coal-fired power plant (order of 10^{23} submicron particles per day), which alone pollutes vast areas (observed at 100 000 square miles) of a four-state region. The airborne particle-size distribution peaks at 0.8 microns and is composed of spherical shells.

To add to the technical difficulties of control of the highly damaging submicron particles one must take practical note of the political and economic probabilities of getting even the most modest state-of-the-art control. These coal-fired power plants represent on the order of \$200 000 000 investments, now much more, (2000 MWe). They hire many people; they financially and politically dominate whole regions and they vigorously protect their profits and freedom from governmental control. They have every economic incentive (and large ones at that) to do so. For instance, I believe the maximum air-pollution fine in New Mexico presently is \$1000 per event (not per day, or per pound of pollutant, or per injury). I leave it to the reader's imagination as to how often this fine has been imposed on so rich and powerful an entity in a poor, lightly educated, job-hungry state like ours.

In sum, coal-fired pollution control is so bad and is foreseeably so bad, that one might only be a little wrong to say that pollution control is nearly as bad as no control at all. It *has* been said by many that the laws are but "a license to pollute." So Eggermont's confidence in "classical" controls and in 99.8% by weight removal is unfounded.

However, there are prime areas of our power problem in which we can all agree. Of the economically viable fuels it is clear that we want to utilize the least hazardous and polluting. At the present time and for the near future, the only large-scale alternatives are coal and fission. The hazards of the latter have been highly studied and publicized. We need to do the same for the former, coal. Indeed, many governments are rushing post haste to place severe restrictions on fission power that will necessarily make coal power more attractive to power-plant executives. How if coal be worse? How if coal be very, very, much worse?

Consequently I submit that the question before us is not: "Is fission power safe?" but rather: "What is the comparative hazard of the whole cycles of the two alternative fuels?" Most needed are further studies of coal hazards. Least needed, because we have already many studies in hand and because of the misuse already being made of them by the public and others, are the non-comparative publication of further fission-cycle safety studies I have tried to warn against.[7] Above all, because the public, the state and national governments and the power-plant executives are deciding right *now* on the fuel cycles that will be used during the remainder of the lives of most of us, we need complete comparative studies, however approximate, however premature, so long as they are timely (with apologies to the authors of the magnificent studies already made). To avoid misuse, I further recommend that every specialized study in these fields include a statement, as complete as possible, indicating the net effect of the findings on the *ratio* of total hazards of coal to nuclear fission power for the same produced electric power.

JOSEPH J. DEVANEY
11/22/76 *Los Alamos, New Mexico*

References

1. Douglas Muir, private communication, 1975. I am indebted to Muir for his kindness.
2. Richard Wilson, statement to a committee of the California Assembly, Nuclear News, February 1976; page 55.
3. Bernard L. Cohen, "Environmental Hazards in Radioactive Waste Disposal", PHYSICS TODAY, January 1976; page 9.
4. D. J. Rose, P. W. Walsh, L. L. Leskovjan, "Nuclear Power—Compared to What?", American Scientist, May–June 1976; page 291.
5. See, for example, R. L. Rock et al, "Evaluation of Radioactive Aerosols in the United States Underground Coal Mines", US Department of the Interior Report 1025 (1975).
6. L. B. Lave, as quoted by N. Rasmussen, lecture, Los Alamos Scientific Laboratory, c. 1974.
7. J. J. Devaney, PHYSICS TODAY, December 1975, page 9.

In praise of engineering

I have followed the discussion on engineering physics in PHYSICS TODAY and the *Forum Newsletter* with some interest, having been a 1962 graduate of the program at the University of Oklahoma. From my perspective of today, I could not be more pleased with the program I followed there or the education I received. I would personally urge all physics departments that have a School of Engineering available to explore seriously the option of an engineering-physics curriculum.

I think of myself as both a physicist and an engineer. I have since received a Master's degree in physics (from the University of Washington, a top-notch department in my opinion) and am a registered Professional Engineer. I feel equally at home with "charm" quantum numbers or steam tables. My work assignments over the years have almost always been in the general area of applied research, ranging from electromagnetic interference investigations to almost basic research in solid-state physics. Following a personal interest, I have moved into the field of air-pollution control over the past few years. In my studies of atmospheric optics and the behavior of aerosol streams I constantly need many of the things I learned in classical mechanics, electrodynamics, or statistical mechanics. I also find I use what I learned in mechanical and chemical engineering every day. I am certain that there must be many similar situations where physics and engineering intersect and engineering physicists could make an important contribution.

T. G. Stinchcomb (September, page 15) wonders about the equivalency of the training that physicists and engineering-physics majors receive at Oklahoma. I will admit that, partly because I took some classes (such as thermodynamics and mechanics) in the engineering school rather than from the physics department, I did have some problems later in graduate school. But I did overcome them and I would do it again in just the same way. I did learn a lot of engineering in my engineering classes, which has served me well. Stinchcomb also wonders about the job market for engineering physicists. I have found that I generally have an easier time finding openings and am generally offered the same or better salary than friends of mine who are physicists (even though they are mostly brighter than I). I believe that is because employers think that with my engineering training I will produce something they can use (although you and I know that it is the physics I learned that enables me to deliver). There are many fields of applied physics that have been ignored by physics departments. Does your department offer undergraduate classes in physical optics, acoustics, hydraulics, high-pressure physics, and so on? Even without an affiliation to an engineering department, such a hard look at the curriculum would be a good place to start.

MIKE RUBY
Environmental Research Group
9/24/76 *Seattle, Washington*

TWT, mags still kicking

I found the article on high-power microwave generation (November, page 18) quite interesting. I was, however, a bit miffed by one statement: "By reviving the old devices (traveling-wave tubes and magnetrons) developed a quarter of a century ago . . . ." I am an engineer working in traveling-wave tube R&D and I would like to inform you that the TWT business is quite healthy with no reviving needed.

TWT's find wide applications in medium and high-power microwave amplifiers. Solid-state devices cannot even approach the kinds of performance we achieve and there is still a lot of exciting R&D going on, some of it even sponsored by NRL. As recently as 1970 an article was published in the *IEEE Transactions*