Letters

Radiation Hazards

It is reported in "Science in the News" (*1*) that fallout amounts to about 1 percent of the man-made radiation. Although this evaluation is given in somewhat ambiguous terms, fallout radioactivity is placed in the same category as the radiation hazards from wrist watches and TV sets.

The most recent data derivable from reports (*2*) issued by the Atomic Energy Commission and its laboratories allow an accurate evaluation of the fallout radioactivity for the specific time period of March 1959 through February 1960. The total contribution of Zr^{95}, Ru^{103}, Ru^{106}, Cs^{137}, Ce^{141}, and Ce^{144} amounts to 68 millirad, if a uniformly contaminated, infinite, smooth plane is assumed. These data were obtained for land in the Chicago area where the natural background radiation, including cosmic rays, is 97 mrad/yr. (*3*).

Thus, for the most recent period for which data are available the "open field" radiation level averaged 67 percent of natural background radiation. It is to be expected that the fallout activity will decrease markedly during 1960, provided nuclear tests are not resumed. For example, the fallout level for January of this year averaged about 25 percent of the background radiation.

The highest value measured for fallout in the United States, exclusive of local "hot spots," was recorded during April 1959 as 8.41 μrad/hr, or a full 75 percent of that from natural sources (*4*). The principal contributor to the fallout dosage at that time was 65-35 day Zr^{95}-Nb^{95}, which accounted for 78 percent of the total. This relatively short-lived activity gained prominence in fallout due to the unexpectedly fast global deposition of fission products from the Soviet series of tests in October 1958. Charles Dunham, director of the Division of Biology and Medicine of the Atomic Energy Commission, has stated (*5*) that a report on "hot spots" and short-lived activities in fallout will be issued soon.

A comparison has been made at Argonne National Laboratory between the calculated radiation dose from fallout and radiation as measured by a sensitive ionization chamber (*6*). For the April 1959 period, a measured value of 18.5 μrad/hr compares with a calculated value of 19.5 μrad/hr for natural background radiation plus fallout.

The "open field" radiation levels may be criticized on the basis that they do not apply to real radiation doses absorbed by human beings, since people spend much of their time inside buildings where physical factors such as geometry and absorption serve to reduce the radiation dose. This shielding effect is difficult to estimate, being different for rural and metropolitan structures. One would expect, however, that an average shielding factor of 4 might apply.

Spokesmen for the Atomic Energy Commission, the Public Health Service, and the Federal Radiation Council (*7*) have been somewhat ambiguous in statements made about fallout. In giving values for fallout radiation levels they sometimes fail to specify what fallout nuclides are assumed to be involved, what time period is covered, and how the radiation dose is meant to apply.

The situation is even more complex with regard to the reporting of the internal hazard associated with the uptake of fission debris in human beings. The Fallout Prediction Panel convened by the Joint Committee on Atomic Energy predicted, in the course of an investigation by the Committee in May 1959 (*8*, p. 1793) that, in the latitude zone 20° to 60°N, there would be an 8 strontium unit "average Sr^{90} equilibrium bone level corresponding to average maximum deposition from weapons tests to date." The time of maximum retention of Sr^{90} is still a number of years in the future, and one must be careful to take this into account in reporting on present levels of Sr^{90} in human beings. Additionally, one should be careful to present the data for pertinent age groups and not average in adults, for whom Sr^{90} uptake is small. There is also the problem of estimating how many individuals will exhibit a higher uptake of Sr^{90} than the average of 8 strontium units predicted for the North Temperate Zone. Jack Schubert has estimated (*8*, p. 1638) that Sr^{90} displays a log-normal distribution in human beings and that 28 percent of a sampled group will retain three or more times the average (geometric mean) bone burden of Sr^{90}. I have stated (*9*) that a significant number of the young population will accumulate a Sr^{90} burden delivering a lifetime radiation dose to the bone comparable to that from all natural sources of penetrating radiation.

If these data are accepted, then both the external and internal hazards associated with radioactive fallout cannot be placed in the 1 percent category.

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References and Notes

1. *Science* **131**, 1656 (3 June 1960).
2. "Quarterly Statement on Fallout," *U.S. Atomic Energy Comm. Rept. No. 4* (Apr. 1960); P. F. Gustafson, "Calculation of Background Gamma-ray Dose Based on Measurement of Radioactivity in Soil" (undated memorandum).
3. See P. F. Gustafson, L. D. Marinelli, S. S. Brar, *Science* **127**, 1240 (1958).
4. P. F. Gustafson and L. D. Marinelli, "Fallout Radioactivity and the Dose Arising Therefrom at Argonne National Laboratory, Lemont, Ill.," appendix to the statement of A. M. Brues in "Fallout from Nuclear Weapons Tests," *Proc. Joint Committee on Atomic Energy* (1959), vol. 2, p. 1400.
5. C. Dunham, verbal comment made during the Joint Committee on Atomic Energy hearings on radiation protection criteria and standards (31 May 1960).
6. P. F. Gustafson, "Assessment of the Radiation Dose Due to Fallout," *Argonne Natl. Lab. Mem.* (1 Oct. 1959).
7. "Radiological Health Data," *U.S. Public Serv. Rept. No. PB 161371-1* (Apr. 1960); "Radiation Protection Standards," Federal Radiation Council staff report (13 May 1960).
8. "Fallout from Nuclear Weapons Tests," *Proc. Joint Committee on Atomic Energy* (1959), vol. 2.
9. R. E. Lapp, *Bull. Atomic Scientists* **15**, 311 (1959).

Our news article was only a summary of what appeared to be the commonly accepted view among the scientists testifying at the radiation hazard hearings. Our wording, as Ralph Lapp points out, was ambiguous. In particular, we should have made it clear that the reported figures referred to the accumulated dose over a period of years. At this time, while fallout is at its peak, it is, as Lapp points out, substantially more than 1 percent of background radiation, although this does not necessarily conflict with the view that the accumulated dose over, say, a 30-year period will be roughly equal to that from television sets or luminous watch dials.—ED.

Education and Research

As an interested outsider to the academic field, I have been keenly following the minor debate on teaching and research. May such an outsider offer an opinion?

The question put in the editorial [*Science* **131**, 71 (8 Jan. 1960)], "why . . . should some instructors oppose the recognition of good research as a consideration second to good teaching?" is, it seems to me, answered by the spirit displayed in Paul Bohannan's letter [*Science* **131**, 1282 (29 Apr. 1960)]. Bohannan's apparent position, that any scholar not doing research simply cannot be a fully effective teacher, represents the camel whose nose the instructors are trying to keep out of the academic tent by refusing to recognize research at all. Bohannan may be describing a worthy ideal, but F. J. Allen's letter [*Science* **131**, 944 (25 Mar. 1960)] has the honest ring of reality.

Surely, a well-balanced view of the situation would run something like this:

1) The primary mission of a college is to educate its students, not to conduct research.

2) Research at such an institution is desirable for two reasons: (i) for the educative value of exposing the student to an environment in which research is