

capacity and destroy multiple DGZs simultaneously, but as ballistic missiles came into prominence, the total yield of the U.S. stockpile declined to reflect the missiles' more critical weight requirements and greater accuracy. ("The rule of thumb," write the weapons historians Robert S. Norris and William Arkin, "is that making a weapon twice as accurate allows an eightfold reduction in yield while achieving the same level of destruction.")

Most Soviet nuclear weapons were tactical, designed for crushing NATO if a conflict arose with Warsaw Pact forces in Europe; the total Soviet arsenal in 1960 of seventeen hundred bombs and warheads included only about 350 strategic weapons. The small Soviet bomber force had been supplemented by late 1960 with only four intercontinental ballistic missiles and a limited and primitive force of submarines carrying short-range missiles. The Soviet bombers were slow and vulnerable; the KGB kept missile warheads separate from the missiles, which required up to twenty-four hours to assemble, warm up, and fuel; and the submarines, which were normally kept in port, would have to cross the Atlantic or Pacific to within about two hundred miles of North America and surface to launch their missiles. "The Soviets had paltry forces," comments the former secretary of defense James Schlesinger—"hardly enough to stage an attack on the United States."

Coordination of multiplying U.S. nuclear strike forces had become an obvious problem by the mid-1950s. "It became possible for fighter-bombers to carry megaton weapons," the chairman of the Joint Chiefs would explain. In consequence, the tactical air forces, the Navy, and the Army added nuclear weapons to their ordnance. SAC controlled about half the arsenal; commanders in Europe, the Atlantic, and the Pacific controlled the other half. Targets frequently overlapped, wasting weapons and threatening fratricide. The Joint Chiefs first tried to solve the problem by ordering annual World-Wide Coordination Conferences convened at the Pentagon where commanders could get together to swap and coordinate their targets and try to resolve what an official SAC history calls "the complex problems of generation, launch, mutual support and maximum bombing involved in preparing a single command's strike plan." But targeting duplications and triplications were not significantly reduced, the history notes. Exercises between 1958 and 1960 by the successors to these conferences, Joint Coordination Centers in Britain and Hawaii that were supposed to handle actual operational coordination, turned up more than two hundred "time over target" conflicts during which the aircraft or missiles delivering the weapons would probably inadvertently blow each other up.

The solution to the problem, the Joint Chiefs concluded in 1959 after

prodding from the secretary of defense, was that "atomic operations must be pre-planned for automatic execution to the maximum extent possible." Thus was inaugurated the Single Integrated Operational Plan (SIOP), developed initially under the direction of Air Force Lieutenant General Thomas Power, who succeeded Curtis LeMay as commander in chief of SAC from 1957 to 1964.

John F. Kennedy was briefed on the first plan, SIOP-62, by the chairman of the Joint Chiefs, General Lyman L. Lemnitzer, on 13 September 1961. SIOP-62, Lemnitzer told the president, was designed to work either preemptively or in retaliation for a Soviet nuclear strike on the United States. Like SAC's earlier plan, it targeted not only the Soviet Union but also the People's Republic of China and allies of the two countries in Eastern Europe and elsewhere, all to be hit at the outset of hostilities with a massive simultaneous attack from all sides at once, bomb as you go. The PRC and Eastern Europe would be hit even if they had not initiated hostilities. (When Kennedy's secretary of defense, Robert McNamara, learned of SAC's targeting priorities, he was appalled. "We essentially blasted our way through the Warsaw Pact countries in order to get to the Soviet Union," he told the Sandia oral-history project, "and I remember thinking, 'My God, what are we going to do to Poland?'" )

The number of U.S. strategic nuclear weapons available to be delivered had increased slightly by 1961 to 3,153, but megatonnage had declined by almost half with the phasing out of SAC's largest bombs. Four-fifths of the SIOP-62 designated ground zeros were military. Lemnitzer explained, however, that "because of fallout from attack of military targets and co-location of many military targets with urban-industrial targets, the casualties would be many millions in number. Thus, limiting attack to military targets has little practical meaning as a humanitarian measure." Contemporary estimates of the consequences of an all-out SIOP attack put the death toll at 285 million Soviet and Chinese citizens and millions more dead in Eastern Europe—more than twice the dead of all the wars of the twentieth century. The journalist Fred Kaplan reports that General David Shoup, the Marine Corps commandant, asked Thomas Power at a similar SIOP briefing in 1960 if the United States had any options to avoid bombing China if that country happened not to be involved in the conflict that had led to nuclear war. "Well, yeah, we *could* do that," Kaplan reports Power replying, "but I hope nobody thinks of it because it would really screw up the plan." Back in Washington, Kaplan writes, other U.S. military leaders endorsed SIOP-62 to the secretary of defense. "David Shoup stood and said, 'Sir, any plan that kills millions of

Chinese when it isn't even their war is not a good plan. This is not the American way."

As if such deliberate democide were not horrific enough, one SIOP reviewer after another discovered that its damage calculations were based only on the blast effects of nuclear weapons, when the primary mode of destruction of weapons with yields greater than one hundred kilotons—most U.S. strategic weapons—is fire. Admiral Harry Felt, the commander in chief of the Pacific fleet, cabled the Joint Chiefs in January 1961 after reviewing the SIOP, "ONLY BLAST EFFECTS WERE CONSIDERED. . . . OTHER EFFECTS SUCH AS HEAT, FIRE AND RADIATION SHOULD BE USED WHEN DRAWING UP DAMAGE CRITERIA FOR THE SIOP." A Ukrainian explosives expert and Manhattan Project veteran named George Kistiakowsky, President Eisenhower's astute science adviser, who was sent out to Omaha in late 1960 to review the work of the Joint Strategic Target Planning Staff, reported back, "The JSTPS used blast effect as the only criterion of damage and neglected thermal radiation, fires which will be caused by it, and fall-out. The question may be raised as to whether the resultant damage criteria are unnecessarily conservative, whether they result in overkill and will create unjustified additional 'force requirements.'"

Why should it matter whether people were killed by fire or blast? The answer began to emerge only in the 1980s, when a few independent scientists looked into the neglected subject of mass fires from nuclear weapons. As one of them, Theodore Postol, found, even a very limited attack on enemy industry "might actually result in about two to three times more fatalities than that predicted by the government for the [all-out] anti-population attack" if mass fires were included in casualty predictions. Two to three times the 285 million Soviet and Chinese dead that SIOP-62 predicted based on blast damage alone would raise that number close to 1 billion.

Until recently, the official explanation for why fire was left out of targeting calculations was that the extent of mass fire in an incendiary attack depends on weather conditions. Such had been true of the firebombings of the Second World War, but according to the preeminent expert on the subject today, the Stanford University scholar Lynn Eden, mass fires started by strategic nuclear weapons create their own environment:

The extraordinarily high air temperatures and wind speeds characteristic of a mass fire are the inevitable physical consequence of many simultaneous ignitions occurring over a vast area. The vacuum created by buoyantly rising air follows from the basic physics of combustion and fluid flow. . . . As the area of

the fire increases, so does the volume of rising air over the fire zone, causing even more air to be sucked in from the periphery of the fire at increasingly higher speeds.

Using as an example a single three-hundred-kiloton airburst over the Pentagon, which by blast effects alone would hardly knock down buildings of heavy construction beyond Capitol Hill, Eden estimates that fire effects would generate "ground winds of hurricane force with average air temperatures well above the boiling point of water. . . . Within tens of minutes, the entire area, approximately 40 to 65 square miles—everything within 3.5 or 4.6 miles of the Pentagon—would be engulfed in a mass fire. The fire would extinguish all life and destroy almost everything else," south beyond Alexandria, Virginia, in one direction and north to Chevy Chase, Maryland, in the other. The intense light of a nuclear fireball, the equivalent at three miles of six hundred desert suns at noon, ignites fires simultaneously and instantly over a large area, with the fireball's shock wave, its blast, arriving long seconds later to break up, spread, and feed the flames. "A nuclear weapon could be considered the nearly ideal example of an incendiary weapon," Postol summarizes, because it delivers its entire yield in an instant—"about 300 trillion calories," Eden estimates, "within about a millionth of a second." Nor is one bomb over the Pentagon even remotely a realistic scenario. A former SAC commander told Eden, "We must have targeted Moscow with 400 weapons. . . . I would be comfortable saying that there would be several dozens of weapons aimed at D.C."

In her book *Whole World on Fire*, Eden finds organizational traditions and prejudices central to the neglect of mass fire in targeting calculations. Targeting planners and military leaders drew on their experiences in the Second World War to frame their priorities. At that time, strategic targeting had been focused on precision bombing—"tossing it right in the pickle barrel"—and only when that effort failed had the Air Force turned to area bombing and then firebombing. Though more successful, these practices were also a reminder of failure; the bureaucratic focus on precision bombing continued and renewed after the war. Precision bombing targeted specific structures that could be accumulated into target lists, so that destroying the structures would quantify destroying the enemy's capacity to make war. It also evoked a tradition of marksmanship with hand weapons that extends back through two centuries of American exploration and pioneering.

Targeting atomic and hydrogen bombs as if they were precision weapons is something like using a large meteor to drive a nail, and it depopulates the

