NUCLEAR WINTER AND NUCLEAR STRATEGY

BY THOMAS POWERS

If the "nuclear winter" theory is correct, an aggressor would destroy himself, even if there were no retaliation

THE ATLANTIC MONTHLY
NOVEMBER 1984

DURING THE OPENING campaigns of the air war against Germany, it didn't take long for the British Bomber Command to realize that the right way to destroy a city is not to break it up with high explosives but to burn it. High-explosive (HE) bombs are purely local affairs. You've got to cube the blast power of the bomb in order to square the area destroyed. Not even a thousand British Lancaster and Halifax bombers, which was the size of the biggest of the fleets raiding Germany by the third year of the war, could carry enough high-explosive bombs to do more than sprinkle cities with holes of destruction. Bomb raids involving HE bombs were terrifying to live through but not very dangerous; casualties were generally few.

But fire is a living thing. Fire consumes and spreads. Fire attacks anything of organic origin the way disease attacks human bodies, and just as epidemics can flash through the crowds of cities, so fire finds a congenial host in the accumulated combustibles—the wood, the paper, and the fabric of cities. In March of 1942 Bomber Command attacked the medieval German city of Lübeck, figuring that its narrow streets of ancient timbered houses meant it would burn well. It did. As the war progressed, the British abandoned daylight attacks on specific industrial targets because too many planes were being shot down and it was too hard to drop bombs accurately. The price was high, the results paltry. So Bomber Command switched to nighttime raids on the sprawling industrial suburbs of German manufacturing centers. Darkness protected the bombers, cities were big enough to find at night, and their size meant that even a miss—and most bombs fell miles wide of the "target"—was still bound to hit *something*. The adoption of the "bomber stream" helped to concentrate the attack. The bombs were fused to explode not on impact but an instant later, which helped to break up buildings. The bomb-load mix was changed as well. A third of each plane's cargo was devoted to HE bombs, which broke windows, blew open doors, and splintered wood into matchsticks. The rest of the load consisted of incendiary bombs to set the wreckage afire.

But the art of burning cities did not approach full flower until July of 1943, when successive raids on Hamburg brought something new into the world—the firestorm. The worst damage occurred on the night of July 27–28, when nearly 750 British bombers dropped 2,326 tons of bombs, about half of them incendiaries. For some reason the bomb patterns were unusually tight that night. A vast fire was ignited, producing temperatures estimated at nearly 1,000° centigrade at the center of the conflagration. Hurricane-force winds roared in from all sides to feed the fire. People abroad in the streets were actually sucked into the fire. Others were mired in molten asphalt, or they melted outside the steel blast doors of bunkers where they had—too late—sought refuge. When survivors inside opened the doors to emerge after the raid, they found pools of fat on the ground. In other shelters the heat was so intense that people were baked brown, leaving shriveled corpses the size of children, or they died of asphyxiation because the firestorm had sucked the air out of the shelter. A study by the United States Strategic Bombing Survey after the war found that the average number of deaths in an ordinary bombing run on an urban area was 1,850. In Hamburg the death toll was over 40,000. Whether this raid helped to win the war

Thomas Powers is a contributing editor of The Atlantic.

is hard to say. One reason for the attack on Hamburg was its importance as a submarine-building center. Some 400 U-boats were launched by the Hamburg yards during the war, about half before the raid and half after. But the Hamburg raid unnerved the German High Command and convinced Allied strategic-bombing enthusiasts that they had found the key to defeat of an enemy from the air.

As things turned out, creating a firestorm was no easy matter; everything had to work just so. But Bomber Command destroyed Dresden with another in February of 1945, and the Americans under General Curtis LeMay succeeded in creating the biggest of all in Tokyo the next month, when a roaring inferno destroyed sixteen square miles of the city and killed more than 80,000 people. In the late spring of 1945 General H. A. "Hap" Arnold asked LeMay how long he thought the war against Japan would last. LeMay said, "Give me thirty minutes." Then he called in one of his operations officers and did the numbers: so many Japanese cities left to burn, so many planes available to fly, so many flying days to do the job. When there were no more cities to burn, the war would be over. LeMay told Arnold, "The first of September." What was new about Hiroshima was not the firestorm—something well understood by that time—but the fact that its infernal horrors had been achieved by one bomb from one plane. This represented a quantum jump in military efficiency. When LeMay saw the Hiroshima photos a few days later, he told me recently, he realized that "we really had something extraordinary."

Burning cities were one enduring image to come out of the war. It obsessed military men for twenty years, but the general public caught the drift as well. I've often thought that this image had a lot to do with the rapid growth of the suburbs surrounding American cities in the 1950s. The message of Coventry, Hamburg, Berlin, Tokyo, and Hiroshima was hard to miss: War destroys cities. *Get out of the cities*. But my notion is a hard one to prove. Perhaps the growth of suburbia was only the doing of the automobile, or of cheap mortgages.

WHAT IS INTERESTING NOW IS SOMETHING THAT was noticed only as a curiosity then—the vast pillars of smoke that rose over the burning cities and then diffused downwind, creating gorgeous sunsets for days thereafter. Color in the evening sky is a function of slanting sunlight shining through stuff in the air—clouds, dust, volcanic ash, the characteristic smoke and fumes of cities. In Cairo once, a friend and I watched the sun set over the Western Desert after a dust storm. The sky was stupendously aflame. On another occasion I took an air taxi down the length of Long Island toward New York City and watched the sun set through the yellow and purple and violet streaks of gunk suspended over the city. It seemed hard to believe that living creatures could breathe that livid stew. A lot of what we think of as nature is really the doing of man. One of the arguments raised against a plan to hide MX missiles among thousands of shelters in the deserts of Nevada and Utah was the dust that construction would stir up—thick enough at the Grand Canyon, hundreds of miles away, scientists said, that tourists often wouldn't be able to see one rim of the canyon from the other.

The general phenomenon is well known. Volcanoes pumping ash into the air can add a streak of color to sunsets thousands of miles away. In 1950 a gigantic fire burned over an area of 10,000 square kilometers of forest in Alberta, Canada. The trees, mostly conifers, were rich in tars and resins, which make oily black smoke. The pall covered about half the land area of the United States, spread across the Atlantic, was detected over Great Britain by aircraft as high as 35,000 feet, and actually reduced the amount of visible light reaching the ground in Western Europe. Smoke hangs well in the air, especially dark, sooty smoke. The particles are small. They absorb sunlight and heat up the surrounding air, which tends to linger aloft in a thick layer. Second World War bombers frequently returned to their bases covered with black soot picked up at altitudes of 20,000 or 30,000 feet. The smoke from the firestorm at Hiroshima, which burned five square miles of the city, was pushed high into the troposphere by the combined heat of the fires and the bomb's fireball. Survivors spoke of the awful darkness and the chill in the August air which accompanied the murk and the gloom. Water vapor condensed and fell back to earth as rain, black with the soot it picked up on the way down. A Japanese novelist, Masuji Ibuse, later wrote a fine novel called *Black Rain* about the bombing of Hiroshima. For him the black rain symbolized the ghastliness of what happened.

But to American officials and scientists who studied the bombing after the war, the black rain—an unexpected effect of the unique explosion—was nothing more than a curiosity. Scores of individuals contributed reports for the U.S. Strategic Bombing Survey account of the attacks on Hiroshima and Nagasaki, but the author of the account, Philip J. Farley, remembers no mention of smoke in the documents he collected. "I thought of the cloud in terms of the scenic effects," Farley said recently in his office at Stanford University, where he now teaches after a long government career spent mostly in the State Department. "Nobody was thinking [of side effects] except in terms of radiation."

Paul Nitze, one of the Survey's two vice-chairmen, took Farley to Japan in August to work on the Survey's study of the Pacific half of the war, and then, in November, assigned him to write the account of Hiroshima and Nagasaki. Farley never visited either city, but the reports he saw covered everything imaginable—heat and blast effects, radiation sickness, the durability of various types of construction, the hopeless task that had faced the city's fire-fighting services, and the like—except the smoke. The limits of the fire were mapped in great detail, but smoke was smoke. How much, where it went, how long it lingered in the air—none of that seemed to matter.

But now the question of smoke is very much on the minds of scientists and military men, for the simple reason that nuclear war would mean large numbers of burning cities, all pumping vast quantities of smoke into the air. Last December five scientists published a paper in *Science* magazine claiming that smoke from as few as a thousand fires in a hundred major cities could cast a sooty pall over the Northern Hemisphere thick and lingering enough to bring darkness at noon and radically cool the earth's surface for months, thereby triggering a climatic catastrophe—a "nuclear winter"—that would threaten many plant and animal species, including man, with extinction.

The invention of nuclear weapons has brought dire warnings aplenty in the past few decades, but this one is on an altogether different scale. It's one thing to say that the United States and the Soviet Union would suffer beyond precedent in a nuclear war, even that a nuclear war "would destroy civilization as we know it." It's our civilization, after all; we built it, and perhaps that gives us the right to destroy it. But we are not our own fathers; we did not create the human race, much less the other forms of life that share the planet with us. A defense policy that threatens life itself on such a scale is simply too crazy to stand.

In a sense, the bad news about nuclear winter is *so* bad that it might even be taken as grounds for a perverse optimism. If we finally admit that we can't fight a nuclear war without destroying ourselves—*really* destroying ourselves—then perhaps the time has come to quit preparing to fight one. Even deterrence—preventing war through fear of the consequences—demands a credible threat. Can it be credible to threaten attacks on Soviet cities that would expose both nations—even without Soviet retaliation—to nuclear winter? Thus the problem of burning cities has introduced a wild card into the calculations of American (and presumably of Soviet) war planners.

Of course, many technical uncertainties remain. The authors of the nuclear-winter paper stopped short of claiming to know that a nuclear war would shroud the earth in a long, freezing night and kill everybody. Much scientific work remains to be done. But the preliminary findings are not encouraging; the prospect of smoke from hundreds of burning cities poses a real problem for defense planners. Even military men, normally skeptical of apocalyptic claims, are worried—especially the ones who draw up the plans for targeting nuclear weapons in the event of war. Some of the ones I've talked to—a retired admiral, for example, who was in charge of war planning for the Joint Chiefs of Staff (JCS) in the early 1970s—look rueful, smile ironically, and give vague waves of the hand and shakes of the head when they respond to claims that a thousand large fires in a hundred major cities could mean big trouble worldwide. The targeting experts know we're planning to do worse than that to the Russians. But if you take the cities out of the war plan, there's no plan left. It's an either/or proposition: either we stick to the plan and court ecological catastrophe, or we get rid of the plan and try to think of something else to do with the 9,500 strategic nuclear warheads in the American arsenal. What that might be is hard to imagine. Nuclear weapons are good for igniting fires over hundreds of square kilometers and obliterating downtowns. If cities are off limits, there's not much to use the weapons on. The public is having a hard time trying to grasp just how uncompromising the choice is, but the war planners got the point right away: if the smoke of burning cities is really a problem, then our current plans for fighting a nuclear war amount to literal suicide for the country that strikes first, even if there is no retaliation.

In the popular mind, at least, nuclear war has always meant the end of the world. Numerous public-opinion surveys have shown that the average American *expects* to die if there is a nuclear war; many even hope that they will die. Until recently military officials, and probably most scientists who take an interest in nuclear strategy, have not shared these apocalyptic fears. Indeed, one badge of the weapons fraternity has been a hardheaded knowledge of how bad nuclear war isn't. But ordinary citizens are difficult to reassure. They're convinced that we passed the point of overkill long ago, not just in rhetoric but in fact. Perhaps the toughest thing for the public to understand is why the military wants more nuclear weapons when "we've already got more than we need to kill everybody ten times over." Anyone who writes or speaks professionally about these matters hears this question again and again. The answer is that the world's nuclear arsenal of perhaps 50,000 weapons would certainly be big enough to kill everybody if people would gather together conveniently in exposed places, but not otherwise—or so the experts have thought. To "blow up the world" in the popular sense of the phrase would take far more nuclear weapons than we've got, probably even more than we could make. "There's just not enough fissionable material," Richard Turco, a scientist specializing in atmospheric studies at R & D Associates, in Marina del Rey, California, told me recently. Turco has been studying the effects of nuclear weapons on the atmosphere for years, and he was one of the five authors of the nuclear-winter paper—the phrase is Turco's coinage—published last December. Turco believes that a nuclear war could threaten man and many of his fellow creatures with utter disaster, but, like most technically minded men, he hates imprecision, and he is particularly irritated by popular fears that imagine disaster of the wrong sort. He once did some calculations to see what it would take to blow down all the world's buildings with blast waves, to ignite all the combustible materials on the surface of the earth with thermal pulse, or to expose everyone on earth to a dose of a thousand rads (units of radiation) within an eighteen-hour period. The first two would take about two million megatons of explosive power (that is, the equivalent of two trillion tons of TNT) and the third about a quarter of that amount. "Blowing up the world" in the literal sense is beyond us.

But there is more than one way to skin a cat. The late Herman Kahn, who made his reputation with a huge tome, published in 1960, titled *On Thermonuclear War*, speculated in that book on the feasibility of an ultimate deterrent, a "doomsday machine" that could destroy the planet in the event that the side in control of the trigger felt that it had been pushed into an untenable corner. Kahn could be something of an intellectual rascal; it amused him to carry rationality to extremes, outraging the tenderer hearts of traditional humanists. But also he had a serious purpose in mind. He felt that atomic weapons were a fact of modern life, and had to be considered rationally; they weren't something just to be brandished with wild threats of an apocalyptic *or else*. Kahn put the war plans of the late 1950s into that category. These plans were hard to execute but simple in theory—obliteration of the Soviet Union. In 1953 the Joint Chiefs of Staff approved a plan named Offtackle, devised by the Strategic Air Command (SAC) under LeMay, which called for opening with attacks on Moscow (twenty bombs) and Leningrad (twelve) and then delivering the rest of the arsenal (about 900 weapons in all) to targets in other Soviet and East European cities. Another plan, named Reaper, adopted the following year, called for dropping 1,500 bombs on Soviet targets. Kahn thought this all-or-nothing approach was crazy, and he attacked it obliquely with his doomsday speculations.

The idea behind Kahn's proposal for a doomsday machine, dreamed up pretty much off the top of his head, was simple: pack the deepest hole that could be dug or found with thousands of megatons of nuclear weapons, thereby threatening to shatter the crust of the earth and literally break the planet apart. He concluded that such a project was feasible but dumb. It might blow up the world, all right, but it wouldn't deter, because the other side wouldn't believe anyone was crazy enough to trigger the machine. In a footnote, interestingly, Kahn wondered if we might not create a doomsday machine inadvertently. He decided not: the planet was too tough; you couldn't kill it without really trying.

Kahn worked for the Rand Corporation in 1960; he had high-level security clearances and was privy to a broad range of the nation's nuclear secrets. But like everyone else at the time, he failed to sense the ecological fragility of the earth; he overlooked the potential importance of the humblest of the side effects of nuclear war—the smoke of burning cities; and it never occurred to him that the United States had already built a doomsday machine and had been preparing since the approval of Reaper, in 1954, to use that machine, in complete ignorance of the possible result.

THE THREAT TO THE WORLD'S CLIMATE THAT THE smoke of burning cities poses was a long time sinking in. It was like Edgar Allan Poe's "Purloined Letter"—hidden in plain sight. One strand of discovery goes back to a 1980 theory that the mass extinctions of dinosaur species at the boundary of the Cretaceous and Tertiary periods, about 65 million years ago, were the doing of a large asteroid, perhaps six or seven miles in diameter, which slammed into the earth with tremendous impact. The dust and debris blown up into the atmosphere by the collision would have darkened the sky for months, cooling the surface of the earth and reducing ambient light—that is, the average visible light at the surface of the earth—below the level at which photosynthesis could keep green things alive. Each of these effects was lethal in its own right, but coming together they precipitated a downward spiral—a kind of unraveling of life systems a bit like an economic crash, in which the failure of one business or industry immediately threatens another, until all lie in ruins. The dinosaur-extinction theory was substantially revised over the following few years, but one point was established pretty thoroughly—junk in the upper atmosphere could have a significant darkening and cooling effect on the earth's surface.

A second strand of discovery began in 1971, when the *Mariner 9* space probe went into orbit around Mars and began transmitting photographs of the planet entirely surrounded by dust from a vast Martian storm. Carl Sagan, the well-known Cornell University astronomer, and other scientists monitoring the probe spent three months studying Martian dust storms, because there was nothing much else to do while they waited for the Martian atmosphere to clear. One thing they learned was that dust in the upper atmosphere tends to absorb sunlight and heat up, while the surface of the planet, in semidarkness, tends to cool down. The models they devised to describe the behavior of Martian dust storms seem to work equally well for the effects of volcanic eruptions on Earth.

The biggest of these, according to a study by the Smithsonian Institution, occurred in April of 1815, on the island of Sumbawa, in the Indonesian archipelago. Days of earth tremors and mighty rumbling like the sound of cannon culminated in a single tremendous explosion that blew off the top 4,200 feet of Mount Tambora and cast up some twenty-five cubic miles of earth and rock into the atmosphere—roughly a hundred times the stuff spewed up by Mount St. Helens or by the eruption of Vesuvius, which buried Herculaneum and Pompeii in A.D. 79. So dense was the dust, smoke, and ash in the air that the Tambora eruption was followed by three days of total darkness over an area 400 miles across. The volcano's plume carried debris into the stratosphere—the cold, rainless, slowly swirling blanket of thin air above the troposphere—where it circled the earth for a year or two before settling out. Scientists have estimated that the dust cloud generated by Tambora resulted in a cooling of the earth's surface that averaged about sixth tenths of one degree centigrade. That may not sound like much, but the result in New England has been remembered ever since as "the year there was no summer." Killing frosts in every month of the year in northern New England, and cold throughout the re-

gion, severely damaged crops and led to wheat prices so high that they weren't equaled for more than 150 years, until 1972. Similar weather in Europe caused outright famine in many areas, probably triggered a typhus epidemic that spread from Ireland to England, and may have contributed in a roundabout way to the arrival of cholera in Europe in the 1830s.

Another strand of discovery emerged in the early 1970s, when scientists demonstrated that the fluorocarbons used to provide the pressure in aerosol cans of everything from shaving cream to oven cleaner and deodorant could break down ozone. Ozone is only a minor component of the earth's atmosphere, but it is nevertheless important. A belt of the gas surrounds the planet and shields it from a good part of the sun's ultraviolet rays, mild doses of which cause sunburn, and strong, direct doses of which can cause skin cancer and blindness. The fluorocarbon controversy, typically, resulted in a broad range of scientific studies demonstrating that fluorocarbons do indeed drift into the upper atmosphere, where they break down ozone. Whether pressurized aerosol cans could release enough fluorocarbons to endanger the ozone layer was never conclusively established, but the controversy directed attention to another problem—the tendency of nuclear detonations in the megaton range to produce large quantities of nitrous oxides and to carry them up into the stratosphere, where, like fluorocarbons, they break down ozone. In 1975 the National Academy of Sciences published a major study titled *Long-term Worldwide Effects of Multiple Nuclear-Weapon Detonations*, which concluded that a major nuclear war would deplete the ozone layer, that this would increase the amount of ultraviolet light reaching the surface of the earth to a serious but not catastrophic degree, and that this effect would persist for several years before the ozone layer replenished itself naturally.

THROUGHOUT THE 1970s the pieces were coming together: the controversy over dinosaur extinctions, the Martian-dust-storm studies, climatologists' increasingly sophisticated understanding of the effects of volcanic eruptions on weather, and the work by the National Academy of Sciences on ozone depletion prepared the way for illumination of the biggest light bulb of all—the realization that smoke, if there were enough of it, and if it reached high enough, had the capacity to plunge the globe into freezing darkness.

The first serious study of the smoke that would be generated by nuclear warfare, by Paul Crutzen, a West German scientist, and John Birks, an American, was published in a special issue of *Ambio*, the journal of Sweden's Royal Academy of Sciences, in June of 1982. Crutzen and Birks assumed that a major nuclear war would ignite about five percent of the 20 million square kilometers of forest in the world's temperate regions. Their calculations showed that the smoke from these vast fires, like the dust generated by volcanic eruptions, but on a much greater scale, would threaten the climate through heating of the upper atmosphere and cooling of the earth's surface.

An early preprint of the *Ambio* article circulated among scientists at a meeting in Santa Barbara, California, in early 1982, where Richard Turco, who had worked on the ozone problem, read it. He started to crunch numbers on his own to see what would happen. Eventually he and four other scientists—Brian Toon, Thomas Ackerman, James Pollack, and Carl Sagan—wrote a detailed, 127-page scientific paper called the Blue Book (the group were also the authors of the article published in *Science* last December; this was basically a condensed and corrected version of the Blue Book), and this was reviewed in detail by about a hundred scientists at a four-day meeting held in Cambridge, Massachusetts, in April of 1983. The Blue Book estimated the ozone and radiation effects of nuclear war along with the smoke problem, and went another step beyond the Crutzen and Birks study by accounting for the smoke from burning cities—a threat to the earth's climate much greater than forest fires, because there is more to burn in cities, and because the nature of the fires would help push smoke high into the atmosphere. By this time the nuclear-winter thesis was a subject of wide discussion throughout military and scientific circles in the United States. Technical objections were numerous, and every aspect of the paper's data base, methodology, climate modeling, and results was scrutinized rigorously at the Cambridge meeting. The TTAPS authors (the acronym is formed from the initials of their last names, and is pronounced as if there were only one T) were the first to admit that their work contained numerous uncertainties, but their science held up with sufficient "robustness" (scientific argot meaning that an answer to a question tends to come out the same even if you fiddle with the assumptions) to make any sober investigator recognize that this problem could not be lightly dismissed.

Available only in mimeographed form, the Blue Book makes hard reading for a layman. It is filled with the names of unfamiliar chemical compounds like peroxyacetyl nitrate, hard-to-imagine numbers like 10^9, numerous technical terms like *entrainment* and *hygroscopic*, and mathematical symbols like $\sim$, $<$, $>$, ℓ, and $\lesssim$. There are seventeen graphs, some of which have more ups and downs than a comb has teeth, and eighteen pages of references to more than 200 published scientific studies, which start with Aandahl, A.R., *Soils of the Great Plains*, and wind up with Yokoyama, I., "A Geophysical Interpretation of the 1883 Krakatoa Eruption." The Blue Book's authors studied several dozen imaginary nuclear wars, ranging from an all-out, 25,000-megaton exchange of the sort Herman Kahn used to refer to as a "spasm war," down to a relatively small (and improbable, as we shall see), 100-megaton war involving a thousand detonations entirely on cities. Keeping these wars straight as one reads is no easy task. The Blue Book frankly confesses, "The overall uncertainty in the present calculations is quite large. It arises from a lack of knowledge of the number, yields and types of nuclear bursts which might be detonated in a war, of the basic

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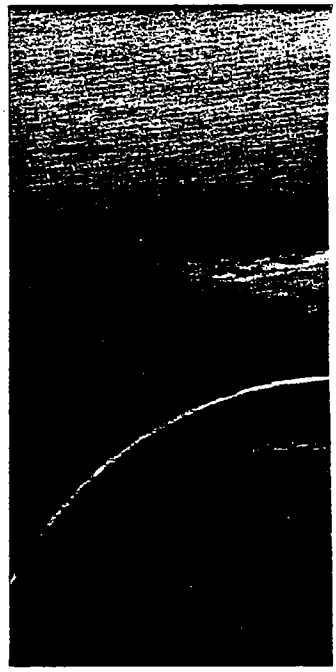
physical properties of nuclear dust and smoke, of the causes and characteristics of mass nuclear fires in cities and forests, and of the response of the atmosphere to enormous particle injections."

Nevertheless, few readers would have difficulty in grasping the disquieting central message of the Blue Book. Nuclear weapons, especially when detonated in the air, produce an intense thermal pulse that can ignite fires simultaneously over vast areas. Any city attacked with nuclear weapons will burn, and many of these burning cities will generate firestorms whose gigantic smoke columns will carry soot particles into the upper atmosphere, where they might linger for months before settling out. The pall of smoke from burning cities would rapidly diffuse over the mid-latitudes of the Northern Hemisphere and might circulate into the tropical regions around the equator, which, for complex reasons, would be even more sensitive to changes in ambient light and temperature. Darkness at the earth's surface would bring a decline in mean annual temperatures of as much as 40° centigrade for months. If the war took place in spring or early summer, temperatures might fall well below zero throughout July, August, and September. For months it might be as dark at midday as it normally is on a moonlit night. The effects of this long, cold "night" on plant ecology—and everything that lives is ultimately dependent on the photosynthesis of plants—are hard to predict in detail but would almost certainly be catastrophic.

The science in the Blue Book may be complex, but it describes a simple mechanism. Think of the relief that comes on a hot, clear day in July when you pass from the brutal glare of the midday sun to the deep shade of a maple tree, or even a beach umbrella. Under normal conditions the heat absorbed from sunlight during the day escapes at night—but slowly, because the earth's atmosphere serves as a kind of blanket. The longer the night, the more heat escapes. In a "night" lasting months, heat would go on escaping and temperatures would go on dropping. In trying to calculate the smoke effects of a nuclear war, the first and most important question is: How many fires would be ignited? The answer is a military secret. It is contained in the war plans for targeting nuclear weapons which have been drawn up by military men in the United States and the Soviet Union.

THE EARLIEST AND THE MOST PERSISTENT CRITIcisms of the nuclear-winter thesis have focused on scenarios—imaginary nuclear wars devised as a tool for predicting effects. When Richard Turco briefed his colleagues at R & D Associates on an early version of the Blue Book, some of them were quick to point out that he was trying to calculate the effects of wars that would never happen. One scenario, for example, describes a 100-megaton war in which 1,000 warheads of 100 kilotons each are detonated over 1,000 urban targets. Such a war would certainly produce a lot of smoke, but it is not anything we have to worry about. It contradicts too many principles of nuclear strategy, which call for wars of extreme caution or reckless extravagance—nothing in between. If American war planners elected to "limit" a war to 100 megatons, they would stay away from cities, which are generally targeted only in the final, all-out phases of war plans. If the planners decided to hit 1,000 urban targets (an attack virtually certain to bring an all-out response), they would use a lot more than 100 megatons and would target a lot of other things as well.

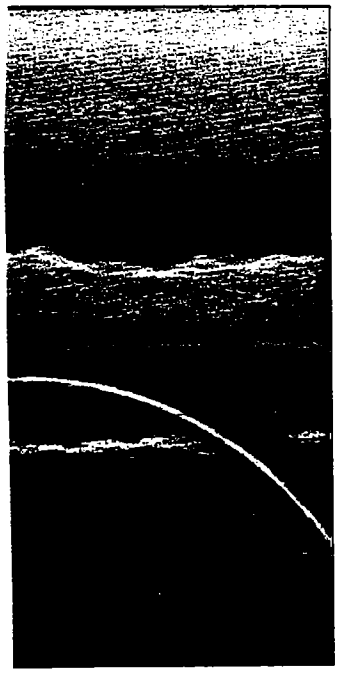
Academic defense analysts have often faulted the TTAPS study for worrying about the wrong sorts of wars, but the Pentagon has not joined them. When the TTAPS group presented its findings at a highly publicized conference in Washington, a year ago October, the response from the White House and the Pentagon was virtual silence. Many skeptical outsiders (including me, at first) interpreted this silence as indifference, as just one more bit of evidence, if any were needed, that the military was narrowly focused on its own obsessions—what the Russians had, and what we had that could destroy what the Russians had. But in fact something deeper was at work. In early December the assistant secretary of Defense for atomic energy, Richard Wagner, arranged for a briefing of Pentagon officials on the nuclear-winter findings. One of those who took part was Michael May, a former director of the Lawrence Livermore National Laboratory, which, like Los Alamos, is mainly concerned with the design and development of nuclear weapons. May, who is still active at the Livermore Lab, and his colleagues—especially Michael MacCracken, an expert on climate—had already studied the nuclear-winter thesis in detail, and they told the assembled Pentagon officials that the problem was a serious one. Although they disagreed with some of the assumptions, they found no obvious faults in the science. The smoke of burning cities posed a serious threat to the earth's climate.



May has spent most of his life in weapons work. The Livermore Lab, founded largely through the efforts of Edward Teller, specialized early in advanced warheads and has designed perhaps half of those in the current American arsenal. The people who work at Livermore believe in deterrence, believe in making good weapons better, and believe that much public criticism of their work is based on misinformation and hysteria. If the nuclear-winter thesis had been full of holes, May and his colleagues would not have hesitated to say so. The briefing—which was gloomy not only from a broadly human but also from a narrow military point of view—resulted in the Pentagon's public silence and its private support for further research. The reason was simple: the nuclear-winter thesis, if valid, threatens to make nonsense of every notion the planners have managed to come up with, in forty years of trying to devise a sensible way to fight a nuclear war.

Theories of how to fight a nuclear war come in two styles—one that is abstract and analytical, often referred to by professionals as metaphysics or theology, and another that is severely concrete and practical, called war planning. Most of what the public knows about these matters comes

from listening in on the debates of theologians, who construct elaborate chains of "if–then" reasoning—if the enemy does X, then we do Y. The theologians are mainly concerned with demonstrating that nuclear weapons are safe to have, because they are too dangerous to use. Nuclear theology is a cottage industry providing gainful employment to many hundreds of academic defense specialists. A cynic might be forgiven for concluding that the Pentagon is willing to pay for so much theology to maintain a kind of smokescreen, behind which the real work is conducted by the war planners—the middle-ranking officers, mostly in the Air Force, who are responsible for the nuts-and-bolts details of running a nuclear war.



War planning is a very different sort of enterprise. Theologians talk about "an opponent" or "the enemy." War planners talk about the Russians. The planners begin with a courtly bow to deterrence—if we're ready, it won't happen—but that's the end of it. All the rest is deciding what to shoot at and when to shoot at it. The fundamental thing to grasp about war planning is that we *plan* to do what we *can* do.

For the past forty years the American nuclear arsenal has been in constant flux, becoming steadily more lethal through increases in the number of weapons, greater versatility in firing and retargeting, and improved accuracy. In the early plans weapons were targeted on the center of Moscow; now they might be targeted on the Ministry of Foreign Affairs, or on the main entrance to a blast shelter intended for top officials of GOSPLAN, the central Soviet economic-planning office, or on a point calculated to include three or more targets—say, a truck plant, a power station, and a local office of the KGB—within the lethal radius of a single warhead. As the weapons grow more numerous, the targets tend to divide, and the number of aiming points, or desired ground zeros (DGZs), always seems to be a jump ahead of the weapons available to attack them. Consider, for example, the problem facing planners who hope to cripple Soviet rail transport. With only a few weapons available for the task, they would limit targets to major switching yards. Given more weapons, the planners would add locomotive production plants and repair facilities to the list of targets. Eventually, with a big inventory of weapons available, minor bridges, rural sidings, telegraph offices, steel-rolling mills for the production of rails, and the central pension office for retired rail workers might all be included in the plan. The Harvard biochemist Paul Doty, long active as a consultant on defense issues, once asked the planners what was the smallest target on the list. The answer was an open field that might be used as a landing strip by returning Soviet bombers.

The dominant tone of the military mind is cautious. War may be hell, as General William Tecumseh Sherman characterized it, after cutting a swath of destruction through the South during the Civil War, but for the men who prepare to fight wars there is something worse than the horrors of battle: losing. From their point of view, too much is barely enough. Thus American planning for nuclear war—and no doubt Soviet planning as well—has always relied on overkill, an attempt to achieve certainty of result through overwhelming strength. General LeMay's theory of war was brutally simple. Back in 1953 he told Sam Cohen, a young defense consultant and weapons designer now best known for his invention of the neutron bomb, "I'll tell you what war is all about—you've got to kill people, and when you've killed enough they stop fighting." LeMay wanted the biggest warheads he could get. Eventually he loaded his planes with 20-megaton bombs, and his staff worked up plans for the virtual annihilation of the Soviet Union. A Navy captain who received a SAC briefing on war plans in early 1954 reported to a superior, "The final impression was that virtually all of Russia would be nothing but a smoking, radiating ruin at the end of two hours."

But it is still hard to say what LeMay's plans called for, because he wouldn't tell anybody—not the White House, not the Joint Chiefs of Staff, and certainly not Sam Cohen, who'd been sent out to SAC headquarters, in Omaha, to find that out, among other things. "This involves our secret war plans," LeMay told him. "I'm not going to tell you what they are." There is even some evidence that LeMay thought it was up to him to decide *when* to go to war.

But for all LeMay's secrecy the war plans were really very simple—hit 'em with everything we have. By 1960 we had a lot. In November of that year President Eisenhower sent a three-man team headed by his science adviser, George Kistiakowsky, to Offutt Air Force Base, in Omaha, to check up on the war plans being devised by the newly established Joint Strategic Target Planning Staff (JSTPS). Eisenhower was afraid that SAC was fiddling with the figures as a way of building pressure for more planes and bombs—for example, insisting that it would take several large nuclear weapons to destroy a hydroelectric dam with 100 percent certainty, when a single small one might do the job with 96 percent certainty. Kistiakowsky was accompanied by two young assistants, George Rathjens, a scientist now teaching at MIT, and Herbert Scoville, a former deputy director for science and technology at the CIA who is now a leading arms-control advocate.

The three men got a royal runaround at SAC headquarters from Air Force briefing officers under instructions to reveal as little as possible as slowly as possible. But they persisted, and eventually got a good idea of what was going into the first Single Integrated Operational Plan (SIOP). They were horrified to discover that the plan would almost entirely ignore the collateral effects of nuclear weapons. With few exceptions, SAC intended to destroy targets by blast pressure alone. If the prevailing winds on D-day were blowing from Leningrad toward Finland, then warheads targeted on the city would be fused to detonate in the air, to avoid the fallout characteristic of ground bursts, but that was about the only concession the JSTPS made to radioactivity. The tendency toward overkill was compounded by establishing a "very high certainty of kill against all these targets," according to Rathjens. That meant using more than one warhead, or warheads with very large yields, or both. The first SIOP, officially approved in December of 1960, called for an all-out attack on Russia with 4,000 weapons fired in "one flush"—everything we had.

THE DETAILS OF THE SIOP HAVE CHANGED A GREAT deal since 1960. The U.S. strategic arsenal now includes twice as many warheads, and many of them are extremely accurate. For our purpose here, one point is of overriding importance: all versions of the SIOP include plans for a society-destroying attack on Soviet "recovery targets"—the Soviet institutions that make Russia strong—and thousands of these targets are in Soviet cities.

We have always insisted that we do not plan to attack Soviet cities or the population per se, but the point is an academic one. Soviet cities are rich in targets—communications and transportation centers, offices of leading institutions of Soviet society like the Communist Party and the KGB, military command posts, blast shelters for the leadership, factories that make war materials, and so on. Even attacks on airfields—a staple of all war plans since the early 1950s—would threaten vast urban areas with fire. A 1978 study by the Arms Control and Disarmament Agency (ACDA) suggests the magnitude of the problem. In order to estimate the effectiveness of Soviet civil-defense planning (a subject of much contention in Washington at the time), ACDA outlined a typical American second strike, to follow a full-fledged Soviet counterforce attack on the United States (the purpose of which would be not destruction pure and simple but the elimination of things identified as the source of military and economic strength). Moscow alone would be struck with about sixty warheads, Leningrad with more than forty, the next eight largest cities with an average of thirteen warheads each. The next forty largest cities would receive an average of 14.4 warheads per million population and the 150 cities after that an average of 25.7 per million; 80 percent of all Soviet cities over 25,000 in population would be struck with nuclear weapons. All of these would burn. The United States could expect to suffer similar damage in return. Such attacks are integral to American theories of how to fight a nuclear war. "There's never been one of those plans that didn't have cities in it," William Kaufmann, a defense expert, says. "I don't care if it's the 1961 SIOP, or the '73 or the '78. The main difference now is that the set of non-urban targets has been expanded." At the Livermore Lab, Michael May said recently that he wasn't sure whether the nuclear-winter thesis would stand up, but that he very much doubted the war planners would be willing to leave cities out of the targeting line-up. "You can say, Don't shoot at the cities—that's fine," he said. "But are they [the Russians] going to leave all our airfields alone and let the B-52s and [midair-refueling] tankers land at them? Think of the aerospace targets in Los Angeles. Are they going to leave those alone even if they have the best of intentions for the Angelenos? It's not hard to come up with five hundred high-priority targets associated with cities, not hard at all."

If those targets are attacked, the cities will burn. If those targets are spared, we have no theory of how to fight a nuclear war. As a result the war planners are now faced with an extraordinary dilemma: either we stick to the theory and plan to run the risk of plunging the Northern Hemisphere into a nuclear winter triggered by the smoke of burning cities, or we abandon the theory and finally admit we simply cannot fight a war with nuclear weapons.

NOT LONG AGO A FRIEND TOLD ME A STORY THAT HE said had been told to him by someone who had heard it from a staff member on Jimmy Carter's National Security Council. It goes like this: When Carter and President-elect Ronald Reagan met after the election in 1980 to discuss the transition, Carter chose to use his time to tell Reagan what "pushing the button" would actually mean. According to the staffer, Carter really laid it out—the numbers of weapons and where they would go, the impossible difficulties involved in trying to keep track of the progress of the war, the excellent chance that the President would find himself aloft in his command plane with nowhere to land and nothing but static coming over the radios. The ghastliness sank in. When Reagan left the meeting, he was ashen and subdued. He finally *knew*.

It's an appealing story. I'm sure we all hope it's true, but it's almost certainly apocryphal. I've heard variants of it many times about other Presidents and high officials. I've come to think of these stories collectively as the Myth of the Frightened President. The drift of the stories is always the same: A man reaches high office, full of insouciant confidence. He gets "the briefing." He comes away sober and shaken. It's as if the collective unconscious of Washington, where these stories are mainly told, needs to be reassured that the men at the top really understand the danger we face.

The evidence suggests that the reality is quite different. With the possible exception of Jimmy Carter, who had an enormous appetite for technical detail, no postwar American President has really understood precisely what we intend to do in the event of nuclear war.

Everything Eisenhower knew about the first SIOP came from George Kistiakowsky's ninety-minute briefing after his trip to Omaha in November of 1960. Four thousand targets in ninety minutes is pretty cursory. President Kennedy was urged to ask for a look at the SIOP early in his Administration, but the JCS discouraged him. They told him it was too technical—routes, refueling schedules, target coordinates, times on target, overlapping E-95 circles, and the like. Lyndon Johnson was bored by nuclear strategy and obsessed by Vietnam. According to people who were there, Richard Nixon's mind wandered when war plans were discussed. Admiral Elmo Zumwalt, the chief of naval operations during the Nixon Administration, describes in his memoirs a National Security Council briefing held shortly after Nixon had signed National Security Decision Memorandum 242, in January of 1974. This was the first of the so-called "war-fighting" documents that have marked a gradual sea change in American nuclear strategy over the past ten years. Before it was signed, the SIOP contained four basic war plans, or options, the smallest of which called for the use of 2,500 warheads. Afterward the JSTPS devised many new options, ranging from the delivery of a "few score" warheads on up to furious salvos intended to annihilate Soviet society—always the last stage of U.S. war plans. Many cities feel that the countervailing strategy adopted in 242 makes nuclear war more likely. Whether they are right is hard to say. But according to Zumwalt, Nixon had no idea what was implied by the new strategy.

Gerald Ford signed a similar document affecting strategy on his last day in office without—according to several National Security Council staffers—any clear idea of what

he was doing. Carter was the exception: he drilled himself with frequent command-post exercises and fully grasped the importance of his own strategy document, Presidential Directive 59, which carried the war-fighting approach a step further and dwelt on the need for enhanced command, control, communications, and intelligence facilities to keep track of a war. Ronald Reagan represents a reversion to the traditional presidential approach: leaving the details to aides.

For the first ten years of its existence the JSTPS was pretty much on its own in coming up with a strategy on which to base its war plans. Guidance from the White House and the Pentagon was limited. Richard Garwin, who helped design the first hydrogen bombs and who has long been an adviser to the Air Force on targeting, told me not long ago that the men who picked targets used to read the public speeches of the President and his principal advisers for an idea of how to proceed. Since 1970 the war-planning process has been rationalized. Now it typically begins with a brief presidential document, perhaps ten pages in length—Nixon's was NSDM 242, Carter's was PD 59, Reagan's is National Security Decision Directive 13. With this as a guide the Office of the Secretary of Defense drafts a somewhat longer Nuclear Weapons Employment Policy (NUWEP), which is further elaborated by the office of the JCS and then forwarded to the JSTPS in Omaha for its twice-a-year revision of the SIOP.

When the revised plan is ready, officers from the JSTPS brief the staff of the Joint Chiefs, who brief the Joint Chiefs, who brief the secretary of Defense, who may or may not brief the President—but the extent of the briefing drops off sharply as it rises up through the Pentagon. Ninety minutes seems to be the outside limit at the upper levels. It is highly unlikely that anyone above the Joint Chiefs of Staff level really understands what is in the SIOP. According to many sources, there is no independent review of the SIOP at any stage in the planning process; the size of the U.S. arsenal provides the only limit to the size of a major projected war; and no one involved in drawing up the SIOP is authorized to consider the gross environmental effects of carrying out the plan. As a practical matter, if the nuclear-winter thesis is confirmed, then participation in the war-planning process, at all levels, will have to be broadened, current theories of how to fight a nuclear war will have to be jettisoned, and a whole new generation of weaponry, designed to implement a whole new strategy, will have to be developed and deployed. All of these things would be difficult, but none would be impossible. The military "solution" to the nuclear-winter problem is particularly clear—a much larger number of much smaller, extremely accurate weapons that would allow targets in cities to be destroyed without burning down the cities around them.

A Pentagon planner recently told William Arkin, a Washington journalist and defense specialist, "I wouldn't mind having twenty-five thousand Pershing IIs with forty-kiloton warheads, if they told me I had to have a hundred-megaton force." The nuclear-winter problem does not end the possibility of a big war with Russia, but it does push planners in a new direction, away from apocalypse. Nothing stands in the way of this change except habit, inertia, and the quite staggering cost in money of building a whole new arsenal.

THE OFFICIAL RESPONSE TO THE NUCLEAR-WINTER problem has been reticence in public combined with funding for more study. Just about everybody, including the TTAPS authors, agrees that more study is required. The National Academy of Sciences is sponsoring a major new research effort, and other projects have been started at Livermore and Los Alamos and in the Pentagon's own Defense Nuclear Agency (DNA), which has been commissioning studies on the effects of nuclear weapons for years. The target planners in Omaha use DNA handbooks for estimating collateral damage, for example, but the current work is probably the first that will come up with guidelines for an overall limit—an admission that there is such a thing as a level of damage too great for the planet to handle.

"More study" will serve by way of response for a year or two, but what then? Pentagon officials are plainly worried about the nuclear-winter problem, and plainly at a loss over what to do about it. In conversation with officials at the nuts-and-bolts level one picks up interesting nuances of reaction: a wistful hope that "more study" will make the nuclear-winter problem go away, embarrassment at having overlooked it for nearly forty years, resentment that the peacenik doom-mongers might have been right all these years, even if they didn't know why they were. Above all, one finds frank dismay at what the nuclear-winter problem does to a defense policy heavily based on nuclear weapons. Being only human, officials are probably hoping to turn up uncertainties enough to justify more study forever, or at least until the next Administration. But to me, recognition of the nuclear-winter problem, awful as it is, seems a piece of immense good fortune at the eleventh hour, and a sign that Providence hasn't given up on us yet. □

The following is quoted from "The Myth of Atomic Diplomacy" by McGeorge Bundy. Harper's Magazine, January 1985, p.24:

"The more we learn about living with nuclear arsenals, the less we are able to find any good use for them but one—the deterrence of nuclear aggression—and the more we are led to the conclusion that this one valid and necessary role is not nearly as demanding as the theorists of countervailing strategy assert."

THE LONG UPHILL ROAD

THE good things of this world are unadvertised. This is probably because people who have some good things and want to spread them around, if they resort to conventional sales promotion, see that the things sooner or later go bad. The "necessities" of the distribution system alter the quality of what is distributed. This is discouraging to people who think that all that the good needs to be more widely popular is the application of modern know-how. It does not occur to them that the know-how used in this way—or any way—is what pulls humans out of shape and distorts their judgment (what little they have left after years of being pulled and pushed). People say, we need a mailing list of at least a million and have to raise the money to pay for six mailings a year—either that, or nothing will happen. Little by little, they copy the techniques of the sales managers and direct mail-experts, until finally they lose what touch with truth they started out with. They still feel virtuous, but have acquired the habits of acquisitive enterprise. Eager to win battles, they have lost the war.

On the other hand, if you don't get through to people with what you have to offer, you'll be like Thoreau, who during his life accumulated numerous copies of the books he had written, but didn't sell; or like van Gogh, who sold only one painting during the fiercely productive years of his life. So, if you want to get distribution in a mass society you have to become part of the system. Years ago, the printer of MANAS, having starry-eyed tendencies, read about the motives of the Renaissance printers and decided to try to publish at least one or two very good books a year, to be able to say that he was part of the Renaissance tradition. So he put into print exquisite translations of certain classics and got a publishers' representative friend in the area to take them around to the bookstores. They sold hardly at all, and the friend explained: "Booksellers are harrassed by detail. They don't buy from a one-book-a-year publisher. They want a supplier who will give them twenty books a year, and get one invoice for the lot. Even if your book is as good as the Sermon on the Mount, if you have only one a year it won't get into the stores." He was right. The "channels" of distribution are controlled by the system and the system doesn't know the difference between the Sermon on the Mount and a lurid tale of violence with salacious trimmings.

Yet the truth seems to find ways of slowly getting around. The wise man does what he legitimately can, and . . . waits. Are the people who want to save the world from self-destruction able to apply this idea?

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The following is quoted from a reply of Andrew B. Schmookler (author of The Parable of the Tribes (U. of Calif. Press, 1984) to a critic in the Forum section of New Options (September 24, 1984, p.6):

"The premise of the parable of tribes is that if all choose the way of peace then all can live in peace; while if all but one choose the way of peace, that one can impose upon all the necessity for power. With so many nation-states, it is vain to hope for anything but the struggle for power. But there are only two superpowers—and they are essentially invulnerable to anyone but each other. Thus, today, it would only take two to choose peace."

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