Letters

Space Weapons and Nuclear Effects

In a recent article (News and Comment, 12 Mar., p. 1372), William J. Broad asserts that a "critical flaw" in directed energy weapons for use in space has been ignored by the Department of Defense (DOD) agencies engaged in developing this technology. From this premise he concludes that these exotic weapons "could easily be destroyed by a single nuclear blast in outer space." Neither statement is accurate.

The importance of nuclear effects on space systems was realized in the early 1960's. Subsequent extensive research by the Defense Nuclear Agency (DNA) and others has led to substantial understanding of such effects and, of course, this understanding has resulted in methods for mitigating nuclear effects. Recognition of such methods led the Joint Chiefs of Staff to publish, in the mid-1970's, guidelines for hardening of military satellites to x-ray fluence levels substantially higher than the 10^{-5} calories per square centimeter criterion used by Broad in his article. A number of satellites (for example, FLTSATCOM, now operational, and DSCS III, soon to be operational) have had hardening incorporated in their design. Further, DOD has been active in testing the effectiveness of satellite hardening, as in the Huron King underground nuclear test in 1980. This test showed that the hardening techniques used were generally effective. The impact of successful hardening will be to reduce dramatically the range at which a nuclear explosion can cause satellite damage or electronic upset. At these shorter ranges other options, such as maneuver or active shootback, may be effective in further enhancing survivability.

Broad correctly reports that the research program on directed energy weapons conducted by the Defense Advanced Research Projects Agency (DARPA) does not include specific engineering efforts on hardened weapons systems. His opinion that this signifies that the nuclear threat to potential future systems is being ignored, however, is wrong. The current emphasis of DARPA's research on high-energy lasers, pointing and tracking, and large optics reflects the judgment of highly qualified independent technical review groups, as well as DARPA's own judgment that these are the critical technical problems that must be solved now. The more mature nuclear hardening technology will be incorporated in the engineering design if a decision is ultimately made to develop a weapons system. Meanwhile, the research under way is conducted with full understanding of the nuclear threat, and the system design and engineering effort to provide nuclear hardness are explicitly included in the DOD program for development of these potentially revolutionary weapons.

Finally, Broad implies a lack of coordination and technical interchange between DARPA and DNA that is counter to the facts. Separation of responsibilities for technology development does not constitute a lack of awareness or mutual appreciation of the real problems faced by both agencies. DARPA and DNA work closely together to determine how DARPA's space concepts might be affected by nuclear effects, with DNA playing a major role in the nuclear hardening of space systems. DNA was actively involved with DARPA in the preparation of last year's DOD report to Congress on space lasers. Furthermore, DNA has an important program to assess the vulnerability of U.S. systems to laser radiation—a program that draws on the DARPA space laser efforts for support. DNA and DARPA are also working together to develop radiation-hardened microelectronic memory circuits.

We appreciate the difficulties in carefully researching an article where national security concerns prevent complete access to information and realize how this can lead to inaccurate conclusions. We commend *Science* for focusing attention on the need for nuclear hardening of space systems. This will continue to be an important task for DOD in the development of such systems.

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Griffith and Cooper argue that the destructive effects of nuclear blasts in space have been understood for two decades and that ways have been developed to deal with the threat.

In fact, military physicists did not realize the existence of the high-voltage surge known as system-generated electromagnetic pulse until the early 1970's, at which time they published the first papers on the subject (*1*). Even then, the problem was not widely appreciated. From 1975 to 1976, for instance, the Pentagon deployed Safeguard, a $5.7-billion antiballistic missile (ABM) system whose nuclear interceptors in the course of confronting Soviet warheads would have accidently knocked out dozens of critical U.S. satellites. Today, ABM designers avoid nuclear intercepts in space at all costs.

Griffith and Cooper assert that satellites and their delicate solid-state components can now be "hardened" and, as evidence, they cite the survival of a satellite in an 1980 underground nuclear test known as Huron King. Indeed, it is easy to deal with the threat under certain conditions—when the blast is far away and the yield small. Yet the Pentagon does not inform the public whether Huron King simulated an explosion at a distance of hundreds, thousands, or tens of thousands of kilometers. Also classified is whether the test represented the explosive force of a few *kilotons* (a standard level in military tests) or the much greater threat posed by 50 *megatons* (the largest warhead carried by a Soviet SS-18 missile).

More than a few nuclear physicists with access to the classified figures do not agree with the assertion that a laser battle station or satellite can be protected from any nuclear threat. As a worried laser advocate and former Pentagon official recently asked (*2*): "What if the Soviets will not play our way and increase the yield of their nuclear space mine by a factor of 100?" The answer has some bearing on whether the United States should embark on a large program for the development of laser weapons.

—WILLIAM J. BROAD

References and Notes

1. See the review article by D. F. Higgins, K. S. H. Lee, L. Marin, "System-generated EMP," *IEEE Transactions on Electromagnetic Compatibility*, vol. EMC-20, No. 1, February 1978, pp. 14–22.
2. W. D. Henderson, "Space-based lasers," *Astronautics & Aeronautics*, May 1982, p. 52.

Erratum. The publisher of *Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind* (abridged version) by Laurence M. Klauber, listed in the Books Received column of 30 April, should have been given as University of California Press, Berkeley.