AIR POWER:

KEY TO SURVIVAL

BY

ALEXANDER P. DE SEVERSKY

SIMON AND SCHUSTER • NEW YORK • 1950

CONTENTS

HIROSHIMA AND NAGASAKI

1

THE ATOM BOMB is a horribly destructive weapon, the most devastating ever used. To accuse anyone of "underestimating" its fury amounts to impugning his sanity.

But awe-inspiring as it assuredly is, the atom bomb does not call for a moratorium on accurate observation and military logic. It must be studied calmly in the cold light of military science. Unless our minds dominate the bomb, the bomb will tend to dominate our minds. World hegemony will then fall, by default, to those of tougher nervous fiber who refuse to be intimidated or stampeded by the new factor.

There has been, in my view, far too much loose talk, fright talk, and exaggeration around the advent of the atomic missile. Too many people with ideological axes to grind—pacifism, world government, isolationism, Sovietism—have seized upon the atomic weapon for their own purposes. The confusion has been worse confounded by the outcries of guilt-stricken scientists, brilliant in their own area but amateurs in the military and political fields.

As a result of the general hysteria we were in danger, on the one hand, of generating a false sense of security so long as we thought we had a monopoly of the bomb. We are still in even more danger, on the other hand, of a false sense of defeatist despair. If, as some proclaim, the next war will see neither victors nor losers but only universal annihilation, then the will to resist aggressions may crumble, the inclination to appease bullies may be encouraged.

The average citizen may be excused if his thinking about the bomb is a bit fevered; but that military minds should be touched by the same fever is inexcusable. Precisely because the new weapon is so terrifying, those charged with working out strategy have an obliga-

tion to remain unterrified. Which brings us to the report submitted to President Truman in 1947 by the Air Policy Commission. While it was a civilian study, it reflected high-echelon thinking. And in relation to the atom bomb it made a most erroneous assumption.

The report divided the *strategic position* of the United States into two "phases": (1) the period when we have a monopoly of the atomic missile; and (2) the period when a potential enemy would also have it in quantity. It set the year 1952 as the likely dividing line.

A more unscientific and misleading conception could hardly be imagined. In effect it promoted a fear, the fear of Soviet bombs, to the rank of a *strategy.* The Rubicon was crossed earlier than expected, though it may be 1952 or later before Soviet Russia has the bomb in quantity. But what actually will be changed when airplanes on both sides, instead of transporting TNT and incendiaries, are in a position to transport atom bombs?

Offensively we shall still need to fight our way through the enemy's air power and other defenses to attack his critical targets. Defensively we shall still need to intercept or defeat enemy aviation seeking to attack us, just as if it were conveying old-fashioned blockbusters. Of course, the penalties for failure will be heavier, the rewards of success more impressive. But the strategic relationships will be unchanged.

Suppose that Soviet air power proves strong enough to deny us access to the skies over its territories. Of what use will our atom bombs be in that case? After all, it doesn't really matter what kind of destruction you *can't* deliver.

We could proceed with the business of bombing the enemy's war-making machine only after having weakened or removed his aerial opposition. The atom bomb may make the process more expeditious —although, as we shall see, other types of explosive would also have to be used. Having conquered the right of way in the air ocean, we could act to reduce the enemy country to military impotence swiftly or slowly, with whatever explosives seemed to us most desirable. Once your opponent is disarmed, it makes little difference whether you subdue him with the threat of a pistol, a knife, or a club.

Or suppose, conversely, that the enemy succeeds in capturing control of the skies over the United States. Our atomic superiority would in that event do us not the slightest good. Once he enjoys freedom

of navigation over our land, he will be in a position to destroy us at his leisure—with atom bombs if he has them, or with the conventional TNT explosives, or, for that matter, with sacks of potatoes. As for our stockpile of atom bombs under those circumstances, it would be utterly useless. Worse, the immense industrial potential tied up in atomic production would then represent a frozen asset. To the extent that it reduced our aviation production, it obviously will have helped the enemy to take command of our skies.

After the Bikini tests, more than one journalist stated, as if it were a self-evident law, that the relative military strength of nations hereafter would be measured by their relative stockpiles of atom bombs. But the core of a strategy is not in the superior explosive. It is in the superior means of delivery, and today that means air power. A new strategic era does not begin when a potential enemy acquires better explosives but only when some nation works out a better technique for "getting at" its foes. The nature of the destructive agent used merely affects the efficiency of the process.

The "phases" identified by the Air Policy Commission were thus, militarily speaking, a division in time without strategic significance. They provided a classic example of the confusion induced by the dramatic character of the atomic weapon and must be credited to atomic jitters rather than military insight.

Sir William Beveridge, the noted economist, writing in the London *Times* immediately after the Japanese atom bombings, made this remarkable statement: "The atomic bomb has almost certainly relegated all other weapons of modern war—tanks, battleships, guns, rifles, and trained conscript masses—to the museum."

The items he listed are agencies for delivering an explosive charge. To confuse them with the explosive itself, the atom bomb, is plain muddle. The explosive and the means of delivery cannot be measured by any common denominator—any more than you can weigh apples in inches or measure distance in pounds. Tanks, battleships, etc., can be canceled out by a new method of transporting destruction, not by a new explosive.

Perhaps it was to be expected that an economist would find himself confused in a field as alien as military affairs; or that nuclear scientists should be equally confused. Great physicists do not necessarily com-

prehend the arts of war. Impressed and frightened by the fury of the new explosive, obsessed with a sense of personal responsibility for having helped unloose the scourge, they have talked of it as if it were *a new military force* superseding all existing military forces. They proclaimed it the "absolute weapon," Promethean, cataclysmic, and so on.

But the key fact is that the atom bomb is simply another explosive, *not* a military force in the sense that the Army, Navy, and Air Force are military forces. It is immensely, horribly more destructive than any hitherto known. But before it can be instrumental in scoring a decision in war, it has to be delivered, like any other explosive, by one or a combination of military forces at the right time to the right place.

It equips the existing forces—and air power in particular—with another and vastly more effective tool for demolition. To that extent it steps up the significance of air power. But it does not revolutionize the basic principles of war-making.

To the layman, I realize, that may sound like an academic distinction. It is the distinction, however, which enables us to understand the place of the atom bomb in our national defense. As long as war has not been outlawed in the world, we must have a military establishment. As long as we have a military establishment it must be geared to win if and when called into action. Should we let a vague awe becloud our thinking, the one certainty is that we will be crushed when the test comes.

The real novelty of the bomb, aside from the magnitude of its destructive power, is its three-in-one character. It produces blast; it is incendiary through flash-heat; and it is poisonous through radioactivity. Thus it presents terrific devastation in a single package.

This package, though, is decisive only when it is in the hands of a belligerent geared to conquer the air ocean through which it must be delivered. Such a belligerent, however, could readily win a war without the atom bomb—even against an adversary who is atom-rich but poor in air power—by the process of destruction in a lot of small packages.

Scientifically, atomic energy is indeed an epoch-making innovation. But it does not at this stage rule out the strategy based on preponderant air power. On the contrary, it enhances that strategy

by giving it a more effective weapon—in much the same way that naval strategy was enhanced with the invention of long-ranged, large-caliber artillery, the torpedo, or radar sighting.

We hear talk about a bomb so potent that it will wreck continents at one blow and maybe explode the planet itself. If such a device could be produced, we may be sure some scientist would build it; and having built it, we might expect him to detonate it, just to prove that it works. Obviously in that case the problems of national defense, and for that matter all other human problems, would be greatly simplified. Concentration of effort on the as yet theoretical hydrogen bomb has revived the fears of such an infinite chain reaction that will dissolve all the oceans and consume our globe.

From all I know, including personal observations of atom-bomb destruction, such imaginative horror is exceedingly premature. The destructive force of the bomb is being stepped up. Yet for the predictable future it must remain a finite quantity. There will still be practical and tactical limits to its size and effectiveness. This holds true for the projected H-bomb as well as the stockpiled A-bomb. As we shall see further on, a bomb "a thousand times more powerful"—the quite arbitrary estimate, regarded as exaggerated by some of the men working on the hydrogen variant—would have a radius of destruction only ten times greater. Scarcely a pleasant prospect, but still a finite weapon.

There will even be a point at which further expansion of explosion in one missile will become wasteful and self-defeating. I venture to suggest that the earlier direction of research will be reversed—in an effort to obtain smaller rather than bigger bombs, to give us better control of destruction in atomic attacks, and to avoid excessive and useless killing.

The emergence of the atom weapon like the advent of more terrible weapons in the past—the Big Bertha, the torpedo, poison gas, the flame-thrower, the V-1 and V-2 missiles—points up the wickedness and stupidity of war. No one hates war more deeply than those who specialize in the arts and instruments of war-making. No one is more keenly conscious of its senselessness. The atom bomb assuredly presents a new challenge to the intelligence of mankind to abolish war.

But the science of war-making continues to make sense. *Far from nullifying military strategy, the atom bomb puts a higher premium on correct strategy.*

2

I WAS in England when the atomic bombs were dropped on Hiroshima and Nagasaki. Naturally I was excited by the new development; my whole life's experience had predisposed me to credit the miracles of science.

From the teeming newspaper and radio accounts I visualized the total devastation of the unhappy cities in one-millionth of a second. "The only way we could tell a city had been there," one dispatch quoted returning airmen as saying, "was because we had seen it a moment before." With my mind's eye I saw the instantaneous evaporation of the cities and their people, not a building left standing in the stricken areas, sand and earth fused to glass, steel dissolved, thousands of human beings "vaporized" in the twinkling of an eye.

Because they were so often and so unanimously repeated, I credited the stories that the ground was heated to an incalculable degree, instantly extinguishing all life and destroying matter. I agreed, as a matter of course, with those who declared that if the bomb were dropped over a battle fleet, the heat would melt the vessels and evaporate the surrounding oceans and generate "tidal waves." In short, I accepted the popular picture of *apocalyptic destruction.*

One curious fact did stir vague doubts in my mind. It was a photograph of Hiroshima after the bombing in which a concrete building stood upright in the midst of the bombed areas, near the center of the explosion. I wondered by what chance one structure evaded the phenomenal force. All the same, if I had not journeyed to Japan and investigated for myself, if I had not witnessed the Bikini experiments, I would perhaps have continued to share some of the illusions so common on the subject.

In disputing my subsequent findings, certain scientists suggested politely that since I am not a physicist I had no right to discuss the atom bomb. I could only return the compliment by suggesting that since these gentlemen are not engineers they had no right, by their own rule, to discuss structural demolition.

One does not necessarily have to comprehend the origins and composition of an instrument to employ it skillfully or to appraise its effects. The expert photographer using complicated chemical processes produces brilliant color prints though he knows little or nothing about the composition and manufacture of the developing solutions. Any good chemist knows more about TNT than General Spaatz does, but this did not hamper the General in destroying Berlin.

A nuclear scientist may of course also be a first-rate engineer and a perspicacious statesman. But his superior knowledge of the nature of atomic energy does not by itself endow him with final authority on war-making and peace-making, even in the atomic age. Scientists have as much right to inject themselves into strategic or political issues as anyone else—but no more. I feel satisfied that most of them will agree with the common-sense view that superior knowledge and achievement in one field does not per se qualify a man as an expert in all fields. Too many physicists, since A-Day in Japan, have set up shop as sociologists, statesmen, and, above all, strategists.

For the most part they take the air-power thesis and transpose it into atomic language. They substitute "atom power" or "atom bomb" for air power and imagine they have discovered new strategic laws. Consider, by way of example, the eminent atomist Dr. Harold C. Urey. In his contribution to the book *One World or None* * he writes:

"The most industrialized countries will be the most vulnerable and the most likely to be attacked by atomic bombs. These weapons stopped the Second World War, and at the same time they ended the defenses of the United States."

To begin with, Dr. Urey overlooks the fact that it was air power, enabling us to impose surrender without surface invasion, that "stopped" the war in the Far East. More important, it was not the new explosive which "ended the defenses of the United States." The new strategic era was ushered in with the invention of the airplane, making possible the delivery of destruction through a medium until then inaccessible. The natural defenses of our continent were ended when that airplane achieved its transoceanic striking range, enabling an enemy to reach the American industrial heart through the skies.

Dr. Urey is quite right in warning that a highly industrialized coun-

* McGraw-Hill, 1946.

try is today the most profitable target. But the advent of the atom bomb did not create this condition; the principle held true long before this bomb was devised. Back in 1942 I explained that "the United States, as the world's most industrialized area, is also the most vulnerable to aerial attack. . . . Industrial concentration is essential to modern civilization, but unfortunately it runs counter to national security in the light of air power." *

The destructive power of the bomb has merely enabled men like Dr. Urey to recognize the revolution in war-making brought about by aeronautics, about which airmen have been trying to tell them all these years. Even today they seem unwilling to understand the core of the matter, so that they attribute to the explosive a military power inherent only in air force, irrespective of the explosive.

The atomic physicist can tell us the amount of energy and radioactivity released. But those who have studied demolition are better equipped to estimate the effects of that energy. It is as an engineer and a specialist in the grim business of military destruction, without any pretense of special atomic knowledge, that I approach the problem.

I have had a most intimate and intensive experience with what explosives can do. My military career indeed began with demolition—I was nearly demolished for good. On my first night bombing mission in 1915 in the Baltic Sea, my plane was shot down. When it hit the water, our own bomb exploded in the cockpit, killing my observer and blowing off my right leg. Upon returning to the front I was bombed and shelled with everything the Germans could throw at me. My headquarters were showered by the heavy bombs of the Kaiser's airplanes and Zeppelins and I saw what they did to installations. My naval air base was the target for fourteen-inch shells from German battle cruisers; I know what these can do to a target.

Against that initial background, I have studied demolition in every conceivable form. In 1921, at the request of General Billy Mitchell, I was appointed Special Consultant to the War Department. My specific assignment was to reduce my concepts of an automatic bombsight to a workable model, and the end product was the world's first synchronous bombsight. In line with this undertaking I had to study

* *Victory Through Air Power,* pages 102-3.

aerial bombs and their effects on various targets, taking part in a great many experimental bombing runs as well as demonstrations at proving grounds. I worked with General Mitchell in the bombs-versus-battleships tests of his day.

Thus I brought thirty years of experience with explosives and diverse targets to the task of investigating demolition in its manifold forms during the recent war. In the capacity of Special Consultant to Secretary of War Robert P. Patterson, I had a unique opportunity to make observations and deductions in hundreds of areas of Europe and the Pacific. I became thoroughly familiar with every brand of damage from high explosives, incendiaries, liquid fire, artillery shells, dynamite, atomic explosives, and combinations of several of these agents. As an engineer who knows how to build structures of given strengths and as an airman who knows how to destroy them, I feel justified in dealing with demolition, whatever the instruments used to accomplish it.

After visiting the major areas of the Pacific, I arrived in Japan. I began the study to which I had been assigned by making an aerial tour of the islands of Honshu and Kyushu, which encompass the main portion of industrial Japan. I flew over Tokyo, Yokohama, Yokosuka, Nagoya, Osaka, Kobe, Akashi, and dozens of other towns and cities which had been subjected to intensive air attack. Some of these towns are so close together that they seem almost continuous industrial sites.

All of these areas of annihilation presented approximately the same visual pattern. The smaller towns were totally burned out. Seen from above, the prevailing color was pinkish—the effect produced by the piles of ashes and rubble mixed with rusted metal. Similar pinkish carpets were spread out in the larger cities, except that among them stood large and small modern concrete buildings and factory structures, unscathed bridges, and other objects that had withstood the impact. Many of the buildings, of course, were gutted by fire, but this was not apparent from the air.

The center of Yokohama, for instance, seemed almost intact when seen from an airplane. Osaka, the Chicago of Japan, was an immense expanse of pink crisscrossed with white lines—the streets—except in the more modern center of the city, where concrete buildings had survived. The long industrial belt stretching from Osaka to Kobe

had been laid waste by fire, but with few exceptions the factories and other concrete structures were still standing.

It was, on the whole, a picture strikingly different from what I had seen in German cities subjected to demolition bombardment; quite different, too, from the picture presented by the Osaka arsenal —the most devastated high-explosive target I have seen on either side of the globe. The difference derived from the fact that Japanese destruction was overwhelmingly *incendiary*, with comparatively little structural damage to non-inflammable targets, whereas in Germany the destruction was of the *demolition* type.

Finally we flew to Hiroshima.

3

I WAS keyed up for my first view of an atom-bombed city, prepared for the radically new sights suggested by the exciting descriptions I had read and heard. But to my utter astonishment, Hiroshima from the air looked exactly like all the other burned-out cities I had observed!

Within an area defined by black, undestroyed houses there was the familiar pink carpet, about two miles in diameter. What is more, precisely as in Yokohama, Osaka, or Kobe, it was dotted with buildings still standing erect, with charred trees, poles, and other objects. All but one of the steel and concrete bridges were intact. A cluster of modern concrete buildings in the downtown section stood upright and seemingly undamaged.

How strange, I thought, that in their concentration on the spectacle of damage observers should have overlooked the telltale evidence of structural survival!

On inspecting the scene on the ground, what I found was essentially a quite typical burned-out city. I knew what the blast of a five- or six-ton bomb could do to near-by buildings. It was apparent at once from the appearance of Hiroshima that, powerful as the atomic blast had been, it was not an "apocalyptic" force but an explosion of finite proportions.

The blast had affected an extensive area. But it had not been powerful enough to demolish the modern concrete buildings within a block from "ground zero"—the point over which the bomb was ex-

HIROSHIMA AFTER THE ATOMIC BOMB EXPLODED: Above—As seen from the air: (A) "T" Bridge, the aiming point, remained intact, except for damaged railings; (B) "ground zero," the point over which the bomb actually exploded.

Below—A cluster of concrete office buildings, standing erect and structurally intact amidst the ashes of the surrounding wooden houses, near "ground zero" (B).

All photographs in this section, not otherwise credited, are by the author.

Two examples, typical of hundreds of sensational photographs published throughout the world, purporting to show "what is left of Hiroshima." By failing to indicate that some types of structure survived, they encouraged the early "atomic hysteria."

The Kind of Pictures That Were Seldom Published. Taken by the author six weeks after the explosion, they show modern buildings that remained standing. *Above*—The main street of Hiroshima. *Below*—The downtown section seen from the river; these concrete structures were directly under the explosion point

Above—An intersection of two main streets close to "ground zero." Electric trolley service was fully restored throughout Hiroshima within 48 hours.

Below—In these primitive hillside shelters, practically at "ground zero," inhabitants of Nagasaki were unharmed by atomic blast, heat, and radiation.

Above—The author at "ground zero" in Nagasaki. The surviving tree trunks in the background refute reports of "evaporation" and "dissolution" of matter.

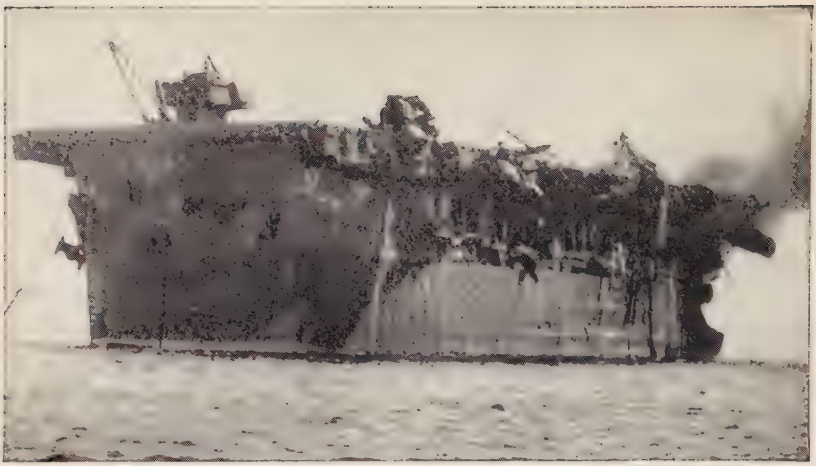
Below—This house is typical of the flimsy wooden structures, with top-heavy tile roofs, that made Hiroshima and Nagasaki so extremely vulnerable to atomic blast and fire.

A Study in Vulnerability: *Above*—A typical narrow Japanese street. After the houses collapsed from blast, such streets were completely clogged and inaccessible to fire-fighters, turning an entire city into a flaming mass of kindling wood. *Below*—This is non-atomic devastation, a section of Berlin demolished by TNT bombs. The horror of Hiroshima was actually exceeded in many German cities, and it was no consolation to the inhabitants that this was done by "old-fashioned" bombs.

Wide World

THE PATTERN OF ATOMIC EXPLOSION AT BIKINI: *Left*—In this *aerial* blast, contaminated particles of fissionable material were carried upward, with no residual radioactivity on the surface. *Below—Underwater* explosion, in which the particles, mixed with water, drenched the targets and left considerable radioactivity.

Wide World



Dept. of Defense photo

The "Hottest Target": The aircraft carrier *Independence*, after the Bikini tests. Its extreme mutilation, the author believes after inspecting it, was due primarily to explosion of its volatile vitals (munitions, torpedoes, etc.) by bomb-ignited fires. This is the usual fate of carriers suffering direct hits by ordinary bombs. Though the *Independence* is often cited as Exhibit A of contamination, it should be remembered that it was already in its mutilated state (result of the *aerial* blast) when placed in the target area of the *underwater* explosion. Thus huge quantities of "poisoned" water were trapped in crevices of the twisted wreckage, making decontamination virtually impossible.

Below—General Douglas MacArthur and Major de Seversky, in Tokyo, October, 1945, during the author's inspection tour of the Pacific theater for Secretary of War Patterson.

ploded. Closer inspection of the buildings, of course, revealed terrific damage by fire and the effects of blast on windows and on flimsy partitions within the buildings. Aside from that, however, the structures did not look any different from those in other towns subjected to incendiary-bomb attacks.

I had heard about buildings instantly consumed by unprecedented heat. Yet here were buildings structurally intact, with outside plaster and stone facings in place. What is more, I found them topped by undamaged flag poles, lightning rods, painted railings, air-raid sirens, and other fragile objects. Clearly they had weathered the blast and somehow escaped the infernal heat, as well as the alleged super-hurricane thousand-mile-an-hour wind.

For two days I examined Hiroshima. I drove to T Bridge, which had been the aiming point for the atomic bomb. In its environs I looked for the bald spot where everything presumably had been vaporized or boiled to dust in the twinkling of an eye. It wasn't there or anywhere else in the city. I searched for other traces of phenomena that could reasonably be tagged "unusual." I couldn't find them.

What I did see was in substance a replica of Yokohama, Osaka, or the Tokyo suburbs: the familiar residue of an area of wood and brick houses razed by uncontrolled fire. Everywhere I saw the trunks of charred and leafless trees, burned and unburned chunks of wood, rubbish heaps left by unchecked conflagration. Obviously there had been fire here, as in other Japanese cities, intense enough to bend and twist steel girders and to melt glass until it ran like lava.

I studied with particular attention the concrete buildings nearest to ground zero. Some of them, only a few blocks from the heart of the atom blast, showed no structural damage, but merely the typical effects of fire. Window glass was shattered, of course, but single-panel frames held firmly. Only window frames of two or more panels were bent and buckled. This was a picture no different from the one presented by thousands of buildings I had seen in Europe and Japan subjected to the blast of ordinary, high-explosive bombs.

The blast effect was remarkable, considering the total area affected by *one* bomb, but did not appear phenomenal in its effects upon individual structures and other targets. Nor did I find startling evidence of heat beyond what is normally generated in a city in flames with-

out benefit of the atomic bomb. Here and there I detected a charring of objects that could be ascribed to the flash heat of the explosion. Scientifically this was a very interesting and unusual phenomenon—the application of intense heat for an extremely brief period. But practically the incendiary properties of the explosive did not seem especially devastating.

The United States Strategic Bombing Survey subsequently reported third-degree burns on human bodies as far as a mile from the point of explosion. On the other hand, I saw highly inflammable objects right at ground zero that had not been ignited. The Survey report noted bodies charred beyond recognition in the vicinity of ground zero. But there were also tens of thousands of bodies, scattered all over the city, no less charred as a result of ordinary fire.

As in any bombed city, many of the victims were killed—theoretically—three times: by blast, by falling debris, and by fire. In Hiroshima people could have been killed four times over, since we can add death from radiation at the moment of explosion.

I questioned a great many survivors who had been inside concrete buildings when the bomb exploded. In particular I talked to occupants of the ten-story Hiroshima Press building, located about three blocks from ground zero. Their accounts paralleled scores of descriptions I heard from people in concrete buildings in areas hit by blockbusters in Germany and in other parts of Japan. They revealed no special effects that could be identified as unusual and ascribed specifically to the atom bomb. The Press building, like other such structures, was badly gutted by fire but otherwise structurally unhurt, except of course for loss of glass and some interior partitions. Most of its population at the time of the explosion survived.

People caught in the building did not observe any exceptional phenomena. They saw a flash, heard an explosion, and shortly thereafter fire broke out on the fourth floor, where inflammable negatives and motion picture films were stored, and the fire spread to other floors. Some of the tenants claimed that the fire started simultaneously with the bomb flash; others insisted that it spread from the adjoining movie theater, which had collapsed and was in flames.

The Hiroshima hospital, about a mile from the explosion center, had most of its window panels blown out. Because it was too far

away to be affected by flash heat and because there were no wooden houses in the vicinity, it escaped fire. The people inside the hospital building were not affected by radiation, but suffered from falling ceiling plaster and flying glass. In general, the effects here were analogous to those produced by blast of TNT bombs.

The more I looked, the more I questioned survivors, the more I became convinced that the world had obtained an essentially erroneous impression of what had occurred in Hiroshima.

Death and destruction were as great as reported. The horror was as profound as reported. But, except for the effects of radioactivity (the least of the elements in accounting for the aggregate death and destruction), *the character of the damage* was in no sense unique. Neither the blast nor the heat had produced effects as phenomenal as generally assumed. Most important, there was clear proof that the same bomb applied to a different type of target would have produced quite different results.

From Hiroshima I flew to Nagasaki. I repeated the process of investigation and cross-examination. It added little to what I had already learned in the other city.

The pink carpet was much smaller. It was also studded with concrete buildings gutted by fire. Fewer of these buildings were in evidence only because there were not so many modern structures in that city. Though the bomb was reported to have been more powerful than the one dropped on Hiroshima, the loss of life was smaller, not only absolutely but in proportion to the population.

All of downtown Nagasaki, though chiefly wooden in construction, survived virtually undamaged. Part of this unaffected section, it was explained, had apparently been shielded from the explosive blast by intervening hills. But the rest of the section lies down the river in a straight and quite unimpeded line from ground zero, yet it escaped serious damage. Only a few of its houses caved in. We must assume that the Nagasaki blast expended itself before it reached this area. *Because the houses did not collapse here, there was no general fire.*

From the published data, my personal observations of the two cities, and the experience gained subsequently at Bikini, let me recapitulate what actually happened in Hiroshima. In essence it holds good for Nagasaki as well.

The Hiroshima bomb, we may deduce from the shadows of flash burns, exploded about two thousand feet above the surface. Its great blast acted like a huge flyswatter two miles square. It slapped down on a city of flimsy wooden houses and rickety brick buildings, flattening them out in one mighty blow and burying perhaps a hundred and fifty thousand inhabitants in the debris.

One must see to believe the flimsiness of average Japanese wooden structures, many of them termite-eaten and dry-rotted for generations. To make things worse they are top-heavy with thick tile roofs, used to protect them from sparks, should neighboring houses catch fire. Sometimes houses tumble down without apparent reason, expiring, as it were, of sheer old age. I nearly crumbled one myself in Nagasaki when I accidentally kicked a wall with my artificial leg.

When the houses collapsed under the bomb impact, the wooden slats of the frame structures were piled like so much kindling in your fireplace. Judging by the Los Alamos test, so-called primary fires—ignited by the heat of the explosion—should have taken place near ground zero. But the direct incendiary properties of the bomb as exploded in Hiroshima were insignificant in comparison with the conflagration that broke out simultaneously in thousands of spots over a wide area through short circuits, overturned charcoal braziers, and broken gas mains.

Had there been no universal collapse of the highly inflammable houses, the primary fires ignited by the bomb itself might have been brought under control. But the whole area under the giant flyswatter exploded into one fantastic bonfire, as normally happens after a major incendiary raid. Those concrete buildings that were surrounded by wooden structures, and thus caught in the heart of the bonfire, were naturally also enveloped in flames.

In normal fires, in buildings that remain erect, people have a chance to escape. Some parts burn before others. They can run from one floor to another, from room to room, and have a chance to find sanctuary in the streets and other open spaces. The streets are not yet cluttered with debris, so that people can run to the rivers or to unaffected parts of the city before the structures crumble.

Hiroshima provided no such escape. All the fragile structures collapsed and thousands of fires broke out simultaneously. Most of the inmates were helplessly trapped. With few exceptions, the streets were extremely narrow, an average of thirty feet in width. Falling houses filled and clogged them instantaneously. The entire area turned into one solid, continuous mass of flames without channels for escape.

Thousands of people must have been killed outright by falling roofs and walls. The rest were crippled and immobilized in a burning hell. Those who managed somehow to extricate themselves rushed toward the bridges and the rivers.

There is reason to deduce that the one steel bridge that collapsed gave way under the weight of the frenzied mob and not, as some maintained, because of the bomb blast. On the other bridges, the crush of hysterical humanity pushed down railings, catapulting thousands to their death by drowning.

On a vast and horrifying scale, it was fire, pure and simple, that took such high toll of life and property in Hiroshima, and in Nagasaki as well.

As for the effects of radiation, according to Colonel Stafford Warren of the Strategic Bombing Survey, "Our best guess is that if there had been no gamma radiation, the total casualties would have been five to seven per cent less. In other words, the gamma radiation and allied radiation effects did not add a great deal to what would have happened if the same amount of energy had been released by TNT." * In Hiroshima this would mean that from four thousand to five thousand people were killed by radioactivity, and in Nagasaki from two thousand to twenty-five hundred.

If the same number of people had been subjected to a similar attack in a modern stone-and-concrete city, those inside buildings would have been shielded against the gamma rays, except where they were exposed by windows. Supposing that as many as half the population in the attacked area were in the open, the Hiroshima figure for radiation deaths would have been cut to twenty-five hundred. Even these, however, would be moving among tall buildings and therefore protected by masonry, so that only about one-third of them

* Volume 15, U.S. Senate Report of Proceedings, before Special Committee on Atomic Energy.

would have been exposed to direct gamma rays, thus reducing the radiation death toll to some eight hundred or one thousand.

This assumes a condition of total surprise such as Hiroshima faced. Though an alert had been sounded, the people saw only one plane approaching and made no effort to take cover. If warned in time and aware of the consequences of atomic attack, people would rush to shelters and huddle in the interior of buildings; they would avoid windows and other exposed places. A large number would succeed in taking refuge in basements, tunnels, subways. With multiple barriers of brick, stone, and concrete between themselves and the bomb-flash, we could expect only a few hundred casualties from direct radioactivity at the moment of explosion.

Some people are deeply convinced that the magnitude of the death record in the atom-bombed cities was due to radioactivity. No amount of sober logic will dissuade them. Of the three-in-one properties of the new bomb—blast, fire heat, and poison rays—radioactivity is the unfamiliar element and consequently the most terrifying psychologically. Yet in an air burst it is the least of the three threats and the one, besides, that can be most easily evaded, given an interval of warning.

The greatest damage, I repeat, was caused by fire—fire on the same devastating scale as in other large Japanese and German cities. The loss of life was much greater only because of the exceptionally inflammable target; because the simultaneous caving in of so many homes cut off roads of escape.

A combined demolition and incendiary attack on Hamburg by some seven hundred British aircraft at the end of July, 1943, brought death and destruction on a greater scale than in atomized Hiroshima and Nagasaki. A secret German document described the havoc as "beyond all human imagination." Small fires, it declared, "united into conflagrations in the shortest time and these in turn led to fire storms. To comprehend these . . . one can only analyze them from a physical, meteorological angle . . . a fire typhoon such as was never before witnessed, against which every human resistance was quite useless." The suction of the overheated air was strong enough to pull trees out of the ground. "To judge from the German description of it," Marshal Harris of the R.A.F. has written, the disaster "must have

been even more cataclysmic than the bursting of the two atom bombs over Japanese cities." *

In the mass incendiary-demolition attack on Tokyo on March 9-10, 1945, an area nearly four times as large as Hiroshima's was destroyed: 15.8 square miles against 4.7 square miles. The density of population was almost three times as great. But only 83,000 were killed or missing. The casualties were thus, percentage-wise, about one-twelfth as serious as in Hiroshima.

It is too easy, under the psychological influence of the atom-bomb novelty, to ascribe the greater losses to the direct and primary action of the new explosive. Actually, the smaller cost in life in Tokyo was due to the kind of bombing we directed against that city.

Its purpose was not to kill people but to destroy property, the means of waging war. Had we chosen to kill more people, we would have mixed a larger proportion of high explosives with the incendiaries. In Tokyo, too, the population would then have been trapped by collapsing buildings with a corresponding increase in deaths. The normal incendiary ignites a structure without collapsing it, enabling more people to escape. Besides, Tokyo had a far larger proportion of noninflammable houses than Hiroshima and these served as shelters against the conflagration.

An atom-bomb explosion in a modern city, even if no shelters were provided and no advance alerts sounded, could not conceivably do damage on the Hiroshima-Nagasaki scale. Incendiary, blast, and radiation casualties would be only a small fraction of the Japanese figures.

Dr. Charles U. Kring, a member of the U.S. Strategic Bombing Survey, in general confirms this view, on the basis of voluminous research by a large staff of experts. He has stated that "a Western city which had been alerted in sufficient time for people to take refuge in basements and bottom floors of multistory frame buildings, in tunnels and deep subways, would probably suffer only a few thousand casualties."

Dr. R. E. Lapp, a physicist and a member of the Manhattan Project, in visualizing an atomic burst over Manhattan, in his book *Must We Hide?* wrote: "Directly under the center of the blast, people in the

* *Bomber Offensive,* by Sir Arthur Harris; Collins, 1947, page 174.

subways would be unaffected either by the blast or by the radiation. They would be perfectly safe." People farther from the center of the blast, he added, would also be safe "if they were in the lower floors of buildings shielded from the flash of radiation." *

Would there be any serious lingering or residual radioactivity? I believe that the answer is no. It has been claimed that faintly discernible pockets of radioactivity were detected in Hiroshima and Nagasaki, but they were too weak to affect human beings. According to the Bombing Survey, measurements taken at Takatsu, at a spot 10,000 feet from ground zero in Hiroshima, and at Nishiyama, 6,500 feet from ground zero in Nagasaki, showed traces of radioactivity, but not in appreciable strength. One explanation for the residual radioactivity that was noted in the Japanese cities is that heavy rain fell shortly after detonation of the atomic bombs. "Infected" fissionable particles were presumably brought down by the rain and deposited in the earth's surface.

Rescue workers and the Red Cross entered the bombed areas immediately and worked without ill effects. The radioactive danger existed only at the moment of explosion, which is an infinitesimal fraction of a second, and affected only those who were directly exposed to the rays.

The confusion on this score has been caused in part by the results of underwater explosion of the atom bomb at Bikini. This bomb was artificially planted under water and detonated by remote control, as a kind of laboratory experiment. Millions of tons of water were mixed with radioactive fissionable material. This "poisoned" water drenched the ships, leaving radioactive particles in all the crevices of the structures, from which they could not be completely removed without dismantling the ships. Hence they had to be scrapped. This condition does not prevail in aerial attacks over land.

And as a practical matter, what difference does it make whether a given section is so contaminated atomically that it has to be roped off, or so pulverized by ordinary bombing that it is inaccessible and useless? In both cases it is eliminated. Indeed, a demolished area would be "out" for good unless it were rebuilt, whereas the same area contaminated would be useless only until the radioactivity subsided. If

* Addison-Wesley, 1949, page 84.

the section contained objects of great value, such as the Louvre or the Metropolitan Museum of Art, demolition would inflict irreplaceable loss as against the temporary inconvenience imposed by contamination. Come to think of it, if we knew how to contaminate for the duration the enemy's entire industrial setup and war-making means, it would be the most humane way to win a war.

The original explosion of the bomb in New Mexico, having been detonated closer to the ground than in either of the Japanese explosions, netted important information. When we explode the bomb immediately over the earth's surface, it is likely that the heat will then be intensive enough to evaporate matter in the immediate vicinity; that this area would be radioactive for some time; that some structures at ground zero would be pulverized by the gigantic blasts.

On the other hand, the damage would be sharply localized. The results would be more intensive, less extensive. Destruction would not be so widespread and the loss of life would shrink proportionately. The level at which an atomic bomb should be detonated therefore depends, as in the case of ordinary bombs, on the target and the results desired.

Detonation about two thousand feet in the air was perfect calculation for the two doomed Japanese cities, if the purpose was to demonstrate maximum destruction and loss of life. The flimsiness of the targets guaranteed the largest possible damage through blast and fire. For the most destructive results in a steel-and-concrete city, detonation will be required much closer to the surface—in which case the area affected would be drastically reduced.

The blasts were strong enough to collapse four square miles of fragile houses, but too weak to raze reinforced concrete buildings even at the focal centers of explosion. The fault, as I see it, with most of the official appraisals of the atomic damage, including the U.S. Strategic Bombing Survey, is this: they emphasize the impressive distance at which some houses were collapsed, but they fail to underscore the no less impressive survival of buildings and even fragile objects close to the point of explosion.

It simply is not true that eighty thousand lives were snuffed out in Hiroshima and forty thousand in Nagasaki in the fraction of a second. The great majority of victims died slowly, from suffocation and fire.

It simply is not true that matter was "evaporated" by the heat. If steel had evaporated, certainly wood could not have survived, as it did survive everywhere.

In neither of the bombed cities was there a bald spot denuded of all inflammables such as was created in the New Mexico experiment. People who happened to be in the crude hillside caves that served as local shelters were immune; those who were shielded by masonry suffered very few casualties.

Damage to underground installations such as telephone and electric lines and sewer systems was extremely slight, except where they had been wrecked by the weight of falling objects. Within twenty-four hours after the historic explosion, electric power was restored in undamaged sections and buildings in Hiroshima; within forty-eight hours trolley cars were running through the heart of the bombed section.

Machinery in industrial plants in atomized areas was only slightly affected. So far as its machines were concerned, the big Mitsubichi factory in Nagasaki, for example, could have been put back in operation in a couple of months. Rather more serious damage, in fact, had been done a week earlier by direct hits with half-ton TNT bombs by George Kenney's Air Force. In fireproof buildings the atomic effects were pretty much like those of light bombs in contact detonation: the structures were damaged but not the machinery within.

Such were the facts as I found them in Hiroshima and Nagasaki. They seemed to me dismal enough without pseudo-scientific trimmings and exaggerations and imaginative assumptions.

ATOMIC HYSTERIA AND COMMON SENSE

1

THE STORY sketched in the preceding chapter obviously was different from the one then being told virtually in unison by press, radio, and scientists. Against the prevailing hyperbole it must have sounded more incredible than I suspected. But it was the only story I could conscientiously tell when I was questioned by newspapermen in Tokyo and back home in America.

I did not "underrate" the atom bomb or dispute its future potential. Certainly I did not dismiss lightly the infernal horror visited on Hiroshima and Nagasaki. As an engineer, I limited myself to an analysis of the demolition accomplished by particular bombs exploded in a particular way. These one-man observations I embodied in a formal report to the Secretary of War, who released it to the public. In addition I wrote several articles on the subject.

Whereupon all hell broke loose over my sinful head. My findings were pounced upon by all sorts of people in angry fury, on the air, in the press, at public forums; scientists who hadn't been within five thousand miles of the atomized cities solemnly issued condemnations of my heretical views. Almost for the first time in my career I found myself in the position of a "conservative" under fire from "extremists."

It seemed to me an exceedingly strange phenomenon, this eagerness of people to protect the original exaggerated version. How did it happen that so many people had acquired a sort of vested interest in misrepresentation of the facts? Why did they defend the myth with such fervor?

It should be noted that my impressions have been confirmed, in substance if not in detail, by official and expert examination. On June 30, 1946, about six months after my first report, the findings of the

United States Strategic Bombing Survey were made public. They represented months of research by about three hundred specialists, assisted by hundreds of military and other personnel. To a surprisingly great extent the elaborate investigation corroborated deductions I had based on a brief study.

Let me cite a specific example. I had declared that two hundred B-29 bombers, loaded with incendiaries and high explosives, could have duplicated the damage wrought in Hiroshima or Nagasaki by a single atom bomb. A group of University of Chicago professors singled out this conclusion for special derision. Then I spent a grueling day on February 15, 1946, before the Senate Special Committee on Atomic Energy defending my estimate. Senator Brien MacMahon, as committee chairman, confronted me with a statement by a British ordnance expert, Major General J. R. C. Fuller, asserting that the destructive power of an American bomber had been multiplied "about three thousand times" by the atom bomb. General Thomas F. Farrell, second in command of the exploding of the two bombs over Japan, testified more modestly that "it would take 730 B-29's to do what one atomic bomb did to Hiroshima."

Four and a half months later the Bombing Survey issued its formal verdict: "*With each plane carrying ten tons, the attacking force required would have been 210 B-29's at Hiroshima and 120 B-29's at Nagasaki*" to accomplish the same amount of destruction.

Subsequently the U.S. delegation to the United Nations Atomic Energy Commission estimated that one atom bomb of the type dropped on Japan is equivalent to 167 ten-ton blockbusters. Since the blockbuster contains only about five tons of TNT, this estimate really asserted that one bomb equals 835 tons of TNT. Yet the energy released by the bomb was generally computed as equivalent to 20,000 tons of high explosives. The disparity between 20,000 and 835 is the difference between the total energy released and its "useful" tactical values. A lot of the misconceptions in the public mind are explained by this ratio.

Even official verdicts and estimates, however, did not suffice to down the original exaggerations. Scarcely a week passes but some writer or commentator repeats that I have "discounted" the atom bomb. I have before me a clipping containing an offhand reference

to "Seversky's contention that the atom bomb is a dud"! Apparently there is a strange reluctance to differentiate between the admitted destructiveness of the bomb and its rightful place in the strategic scheme of things.

In *One World or None,* Professor Philip Morrison of Cornell insisted that "a single bomb can saturate a city the size of Indianapolis, or a whole district of a great city like lower Manhattan . . ." with a death toll of about 300,000. I have no way of knowing whether he risked that swollen estimate before or after the Bombing Survey report was published, but he had been in Hiroshima and should have known better.

In an imaginative preview of what a single bomb would do to New York, the Professor may have been taking an imaginative revenge on me. Among those who in his fantasy died from the delayed effects of radiation there was a "well-known aeronautical engineer" and he died "while working on a report on the extent of the damage to steel structures" in that bombing. In the face of my promised doom I still repeat that neither 167 blockbusters nor the bombing power of 210 B-29s—equivalents of a single atom bomb—would cause the amount of devastation he describes for New York, Indianapolis, or any other modern town.

"The atomic bomb is not a bomb," General Thomas F. Farrell exclaimed in type. "It is a catastrophe, a world upheaval, a deluge, a debacle, and a disaster rolled into one." In a daring magazine forecast of what the bomb would do to ships off Bikini, the same gentleman foresaw effects—and a flamboyant artist translated his visions into drawings—which were about as wrong as they could be. As if the reality were not sufficiently harrowing, there was and there remains this straining to outdo reality.

"The atomic bomb," wrote William L. Laurence, science writer for the New York *Times,* "is not just another weapon against which our military minds will find a defense, but the greatest cataclysmic force ever released on earth." Unless it is forthwith controlled, he said, "it will inevitably lead to the destruction of civilization." He was not the only one writing off civilization and dealing in inevitabilities just then. The bomb seemed to have touched off a prophetic wave.

In time, as was to be expected, more restrained voices began to

make themselves heard through the din. Estimates of damage per bomb were scaled down. The early headlines about one bomb wiping out one metropolis evolved into "Six Atom Bombs Could Wipe Out New York" (New York *Mirror*, January 18, 1948), then eight, then fifteen. The hysteria generated around radioactivity subsided, as a number of specialists reduced the wild generalizations to manageable fact. Here and there people even warned that the fear of radioactivity might do more harm than radioactivity itself.

One after another, military commentators climbed off the limb with statements that the atom bomb, after all, was not the "absolute weapon." The absurd notion that it was an all-purpose bomb was abandoned, with a growing realization that the bomb was suitable and economic only against specific types of targets. Rear Admiral William Sterling Parsons in an Associated Press interview declared that there had been "tremendous overemphasis of the atom bomb." Colonel James P. Cooney, an Army observer at Bikini, said that "unreasoning psychological fears" of the effects of gamma rays "could well interfere with an important military mission in time of war."

The tall tales of lush vegetation in Hiroshima were debunked and those visions of cucumbers like skyscrapers and hydra-headed onions on atom-infected ground faded out. Said Science Service on the basis of data from David Lilienthal: "Reports of enormous increases in vegetables obtained on Hiroshima's bomb-blasted soil by a Japanese truck farmer were true enough . . . only the farmer had used five times as much fertilizer as his neighbors—which may have had something to do with the results."

Bikini, we had been assured, could never be decontaminated and would never again be suitable for normal animal or plant life. But one year after the big blasts investigators could report that animal, vegetable, and marine life was normal and as ample as before the tests. The Hiroshima and Nagasaki areas, it had been expected by many people, would be uninhabitable for eighty years; the estimate proved wrong by approximately eighty years.

2

THERE seems to have been a conspiracy of circumstances to whip up atomic hysteria.

To begin with, Emperor Hirohito, his court, the Japanese military clique, their press and radio had obvious reasons for propagating the most extreme version possible of the atom-bombing effects. *It gave them the perfect face-saving excuse for surrender.* The more devastating, the more nearly "supernatural," the new weapon, the more justification for calling off resistance.

The Mikado's court, as was generally known, had been eager to make peace long before the atomic offensive, but was opposed by the military clique. Didn't they have six or seven million armed and able men at their disposal? The military chiefs looked forward with some hope to the "decisive battles" on the ground in Manchuria and the home islands. Their whole education, like the education of their opposite numbers in the Allied camp, made them certain that the war could not end while powerful armies were still intact.

The American atomic blows dramatically swung the balance to the Mikado's side. Even the generals could now pretend, to themselves and to the population, that they were not to blame for the defeat; that a new, almost magical force had intervened to explode their otherwise correct calculations.

Court and generals alike, indeed, could throw the onus for defeat on the people. Not any paucity of valor, wisdom, and military genius on the part of the leaders, but technological retardation on the part of the Japanese people as a whole explained the humiliation.

The truth, of course, is that Japan was already a defeated and helpless country. Hirohito and his associates groped for an exit that would allow them to salvage a few shreds of dignity and prestige. The atomic demolition of Hiroshima and Nagasaki was welcome, in that it "explained" their failure in the most expeditious and impressive fashion. After the surrender I had the chance to interview Emperor Hirohito and high-ranking members of his household. I also interrogated Rear Admiral Takata of the Imperial Japanese Navy; Lieutenant General Kawabe, commanding at Kokosoguan; Major General Miwa; Lieutenant General Saburo Endo, who was in charge of aircraft and engine production for the entire Japanese Empire; Lieutenant General Samo, commandant of the Osaka Arsenal; and many key leaders of industry. My impression, as summarized above, was strengthened.

It must be acknowledged that the bomb provided a no less provi-

dential face-saver and conscience-pacifier for the American military leadership. Having failed to comprehend the decisive role of air power, we were deeply and expensively committed to colossal invasion plans. Every attempt to prove that a nation can be defeated by the direct application of air power to its industrial vitals had been brushed off by our high command. Having insisted so loudly that there could be no victory without coming to grips with the Nipponese surface forces in the traditional bayonet struggle, they were practically forced to finish the conflict in that way.

Accordingly, a free gift of Manchuria was made to Stalin for his promised use of the Red Army on the Asiatic mainland. Accordingly, the storming of the Japanese homeland by vast invading forces was set, dates fixed, gigantic resources deployed. The bloody battle of Okinawa had been fought strictly as a preliminary action looking to invasion.

Although to all airmen and many people in the other services it was sufficiently evident that Japan was being knocked out by air power, the momentum of the old assumptions was too great to be arrested. We would undoubtedly have gone through with the invasion plans as scheduled and paid a tragic price in life. Came the atom bomb! Instantly it released everybody from past commitments and psychological fixations. Old-style leaders could assure themselves, in all honesty, that they had been perfectly right in their strategic concepts until a new, unforeseen element amounting to an act of God had intervened.

Now they could gracefully, without sacrifice of prestige, accept surrender without the formality of invasion or a mile-by-mile bayonet struggle. Six million Japanese were still under arms. The exorbitant price exacted by the Kremlin for its help was a dead loss. But there was "science" as an alibi. It wasn't air power that did the trick but a new and unpredictable force limitless in potency. The more extreme the picture of the atomic effects, the more hysterical the mood induced in an awe-struck world, the more clinching the explanation for an unorthodox victory.

Our high command, like its Japanese counterpart, could pretend that there had been no surrender approaches. They could overlook the circumstance that Japan was already beaten. The very fact that it was

possible for a single airplane to deliver the atom bomb in broad daylight without molestation was proof that opposing air power had been eliminated, giving us absolute freedom of navigation in the Japanese skies.

Air power, in the phrase of a great many military and scientific leaders, had been "superseded by atomic power." The Hiroshima and Nagasaki episodes added less than three per cent to the aerial devastation already rained on Japan. With the country helpless under skies controlled by the enemy, total annihilation had resolved into a mere trucking job. Had the atom bomb remained a secret for the future, the actual physical picture would have been no different. But the psychological picture was another matter. We now had a face-saving miracle which spared perhaps a million American and Japanese lives.

Thus both sides were equally eager to depict the Hiroshima and Nagasaki events in the most flamboyant colors.

There were, besides, other powerful motives in the dramatization of the atom bomb. Somehow it fitted nicely into the propaganda patterns and wishful-thinking of a great many different groups. For isolationists it offered the final proof that we could let the rest of the world stew in its own juices; with the miracle weapon in our sole possession and a head start in its further development, who would dare challenge us? Internationalists and ardent proponents of a world order exclaimed that there would no longer be victors in future wars, but only mutual extermination, the end of civilization; hence there was no alternative but to abolish nations and frontiers.

Moreover, as tension between the Soviet Union and its democratic allies mounted, atomic hysteria was turned into a useful propaganda weapon for partisans of the Soviets in our midst. War, they argued, had now become so destructive that no price in principle or in territory was too great to head it off. There were a few voices which suggested that "no world" was preferable to "one world" on Moscow's terms, but they were drowned out by the new pacifism.

Perhaps it was not accidental that so many of the panic-mongers on the atomic issue, writers and physicists, were pro-Soviet in their political bias. Now they had a scientific and humanitarian basis for urging appeasement of the Kremlin, and disarmament. The art of war

having allegedly been blasted out of existence, what was the use of maintaining a costly national security setup?

This does not mean that I take exception to their estimates of the horror of atomic warfare. Had they been able to impress all mankind, and in particular the portion behind Stalin's iron curtain, their dire prophecies of universal dissolution might have served to scare the world into peace. Unfortunately their grim propaganda could reach only the free peoples, thus inducing a mood of despair which Moscow exploited to extend and consolidate its postwar conquests. Stalin, be it noted, hasn't been scaring his subjects with the atom bomb.

Later the Soviet-inspired propaganda around the atom bomb was reversed. The "pacifist" drive had failed, except insofar as it delayed American rearmament. The democracies were forging defensive pacts and restoring military vitality as fast as they could. It served Moscow's purposes therefore to dismiss the bomb as ineffective in modern war. What the new "line" will be now that the U.S.S.R. is presumably building up its own atomic stockpile remains to be seen.

There has also been a curious change of party line in American naval circles. At first the admirals joined the general chorus of atomic exaggeration. They merely insisted that ships and aircraft carriers were the best means of delivering the new bomb; the supercarrier was projected as the special instrument for this purpose. But when it became fairly clear that atomic warfare was being accepted by the government as a function of air power, the admirals made a hairpin turn of opinion. They now discovered that the atomic explosive was not "what it was cracked up to be" and that its use, moreover, was immoral. Their testimony on this score before the House Committee in October, 1949, makes amusing reading when compared with naval opinion a few years earlier.

In many quarters hysteria continued to grow. What is, for all its fearsome potency, a finite instrument was raised to an apocryphal and limitless dimension. What is in essence a new explosive—an "efficient" piece of ordnance—was promoted to the status of a new military force. What is basically an improved weapon of air power was accepted as a substitute for air power.

The truth is that Berlin, Dresden, Cologne, Hamburg, Bremen, and a great many other German cities suffered as grievously and on as

great a scale as Hiroshima and Nagasaki. Both the human and property loss was as vast, the sum-total of suffering no less terrifying. To the victims it was small consolation that their tragedy was accomplished by TNT rather than by atomic explosives. To the crippled, homeless, and miserable victims it made little enough difference whether they were hit by one atomic bomb or by hundreds of conventional bombs.

John Hersey wrote a terrifying description of atomized Hiroshima which shocked the American reading public. Yet there was little, if anything, he reported from the Japanese city that he could not have found in any of the great bombed-out cities in Germany or some Japanese cities razed by blockbusters and incendiaries. *The New Yorker,* I fear, unwittingly did a disservice to American thought in devoting an entire issue to the Hersey story. It reinforced the fallacious notion that horror is a special attribute of the atom bomb, rather than of modern war generally.

3

"If a raid of only two hundred Superforts with ordinary explosives can wipe out Hiroshima as the atomic bomb did, these same two hundred Superforts using atomic bombs could, in a single raid, wipe out two hundred cities with a population of about three hundred thousand each."

This profound comment on my estimate of atomic destruction in Japan was made in a broadcast by Chicago University professors. Perhaps because of their academic background, they assumed perfect laboratory conditions, merely neglecting to specify two real-life conditions: (1) The doomed two hundred cities should be as flimsy and dry-rotted and primitive as Hiroshima; and (2) the attackers should enjoy unimpeded right of way to the two hundred targets; or, to put it more concretely, the atom-bombing should come after the adversary's air power has been totally defeated.

Scientists who reckon that one atom bomb will wipe out one major modern city are venturing beyond their depth. With the valor of their military innocence they figure out the number of cities to be destroyed to knock out a given nation, assume a bomb stockpile of the same number, and imagine they are solving strategic problems. Their as-

sumption is that under all conditions the bomb-bearing airplanes will reach their goal and that the score of hits will be one hundred per cent. Which does simplify matters considerably.

People forget that even in gunfire target practice under peacetime conditions the average score is fifty per cent, though some exceptional records of ninety per cent or more hits have been made. But the same men under battle conditions rarely exceed three per cent.

When we begin to speculate about the number of atom bombs that would be required to destroy a Detroit or a New York we must take into consideration the difficulties of penetration, the nature of the defenses, the best accuracy attainable under desperate combat conditions. In the light of experience, and of new scientific defense measures already in the offing, an enemy would probably have to fly a hundred and fifty bombs in the direction of New York in the hope of scoring ten or fifteen direct hits, the least that would be required to put that metropolis out of commission.

A bomb today costs millions of dollars. Though production costs will be reduced in time, they will still be enormously expensive in terms of labor and materials. The interception of ordinary bombs in transit was no tragedy; the interception of an atom-bearing plane would wipe out a real chunk of the attacker's national wealth. We might find the aggregate cost and effort economically prohibitive—that the same aeronautical effort put into conventional bombs would eliminate the same target at a great deal less cost. In the last war bombs were so cheap that in considering the cost of an operation we reckoned only crews and planes. In an atomic operation we shall have to consider crews, planes, *and bombs.*

This consideration of costs is rarely touched upon by atomic enthusiasts. Yet in a war of attrition it may well become a central factor. If we relied on atom bombs only to defeat an enemy as large as Soviet Russia, so much of our economy, so much of our available manpower and raw materials would have to be invested in bombs that not enough would be left for the massive and invincible air power we would need to assume control of the skies so that those bombs could be delivered.

4

Reference to atomic destruction is meaningless until it is related to specific targets. The likely effects on one type of objective do not necessarily correspond to the effects on other types.

One atom bomb of the kind dropped on Hiroshima—or two hundred B-29's loaded with TNT and incendiaries—could destroy four square miles of a target as inflammable as Hiroshima. As we have noted, it could not conceivably produce comparable results in a steel-and-concrete city. For one thing, the bomb would have to be exploded much closer to the surface, which would reduce the affected area correspondingly. And if the city is defended, a substantial number of atom planes would have to be dispatched, with large escort forces, to fight their way through to the target.

At the risk of oversimplification, let me emphasize the significance of the target in choosing an appropriate agent of destruction.

Assume that the four square miles to be demolished consisted entirely of hay. A single match would then be as effective as one atom bomb. But if the four square miles consisted of concrete slabs, the atom bomb would be as futile as the match.

To annihilate the second kind of target, we need heavy, high-velocity, armor-piercing bombs. Eventually an atomic bomb may be developed encased in steel and detonated below the surface of the earth. Its explosion would create a minor local earthquake, possibly strong enough to topple over tall buildings in a modern city and destroy strong concrete underground installations. Even then, however, there is room for doubt whether the atomic weapon would be more efficient and more economical, in terms of national effort invested, than conventional explosives.

It has been stated that the Hiroshima bomb contained more power than twenty thousand tons of TNT. While this may be true as a fact in physics, it is misleading as military fact. The implication, for a layman, is that the bomb will be as *destructive* as a raid with twenty thousand tons of ordinary high-explosive bombs, which is patently false.

When an enormous amount of energy is released at *one* point, its efficiency, measured in results, is extremely poor in relation to the total

released. Only a fraction of the energy is effective, the rest being dissipated in space. The same aggregate of energy divided into small packages and distributed evenly over the same area would produce vastly more destruction.

To make a homely analogy: Suppose a farmer attempted to pile enough manure at the center of an acre of land to fertilize the entire area. If he piled enough of it, he *might* do the trick. Yet a very small fraction of the towering pile, if spread evenly over the entire acre, will give perfect results.

Similarly, in the application of destructive power, such "piling up" at one point is clearly uneconomical. An atom bomb concentrates terrific energy at the point of detonation, wholly out of proportion to the job to be done. It not merely wrecks but evaporates matter; it kills people not once but four times over—by blast, fire, flash heat, and radiation. If such squandered energy cost us nothing, it would not matter. But actually the process of compressing that immense energy into a single pill costs millions. Such promiscuous application of our national wealth may prove self-defeating.

That is why two hundred Superforts dropping only about two thousand tons of conventional explosive—not at one point but at hundreds of points—over four square miles of Hiroshima would have accomplished the same results as twenty thousand tons in a single atomic package, and at a far smaller cost per unit of destruction.

"But the atom-bombing involved only one airplane as against two hundred, a saving of a hundred and ninety-nine planes," the reader may protest. That, however, is true only if the attack is aimed at African savages who possess no air power, or at a defeated enemy who, like Japan in 1945, has been stripped of air power. When the target area is defended by aviation of adequate vitality, hundreds of supporting aircraft will have to be sent to guarantee the delivery of the atom bomb. So far as the aggregate air effort employed is concerned, there will be little if any advantage in favor of the atom bomb.

The idea that the original atom bombs were only "firecrackers" compared to those yet to be developed became a cliché of the more hysterical atom talk. The implication was that the military value of the bomb would be raised in proportion as its power was increased.

This is, of course, a fallacy. The problem, in making the use of atomic energy more efficient and more economical as a war weapon, is not to step up but to step *down* the amount of energy released by a single bomb. Even in its Hiroshima-Nagasaki-Bikini versions too large a part of the investment was militarily unproductive.

Another crucial consideration to be kept in mind is that ordinary explosives allow for better control of the character of the damage to be inflicted and the results to be attained. The attacker has a choice between destroying property and destroying human life; he can apply demolition bombs or incendiaries or a combination of the two in some planned ratio.

There is no such flexibility in the employment of atomic explosives. To us, as civilized people who value life and would not kill needlessly and recklessly, this is a most important feature. After all, our aim is to break the enemy's will to resist, and to do so with a minimum of destruction of both life and matter.

But to return to our discussion of targets: the greater their resistance to fire, blast, and radioactivity, the less the military effectiveness of the atomic weapon. Suppose the attack is directed not against a city but against an underground plant, or a modern concrete military objective such as a vital headquarters or a submarine pen or an atomic-energy plant shielded by massive concrete walls and roof. Then an atomic missile like the ones used on Japan could not duplicate the effects of an armor-piercing missile, rocket-driven to increase its terminal striking velocity.

The atom bomb, in short, is not an all-purpose weapon. There are, of course, tactical conditions and targets which justify its use. There are other targets and other conditions in which the conventional explosives will give better returns for the investment of wealth and labor and materials. The atom bomb is efficient primarily against the bigger cities. It can be used to paralyze the functioning of large administrative centers and the nerve-knots of industrial life of a nation. But against small targets requiring pinpoint and precision bombing, its use would be both inefficient and stupidly wasteful. And obviously we would not want to use the A-bomb against friendly areas under enemy occupation.

According to Dr. Kring, an individual plant spread over fifty acres

can be demolished with one hundred tons of conventional bombs properly placed. If the same industrial potential is concentrated on only three acres, ten tons of explosive will suffice.

One obvious reason for using an atomic bomb on such a plant is that it cannot possibly miss a three-acre target. But the same assurance of hitting the target can be guaranteed by using one hundred tons of ordinary explosive instead of the minimal ten tons. This tenfold investment of TNT and incendiaries will still be vastly cheaper than a single atom bomb.

This assumes an industrial plant of the ordinary construction of World War II vintage. But suppose that it is a new structure designed to resist or minimize atomic offensives, not necessarily buried under the surface but built to withstand the blast pressures of an atomic explosion. Toward the end of the last war the Germans were beginning to build shelters of that immense vitality. In that event only a direct atomic hit will be effective. But one hundred tons of ordinary bombs, covering an area ten times greater than the actual target, will come closer to guaranteeing a hit. Even if the whole hundred-ton pattern misses the target, our loss will be insignificant compared to a wasted atom missile.

Another fallacy remains to be dealt with. When scientists talk of an atom bomb one hundred times more powerful than the one released in Japan, the layman is likely to assume, mistakenly, a hundredfold increase in potential destruction. But the *effective* part of the increased power is only the part that makes contact with the target, the rest being dispersed in space. We must visualize the released energy as a gigantic sphere, only the lower segment of which is useful in the operation.

Let us put it this way: If an atom bomb can destroy a given building one mile from the center of the explosion, it must be enlarged a thousandfold to destroy the same building ten miles from the explosion. The bomb must be one thousand times more powerful in order that the radial striking distance affected by the released energy may be extended tenfold!

What is more, in a modern city of steel and stone and concrete, the explosion would necessarily have to take place close to the ground. The additional energy will be in large measure absorbed by inter-

vening structures, so that the radius of total destruction is likely to be far short even of the theoretical tenfold enlargement. The popular error is in confusing a three-dimensional expansion of power with the linear distance to which that power is applied. Theoretically, *radius of destruction is proportionate to the cube root of the energy released.*

This is relevant to the projected hydrogen bomb, which, some scientists guess, may release one thousand times more energy than the A-bomb and would therefore have a tenfold radius of destruction. It is difficult to appraise the tactical implications of the H-bomb until more data are available. At this writing it is still smothered in question marks. Some scientists, among them a top nuclear specialist like Dr. Millikan, are dubious whether it can be produced at all; Sumner T. Pike of the Atomic Energy Commission placed the chances somewhere between "probable" and "possible." Others estimate its strength from ten to one thousand times the A-bomb. Estimates of the costs of developing the first H-bomb range from two hundred millions to two billions, a disparity of one to ten. The time estimates range from two years to infinity.

Personally, I doubt whether the H-bomb can be produced and *stockpiled* soon enough to affect the present political emergency. Even if it is made available, I do not believe that it will be unleashed, since it would mean the certainty of instant retaliation in kind. Our ability to strike back will remain no matter how destructive an enemy's attack on our cities; after all, the American atom-bearing air force will not be deployed at Forty-second Street and Broadway. The same considerations which stopped the Nazis from using poison gas against enemy populations or slaughtering all prisoners of war are likely to be operative with respect to H-bombs. Moreover, as we have already seen, further release of energy at one point is not necessarily desirable or militarily efficient; a few A-bombs properly dispersed may be far more devastating, and at a critical saving in cost, than the theoretical H-bomb.

National conduct of war does not aim at killing for killing's sake. It does not seek to annihilate but to *disarm* the adversary. This sets limits on the military utility of A-bombs; and the larger the bomb, the narrower those limits. If and when a hydrogen bomb of the extreme dimensions under discussion is produced, its use may prove prohibitive,

both economically and in terms of the retaliation it must provoke. The science of war will not be abolished. Relative abilities to deliver destruction—which is to say air power—will still remain the decisive factor in the equation. Indeed, as the power of the atomic bomb is increased, the ability to carry retaliation in kind, regardless of enemy defenses, becomes paramount. As the threat of annihilation grows, the importance of *insurance of survival* grows with it, and that today means preponderant air power for offense and defense alike.

Of course, nuclear physics is in its infancy. The phenomena of fission have yet to be explored and applied. We have a right to speculate about bombs that will touch off endless chain reactions of destruction, capable of disintegrating a nation, a continent, a planet. Such speculations make exciting and nerve-tingling Sunday supplement articles. But there is no reason to allow them to distort strategic thinking and planning. We are still in the primitive stage of the development of atomic weapons. The next war, if there is one, will be fought within the confines of that stage.

Yet in the panic mood generated by the first exhibit of atomic destruction, mankind was stampeded into a species of hysteria. There was talk—since then muffled but by no means silenced—about the existing military forces having been canceled out, about military science having been obsoleted. Great masses of people, it would seem, have worked up an emotional stake in the bomb. In the anger with which they react to contentions that the atomic weapon is not apocalyptic, that the end of the world is not yet in sight, there is an undertone of disappointment. I must leave it to psychologists to explain this state of mind.

5

THE PREVAILING MOOD of hysteria was reflected in far-fetched theories of overwhelming one-blow attacks on the United States by atomic saboteurs in our midst. Bombs in suitcases would be planted at key spots in important American cities and exploded on signal from a foreign foe. Bombs conveyed in innocent-looking ships would be detonated in our great harbors, simultaneously, crippling coastal commerce and inundating the port cities with radioactive tidal waves.

The underlying notion—based on the dramatic Japanese surrender—seemed to be that a few bombs in the right places could force a country to quit. If two bombs sufficed for Japan, then half a dozen or a dozen could make Uncle Sam cry uncle!

The superstition that there are "easy" one-shot methods for knocking out a great nation may be good enough for the cartoon comics; it has no place in serious strategic thinking. If it causes the jitters and if it puts brakes on genuine preparedness for genuine military struggle, it can be positively harmful.

Sabotage has always been a hazard in time of war. But its value has been of the nuisance variety. It has never determined the outcome of a conflict. Conceivably a resourceful adversary might smuggle a few atom bombs into a country and explode them, doing great damage. But that this can possibly be carried out on a decisive scale is quite inconceivable.

We have need for keen intelligence work to intercept such dangers, but they can be discounted in basic war planning. Surprise blows on a sabotage basis may work out on paper. In practical warfare there is no substitute for sustained and organized combat.

When radio was first developed, there was a wave of apprehension in most military circles. Until then spies could transmit information only visually or orally, and therefore be easily detected. But radio was invisible and, at the point of origin, inaudible. Here, it was thought, was a means of safe espionage that left a country helplessly exposed. The spies could transmit all vital information without possibility of detection. But soon enough this threat was eliminated by the discovery of effective countermeasures. The direction finder was developed. Today no one can transmit radio signals without being swiftly located. I have no doubt that the atom-bomb saboteur will meet a similar fate. There are so many factors entering into the handling of the atomic weapon that methods for locating installations are inevitable.

The most widely feared of the sabotage theories is "suitcase warfare." According to this fantasy, compact atom bombs will be brought into the country in packing cases, presumably by characters wearing false whiskers; they will be deployed at strategic points and exploded on signal from abroad.

The scheme does not survive calm examination. The bombs them-

selves and the paraphernalia for exploding them in a stationary position are too massive and bulky for easy secret handling. Contrary to the popular notion, the bombs cannot be kept in any old cellar or loft awaiting zero hour. There are technical problems of storing and maintenance—proper temperatures to prevent decay, for instance—which demand large premises, continuous servicing, and considerable personnel. A "suitcase offensive" on foreign soil would therefore be a major effort involving major dangers of accidents, denunciations, and discovery. And discovery of a single bomb would instantly alert us.

Even if successfully stored and detonated, the bombs would not cause enough havoc to be worth the risks. They would necessarily be exploded close to the ground, with destruction narrowly localized. Dr. Lapp reduces what he calls "a basement burst" to its proper proportions. Assuming the detonation of a secretly stored bomb in the basement of City Hall in lower Manhattan, an area of skyscrapers, he writes:

"Those who expect that the City Hall would be completely vaporized overestimate the power of the bomb. They should remember that at Alamogordo [New Mexico] the base of the hundred-foot iron tower still remained intact. *Even objects only one hundred feet from the center of the bomb explosion were not completely destroyed.* It is also pertinent to recall that the bomb crater at Alamogordo was only three hundred feet in diameter and quite shallow. This area, which is still *detectably* radioactive, is by no means *dangerous* today and was a hazard for only a short time." *

What would happen to the City Hall structure?

"Undoubtedly the building itself would collapse," Dr. Lapp believes. "There would be a considerable earth shock in the vicinity but the actual displacement of earth to form a crater would not be enormous. A crater some five hundred feet in diameter might be expected. Major physical damage would be confined to an area not more than one thousand feet in radius, but the blast wave would undoubtedly cause superficial damage to buildings at a greater distance." †

Obviously such descriptions are highly speculative. But I agree that the damage would be strictly local. It could not paralyze the life

* *Must We Hide?*, by R. E. Lapp, page 81.
† *Ibid.*, page 80.

of a great city like New York or Pittsburgh or Chicago. Of course, if exploded at a vital point, such as a central powerhouse, it might temporarily dislocate a city's life. But that is true of any kind of sabotage, whether with conventional dynamite or the latest atomic explosives.

Another of the hysteria-born theories assumes the deployment of ships carrying atom bombs in our major harbors, ready to explode themselves and drench the port cities with atomically poisoned waters. The theory derives from one of the phenomena observed in the underwater burst at Bikini. I saw that phenomenon with my own eyes.

This is a convenient point for recalling the exaggerated expectations aroused by the advance announcements of Operation Crossroads. Earthquakes and tidal waves were forecast that would be felt thousands of miles from the scene. The temperatures unloosed, we were led to think, would melt the steel of ships; all fish and marine vegetation would be wiped out; mountain-high waves would wash away and great winds uproot every tree and man-made structure on Bikini Island. The whole ocean, it was feared, would be poisoned for a long time by radioactivity. Artists gave rein to their imaginations: I recall a drawing in which huge aircraft carriers were sliding down the steep walls of tidal waves to their nether doom.

Not one of these fevered prophecies came true. The extreme temperature at the center of the explosion lasted only for the twinkling of an eye. In the words of one observer, "its effect on ships is a flash 'sunburn'—surface paint blistered but undercoat unburned even within half a mile of the air burst." The wind velocities set up by the explosion fell away rapidly, so that not a leaf was wrenched from a Bikini tree. No ships were "melted" or "evaporated." Even light destroyers were floating upright when the waves subsided.

The towering water spout created at the point of detonation collapsed quickly. By the time its impact reached the island the waves were only about four feet high. They did not drench Bikini much beyond the high-tide water line. Yet this is the phenomenon on which the "harbor explosion" theory rests.

The "base surge" set moving by the underwater explosion was estimated to possess an initial velocity of about fifty miles an hour. But by the time it reached the Bikini shore its force was spent. It must be

remembered, in addition, that the Bikini lagoon is extremely deep in comparison with the shallow waters of a protected harbor like Boston or New York. A bomb exploded in a typical harbor could not possibly produce comparable water spouts and waves; there simply isn't enough water.

Besides, the Bikini surge was unimpeded, whereas in New York or Boston or Norfolk its force would be stemmed and broken by the large buildings. The zone drenched would hardly be more than a few hundred feet deep. Any poisoned spray, too, would be cut off by the city buildings and its possible danger thus narrowly restricted. At worst it would constitute a costly episode of sabotage, but of minor value in the overall struggle.

6

It seems to me that the Atomic Energy Commission was born in the superheated atmosphere of atomic excitement. Its primary purpose was presumably to promote peacetime uses and commercial exploitation of the new source of energy. These are important objectives. No one "underrates" the ultimate civilian values.

Under the initial impact of the thrilling atomic story, uncritical and credulous Americans saw atom-driven ships, planes, and trains around the corner. The coal, oil, and electric power industries were led to worry about their tenure. But since then the optimism has abated; scientists themselves estimate the time factor for non-military uses at from ten to fifty years. Dr. J. Robert Oppenheimer, giving his views on commercial atom power to the United Nations Atomic Commission in August of 1947, said that no practical demonstration could be expected until 1952. But, he added, it will be somewhere between 1977 and 1997 "before atomic energy can in any substantial way supplement the general power resources of the world."

Dr. Lyle B. Borst, Major General L. R. Groves, and others have gone on record with cautious statements similar to that of the distinguished Italian scientist Dr. Enrico Fermi. Testifying before a Congressional committee on July 8, 1949, Dr. Fermi said that people had been "somewhat underestimating the difficulties," and concluded

that he does "not expect extremely startling industrial results for at least very, very many years to come." * There is substantial agreement that atomic energy as a civilian power factor is in no sense immediate.

The only non-military feature of the atomic force actually developed is the radioactive isotope for radiological medicine. According to press dispatches in October, 1948, five pounds of that substance had been produced at that point, though many billions had been spent in the process. To package the five pounds for worldwide distribution required some 100,000,000 pounds of "wrapping."

Without belittling the value of isotopes or the eventual commercial-industrial potential of atomic energy, the fact remains that at this stage atomic energy is essentially and overwhelmingly a military potential. And it is sure to remain primarily military for the next ten years -a critical period in world affairs during which a life-and-death *military* decision may have to be made in our world.

Under these circumstances the creation of a civilian body in this area seems to me premature and unrealistic. To the extent that this may detract from the fullest military exploitation of the new factor it is also unhealthy. By the same logic we might as well set up an Interplanetary Commerce Commission since the progress of rockets leaves no doubt that interplanetary communication is only a matter of time.

Dr. Fermi testified that the obstacles to the commercial exploitation of atomic energy are not theoretical but "of a technical nature." The same thing is true of interplanetary rocketry. The problems of a man-carrying rocket to the moon have been theoretically solved, and the vehicle designed, for a long time. What holds us back is likewise minor problems "of a technical nature." On the whole, therefore, an Interplanetary Commerce Commission has almost as much justification at this time as a civil Atomic Energy Commission.

In the dawn of the aviation epoch, the initial large-scale utilization of aircraft was entrusted to military direction. Research and development by our government was conducted in terms of national defense. The creation of the National Advisory Committee for Aeronautics before the First World War was promoted by military considerations.

* Investigation into the U.S. Atomic Energy Project, Part II, pages 866-7.

Only after the commercial use of aircraft expanded to an appreciable degree did we establish a Civil Aeronautics Authority in the Commerce Department.

No one can guess what would have happened if immediately after the Wright Brothers' flight our government had set up a civilian Aviation Commission with exclusive power of research, control, and regulation, military and non-military alike. This, by analogy, is precisely what we have done in the atomic domain—and at a time, moreover, when the military importance of atomic energy is an urgent fact, involving the very survival of our country and our civilization!

Only time will tell whether this is a mistake: whether we have been wise in putting the accent on commerce at a time when the new force is almost exclusively military. My own belief is that until the balance swings toward civilian uses, our approach to atomic energy ought to be frankly, intensively, unimpededly military, whether this energy is explosive, propulsive, or any other type.

When atomic energy is ripe for use in transportation, the principal beneficiary, we may be sure, will be aircraft. Every scientific advance in propulsion hereafter will pay greatest dividends in the air.

Atomic propulsion may bring great economies in surface transport, but it can have no revolutionary effects. Railroad engines, for instance, can already be built with power beyond what a train can absorb, so that a further increase in energy will change nothing. The speed will be limited by tracks, and carrying capacity by practical restrictions on size of cars and length of trains. Nor will atomic power basically alter the automotive picture. The limiting factors here are not in the engine, but in practical ceilings on speed, weight, size, head clearance—none of which will be materially affected by the availability of tremendous power.

Sea transportation will also draw comparatively small benefits. The laws of physics set bounds on speeds on or under water. Tonnage limits will be fixed by structural considerations—after all, it would make no sense to build a liner a hundred times as large as the *Queen Mary*.

In the air, on the contrary, the effects of atomic propulsion will be revolutionary to a degree that staggers the imagination, particularly if the energy is available at virtually no weight. Interplanetary com-

munication will become practical. Aircraft will be able to transport tonnage restricted only by the dimensions of the plane, just as in an ocean liner today. With such power at their disposal, planes will be able to rise vertically; to hover; to fly with unlimited speeds for unlimited distances. Indeed, with the advent of atomic propulsion, the surface of the earth may well be largely abandoned as a roadbed for transportation. Everything will move in the air, including even individuals, in personal carriers no larger or more complex than a motorcycle.

The future, in short, promises ever greater and ultimately absolute dominance of air over all surface forms existing or yet to be devised. And the predominant form of transportation, as we have seen, always defines the predominant military strategy of its era.

7

Estimates of the number of atomic bombs required to destroy a great nation range from 40, the figure used by journalist William L. Laurence,* to 6,500, that used by Dr. Stefan T. Possony, "*provided* no bomb carriers are intercepted and no defensive measures against atomic bombs are taken." †

To get a clearer picture of this issue, let us attempt to translate the actual aggregate World War II Anglo-American aerial attacks on Europe into atomic equivalents. Naturally, the calculations can be no more than very rough approximations. There are too many imponderables for hard and fast ratios. The size and destructiveness of the bomb are variables, as are the effects, depending, as we have seen, on the character of the targets, the altitude of detonation, and other factors. But there is fairly general agreement on some basic figures.

The Hiroshima bomb annihilated 4 square miles, a total destruction which could have been duplicated by 2,000 tons of ordinary bombs. The equivalent for one atom bomb here is therefore 2,000 tons, but the ratio is reduced as we consider more resistant targets.

Take Hamburg, for instance, both the modern center and the flim-

* Town Meeting of the Air, October 25, 1949, page 9 of published text.
† *Strategic Air Power,* by Stefan T. Possony, Infantry Journal Press, 1949, page 61.

sier outskirts. The British dropped 7,196 tons on this objective and the Americans 800 more, a total of about 8,000 tons. With this they destroyed 10 square miles—800 tons per square mile. The consensus is that the Hiroshima bomb applied to a city like Hamburg would have razed 1½ square miles, making the equivalent for that target 1,200 tons of conventional explosives to one atom bomb.

To destroy one square mile of the heart of an average modern American or German city, about 1,300 tons of TNT would be needed. An atomic bomb exploded low enough to deal with such a target would destroy about ⅔ of a square mile, making an equivalent of about 900 tons to one atom bomb.

Finally we come to the sturdiest and most resistant urban target, the steel and concrete centers of modern cities like New York and Chicago. I subscribe to the estimates made by Dr. Lapp, Dr. Kring, and others, to the general effect that the Hiroshima bomb, exploded low enough to achieve severe concentrated destruction, would wipe out about ¼ square mile. With conventional explosives a square mile of such a target requires perhaps 2,000 tons, making the equivalent per atom bomb 500 tons.

Thus we have ratios ranging from 2,000 tons, when a highly fragile and inflammable target is involved, to 500, when blast- and fire-resisting objectives are involved, pointing up the fact that *the more resistant the target, the less efficient the atom bomb becomes as compared with ordinary bombing.*

The reasons for this rapid drop in atomic efficiency have been sufficiently explained in the foregoing pages. To put the idea in the most elementary form: An atomic bomb equal to 20,000 tons of TNT (40,000,000 pounds) can destroy a brick house 2 miles away; but that same house can be destroyed with only 500 pounds of explosive deposited on it directly.

According to official American computations, the Allies dropped a total of 2,638,000 tons of bombs on Germany and German-held Europe. This tonnage is broken down according to types of target, as follows:

1. Land Transportation 800,000
2. Industrial Areas 640,000
3. Military 300,000

4. Oil and Chemicals	250,000
5. Airfields	190,000
6. Aircraft Factories	48,000
7. Others	410,000
TOTAL	2,638,000

In order to transpose this aggregate tonnage into atomic terms, we must divide the targets into two categories: those that are inflammable and blast-susceptible, and the balance, more fire- and blast-resistant.

The whole of the tonnage applied to Industrial Areas and Oil-Chemicals, as well as about one-half of the explosives absorbed in the Military and miscellaneous (Others) groups, fall into the first category. We are safe in taking the Hamburg 1,200-to-1 ratio for these targets. The total being 1,250,000 tons, it would require about 1,000 atom bombs to attain the same amount of destruction.

For the balance, 1,388,000 tons, we must use the smaller 500-to-1 ratio, giving us 2,800 atom bombs. In other words, a total of 3,800 A-bombs is the equivalent of the 2,638,000 tons of non-atomic explosives unloaded on Europe.

But a far-reaching corrective is inescapable at this point. There were innumerable bombing objectives which would have been utterly unprofitable for atomic attack. Submarine pens, bridges, railroad depots, dozens of other targets calling for pinpoint demolition would have absorbed one atom bomb each, had we insisted on using no other types. Important but relatively small and isolated factories likewise would have required one atom bomb apiece. The estimate of 3,800 must therefore be stepped up to allow for such targets, raising the figure, conservatively, to 5,000 atom bombs.

Theoretically—assuming that atomic explosives only were used—5,000 is a fair and even modest atomic equivalent for the non-atomic destruction imposed on Germany and its associated or conquered territories.

This obviously is a long way removed from the vague talk about forcing a nation to surrender with "a few" or "a handful" of atomic missiles. A stockpile of 5,000 is many times larger than the whole world possesses or is likely to manufacture in a few years. Their cost,

not in monetary terms only but in labor and materials, would be enormously in excess of the cost of the 2,638,000 tons of old-style demolition and explosive bombs actually used. We need only think of the annual appropriations for atomic purposes and relate those to the likely size of our stockpile (still a secret but known in a general way) to realize that the enterprise begins to look economically preposterous.

Besides—and here we are at the crux of the matter—while the atom bomb would be an efficient substitute against some of the targets, it would be entirely unsuited for others. We must analyze the total destruction to determine against which of the targets atom bombs could be reasonably applied.

Our problem is to estimate what proportion of the tonnage, dropped on each of the target groups, might be *efficiently* replaced by atomic explosives and then to apply the TNT-atomic ratio appropriate for each group. Taking them in the order as listed by the Survey:

1. *Transportation:* This is clearly an unprofitable atomic target. Trolley tracks and overhead trolley cables in Hiroshima were back in use within two days after the atomic attack. Marshaling yards and even some depots could withstand atomic blows. Pinpoint bombing with appropriate non-atomic explosives is called for. Thus in attempting to transpose the destruction into atomic terms, at least 600,000 of the 800,000 tons must be reassigned to "old-fashioned" weapons, 200,000 being reserved for atomic doom. Since transportation objectives are virtually all exceedingly resistant, the 500-to-1 ratio is in place—indicating a need for 400 A-bombs.

2. *Industrial Areas:* Some of these were concentrated in large centers and would have justified the use of atom bombs. Others were isolated plants, or types of structures requiring precision demolition, and therefore to be dealt with more effectively and economically by non-atomic bombs. To use the A-bomb against these small individual targets would be like shooting squirrels with 75 mm. shells. We are safe in assigning about ⅗ of the total, or 480,000 tons, to the atomic column. Here the Hamburg or 1,200-to-1 standard is applicable, giving us again 400 A-bombs.

3. *Military:* Not more than one-half of these, or some 150,000 tons, can be earmarked for atomic demolition. Lying somewhere between

the extreme ratios, 750 tons per atom bomb is reasonable, with 200 A-bombs indicated.

4. *Oil and Chemicals:* These might be dealt with largely atomically, let us say to the extent of displacing 200,000 tons. Being considerably more resistant than average area targets, let us assign a 1,000-to-1 ratio, with 100 A-bombs again indicated.

5. *Airfields:* The employment of the atomic weapon against these would be sheer waste, and inefficient as well. Nevertheless, let us suppose that 50,000 tons might in exceptional cases be substituted for by atom bombs. Being isolated and highly resistant targets, the 500-to-1 ratio applies, giving us 100 more A-bombs.

In the last two categories—*Aircraft Factories* and *Others*—we can safely divide the job on a fifty-fifty basis, putting an aggregate of some 225,000 tons into the atomic column. Using the Hamburg ratio, this would add 200 A-bombs to the total.

When we add up these estimated replacements as translated into atomic equivalents, we get a total of 1,400 atomic bombs, with the difference—1,329,000 tons—remaining for destruction by the conventional types of bombs.

The explosives rained on Germany were carried by B-17 Flying Fortresses and Liberators with an average of 3 tons in useful striking power. It therefore required nearly 1,000,000 sorties—that is, flights by individual bombers. Had we employed B-29's with a 10-ton capacity, the sorties would have been cut to 270,000. With atom bombs taking the place of nearly half the tonnage, the sorties are reduced to about 135,000, of which 1,400 would be flights by aircraft conveying atom bombs.

This seems a substantial reduction of effort. But the picture is a lot less optimistic when we consider *attacks* instead of sorties. The attack, by a formation of bombers with their complement of escorting combat force, aims at the annihilation or neutralization of a given target. The number of attacks is not determined by the character of the explosives but by the number of targets and their distribution in the enemy territory. Generally speaking, it is not variable; the number of attacks required would not have been too much affected by the substitution of the atomic for the pre-atomic missiles wherever possible.

In delivering an atom bomb, the attacking force will have to be formidable. When one hundred or more old-style bombs are to be dropped, some planes will reach their mark and others will be shot down. But when the entire bombload in a given attack is in a single package, in one bomb carried by one plane, the margins for failure must be reduced as near to nil as possible. Should the one bomber be intercepted, the whole attack would fail. Vastly more elaborate escort force must therefore be set up, requiring more planes and therefore offsetting the saving in sorties.

In addition, future defenses will assuredly be more effective. The strategic surprise element will be drastically reduced. That in turn will demand still more technical and expensive protective forces. The overall complex of aviation per attack will consequently not be substantially smaller—certainly no smaller when reckoned in economic terms—than in the past.

Thus, while the number of sorties could be reduced by nearly half, the number of attacks would remain about the same. And the overall air effort as measured in tonnage of aircraft employed to make delivery possible, as well as the aggregate crews, would probably be no smaller than in the actual World War II effort.

These estimates are of necessity rough. But they do sketch the basic picture. Discounting mistakes in both directions, they should suffice to end the notion that the advent of the new explosive has miraculously "simplified" the task of defeating a great nation; that the next war will be decided in a few days or a few weeks. To destroy the war-making vitals of a well-prepared and mighty belligerent will take not a few but thousands of atom missiles, along with millions of the non-atomic varieties.

As one who has fought against inertia and apathy in relation to air power, I am gratified that the emergence of atomic energy has found an alert public. But I see no excuse for a frenzy that hampers understanding and sensible planning. Our only safety is in a calm contemplation of the truth, so that we may place the atom bomb in a reasonable relation to existing forces.

After my return from Hiroshima and Nagasaki I urged a cooling-off period on atomic speculation. I still feel that we need time and

strong nerves to digest the new facts. There will be no common-sense ceiling on fantasy unless the American people have those facts.

Excessive secrecy and mystery—on matters which are neither secret nor mysterious to nuclear scientists and engineers in other countries—is a product of the hysterical temper and also fortifies that temper. The American people should know where they stand in the dawning atomic era. Only then can they avoid fatalistic apathy at one extreme and overconfidence at the other. "Atomic energy injects a vital and perhaps revolutionary new factor into military science and world relations. But I do not believe that the revolution has already taken place and that we should surrender our normal faculties to a kind of atomic frenzy." *

A future war will not necessarily be decided in one wild atomic flash. The twenty-four-hour or twenty-four-day victory is a tempting vision—at least when it presupposes *our* victory—but hardly a sound basis for planning national security. A new world struggle may last years, with triumph for the side that can mount and sustain an offensive involving huge attrition.

Neither the scaring nor the slaughter of the population in an enemy country will end a war. Only the actual physical elimination of the foe's means to wage war, the realization of the hopelessness of continued resistance, will bring surrender. The kind of explosives used to bring about this elimination will not alter this military truth.

At this point I must again underline that I am not "belittling" the atom bomb or its horizons of future improvement. My purpose is only to put some common-sense brakes on runaway fantasy; to help undo the mental mischief wrought by the heralds of apocryphal, cataclysmic, absolute, and all-purpose weapons.

The destruction of the industrial potential of a major country, to the point where its capacity to resist is canceled out, will call for gigantic effort, the application of the science of war, and extensive advance planning—precisely as in the pre-atomic era. The hit-and-run fallacies, the neglect of the combat factors, and the rest of the wishful thinking in the wake of the atom bomb must be forsworn in any serious preparations for warfare and victory.

* "Atomic Bomb Hysteria," by the author; *Reader's Digest*, February, 1946.

The atom bomb alone cannot win a war, because other brands of explosive have not lost their role. The notion that the new bomb enables us to carry war to an enemy easily and with relative impunity must be counted out.

Stripped of its doomsday aura, set in its proper place as a more potent but still finite explosive in the military arsenal, even the political implications of the bomb are more easily comprehended. To single out one explosive for special international treatment becomes rather far-fetched.

To outlaw the use of atomic missiles would be as illogical as outlawing planes or blockbusters, tanks or bazookas, and legalizing war only if it is fought with bayonets. In effect it would put a premium on technological backwardness. As long as resort to force remains to plague us, the American people should have no scruples in preparing to exploit their technological advantages to the limit, to guaranee victory. In both military and moral terms, President Truman is fully justified, it seems to me, in warning that the A-bomb would be used, "if the welfare of the United States and the democracies of the world are at stake." *

Once we are at war, whether or not this weapon is employed should be governed by purely military considerations. Naturally, wise and civilized strategists will apply the most humane methods of conducting a conflict and assuring victory; but the most devastating explosive if applied skillfully and on time may prove the most humane in the end.

It is not the atomic weapon, but *war itself*, that should be outlawed.

* In an address to new members of Congress on April 6, 1949.

DEFENSE IN THE ATOMIC AGE

1

We have discussed the atomic weapon from the angle of the offensive. Turning to defensive considerations does not require an abrupt switch of perspective. That the best defense is a vigorous offense is an old rule, but never before has its truth been more to the point.

If the contention is valid that superior means of delivery are more important than larger atomic stockpiles, then the heart of the defensive problem is in air power. When we reduce the enemy's aerial might, we reduce his ability to deliver destruction, the atomic kind included. Should we succeed in keeping him out of our skies altogether, we will for all practical purposes have eliminated the atomic threat.

True, the enemy will probably crash through to drop bombs—many or few—despite everything. But he will know that these cannot score a decision. He will be acutely aware that his own skies are wide open to our aircraft for overwhelming punishment. Under those conditions he is not likely to indulge himself in futile and provocative actions.

Since August 6, 1945, we have heard choral warnings that there is no defense against the atom bomb. They are curiously illogical, suggesting as they do that there *are* defenses against other varieties of bombs. But what defense did the inhabitants of Hamburg, Cologne, or Tokyo have against the saturation bombings with pre-atomic explosives that brought wreckage and wholesale death much greater than at Hiroshima? What defense was there on the high seas in pre-aviation eras against hostile naval force, except its elimination by superior naval force?

It is often assumed that for every weapon there is, or should be, a counterweapon. But there is still no "defense" against bullets and

bayonets, short of disarming or destroying the opposing soldier before he can use them. Human life is so fragile that, as between ordinary bombs and an atomic burst, there is little to choose. The candle flame is no less doomed in a mild draft than in a hurricane.

The appearance of every new instrument of war, from gunpowder to poison gas, from cannon balls to atomic bombs, has alarmed mankind to the panic point. We still remember the chill down our spines when buzz bombs began to fall on London. Momentarily the wielder of a new weapon has the physical and psychological advantage of surprise. But in time the balance is restored on the new level of destructiveness.

A direct hit will kill, whether it is a bullet, a half-ton demolition bomb, an eleven-ton grand slam, or an atom bomb. In every instance protection is provided by distance and by physical mass. The energy released by the atomic explosive being vastly greater, the shields of distance and mass must be correspondingly greater. But when we think of the atom bomb as the equivalent of a mass assault with two thousand tons of high-explosive and incendiary bombs—a familiar enough occurrence in the last war—the atomic attack loses some of its aura of *unique* and special hopelessness.

Huge casualties are in the nature of modern technological warfare. Advance planning, however, can minimize the toll of death and mitigate the sufferings of the wounded. As pointed out in Chapter IX, the staggering loss of life in Hiroshima and Nagasaki was in large measure due to the factor of absolute surprise, made worse by the utter bewilderment and panic induced by the novelty of the weapon. On this point, at least, there is general agreement.

True defense lies in the capacity of a nation to intercept and destroy the attacking force. This is "active defense." Beyond that there is only "passive defense"—the planned readiness to reduce the effects and to deal with them efficiently where they cannot be evaded. As in any other type of bombing, the final outcome will be decided by the relative ability of belligerents to absorb punishment while carrying more of it to the enemy.

This vigor under attack is the essence of passive defense. The first imperative, of course, is the fortification of the physical plant, of the country's productive potential. Obviously the entire surface cannot

be made impregnable. The job comes down to shielding the most vital organs of national life. In protecting warships, tanks, or aircraft, we do not encase them totally in armor; we only shield the portions most important for combat vitality and survival. The same reasoning applies to a country as a whole. Areas and structures germane to the successful prosecution of the war will logically be the enemy's priority targets and should, by the identical logic, be accorded priority in "armoring."

The second imperative is the fortification of the morale of the population. We need the robust popular morale that derives from confidence. Our people must realize that there *are* defense measures, properly and efficiently organized in good time. Large-scale evacuation of children and non-essential adults from vulnerable districts will be of the utmost importance in holding down casualties. Detailed mobilization, transport and resettlement plans, and the stockpiling of critical food and medical supplies in well-protected spots should be worked out far in advance of any war danger.

The morale of a nation determined to defend itself cannot easily be broken. Ideologically inspired people can withstand great amounts of punishment. It is never fear, horror, or misery which makes a people at war collapse but the actual elimination of the physical industrial means to make war.

Life is scarcely worth living at the price of permanent prostration before the specter of death. We do not fall into defeatism because earthquakes, cyclones, floods, epidemics, and, for that matter, highway traffic threaten us continually with sudden extinction. The perils of aerial bombing must be faced in the same common-sense spirit of calm courage.

Having taken every reasonable precaution, having provided adequate military force of the right kind to meet any challenge, having organized medical and other civil forces to deal with the various problems, a nation must go about its business of living without atomic jitters. Any other attitude merely gives the right of way to aggression and international extortion.

The "one world or none" approach being preached by some Americans seems to me at this stage militarily unsound and morally defeatist.

2

Most of the men and women in the atomized Japanese cities who survived at points almost directly under the explosions had been shielded only by the masonry of a modern building. Others had happened, by sheer chance, to be in natural earthen shelters.

"The most instructive fact at Nagasaki," the U.S. Bombing Survey declared, "was the survival, even when near ground zero, of the few hundred people who were placed in tunnel shelters. Carefully built shelters, though unoccupied, stood up well in both cities. Without question, shelters can protect those who get to them against anything but a direct hit. Adequate warning will assure that a maximum will get to shelters. . . .

"Analysis of the protection of survivors within a few hundred feet of ground zero shows that shielding is possible even against gamma rays. Adequate shelters can be built which will reduce substantially the casualties from radiation. . . .

"It appears that a few feet of concrete, or a somewhat greater thickness of earth, furnished sufficient protection to humans, even those close to ground zero, to prevent serious aftereffects from radiation. . . ."

It should be kept in mind that the chief killers in an atomic burst are blast and fire—exactly as in TNT and incendiary attacks. The defensive techniques are therefore of the same general order. Congested areas are the most vulnerable; they also offer the most inviting and profitable targets for atomic attack. The obvious theoretical answer is proper dispersal.

A modern industrial plant consisting of a dozen buildings in a tight cluster that can be damaged with a single A-bomb represents a profitable target. The same plant, if its buildings are separated from one another by, say, a mile, would require twelve bombs, which might mean more of an investment in national effort than the plant is worth. The use of ordinary bombs would be more sensible.

As a practical matter, however, dispersal is hardly a consoling answer. Ours is an urban civilization. Decentralization of life on a scale sufficient to evade bombing risks would be an undertaking of such stupendous size that it would soak up all our energies and pauperize

us in the process. Even if we were compelled to start so drastic a recasting of our physical pattern of existence, it would take many decades to finish. The emergency with which we are concerned is too immedate for that.

Within reasonable limits, of course, much can be done to obtain not total but *more* and *correct* dispersal. After all, the abolition of slums, the spread of population to spacious suburban developments, are desirable ends in themselves. The fact that they also cut down bomb hazards should stimulate these healthy trends. Greater safety in the air age should become a conscious element in planning, rather than an accidental by-product.

With respect to industry, too, it is self-evident that concentration raises the wartime risks. As far as it can be done without destroying efficiency, our production facilities should therefore be distributed over larger areas. In projecting new factories, certainly, the safety factor with reference to bombing must hereafter be taken seriously into consideration.

Industries vital for war-making, and particularly for air power, ought not to remain close-packed at a few points. That amounts to putting all our eggs in one basket. In the next war many of the most decisive products will be of recent or entirely novel development: the atom bomb, radar, jet and rocket engines, electronic devices, guided missiles, etc. Of necessity their output will be expanded in the years ahead, necessitating new industrial construction. It would be unpardonable if we did not exploit the opportunity to disperse the new facilities and to make them bomb-proof from the outset.

I am not suggesting that industry arbitrarily be spread thin over the entire country. The danger of such extreme dispersal, as German experience showed, is that it makes industry too dependent on transportation. Enemy bombers are thereby provided with another and sometimes easier method for stalling production—by wrecking transport facilities.

It should be noted that American transport enjoys certain advantages compared with that of Soviet Russia. Besides railroads, we have unequaled systems of motorized and air communications. The cutting of rail lines would simply throw more traffic into motor vehicles and airlift. The crippling of motor highways would be answered with

more caterpillar trucks. An enemy who plans to paralyze our life by wrecking transportation will be faced with a formidable task.

I do suggest that component structures of a given industrial unit be so deployed as to require a maximum number of individual bombing sorties. This would make the use of atomic missiles prohibitive, and the application of any explosives more difficult. Defensive dispersal, in other words, does not necessarily mean moving a Connecticut plant to Kansas.

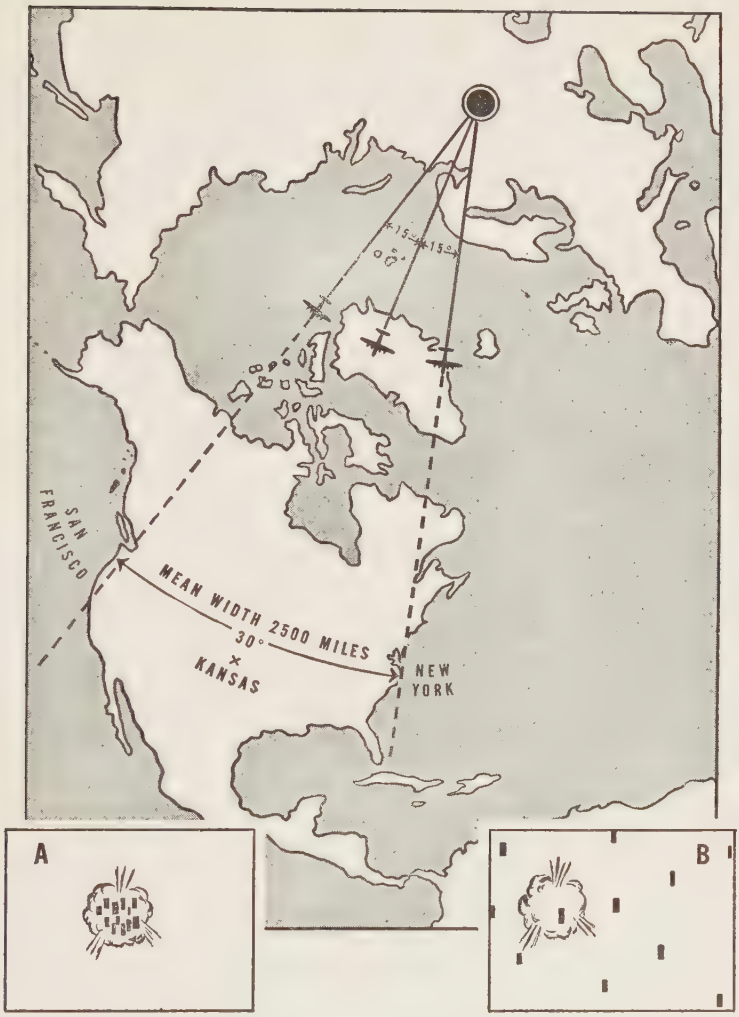
To an attacker across the North Pole, it would mean only a change of a few degrees on his compass course to bomb Kansas instead of Connecticut. What is important at either place is putting a few miles of distance between the various structures of the plant, so that their elimination in one blow becomes impossible.

The dangers of industrial concentration, in any event, are not products of the atomic age. The atom bomb has merely intensified a condition that has long been apparent. In 1942 I wrote:

> The hazards of the present excessively centralized industrial and power resources are obvious. Consider such extreme cases as those provided by the American manufacture of bombsights and other precision instruments for aviation, or of airplane engine production, at the outbreak of the war.
>
> A few tons of explosive well placed on a relatively few plants might have paralyzed all our airplane output! Despite the sacrifice in economy, decentralization of American industry in general, and war industries in particular, cannot be avoided. The value of dispersion and of both natural and artificial camouflage must hereafter be considered in planning factory construction. Certainly military defense enterprises must . . . be broken down into relatively small units scattered through the nation, each absolutely self-contained, fed by its own power-plant constructed far underground, beyond the reach of enemy bombs.*

From this point of view, great power aggregates like TVA, Grand Coulee, and Boulder Dam are weak points, running contrary to sound military defense principles, however desirable they may be in a purely peaceful context. Obviously they offer highly profitable

* *Victory Through Air Power,* page 327.



THE MEANING OF INDUSTRIAL DISPERSAL

For an airplane taking off from Russia, the distance to New York or Kansas City or San Francisco is about the same. Kansas City is therefore as accessible as a coastal city, requiring simply a 15-degree shift in compass course. Transfer of a plant from Connecticut or California to the Midwest does not make the attacker's task any more difficult. The essence of defensive dispersal is not in geographical location but in the local deployment of component units. A dozen buildings in a tight cluster (A) offer a profitable target, subject to destruction with a single atomic missile. The same buildings properly dispersed (B) would require 12 bombs and might make the attack unprofitable.

targets, since their destruction would cripple a large industrial area, and consequently would require substantial air defense.

The scope of camouflage has been greatly extended since World War II. In addition to visual camouflage, and deception by duplicating the structural contours of some valuable target, electronic deception will be possible. Distorted and misleading patterns can be produced on the enemy's screen; he will see and identify the electronic image of some city far from its true location.

3

In theory, the bombing threat, atomic and non-atomic, could be largely met by sinking our society deep underground, beyond the reach of blast, flash heat, and radiation. But in practice, again, this answer is scarcely satisfactory. The cure—reducing us to a race of molelike creatures—is not much better than the disease. There is little point in discussing any such far-fetched undertaking. Besides, an enemy need only plug the holes by pinpoint bombing to make the burial complete and permanent.

Yet the immunity offered by below-surface locations must be kept in view in projecting new factories, especially in the key war industries, and even in planning mass dwellings and office structures. Underground shelters like subways and deep cellars offer nearly complete protection against all the effects of an atomic burst, except in a direct hit.

In our largest cities a considerable part of the life of inhabitants is already below the surface. Anyone who has wandered in the maze of interlaced subways in Manhattan, or on the under-surface level of Radio City where the various buildings are linked through underground passages, is aware of this. It can be taken for granted that more and more essential functions will be carried on in those safer depths as a precaution against bomb dangers.

Civilian architecture will inevitably be affected by the air age. Materials will be increasingly selected for their resistance against bombs. Gathering places which do not require daylight—such as motion picture theaters, ballrooms, and banquet halls—may well be built underground as natural air-raid retreats. Advances in air conditioning and

artificial lighting may combine with this tendency to invert our architecture; skyscrapers may be built downward as well as upward.

In the initial stage of a war the offensive and defensive equipment *already in existence* must be given number one priority in the matter of underground protection (as well as dispersal, bomb-proof construction, and so on). The aircraft industry, repair and maintenance depots, stockpiles of explosives, radar detection facilities, fuel storage, centers of military administration—in short, the aeronautical potential in the widest meaning of the phrase—must be made as nearly immune to overhead assault as is humanly possible.

Why this element has been largely neglected in new industrial construction during and since the war is a mystery to me. We did move some of the enlarged aviation industry facilities to Texas, Oklahoma, and other interior sites. For better concealment and partial protection, these new plants were built without windows, being artificially lighted and ventilated. Such steps in the right direction, taken when the bombing threat was still very remote, make it all the more remarkable that subsequently, when the danger became more and more real, billion-dollar industries, representing sizable chunks of our national wealth, should have been grouped in a few aggregates above ground where they provide perfect targets for ordinary lightweight bombs.

According to Dr. Charles Kring, immense amounts of information were netted by our intensive studies of the behavior of structures under bombardment in World War II. Intelligent application of available data could make buildings two or three times more resistant to blast, at only a fractional increase in costs. But we need not delude ourselves that a plant below surface or built into a hillside is automatically made impervious to bombing. Much depends on where it is built, how it is designed, its power and communications facilities, a lot of other factors. Of what avail will a structurally bomb-proof factory be if it can be neutralized through destruction of its communications, so that neither raw materials can arrive nor finished products leave?

The Messerschmitt plant in Kahla, in the foothills of the Harz Mountains near Jena, home of the Zeiss works, is frequently cited as the great German achievement in underground construction. I spent an entire day wandering through the nether labyrinth, studying the

installations, entrances, and exits. In addition I flew over the area to appraise its vulnerability from the air. And I reached the conclusion that far from being the masterpiece of ingenuity so widely heralded, the Kahla project was a monstrosity from the viewpoint of efficiency. The subject is so pertinent to American aircraft manufacturers, industrial designers, and architects that it merits some attention.

The plant, built inside a hill, consisted of a maze of long corridors or tunnels, broadened at intervals into a series of assembly shops. The peak of the hill was leveled off into a sort of flattop or airdrome from which the finished planes—ME-262 jets—could take off. Access to all the entrances and exits was along a high, narrow concrete road winding on the side of the hill. Part of that road was of cantilever construction, supported by beams anchored in the hillside. Planes were conveyed to the flattop by a completely exposed escalator. Incredibly, all the engineering and administrative offices, instead of being buried like the rest of the plant, were in a structure projecting from the side of the hill like a great concrete wart. Though designed to withstand a direct hit by fairly large bombs, it could have been neutralized by an avalanche of earth loosened by small bombs striking above the structure.

As for the precarious road to the plant, and the escalator as well, a salvo of lightweight bombs would have sufficed to "shave" it off, making the whole enterprise useless. The airfield, too, was wide open to bombing. To bring materials, machinery, and labor to the top for repairs—along a road so easily blasted and blocked—would have been a superhuman job. Despite concealment within a hill, the plant was therefore extremely vulnerable.

To make matters worse, only the sheet-metal work, the facilities for air-frame manufacture, and aircraft assembly were centered at the Kahla hideout. All the engines, instruments, accessories, and other parts were brought from the outside, again by way of the exposed winding road. The successful bombing of any of the plants feeding parts to this factory would therefore have sufficed to make the entire effort worthless. Indeed, the more I looked the more I wondered whether some anti-Nazi saboteur had thought up the grotesque plan.

This is not the place for a full analysis of correct underground construction. Yet a few principles, based on my inspection of a great

many sub-surface installations both in Germany and Japan, deserve to be touched upon. Such plants must be made as nearly self-contained as is physically possible. Under ideal conditions, raw materials should roll in at one end and finished goods roll out at the other end. In any event, dependence on other plants for vital parts must be reduced to an absolute minimum. If it is an aircraft factory, the planes should take off from concealed runways, like bees leaving a beehive. It would be advantageous, of course, if the main approaches were through tunnels beginning miles from the main underground aggregate. If not, the approaches should be, as far as possible, on level ground, so that their repair after bombing raids will not be a major engineering problem. In supplying raw materials and other necessities, motor transport is preferable—highways being less vulnerable to bombardment than railways.

Underground protection, it thus appears, is not as elementary as it sounds. Invulnerability to direct attack is the beginning, not the end, of the problem. Numerous elements, such as accessibility, communications, power, raw materials, self-sufficiency, etc., enter into the design formula.

4

In addition to blast and incendiary effects, the atom bomb deals out death by flash-heat and by radiation. These are the unique atomic phenomena, especially frightening because of their novelty. Widespread education on these dangers will reduce the psychological factor, the element of paralyzing fear. A "mysterious" peril is infinitely more dangerous than one that is clearly foreseen and comprehended.

Our people must learn how flash-heat and radioactivity affect the human organism, and how to protect themselves against them. They must grasp the fact that effective shielding is possible and feasible. The proof is in the circumstance that hundreds of people in the atom-bombed Japanese cities within the immediate radius of explosion remained alive and unscathed.

Even the flimsiest wooden wall is enough to shield life against the moment of intense flash. Protection against gamma rays requires much greater mass. But the aggregate thickness of many intervening walls did the trick in Japan. The lethal effects of radiation depend, of

course, on distance as well as intervening mass. About a mile from the explosion, a foot of concrete will suffice to protect the human body; at ground zero three feet are needed. An inside room or corridor, placing several walls between you and the radiations, will spell safety. Much still remains to be learned about the effects and safeguards against radiation.

Burns of moderate intensity can be healed; they are no different in kind from the familiar effects of extreme sunburn. Under the urgency of the atomic threat, physicians are also learning rapidly how to treat radiation effects which, untreated, killed their victims in Japan.

According to the Associated Press, "a commercial dye, toluidine blue, has been found to be a potent antidote to one of the most deadly effects of the atom bomb." It stops hemorrhages caused by exposure to atomic rays, after which blood plasma is administered to the victim. At the Scripps Memorial Hospital in Lajolla, California, promising results in overcoming blood damage through radiation have been attained with a chemical from lemon peel.

Studies on animals at the University of Oregon Medical School have indicated the possibility of raising or lowering sensitivity to radiation. In October, 1949, five scientists reported encouraging experimental results in the treatment of atomic-radiation sickness with aureomycin. It is within the range of the possible that at the sound of the air-raid siren people will fortify themselves against radioactivity by taking prescribed tablets.

Whatever the ultimate value of any of these discoveries, the heartening fact is that medical researchers are at work on the challenge, and not without success.

Although the flash-heat in an atomic explosion lasts only for a fraction of a second, this is enough to scorch to death those directly exposed to it, and to inflict third-degree burns even at distances of over a mile. Ultraviolet rays—plain sunburn in extreme doses—caused more deaths than flash-burns in Japan.

On the other hand, a thin layer of masonry (wall or ceiling) can give full immunity. In the Japanese cities it was found that even clothing offered some protection. Garments of light colors deflected the flash better than dark shades. A white bedsheet over the entire head and body will ward off the momentary heat menace. The preva-

lent color in the next war is likely to be not khaki but white. White overalls and head cowls may well become part of the civilian defense provisions.

These random observations are intended only to indicate that foolproof shelters against atomic dangers are possible and should be planned without delay in areas subject to atomic attack. They seem to me suitable and urgent projects for municipal, state, and federal public works programs. In conjunction with an effective alert system, they promise to reduce casualties to a negligible fraction of those sustained by the unalerted and unsheltered Japanese populations.

Some of the shelters which I examined in Germany, erected in the last stages of the war, were perfectly immune to bombing, including direct hits by missiles up to two thousand pounds in weight. Those shelters would also have provided full immunity to atom bombing, except for direct hits. Retreats of this kind were built to accommodate the entire personnel of a factory building. As an additional precaution, they should be provided with a long underground tunnel. Thus even if an atom bomb exploded so close that the ground above became temporarily radioactive, the occupants could emerge at a safe distance.

There are protective measures the management of apartment houses, office buildings, even the individual family, can take. Atomic defense, like charity, begins at home. The atom-wise housewife will know in advance the safe or "blind" spots in her house, where neither radiation nor flash-burn can penetrate: a windowless corridor or a cellar, for instance.

New theaters, concert halls, sports arenas, and the like should hereafter be of massive construction, either underground or without windows, so that they could also do service as bomb shelters. They can be designed to accommodate tremendous numbers of people in an emergency. Underground passages connecting with subways would enable people to leave without fear of radio-contamination. Reasonable construction laws and regulations should require new large buildings to provide spacious cellars—perhaps designed to serve now as garages, indoor playgrounds, etc., to improve urban life, but available for instant sheltering purposes. Possibly the government could share the additional costs involved.

In private residences, a shelter outside or under the house is desirable, because of the hazards of fire and of walls collapsing from blast. A simple dugout will answer the purpose, provided it is fitted with an air-tight cover or ceiling of thick masonry. Lead, being most resistant to gamma rays, makes the most useful lining for such covers.

Many new American dwellings nowadays are erected upon a slab of concrete instead of the traditional foundation. If this slab is at least twenty inches thick at some point, a dugout under it will give immunity to blast, heat, and radiation. A simple manhole cover, lined with lead, located inconspicuously in some room or corridor and giving access to such a dugout, will in effect make a perfect one-family shelter as part of the house.

It is apparent that the American woman is destined to take a primary part in meeting the atomic challenge. The domestic preparations for atom-raid retreats are her sphere. Being at home, with radio and television at her disposal, she will normally be the first person alerted. Upon her cool head and steady nerves will depend not only her own life but the lives of those around her.

Moreover, skilled and swift first aid to victims will be more important than ever before. This responsibility will fall first of all on our women. They will have to learn in advance what needs to be done and how to do it, so that they can bring relief to their families and neighbors. The management of local shelters, too, is likely to be in the hands of local women.

The breakdown of normal provisioning is among the vital dangers inherent in a large-scale bombing. The deep-freeze will thus tend to become an item in the defensive preparations. Its proper stocking and the rationing of available supplies are clearly jobs for intelligent women.

Of course, upon emerging from the shelters people may find their home reduced to rubble or razed by fire. They will still be endangered by latent radioactivity, particularly close to the point of explosion. Geiger counters and more advanced instruments to indicate the degree of contamination, if any, will inevitably become a piece of everyday household equipment. Luckily they can be as easy to read as a watch or thermometer. Radio and TV sets can be made to serve as contamination warning devices through simple attachments.

5

ORGANIZED CIVILIAN DEFENSES such as firefighting, first aid, emergency housing, evacuation, public feeding, etc., on a national scale will add up to a vast undertaking. London under aerial blitz showed how much can be done to reduce the toll of death and suffering by timely and wise community effort.

The organization charged with planning and regulating this phase of defense will be large and elaborate, staffed by experts in many special fields and enlisting the collaboration of millions of volunteers. In the hour of crisis it would virtually regulate and control the lives of the mass of our population, unavoidably cutting into the freedom of the individual. The setup must therefore be kept strictly under civilian leadership—that is the logic of our democratic society—although in intimate liaison with the military high command. The head of the organization might be a member of the National Security Resources Board.

In local civilian defense organizations, it would be inexcusable if posts of leadership were treated as political plums. The lives of millions in our great cities will depend upon the personal abilities of the men chosen. Positions must be entrusted to experts who have the requisite experience and background, plus the personal prestige that will command confidence and intelligent obedience.

Fire being normally the greatest killer in air raids, fire-fighting techniques in all urban centers ought to be prepared to meet this special challenge. In studying devastated cities I observed that thousands of lives and much property were unnecessarily lost because fire-fighting vehicles and ambulances were blocked by debris and broken streets. Some arrangement for putting all such vehicles on caterpillar treads for emergency use seems feasible and well worth the investment.

In addition, fire-fighting machinery and ambulances ought to be housed in fireproof and bomb-proof structures, preferably located on large open squares, where they will not be bottled up by avalanches of rubble. Except for emergency units, the main fire-fighting and medical-aid facilities should probably be outside city limits, or beyond the vital target areas, to reduce the chance of their immobilization. They should be so deployed that they can converge quickly on the

bombed city and get to work. In Europe, as in the atomized Japanese cities, fire-fighting and ambulance vehicles were frequently destroyed along with the rest of the target.

Population centers located on rivers or lakes should be in a position to receive swift additional succor from seaplanes and amphibious aircraft, particularly for evacuation purposes. Flying ambulances and clinics deserve immediate consideration. Helicopters, too, will play an important role in rescue operations.

Detailed exploration of the needs and the possibilities of "passive defense" does not come within the scope of this book. But we may note in passing that radio and the fast-growing availability of television give Americans a real margin of defensive advantage. They will enable us to learn quickly how to protect ourselves and to keep abreast of any new means of defense. The last war proved that visual education is the fastest and most efficient method of training. Millions can be taught simultaneously by a single instructor how to use radioactivity detectors and other defensive gadgets, how to treat various injuries, how to improvise shelters.

In menaced areas the population can be given continuous guidance and instructions over the air waves. In case of large-scale damage to a city, maps flashed immediately on TV screens can indicate contaminated areas, detours, locations of first-aid stations, and the like. The use of short-wave radio telephones by private citizens in their homes and cars, and even miniature walkie-talkies, should be encouraged, so that the population is constantly in touch with the civilian defense authorities. In any emergency program for curtailing civilian production, television and radio must be regarded not as dispensable luxuries but as indispensable defense necessities.

In at least one respect cities under aerial attack in the future will differ from those in the past. There will be hardly any blackouts. Whether by day or night, future bombing will be done by radar and darkness will cease to offer protection. If electric power is switched off, the purpose will be the reducing of fire hazards through short-circuiting.

The insistence that there is no defense against the bomb is related to the erroneous popular conception of atomic war as a super-blitzkrieg to be decided in a matter of hours, or at most a few days. The

terrifying wallop carried in a single missile has focused people's thinking on the offense to the point of obsession. But this frantic state of mind is already beginning to wear off. The realization grows that this time, as always in the past when new death-dealing weapons have appeared, the defensive will in time catch up with the offensive. The human ingenuity which produced the offensive instrument will not be frozen at that stage; it will devise an equilibrium.

This is not wishful thinking, as anyone aware of the direction of military research in our country and other countries knows. The basic element in active defense, air mastery over the entire globe, is the message of this book. While that mastery is in the balance, each belligerent will gear to detect and stop the bomb-bearing airplanes before they reach their targets; he will perfect his machinery for instantaneously alerting the threatened area.

Where the offensive potentials of opposed nations are roughly in balance, the relative defensive potentials become decisive. Which is a formal way of saying that when the capacity to "dish it out" is equal, the nation best equipped to "take it" holds the upper hand.

The United States, as the world's most technologically advanced country, will enjoy distinct advantages. It is true that the physical assets of an industrialized nation are more vulnerable to bombing. But this handicap is more than balanced by our higher capacity for technological self-protection.

Defenses against high, fast-flying aircraft will have to function with the speed of electronics, which is the speed of light: 186,000 miles per second. The new jet fighters do not rely on human sight to locate and shoot at the enemy planes, but on automatic means and radar. Interception and anti-aircraft weapons will of necessity operate electronically.

In consequence of this, the defensive advantage will lie with a country densely covered with a network of electronic means: millions of miles of telegraph, telephone, and electric wires and conduits, elaborate radio and television networks. The mere statement of this truth attests our enormous advantage over a country like Soviet Russia.

America is virtually encased in a close-woven fabric of electric wiring and radio carrier waves that can be utilized for electronic de-

fenses without interrupting light, power, and communications. Despite its industrial progress, Russia remains comparatively primitive in this respect. It will be another generation at least before its gigantic spaces can be efficiently wired. Until then, gaping holes will remain in the Soviet electronic shield.

"The chief difficulty connected with radar detection of missiles directed at us in a future war," one expert warned in 1946, "would be that of separating the radar signals produced by such objects from those caused by friendly and normal air traffic. This calls for the development of an identification system of unparalleled effectiveness and subtlety. . . ." *

Perhaps he underrated American ingenuity. Only three years later, in the course of the Congressional hearings on the B-36, it was disclosed that we already possessed "secret equipment" that distinguishes between friendly and hostile aircraft.† Millions in our armed forces were taught the art of aircraft recognition in the last war. Now science again replaces and surpasses human senses, furnishing us with instantaneous and infallible identification of friend and foe.

The erection of a dense radar screen around the United States will be a costly enterprise. In proportion to the total defense effort, however, it will probably be no more expensive than the picket fence of Coast Artillery protecting the periphery of the country was in relation to total defense effort in the old days.

Naturally the Continental Defense Air Force, like the Strategic Air Force, must be "in being" and geared to instant action. Its magnitude and lien upon national resources should be second only to the Strategic Striking Air Force. Its present arbitrary deployment, without specific reference to priorities of objectives to be defended, has become anachronistic. Funds should be provided for more rational deployment, critical industries and the strategic bases of our retaliatory intercontinental air force having first priority. At the same time the air units of the National Guard, heretofore an adjunct of the Army and equipped with tactical aircraft, should be reorganized as defense units of the Air Force; their intimate knowledge of the localities in which they would operate gives them an advantage that should be

* *One World or None*, Louis Ridenour, page 38.
† Associated Press, October 10, 1949.

exploited. Not only aircraft but all types of aerial defense—warning radar stations, anti-aircraft artillery, guided missiles, etc.—ought to be unified in a single Command, under an airman in charge of the entire continental air defense.

In absolute terms the financial drain of proper defense will be heavy. Where is all this wealth to come from? No nation has the remotest chance of possessing adequate means for complete control of the air space above the enemy and over its own territory, and of generating the means for passive resistance, while continuing to pay for outmoded forces and installations on the traditional scale. From the angle of defensive necessities in the atomic age, we again reach the conclusion that we cannot afford the luxury of "balanced forces." To provide adequate air power and adequate defenses without bankrupting ourselves, we must devise strategy that boldly stops the heavy drains of supporting outlived and irrelevant military forces.

The economic facts of life can no longer be ignored in the military picture. The high cost of atomic warfare, in explosives and air power, has far-reaching implications. Our every defensive tactic—dispersion, bomb-proof construction, underground projects, electronic detection systems, etc.—will have to be paid for. At the same time they will oblige the enemy to use more atom bombs and aviation, to the point where his costs, in relation to results achieved, become uneconomic and in the long run prohibitive.

A nation prepared, with enough and the right kind of defensive means, geared to minimize and absorb atomic and other explosive damage, can force upon the adversary a rate of attrition in offensive action beyond his capacity. It will be a long time, I am convinced, before atomic weapons can be provided by any belligerent at a cost and in quantities allowing their use as lavishly as ordinary TNT and incendiaries can be used.

6

This is perhaps a convenient place for brief comment on hysteria in another dimension: the forecasts of horror unlimited through disease or biological warfare. Even the panic-mongering on atomic destruction pales when the bacteriological prophets take over.

In theory a biological offensive can be outlined convincingly

enough, given an ample supply of creepy adjectives. Actually, such a weapon of terror could not impose surrender, and therefore would boomerang against the belligerent who unleashes it. The history of war-making shows that resort to such terror weapons comes, if at all, in the extreme of desperation. No country will commit its major energies and resources to the manufacture and delivery of disease germs —and such an effort on a smaller scale, short of the magnitude for victory, would be futile.

Before World War II, extreme claims were made for bombing with poison gas. It was said that poison gas from the skies would result in "ghost cities" and even "ghost nations"; also that such attacks would have the advantage of destroying people instead of things, and that an attack of that kind on a capital city alone would bring panic and precipitate immediate surrender.

Yet we saw no use of gas in the last war. Why? Certainly not because of humane scruples but because poison gas, for all its diabolical qualities, was not practical enough to exact surrender. It represented a highly inefficient exploitation of offensive power. Its target was human life, but destruction of life while a nation retains its physical instruments for waging war can never in itself bring a decision. War against people is an unprofitable undertaking. Only war against the means to make war pays high military dividends. Neither gas nor bacteria will be used as long as there are more economical methods for compelling an enemy to quit.

Bacteriological warfare through saboteurs can be discounted at the outset. It would necessarily be on a minor scale, readily localized and isolated. No nation would conceivably undertake this strategy except on a gigantic scale through the air. For this purpose it would need absolute control of the skies, as a guarantee that the victim nation would not retaliate with the same weapon. But if it controls the skies it has less barbarous and more effective ways of imposing defeat.

In most cases simple and effective countermeasures are available. And the United States would start with a substantial advantage in a bacteriological war by reason of its high standards of sanitation, hygiene, and medical service. The elementary facts of aseptics and antiseptics, commonplace knowledge for Americans, are still deep mysteries to the majority of Russians. In the Pacific war, our troops

exposed to fever-ridden swamps and jungle diseases suffered less from those unaccustomed perils than the natives of those areas.

Over and above the old and the new drugs, many new protective methods are on the horizon of preventive medicine, and their development would proceed at a swift rate with the first sign of biological warfare. Radioactive salts, ionized metals, and radioactive alloys will play a great part in the defense against bacteriological threats. According to some scientists, the entire water system of a city could be sterilized with ionized metal alloys. As always in the past, the offensive menace will generate techniques of defense.

I am not implying that we should be complacent about the possibility of biological offensive, no matter how remote. We were prepared to meet a poison-gas attack and to use it in reprisal. If we are similarly prepared for bacteriological warfare, the chances are overwhelming that it will never come.

As for the so-called radioactive "clouds" that supposedly will drench huge areas and destroy all life, they are another product of the hysterical speculation which confuses the theoretically possible with what is, as yet, highly improbable. The technical difficulties of shielding radioactive materials for producing such clouds are every bit as formidable as those that hamper the use of atomic energy for industrial and propulsion purposes. It is still highly problematical whether it would be possible to deliver by air the substances for generating radioactive clouds.

By the time such problems are solved, countermeasures are likely to have been developed. One such measure has already been suggested by Dr. Oleg Yadoff, a scientist formerly at the Sorbonne and now with Columbia University. He has devised a process for creating clouds of electrically charged particles; in contact with radioactive clouds, these will decontaminate them completely or at least reduce them to a non-lethal dose.

Even such a brief appraisal of our defensive capacity, both passive and active, indicates that if we force the enemy to fight on our terms —to accept air battle—we can attain decisive superiority.