LETTERS

Minuteman Vulnerability

The otherwise excellent article by Eliot Marshall (News and Comment, 12 Oct., p. 198) on the MX missile contains the statement that, by 1982, the Soviet Union "would be able to use their land-based missiles to destroy over 90 percent of the U.S. Minuteman arsenal." This alarmist figure may make for exciting copy, but has nothing to do with the actual vulnerability of the Minuteman force.

The optimal attack against a silo is to cross-target two reentry vehicles against it, each launched by a different missile, explode the one that arrives first in the air above the silo and the second on the ground in order to minimize fratricide effects. In this scenario the single silo kill probability (P_k) is:

$$P_k(\rho,2) = 1 - [1 - \rho \cdot P_k\ (\rho = 1)]^2$$

where ρ is the reliability of the missiles used and

$$P_k(\rho = 1) = 1 - \exp\left[-\frac{Y^{2/3}}{0.22 \cdot H^{2/3} \cdot (CEP)^2}\right]$$

where Y is the yield of the warhead in megatons carried by a reentry vehicle with a given circular error probable (CEP) in nautical miles, and H is the hardness of the silo measured in pounds per square inch (psi), expressing the upper limit of overpressure the silo is able to withstand without being damaged. If one assumes that the Minuteman silos are superhardened to 2000 psi, one can calculate $P_k(\rho,2)$ from the parameters of Soviet weapons (*1*). The yield of the new Soviet land-based warheads is listed in (*1*) as 0.75 megaton. The CEP is now estimated to be 0.17 nautical mile and is expected to improve to 0.15 nautical mile by 1982. Using these values and assuming quite generously that the reliability of Soviet missiles is 80 percent and that their reentry vehicles and warheads will function perfectly, I calculate that the theoretical probability of destroying one Minuteman silo now is 69 percent and in 1982 will be 73 percent. To attempt to predict the vulnerability of the entire Minuteman force by simply extrapolating to all silos of the force the results of the calculation of the vulnerability of one silo leads to the theoretical prediction that, if attacked in 1982, 73 percent of them will be destroyed. This, however, is an unrealistically inflated figure of vulnerability, because such a prediction ignores numerous uncertainties inherent in the complex operation of launching along untested trajectories hundreds of missiles carrying thousands of warheads cross-targeted on more than 1000 silos. Systematic degradation of the theoretical performance characteristics is bound to occur, and that would lower the vulnerability figure below the theoretically calculated 73 percent. Yet, since such an attack can be rehearsed but never tested, there is no way of ever estimating these systematic biases.

Therefore, to claim that a Soviet attack in 1982 would destroy 90 percent of the Minuteman silos is nonsense without any theoretical, and even less pragmatic, basis.

K. TSIPIS

Department of Physics,
Massachusetts Institute of Technology,
Cambridge 02139

Reference

1. P. Nitzè, *Congr. Rec.* 20 July 1979, p. S10077.

Gordon Research Conferences

The following arrived too late to be included in the winter program of the Gordon Research Conferences (19 Oct., pp. 365–369 and 373).

Angiotensin Interaction with the Cell

Philip A. Khairallah, chairman; Hiroko Nishimura, vice chairman.

11 February. Structure activity studies and conformation of angiotensin II and analogs (M. Printz, chairman): F. M. Bumpus, speaker; Richard E. Galardy, Richard Freer, Mahesh C. Khosla, Serge Fermendjian, Garland Marshall, participants. Renin and converting enzyme inhibitors: angiotensin antagonists (H. Nishimura, chairman): Miquel Ondetti, speaker; James Burton, James Ryan, Joseph Turcotte, participants.

12 February. Angiotensin receptors (F. M. Bumpus, chairman): Philippe Meyer, speaker; Ted Goodfriend, Thomas J. Moore, Janice Douglas, participants. (N. Speralakis, chairman): Una Ryan, speaker; Mike Gimbrone, Wayne Alexander, Jim Lewis, James Jamieson, Robert Smeby, participants.

13 February. Interaction between angiotensin and other vasoactive agents (K. Munday, chairman): Alberto Nasjletti, "With P. G.'s"; Joan Summy-Long, "Enkephalins"; Ben Zimmerman, "Catecholamines"; Leonard Share and Richard Malvin, "Vasopressin"; Ervin Erdos, "Kinin"; Margaret Boadle-Biber, "Serotonin." Mechansim of action (M. Peach, chairman): Subha Sen, "Protein synthesis"; P. A. Khairallah, participant.

14 February. Mechanism of action of angiotensin (T. Goodfriend, chairman): Hiroko Nishimura, "Evolution"; David Bohr, "Vascular smooth muscle"; Nick Speralakis, "Cardiac muscle"; Kenneth Munday, "Ion transport"; E. Bravo, "Aldosterone." Mechanism of action of angiotensin (P. A. Khairallah, chairman): Mike Peach, "Action on a molecular level"; Gordon Williams, "Na, AII interaction"; Philippe Meyer, "Cyclic nucleotides and calcium"; Antonio Paiva, "Tachyphylaxis."

15 February. Central action of angiotensin (P. Meyer, chairman): Joe Buckley, speaker; M. I. Phillips, Carlos Ferrario, Alan Epstein, Morton Printz, participants.

ALEXANDER M. CRUICKSHANK

Pastore Chemical Laboratory,
University of Rhode Island,
Kingston 02881

Anonymous References?

The picture of the Victorian style Cliff House (used as advertisement for the coming San Francisco AAAS Film Festival) in the 5 October issue of *Science* (p. 45) was taken and composed by my grandfather, Tsunekichi Imai (1873–1929), sometime before 1906. I mention this because when the photograph was entered in a San Francisco newspaper photography contest and won a prize, it was credited to "a young (anonymous) Japanese boy. . . ." Although the exact date of the photograph is unknown, it is certain that at the time Imai was a self-supporting young man and had no reason to wish for anonymity. During that period of California history, it was illegal for Japanese to enter such contests. It was also not possible for them to become naturalized citizens during his lifetime. (We know this to be called Catch-22).

Imai later became a professional photographer (and one of the finest bonsai horticulturists), with a studio in San Francisco. Immediately after the 1906 San Francisco earthquake, he disappeared without a word for several days, leaving his family to assume that he had accidently been killed in the earthquake or its aftermath. Fortunately, he was simply an excited professional, recognizing the urgency of the event. Many of the now well-recognized earthquake photographs are those that he took during his "disappearance."

B. T. TSURUTANI

Jet Propulsion Laboratory,
California Institute of Technology,
Pasadena 91103