acid mist, a droplet aerosol; and fly ash, a particulate aerosol. These are the three most conspicuous pollutants emitted from the stacks of coal-burning powerplants. Graded levels of these substances, spanning the range of concentrations that have actually been measured in polluted urban atmospheres, are being employed. Exposures are being conducted in large chambers operated on an around-the-clock basis so that the daily exposure exceeds 22 out of the 24 hours, 7 days a week, for uninterrupted periods of a year or a year and a half. Two species of animals are under test, guinea pigs, which get the 1-year exposure, and monkeys, which get the year and a half. The greater emphasis in the work attaches to the primates, and it is rather easier to extrapolate from the monkey to man than to make the jump from a mouse to man. Guinea pigs were included in order to provide a connecting link with some of the earlier published studies. In the various trials which make up the complete program, the animals are being exposed not only to the single agents, but also to some of the binary and ternary mixtures of them. It is not feasible to examine all of the theoretically possible combinations, but an adequate and representative number of them have been selected.

Let us turn now to a most important consideration—the measures of response in the animals. In a biological study of this magnitude and duration, it is customary to perform certain conventional or routine tests. Thus, basic hematological and clinical parameters, X-rays, electrocardiograms, and growth data will be collected throughout the study. However, we do not anticipate that any striking changes will be seen in these variables, although we may be surprised.

Our interest is focused intensively on the results being obtained from a battery of very advanced and highly sensitive pulmonary function tests. These include measures of the mechanical, ventilatory, and diffusional characteristics of respiratory function. With the aid of an online computer facility, about 3 dozen primary and derived parameters are obtained. The tests are performed on all animals on a scheduled basis prior to, during, and at termination of the exposures. It is possible to apply these tests on this repetitive basis because they are what we call nondestructive, that is to say, the animal under examination requires no anesthetic, operative procedures or other techniques which would interfere with the test or preclude its repeated performance. It is only at the termination of the year or year and a half of exposure that we add one or two final tests that will render it necessary to sacrifice the animal after conducting them. At this point, a thorough gross and microscopic examination of all major tissues and organs of the animal completes the experimental phase of the investigation.

Although this program was authorized a year and a half ago, it is too early yet to speak of the results which are beginning to accumulate. When the results are available from each series of exposure trials, the final phase of the investigation may be entered into. This will be an evaluation and interpretation of the findings as they relate to the standards for the specific pollutants and their mixtures. The objectives of the study, then, are of a quite practical significance.

Mr. DADDARIO. Mr. MacFarland, what are the difficulties in extrapolating this information obtained through your animal studies to man? What do we learn? How far can we go? What do we then need to do? Where do your studies bring us?

Dr. MACFARLAND. This is a long and difficult question.