Letters

Overkill

Seymour Melman's reply to D. S. Greenberg's analysis of his views (Letters, 17 July, p. 232) deserves fuller comment. I should like to return the discussion to its central thesis: the calculation of "overkill ratios."

Melman's method of calculating fatalities due to a nuclear detonation, which is not made fully explicit, is this: the number of fatalities varies linearly with yield, the derivative being given by the ratio of fatalities to yield in the Hiroshima experience. In the exchange between Melman and Greenberg, much is made of whether the Hiroshima fatalities were 68,000, or 100,000, or perhaps 180,000. As a contribution to the accuracy of this debate, I would offer the fact—now public knowledge—that the yield of the Hiroshima bomb was about 17.5, not 20, kilotons. Nevertheless, let us use Melman's assumed data to obtain a constant of proportionality of 5000 fatalities per kiloton, or 5 million per megaton.

It is at this point that the argument can be inverted. Instead of calculating the "overkill ratio" by reference to the populations and nuclear stockpiles, let us, for example, calculate that a single 38.4-megaton bomb could destroy the entire United States population. If this were true, it is evident that the Soviet 58-megaton test of 1961 would have killed everyone in the Soviet Union. Melman's method also allows us to calculate that a 10-megaton bomb dropped on Wake Island (population, 349) would kill 50 million people.

This is not mere haggling over 68,000 versus 180,000 or 17.5 kilotons versus 20 kilotons. The assumption upon which the "overkill ratio" is calculated is an extremely blunt instrument. It makes no provision for the complex and time-varying distribution of population, nor does it differentiate effects of very small and very large weapons which are of a known nonlinear character. It is not sufficient to observe, as Melman does in his letter, that "all forecasts concerning the effect of the use of nuclear weapons on a large scale involve estimations for circumstances where the error of estimate cannot be known." Of course this is true; but it seems rather unreasonable to support a hypothesis on the basis that it cannot be proved false without conducting a large nuclear war as an experiment.

It seems clear that available knowledge is not being used to the fullest feasible extent in Melman's theory. I was able recently to calculate the effects of nuclear attack on New York. The model used took into account the time-dependence of population distribution, the varying density of haze over the region, and various other detailed effects. The result (for 35 megatons) varied between 8.8 and 9.2 million fatalities, short-term. The model used was considered pessimistic. The linear theory indicates 175 million fatalities: the minimum discrepancy is a factor of 19. A much more representative city, Wichita, Kansas, had a discrepancy of 27 times between the linear and detailed models for 1.5 megatons (150 times for 10 megatons), effectively indicating that Melman's theory is worse, not better, when smaller population centers are considered.

These results do not mean that one should merely divide Melman's "overkill ratios" by a factor of 19 or 27, or 150, to obtain the "actual" ratios. About 63 percent of the U.S. population is in cities (212 of them) with a nominal population over about 60,000. Perhaps 250 Soviet missiles might be needed to destroy 80 percent of this 63 percent (50.4 percent of the total population). Thereafter, however, a truly impressive number of missiles would be required to destroy each additional 5 or 10 percent of the population. This saturation effect, which is *not* overkill but rather diminishing returns, is observable both in the case of calculations for individual population centers and in the percentage of the total population contained in an increasing number of cities (it is particularly marked for the Soviet Union). It is extremely questionable that the world's nuclear stockpile is sufficient to overcome the effect of diminishing returns and to approach the destruction of the world population. This observation is made in full appreciation of the estimate that the world stockpile is probably 200,000 to 300,000 megatons, about ten times the common estimate. One might note that the strict meaning of overkill implies that at some level of nuclear attack precisely everyone in the world (or whatever other group is considered) will have been killed. If this is not true for some finite attack, overkill (in the strict sense necessarily implied by statements of the form "capability to kill everyone in the Soviet Union x times over") is not possible. In some situations it might require quite a bit of energy to destroy a few people. If we were to take the 1964 Alaskan earthquake as a model, instead of Hiroshima, it would require 1400 megatons to kill a single human. Thus we calculate that the world nuclear stockpile (say 200,000 megatons) could kill 143 people. The fact that there are uncertainties involved does not qualify the crudest theories as the best.

To forestall certain types of reasoning, I should perhaps note that I am in no way connected with the Air Force or any other part of the Department of Defense.

THOMAS M. CONRAD
550 Red Fox Lane,
Strafford, Wayne, Pennsylvania

Montreal: Historical Note

The recent correspondence about the circumstances under which the tradition of the inertness of the noble gases became implanted in the literature has cast a good deal of light on the conservatism of science. It is consequently amusing to see an even more venerable tradition, no less unfounded, perpetuated in the description of Montreal in the issue of 22 May (p. 1033).

The Indians whom Cartier found in 1535 at the village of Hochelaga, on the site of Montreal, were indeed linguistically related to the Hurons. This relationship may have been re-