. The material damage caused by fires can well exceed the damage caused by other nuclear-weapons effects. Our underemphasis of the material damage may be excused by Lenin's words, much quoted in the USSR: "The primary productive factor of all humanity is the laboring man. If he survives, we can save and restore everything..."

Carl Friedberg is also quite right: it is not possible to foresee accurately the number of casualties in a nuclear war. The numbers we gave and he quotes are, as we mentioned, those of the Ponast II study and we assumed that all physicists would realize that they cannot be precise. Most of us hope, in fact, that with careful and detailed planning an even greater effectiveness of the proposed measures can be achieved. We are glad to note that he did realize that no entirely accurate forecast can be made—and the main purpose of civil defense is, as the Swiss say, that no test of the numbers ensue—but we are a bit surprised that he assumes that the other readers of the article would not realize this.

The annual "income maintenance" expenditures of the US are given, for instance, in the Social Security Bulletin issued by the Department of Health, Education, and Welfare. The last year for which data are given is 1974 (page 35 of the March 1976 issue). If one extrapolates these data linearly, one obtains for 1976 an average daily expenditure of \$450 million; if one takes the curvature into account, the result is \$575 million. Our estimate of \$500 million is surely not precise but one may consider it reasonable. Actually, even a significant change of this number—which was given only for comparison purposes—would have little effect on our argument.

Let me add to all this that I continue to be surprised how some critics deplore all our defense measures, speak of our civil-defense hysteria, but do not even mention the much more elaborate, and much less defense-oriented, civil-defense measures of the USSR.

Friedberg accuses me of not stating my political bias, which is a strong desire to



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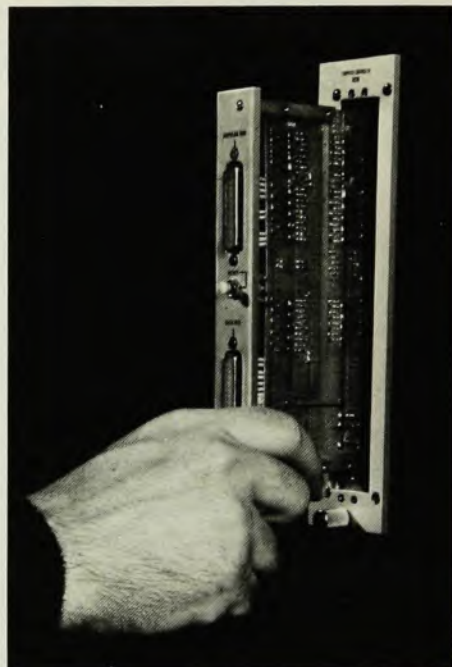
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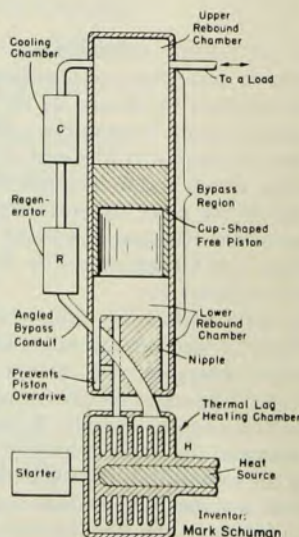
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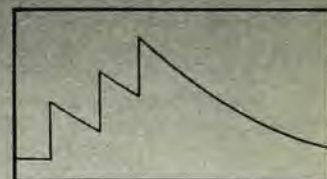


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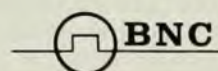
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defend our country and our freedom. I admit it now and surely I cannot accuse him for not making his bias evident.

EUGENE P. WIGNER
Princeton University
New Jersey

The danger from fire in a nuclear attack is analyzed in an article in *Survive* (P.O. Box 910, Starke, Florida) 2, 14 (March-April 1969) and in documents referenced therein. That article notes that 43% of the people in the Nippon Building, Hiroshima survived the fire storm of over a mile radius although the building was located $\frac{1}{2}$ mile from the center. These people had no warning and would have been much better off in a shelter. To obtain maximum fire-ignition effects from a nuclear bomb, it must be exploded at an altitude higher than that for optimum blast effect and, therefore, will produce negligible local radioactive fallout. Fire effectiveness of a bomb depends heavily on local atmospheric conditions, because clouds, fog or smog can greatly reduce the range of the heat radiation. Rather simple measures, such as cleaning up papers and wetting dry leaves, can greatly reduce the fire ignition range. In my opinion, we would be much better off under an enemy attack directed towards starting fires than one designed to maximize blast or fallout provided civil-defense preventive measures are taken beforehand.

Carl Friedberg draws the conclusion that our article implies that Soviet World War II losses were "acceptable." Our point is not this, but rather that it is unacceptable to leave the United States population exposed to the terrible losses that it would suffer if a nuclear attack should occur. The saving of human lives is our objective.

ARTHUR A. BROYLES
University of Florida
Gainesville, Florida

We are glad to see that Sidney Drell, in opposing civil defense, makes really an excellent case for it.

Drell outlines well and at some length a number of well-known difficulties inherent in achieving a meaningful civil-defense program—difficulties which are among the basic planning problems of civil-defense staff workers.

Then he strongly and repeatedly alludes to the admitted effectiveness of civil defense. (For instance: "Few dispute the technical facts concerning the means to protect large populations for one to four weeks after an attack from the physical effects of blast, fire, radiation and fallout.") These admissions of effectiveness—although to some extent contradicted elsewhere in his presentation—

complement his final warning not to develop civil-defense programs on unrealistic premises. That warning merits close attention. It is where we are today.

Drell's serious objection he defines as one of cost. If the protection of American lives against the known, poised, devastating threat of nuclear missiles is considered not to be important, then his cost-oriented anti-civil-defense stance smacks of a certain validity. We would, to be sure, if we chose to defend our people against nuclear attack, be forced to commit ourselves to costs similar to those borne by Russia, China and other nations whose leaders have opted for citizen survival (nations whose GNP's are much less than ours). These costs, however, would be considerably less than many of today's much-criticized "frivolous" government adventures.

Such a program would mean a contribution of anywhere from one-half cent to seven cents a day per capita for the next five years, depending on how well we wanted to do the job. Survival and peace might just be worth it.

WALTER MURPHEY
Editor
Journal of Civil Defense
Starke, Florida

THE AUTHOR RESPONDS: Walter Murphey misrepresents my opposition to an expanded civil-defense program when he states my "serious objections" as being based on dollar costs. I am very puzzled by this characterization of my arguments, because my article analyzed the "cost" of civil defense in all its aspects other than the dollar costs. The concerns to which my entire discussion was devoted were the costs to strategic stability of developing and deploying new missiles to implement a strategy of limited nuclear counterforce strikes and the social and human costs if we were to implement the massive training programs required to construct an effective civil-defense system in this context.

Murphey's letter completely ignores these issues, which formed the basis of my opposition to developing massive population relocation and evacuation schemes beyond our present civil-defense system.

SIDNEY D. DRELL
Stanford University
Stanford, California

Ozone clarification

Whereas it is understandable from reading the article on "Fluorocarbons and the stratosphere" (October, page 34) that Charles Wang (March, page 15) of the Ford Motor Labs should want to point out some of the very significant accomplishments of his group, I believe that some of

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