

Nuclear Pulse (III): Playing a Wild Card

In the strategic game both hawks and doves seek to use the issue of electromagnetic pulse to their own advantage

In the middle of the Pacific is a small atoll on which 165 people, including dozens of engineers and physicists, are waiting for a chance to fire a nuclear-tipped missile into space so as to better understand one of the minor mysteries of the nuclear age. The task force is organized by the Defense Nuclear Agency, which spends \$11 million each year to maintain this outpost among the palm trees. One mission of the engineers and physicists on Johnston Atoll is to measure, at a moment's notice, the chaos-producing effects of electromagnetic pulse (EMP),

nuclear war. The chaos that EMP would wreak on lines of military communication, no matter how much hardening went into global cables and circuits or how many new communication satellites were shot into space, means that only a "use it or lose it" war philosophy can work. Notions of controlled escalation, doves say, must give way to the older and more profound deterrent of mutually assured destruction (MAD). Further, doves view the test ban treaty as one of the few triumphs for sanity in the nuclear arms race.

clear war would be uncontrollable, as a practical matter, shortly after the first tens of weapons are launched."

A hawk who would like to roll back the partial test ban treaty so that more can be learned about EMP is Edward Teller, father of the hydrogen bomb. "EMP is an important question in discussing what to do about forbidding weapon tests inside and outside the atmosphere," he says. "Because of the laws of classification I cannot say too much. . . . We insist that our citizens remain ignorant and cast their votes in ignorance, while we have every reason to believe that our adversaries, the Soviets in particular, are well informed on the subject."

The development of the hawk position started back in the early 1960's, when physicists were only beginning to understand the dimensions of the EMP threat. The issue emerged briefly during the 1964 presidential campaign, with Senator Barry Goldwater (R-Ariz.) calling attention to the danger. "As these scientists conclude," he told his colleagues from the Senate floor (2), "catastrophic electrical and electronic failures can be expected in most military facilities. . . . We are talking about the electromagnetic impacts which some scientists say can travel 1100 miles."

By 1968, the Senate chambers echoed with complaints about lack of information on EMP. Observed Senator Henry M. Jackson (D-Wash.) from the floor of the Senate (3): "When our preparedness investigating subcommittee was conducting hearings on the then-proposed Limited Test Ban Treaty over 5 years ago, several expert witnesses warned us that we did not know enough about EMP and the possible effect it might have on our IBM and other missile systems. However, expert proponent witnesses assured us that overdesign, that is, providing more hardening against EMP than was thought necessary, would solve this problem and we should not be too concerned about it. Now, 5 years later, EMP is still a serious problem."

By 1970, Pentagon officials were telling Congress that the Soviets had a better understanding of the EMP threat and implied that the United States had been

Defense strategists today assume that a single Soviet warhead detonated 200 miles above Nebraska would knock out unprotected communications equipment all across the United States. The reason is electromagnetic pulse (EMP), a by-product of high-altitude nuclear explosions that blankets huge tracts of the earth with peak fields of 50,000 volts per meter.

The first installment of this three-part series described how EMP was discovered and why its potentially chaos-producing effects were overlooked for more than a decade. The second part examined the ongoing debate in the Pentagon over how to cope with the EMP threat. The third part discusses questions EMP raises about waging a limited nuclear war.

a high-voltage by-product of nuclear explosions in space. If the partial test ban treaty of 1963 were for some reason abrogated, they would start a countdown toward the first aboveground nuclear explosion by the United States in more than 18 years.

Hawks would like nothing better than to get a firm grasp on the dimensions of the EMP threat, the present dim outlines of which are the result of retrospective analysis and laboratory simulation. Even if it takes billions of dollars, hawks want to "harden" the U.S. military, which becomes more vulnerable each day as the nation's arsenal fills with ever more delicate spin-offs of the semiconductor revolution. Further, hawks suggest that the current backward state of affairs is the result of maneuvering by the Soviets, who long ago realized the EMP threat, took steps to protect their strategic systems, and tricked the United States into signing the test ban treaty.

Doves, on the other hand, see EMP as an issue that cuts through glib assertions about fighting and "winning" a limited

Since the chance of a nuclear test in space seems slim at this point, the debate between the hawks and the doves will probably remain deadlocked, with neither side able to prove whether the U.S. military and its vital communication links can be completely hardened against EMP. However, alleged gaps of one sort or another have traditionally influenced presidential politics and touched off surges in military spending. During the 1960's it was the missile gap. Perhaps the strategic debates of the 1980's will revolve around the doves' contention that closing the communications gap is impossible and the hawks' claim that closing the communications gap can and must be accomplished for the security of the nation.

A dove who testifies on Capitol Hill about the strategic implications of EMP is John D. Steinbruner, a senior researcher with the Brookings Institution. "Regardless of the flexibility embodied in individual force components," he writes (1), "the precariousness of command channels probably means that nu-

tricked into signing the test ban treaty. In the following dialogue (4), former Senator Stuart Symington (D-Mo.) is listening to the testimony of Vice Admiral Lloyd M. Mustin, director of the Defense Atomic Support Agency, and John A. Northrop, his deputy. These officials are talking about the Soviets' sudden breaking of the moratorium on nuclear weapons testing in 1961.

MUSTIN: "We were caught technically and operationally in surprise when in the summer of 1961 . . . they did a high-altitude program. . . . The one we did commencing in 1962 was generally comparable to their 1961 program, but they followed on with a late 1962 program that among other things reflected the proof testing and the new lessons they had learned in 1961. They were a significant jump ahead of us and of course thereafter we went into the limited test ban treaty so everything stopped there."

NORTHROP: "One could say that our test was comparable to their first series, and then they did . . . the more elegant follow-on, and then we were blocked from doing the equivalent ourselves."

SYMINGTON: "Apparently, the farther ahead we are the more behind we are. It is hard to figure out."

MUSTIN: "It takes only one weapon to get one detonation up there, but it takes hundreds of other things like computers and radars and so forth, distributed around, to be exposed to the effects or to observe them. It was this later area where we were caught short."

SYMINGTON: "You have me scared again."

MUSTIN: "That certainly is not the intention, Senator Symington."

Although the EMP issue has simmered among conservatives for almost two decades, it is the doves who recently took hold of it as a tool to demolish what they consider the myths of limited nuclear war and conflicts involving controlled escalation. In 1980 the Federation of American Scientists devoted a special edition of its newsletter (5) to a discussion of the implications of EMP on military communications. The lead article concluded: "We ought not kid ourselves that we are prepared to fight a protracted nuclear war when no plausible improvement in command, control, and communications is likely to permit it; countervailing strategies with numerous complicated options that cannot, in fact, be carried out could become an expensive kind of self-delusion."

The path to the concept of a limited nuclear war has been a long one. Since the early 1960's, strategists have pressed for a "counterforce capability," mean-

ing weapons to knock out weapons. But it was the Carter Administration that unveiled, in August 1980, the strategic culmination of this drive: Presidential Directive 59, a classified order calling for a U.S. ability to fight a "limited nuclear war" by targeting the Soviet military and not the whole nation, thus holding in reserve some of the U.S. nuclear forces. In his 1981 posture statement, Secretary of Defense Harold Brown said there should be enough of a reserve force so that the United States could wage war "for a substantial period after a strategic exchange."

One month before news of PD 59 was leaked to the press, the Republican Party had endorsed a similar strategy and taken a swipe at the Democrats: "We reject the mutually assured destruction strategy of the Carter Administration, which limits the President during crises to a Hobson's choice between mass suicide and surrender. We propose, instead, a credible strategy which will deter a Soviet attack by the clear capability of our

forces to survive and ultimately to destroy Soviet military targets." During that election year, on 12 January, George Bush was quoted in the *Los Angeles Times* as saying "you can have a winner" in a "nuclear exchange."

The doves' issue is whether exotic nuclear effects such as EMP would allow for the surgical precision of command and control that is a prerequisite for these idealized war scenarios. Even Secretary Brown in his 1981 posture statement hinted at the problem. "We need to maintain forces able to survive a Soviet attack and deal a victory-denying counterblow while maintaining significant forces in reserve, *assuming that we have command and control to operate these forces*" [italics added].

At first glance, the command channels to the U.S. nuclear forces look invulnerable. Launch control centers at the Minuteman missile fields, for instance, were originally built with four separate channels to the outside world: two by cable (one for telephone and one for teleprint-



U.S. Air Force

Strategic arsenal: Use it or lose it?

Doves say the whole strategic arsenal must be unleashed at the start of a nuclear war, since failing communication links would soon inhibit further response. Pictured here is the test firing of Minuteman missiles.

Shunning Cryptocensorship

A panel advising the National Science Foundation (NSF) about support of cryptological research has registered opposition to prior restraints, voluntary or otherwise, on publication of academic research in this field.

The panel's report expands the controversy over relations between NSF and the National Security Agency (NSA) in respect to their roles in cryptological research. NSA is a Defense Department agency responsible for gathering and protecting communications intelligence. NSA officials claim that open dissemination of some academic research in this field could damage U.S. security interests.

The new report, endorsed by NSF's Mathematics and Computer Science Advisory Committee, takes specific exception to a recommendation by a study group established by the American Council on Education (*Science*, 20 February, p. 797). The ACE group advocated that researchers accept a system of voluntary prepublication review of research papers in cryptography for possible security classification. Such a system, the new report states, is "unnecessary, unprecedented, and likely to cause damage to the ability and willingness of American research scientists to stay at the forefront of research in public sector uses of cryptography."

As an alternative, the NSF panel recommends that researchers notify federal agencies of results that might be security-sensitive but leave the initiative in respect to classification to the agencies. John Guttag, Massachusetts Institute of Technology computer science professor and chairman of the NSF advisory panel that drafted the report, said, "What we're recommending is that people send their papers in for information and allow NSA to set things in motion legally if necessary [to classify material]." Furnishing material "for information is different from submitting it for approval," he said.

The report and its recommendations were endorsed, with some modifications, by the advisory committee at a meeting on 29 May, but exact phrasing of some sections, including that on the handling of potentially classifiable research, must still be refined.

Citing a significant "point of disagreement" with NSF, the report objects to possible tightening of NSF requirements for researchers reporting progress on cryptology research funded by the foundation. The panel's report says that "any attempt to change the de facto policy by imposing more rigorous reporting requirements, either in general or on a particular group of researchers, should be considered to be a significant change in policy," and researchers should be fully consulted.

Guttag, whose own research field is not cryptology, said that his panel reacted vigorously against the ACE group's recommendations on prepublication review largely because the ACE group appeared to concentrate on military and diplomatic uses of cryptography and pay little attention to its rapidly growing importance in the public sector. In recommending against prior restraints on publication, the NSF advisory committee expressed the view that such a system does not have a consensus of the scientific community behind it.

The new report also urges NSF to continue to support cryptological research and encourage other agencies besides NSA to support such research.

In a concluding section, the report expresses the committee's view that the controversy over cryptological research is "just the tip of the iceberg" and that similar controversies will soon affect other fields. Most of their recommendations "have as their implicit goal promoting the clean separation of the procedures for funding and otherwise promoting basic research from the procedures for handling national security and other nonscientific considerations."

The report, which reflects attitudes in NSF's academic research constituency, is intended to assist the NSF leadership in amplifying NSF policy on cryptological research. The NSF will have to coordinate that policy with NSA, which is conducting a similar policy-formulating effort, and may have some differing views.—JOHN WALSH

er), one by high-frequency radio, and one by ultrahigh-frequency radio. Later, low-frequency radio was added, and plans are under way to install satellite ground stations. Even with this redundancy, however, there is some doubt by the military about getting the message through. Asked about the EMP threat, one Pentagon official who deals with Minuteman capabilities on a day-to-day basis said: "It may take hours, and we

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might have to send runners with handwritten messages, but somehow the message will get out." It is commonly assumed that of all the U.S. strategic forces, Minuteman missiles have the most reliable command channels.

Hawks think it is possible to add enough hardening and new technology to make the U.S. military invulnerable to EMP, and thus able to fight any kind of conflict. Doves say this is improbable and that the current situation will reign for the foreseeable future. At best, as Steinbruner testified before Congress in 1979 (6), "enough protection can probably be provided to plant serious uncertainty in the mind of an attacker contemplating a strategy based on electromagnetic pulse effects. Feasible protection is likely to fall well short, however, of what would be required to have unquestionable assurance that strategic invulnerability had been achieved." Saying essentially the same thing about the deterrent aspects of the communications situation today is Gerald P. Dinneen, the top Pentagon specialist during the Carter Administration on communications issues: "Since there is a great deal of uncertainty about EMP, and most of the information has been derived from simulations, it is unlikely that the Soviets would take a chance."

However, just as there is uncertainty about the degree of destruction that EMP would cause, so too is there uncertainty about the Soviets, who might decide that the risk is worth taking. After all, executing an EMP attack would be simplicity itself. The United States is frequently crossed by picture-taking Cosmos series satellites that orbit at a height of 200 to 450 kilometers above the

earth. Just one of these satellites, carrying a few pounds of enriched plutonium instead of a camera, might touch off instant coast-to-coast pandemonium: the U.S. power grid going out, all electrical appliances without a separate power supply (televisions, radios, computers, traffic lights) shutting down, commercial telephone lines going dead, special military channels barely working or quickly going silent. At the very least, such a scenario points out the mythic nature of the 11- to 15-minute "warning time" the President allegedly has to make decisions and send critical messages to commanders prior to a Soviet first strike.

This is a worst-case scenario, based on the calculations of physicists who in the early 1960's looked at a few unanticipated events surrounding a 248-mile-high weapons test in the Pacific (street lights failing in Hawaii) and wove them into a theory that predicts catastrophic events. But perhaps they were wrong. Perhaps

the effects of EMP would not be this devastating.

It was partially because of uncertainty about the effects of nuclear weapons that the Senate, when it ratified the 1963 limited test ban treaty, also agreed to what are known as the "Jackson Safeguards," after Senator Jackson, a power behind their adoption. These four statements of U.S. policy were meant to ensure the development of nuclear weapons and the understanding of their effects. The third safeguard calls on the United States to maintain an "atmospheric test readiness capacity." As Senator Jackson explained on the Senate floor in 1968 (7), this means "the maintenance of the facilities and resources necessary to resume promptly atmospheric testing should it be deemed essential to our national security or should the treaty be abrogated by others." The facility on Johnston Atoll is part of this readiness task force.

Perhaps an exoatmospheric test would be the only way to resolve the debate. Short of that, it seems that the lines of the controversy will remain clearly drawn: the hawks maintaining that the military can eventually be hardened, the doves maintaining that none but a fool would think of fighting a nuclear war.

—WILLIAM J. BROAD

References and Notes

1. "National security and the concept of strategic stability," *Journal of Conflict Resolution*, vol. 22 (No. 3), September 1978, p. 421.
2. *Congressional Record*, 19 September 1963, p. 16657.
3. *ibid.*, 25 September 1968, p. 28130.
4. Senate hearings before the Committee on Appropriations, H.R. 15090, 91st Congress, first session, 1970, pp. 871-872.
5. *F.A.S. Public Interest Report*, vol. 33 (No. 8), October 1980.
6. House hearings before the Committee on Armed Services, 7 February 1979.
7. *Congressional Record*, 25 September 1968, p. 28129.
8. Readers interested in further information on EMP and its effects should see *Science News*, 9 May 1981, and *IEEE Spectrum*, May 1981. Also see an excellent five-part series in the *Atlanta Constitution*, starting 21 September 1980, p. 1.

Utilities Choke on Asthma Research

Polluting industries have mounted a major campaign against protection for sensitive populations under the Clean Air Act

The utility industry is up in arms over the practical and potentially costly implications of recent studies indicating that asthma victims are sensitive to concentrations of sulfur dioxide in the air that are far lower than previously thought to be harmful. The studies were conducted by Dean Sheppard and his colleagues at the University of California at San Francisco, and involved 20 asthmatics.

Their research will be part of the debate on an important and increasingly controversial provision of the Clean Air Act, which is now up for renewal in Congress. The act requires that limits on air pollutants be set low enough to protect not only the general population from adverse health effects but also sensitive or highly susceptible populations, such as asthmatics, with allowance for what is loosely called "an adequate margin of safety." Previous studies had shown that sulfur dioxide causes eye irritation and aggravates a number of lung diseases, but Sheppard's is the first to link such low amounts (as low as 0.5 parts per million) with such serious effects. As a result, the Environmental Protection Agency (EPA) may be required under the act to substantially lower the stan-

dard for sulfur dioxide in the ambient air of urban areas. Utilities, which have already spent millions of dollars to purchase low-sulfur coal or to install sulfur dioxide scrubbers in the smokestacks of their power plants, could be forced to spend more.

EPA is cautiously awaiting replication of Sheppard's work before it completes its revision of the sulfur dioxide standard, in process since 1976. But the business community fears the worst. The studies, published recently in the *American Review of Respiratory Diseases*,* may soon be verified by work under way at the University of Washington and the Rancho Los Amigos Hospital in Downey, California. The utility, petroleum, and chemical industries, which each generate copious amounts of sulfur dioxide, have targeted for extinction the part of the act that requires protection for sensitive health groups.

The dispute is only one of several that

members of Congress will face as they attempt to rewrite the act, but the questions it raises are fundamental philosophical issues. The dilemma is obvious: Should the entire populace assume the burden of preventing aggravation of a disease in a relatively small group of people who unfortunately live in large cities? The Senate Environment and Public Works Committee plans hearings on the issue this week. Representatives of various affected trade groups will say no, that excessive costs to protect such persons inhibit industrial growth, exacerbate inflation, and prevent the development of needed energy resources. But these groups will also acknowledge that researchers are discovering adverse health effects for most air pollutants at levels far lower than previously known, with the result that assuring "an adequate measure of safety" has become increasingly difficult and may soon become impossibly expensive.

An example is posed by EPA's revision of the pollution standard for carbon monoxide last year. A review group in the Carter White House claimed that the new proposal would cost the automobile

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*Dean Sheppard, W. Scott Wong, Cristine F. Uehara, Jay Nadel, Homer Boushey, "Lower threshold and greater bronchomotor responsiveness of asthmatic subjects to SO₂," *ARRD*, vol. 122 (Dec. 1980), pp. 873-878; Dean Sheppard, Albert Saisho, Jay Nadel, Homer Boushey, "Exercise increases SO₂-induced bronchoconstriction in asthmatic subjects," *ARRD*, vol. 123 (May 1981), pp. 486-491.