Letters

Man on Mars: A Turnabout

In his article commenting on the lack of direction in the U.S. space program, Colin Norman (News & Comment, 28 Aug., p. 965) makes the point that the Planetary Society is now leading the charge for a manned mission to Mars. To those who know the officers of the society (Carl Sagan, Bruce Murray, and Louis Friedman) and who, like them, have spent years in unmanned planetary science, it comes as no small surprise to learn that they are now calling for manned exploration of Mars. The reason for this sudden turnabout can be found in their May 1987 statement to the Senate Appropriations Committee (*1*). Here, the three authors give it as their view that the manned exploration of Mars is an "optimal goal" that will restore life to NASA. Unfortunately, they are silent about recent history which demonstrates that, for NASA, manned spaceflight and planetary science are opposed goals. A large manned program—and this one would be very large indeed—practically guarantees that science will be un- or underfunded for the indefinite future.

Among scientific objectives for men on Mars, the authors list the search for life; later they warn that samples returned to Earth must be quarantined in earth orbit. Apparently, we are being told that there may be life on Mars and that it may be dangerous. One might never think that there was once a Viking mission to Mars. Again, this proposal ignores history in favor of a dreamworld.

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REFERENCES

1. C. Sagan, B. Murray, L. Friedman *Planet. Rep.* 7, 12 (July/August 1987).

Chernobyl Public Health Effects

Any reasonable person must take strong exception to a comment in Richard Wilson's article, "A visit to Chernobyl" (26 June, p. 1636). Wilson states: "If . . . the average public health is the sole objective, and a Chernobyl accident happens less than once a year, the RBMK reactors in the Soviet Union can be considered less hazardous than coal-fired power plants of similar size."

While Wilson himself objects to this "too narrow an application of risk-benefit analysis," he does not broaden the risk analysis terms of reference by very much. His discussion of public health risks is limited to cancer morbidity and mortality due to internal and external radiation exposure resulting from "a Chernobyl accident."

A reasonable risk analysis should include a number of public health factors besides the direct effects of radiation. A nonexhaustive list of such public health factors includes

- evacuation-caused illness and death;
- evacuation-caused disruption of public health norms (for example, poor sanitation, poor hygiene, and restricted health care access);
- disaster "trauma" and related mental health effects (*1*);
- resettlement effects on public health; and
- public health effects, direct and indirect, of postdisaster changes (for example, new drinking water sources and restricted zones of travel).

A number of these selected factors are mentioned by Wilson, but not in the context of public health. Rather, he presents some of these factors as problems only in the context of postaccident radiation exposure.

Clearly, if the group of RBMK reactors suffered "a Chernobyl accident" every 2 years (which is "less than once a year") the "average public health" effects of such an accident would soon be seen for what they are: catastrophic and certainly far greater by several orders of magnitude than the average public health hazards posed by "coal-fired plants of similar size."

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REFERENCES

1. R. E. Cohen and F. L. Ahearn, *Handbook for Mental Health Care of Disaster Victims* (Johns Hopkins Univ. Press, Baltimore, MD, 1980).

Response: Lawless questions whether I correctly compared all the possible effects on public health of coal burning and nuclear power accidents. Coal burning can, and has, killed people. The question is, How many people does it kill now? It is important to consider the whole fuel cycle, from mining to final disposition of the waste. In most cases there are historical data. The best summary is probably in the report of a French conference on the comparison of health risks from different energy sources (*1*), at which Italians, French, and Americans—from their varied perspectives—agreed.

It must be remembered that for a given amount of energy we must burn 3 million times as much coal as uranium-235. Of course, uranium ore contains only 0.1% to 1% uranium and a little less than 1% uranium-235, while 50% of the coal that is mined can be burned. Nonetheless, we must still mine, purify, and transport at least 100 times as much material to get electricity from coal as from uranium. It is this factor of 100 that makes nuclear power more benign, both from an environmental and from a public health point of view, than burning coal.

The death toll starts in the mines. Although coal mines are improving, more than 100 people still die in coal mining accidents in the United States each year. Black lung disease is still a cause of suffering and death that is numerically more important than the uranium-mining cancers. In 1975, 30% of rail transport was moving coal, and 30% (or 570) of the 1900 persons killed in railroad accidents that year can be attributed to moving coal.

Air pollution from coal burning has been a problem since Edward I of England banned the use of coal in the kilns of Southwark in 1307. But air pollution "incidents" have been diligently recorded only in the 20th century. At Donora, Pennsylvania, in 1948, 20 people were killed and half the population got sick; in London, in December 1952, the weekly death rate rose from an average of 1800 individuals to nearly 5000; 4500 deaths were attributable to the dense fog that had settled on the Thames Valley. These numbers are generally accepted, but average air pollution concentrations today are 50 to 100 times less than the peak concentrations of these short incidents. How to extrapolate to low concentrations remains a matter of controversy.

In 1970, Lave and Seskin (*2*) found a correlation between U.S. mortality rates and air pollution variables. Despite the implication that air pollution, at present levels, has been widely questioned, this correlation refuses to go away. Data up until 1981 were reviewed by Wilson *et al.* (*3*), and correlations using 1980 mortality data have recently been found by Ozkanyuk *et al.* (*4*). Taken together, these suggest that 50,000 among the 2 million persons who die each year in the United States may have their lives shortened by air pollution. Some would state a number ten times lower, at present air pollution levels, but it would be a bold optimist who would set it at zero.

Problems with coal waste, a million times as voluminous as high-level radioactive waste and not handled carefully by society, are harder to document. One notes, however, that 137 children died when a coal tip slid into their school at Aberfan, North Wales.

These are all statistics from the Western world. The Russians do not keep good records on accidents, but quote ours (*5*).

However, coal mining in the Donetz basin is infamous, and 40% of all rail transport in the U.S.S.R. is moving coal. Most observers would agree that the Russians are less careful about accident prevention and pollution control than we are in the West, and emissions from generating plants are less carefully controlled. These emissions were reported in general to the Organization for Economic Cooperation and Development for a 1977 study (*6*). From this it became clear that coal burning in the U.S.S.R. contributes to Western European air pollution and is thereby as serious internationally as the long range transport of the radioactive iodine and cesium from Chernobyl.

From these considerations I estimate that, although the Soviets burn less coal than we do in the United States, the average effects on public health are similar. The death toll from coal burning in the U.S.S.R. on this basis is then between 5,000 and 50,000 individuals per year. A Department of Energy report (*7*) calculates that 20,000 cancer cases worldwide may be caused by Chernobyl. Only 200 of these will be among people exposed to radiation levels where there are data. The calculation depends on an extrapolation of the dose-response relation to very low doses and dose rates. The authors of the report remind the readers that the number could be zero. This uncertainty is similar to, although not identical to, the uncertainties of the air pollution estimates. That 20,000 lies between 5,000 and 50,000 is the basis for my statement that the average public health effects are similar.

Society has always treated accidents in which a number of people are killed or injured in one incident differently from the way they treat the continuous death toll of day-to-day operations (*8*). A coal mining accident killing 100 miners is news; the yearly death toll of more than 100 miners by accident is not. To èquate the average effect on public health of accidents and the effect of continuous operation would therefore not correspond to public perception and would be what I called "too narrow an application of risk-benefit analysis." I would definitely recommend *against* any nuclear power program that involves a Chernobyl-size accident once a year, even if it were to replace a similar number of deaths from coal burning. However, it is up to the public, when presented with these comparisons, to decide whether or how often such large accidents may be permitted, or whether to revert to older technologies that are more hazardous on average.

Lawless mentions a number of other issues related to the Chernobyl accident that must be included in an overall summation of health effects. One is negligible, as implied in my article; Kiev never had to turn to alternative sources of drinking water, so the health effects of doing so were small or nonexistent. No accidents or illnesses were reported during the evacuation, and it is unlikely that more than ten or so would go unreported. Another effect is clear: the Soviet authorities take the accident very seriously, so those evacuated have, and will have, much better medical care than the average in the Soviet Union.

There was some trauma in the Western world (not mentioned by Lawless), but we must depend on Soviet sources for details of most of the effects he lists. In a video link to the United States in early September 1986, the chief pediatrician of the Ukraine stated that 400 normal children had been born to mothers who were among the 115,000 persons evacuated. She made a plea to the Western world not to exaggerate the health effects of the accident and produce unreasonable fear among the children. The point is clear; some of the adverse effects that Lawless describes depend critically on public reaction to the accident. For most of the evacuees, the process was orderly and relatively painless.

If, therefore, I make estimates of what I think the effects of the evacuation are on health, I find figures much lower than the 20,000 hypothetical cancers listed by the Department of Energy (*7*). However, these effects are even more uncertain than the effects of radiation or of air pollution at low levels and are strongly influenced by the societal response to accidents. I believe the Soviet response to the Chernobyl accident was remarkably good. I hope the response of America to such an accident, in any industry, would be as good as it was in the Ukraine. However, such optimism may be modified by a comparison of public behavior during the New York blackouts of 1963 and 1977. Technically, the former was more serious, whereas the bad public behavior in the second was expensive.

A good response depends on understanding, to some extent on prior training, but primarily on a general refusal of society to panic and a willingness of those controlling the accident to do their jobs without hesitation, as the firemen did so bravely at Chernobyl.

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REFERENCES AND NOTES

1. Société Française d'Energie Nucleaire, *Colloque sur les Risques Sanitaires des Differentes Energies* (Gedim, Saint Etienne, France, 1980).
2. L. B. Lave and E. P. Seskin, *Science* **169**, 723 (1970).
3. R. Wilson, S. D. Calome, J. D. Spengler, D. G. Wilson, *Health Effects of Fossil Fuel Burning* (Ballinger, Cambridge, MA, 1980).
4. H. Ozkanyuk, J. Spengler, A. Gast, G. Tosten, in *Aerosols: Research, Risk Assessment and Control Strategies* (Proceedings of the 2nd U.S./Dutch International Symposium, Williamsburg, VA, 19 to 25 May 1985, Lewis Publishers, Chelsea, MI, 1986), pp. 1067–1080; H. Ozkanyuk and G. Tosten, *J. Risk Analysis*, in press.
5. For example, E. E. Shpilrain of the Academy of Sciences of the U.S.S.R. repeated without comment data from (*1*) at a seminar on cooperation in nuclear power in Rome in 1986. He also stated that he knew of no comparable statistics in the U.S.S.R.
6. *The Organization for Economic Cooperation and Development Programme on Long Range Transport of Air Pollution: Measurement and Findings* (Organization for Economic Cooperation and Development, Paris, 1977).
7. "Health and environmental consequences of the Chernobyl nuclear power plant accident" (report of an interlaboratory task force, Department of Energy, Washington, DC, August 1987).
8. R. Wilson and W. Jones, *Energy, Ecology and the Environment* (Academic Press, New York, 1974).

Arresting Vocabulary

As a technical editor, I found the first two sentences of the report by J. William Schopf and Bonnie M. Parker (3 July, p. 70) arresting—literally, as I have been unable to read further into the report. I'm (temporarily, I'm sure) spellbound by the nuggets of invective lying there in plain view. I can now address my putative father as "you dubiofossil!" and some unsuspecting opponent in group debate as "You contaminant!" Doubtless the term "pseudofossil" also may have rich application outside its paleontological home, perhaps as a categorization for Machiavellian young professors who unleash their high spirits only when off duty.

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Erratum: In table 2 of the report "Free energy calculations by computer simulation" by P. A. Bash *et al.* (1 May, p. 564), two minus signs were omitted. The $\Delta(\Delta\delta)$ for the transformation of thymine to cytosine and that for adenine to guanine should have been -5.24 ± 0.33 kcal/mol and -6.95 ± 0.54 kcal/mol, respectively. In the caption for figure 2, the structure designations for the "additive" model and the real model of *p*-nitrophenol were reversed. The first two sentences of the caption should have read, "Partial charges determined with the methods described in (*19*) with the use of a 6-31G* basis set for phenol (**1**), nitrobenzene (**2**), benzene (**3**), and *p*-nitrophenol (**5**). The partial charges for the additive model of *p*-nitrophenol (**4**) were determined as follows. . . ."

Erratum: In Leslie Roberts' Research News article "Agencies vie over human genome project" (31 July, p. 486), the new executive office subcommittee on the human genome was incorrectly identified as part of the Biotechnology Science Coordinating Committee. It is actually a subcommittee of the Domestic Policy Council Working Group on Biotechnology.

Erratum: The caption for the photograph on page 1405 in Leslie Roberts' article "Federal report on acid rain draws criticism" (News & Comment, 18 Sept., p. 1404) incorrectly implies that acid rain has damaged spruce trees on Whiteface Mountain. The cause of the spruce decline is not yet known, although air pollution is generally believed to have contributed.