earth. Just one of these satellites, carrying a few pounds of enriched plutonium instead of a camera, might touch off instant coast-to-coast pandemonium: the U.S. power grid going out, all electrical appliances without a separate power supply (televisions, radios, computers, traffic lights) shutting down, commercial telephone lines going dead, special military channels barely working or quickly going silent. At the very least, such a scenario points out the mythic nature of the 11- to 15-minute "warning time" the President allegedly has to make decisions and send critical messages to commanders prior to a Soviet first strike.

This is a worst-case scenario, based on the calculations of physicists who in the early 1960's looked at a few unanticipated events surrounding a 248-mile-high weapons test in the Pacific (street lights failing in Hawaii) and wove them into a theory that predicts catastrophic events. But perhaps they were wrong. Perhaps the effects of EMP would not be this devastating.

It was partially because of uncertainty about the effects of nuclear weapons that the Senate, when it ratified the 1963 limited test ban treaty, also agreed to what are known as the "Jackson Safeguards," after Senator Jackson, a power behind their adoption. These four statements of U.S. policy were meant to ensure the development of nuclear weapons and the understanding of their effects. The third safeguard calls on the United States to maintain an "atmospheric test readiness capacity." As Senator Jackson explained on the Senate floor in 1968 (*7*), this means "the maintenance of the facilities and resources necessary to resume promptly atmospheric testing should it be deemed essential to our national security or should the treaty be abrogated by others." The facility on Johnston Atoll is part of this readiness task force.

Perhaps an exoatmospheric test would be the only way to resolve the debate. Short of that, it seems that the lines of the controversy will remain clearly drawn: the hawks maintaining that the military can eventually be hardened, the doves maintaining that none but a fool would think of fighting a nuclear war.

—WILLIAM J. BROAD

References and Notes

1. "National security and the concept of strategic stability," *Journal of Conflict Resolution*, vol. 22 (No. 3), September 1978, p. 421.
2. *Congressional Record*, 19 September 1963, p. 16657.
3. *ibid.*, 25 September 1968, p. 28130.
4. Senate hearings before the Committee on Appropriations, H.R. 15090, 91st Congress, first session, 1970, pp. 871–872.
5. *F.A.S. Public Interest Report*, vol. 33 (No. 8), October 1980.
6. House hearings before the Committee on Armed Services, 7 February 1979.
7. *Congressional Record*, 25 September 1968, p. 28129.
8. Readers interested in further information on EMP and its effects should see *Science News*, 9 May 1981, and *IEEE Spectrum*, May 1981. Also see an excellent five-part series in the Atlanta *Constitution*, starting 21 September 1980, p. 1.

Utilities Choke on Asthma Research

Polluting industries have mounted a major campaign against protection for sensitive populations under the Clean Air Act

The utility industry is up in arms over the practical and potentially costly implications of recent studies indicating that asthma victims are sensitive to concentrations of sulfur dioxide in the air that are far lower than previously thought to be harmful. The studies were conducted by Dean Sheppard and his colleagues at the University of California at San Francisco, and involved 20 asthmatics.

Their research will be part of the debate on an important and increasingly controversial provision of the Clean Air Act, which is now up for renewal in Congress. The act requires that limits on air pollutants be set low enough to protect not only the general population from adverse health effects but also sensitive or highly susceptible populations, such as asthmatics, with allowance for what is loosely called "an adequate margin of safety." Previous studies had shown that sulfur dioxide causes eye irritation and aggravates a number of lung diseases, but Sheppard's is the first to link such low amounts (as low as 0.5 parts per million) with such serious effects. As a result, the Environmental Protection Agency (EPA) may be required under the act to substantially lower the standard for sulfur dioxide in the ambient air of urban areas. Utilities, which have already spent millions of dollars to purchase low-sulfur coal or to install sulfur dioxide scrubbers in the smokestacks of their power plants, could be forced to spend more.

EPA is cautiously awaiting replication of Sheppard's work before it completes its revision of the sulfur dioxide standard, in process since 1976. But the business community fears the worst. The studies, published recently in the *American Review of Respiratory Diseases*,* may soon be verified by work under way at the University of Washington and the Rancho Los Amigos Hospital in Downey, California. The utility, petroleum, and chemical industries, which each generate copious amounts of sulfur dioxide, have targeted for extinction the part of the act that requires protection for sensitive health groups.

The dispute is only one of several that members of Congress will face as they attempt to rewrite the act, but the questions it raises are fundamental philosophical issues. The dilemma is obvious: Should the entire populace assume the burden of preventing aggravation of a disease in a relatively small group of people who unfortunately live in large cities? The Senate Environment and Public Works Committee plans hearings on the issue this week. Representatives of various affected trade groups will say no, that excessive costs to protect such persons inhibit industrial growth, exacerbate inflation, and prevent the development of needed energy resources. But these groups will also acknowledge that researchers are discovering adverse health effects for most air pollutants at levels far lower than previously known, with the result that assuring "an adequate measure of safety" has become increasingly difficult and may soon become impossibly expensive.

An example is posed by EPA's revision of the pollution standard for carbon monoxide last year. A review group in the Carter White House claimed that the new proposal would cost the automobile

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*Dean Sheppard, W. Scott Wong, Cristine F. Uehara, Jay Nadel, Homer Boushey, "Lower threshold and greater bronchomotor responsiveness of asthmatic subjects to SO_2," *ARRD*, vol. 122 (Dec. 1980), pp. 873–878; Dean Sheppard, Albert Saisho, Jay Nadel, Homer Boushey, "Exercise increases SO_2-induced bronchoconstriction in asthmatic subjects," *ARRD*, vol. 123 (May 1981), pp. 486–491.

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industry about $250,000 for each day of angina pain averted in a small group of heart patients that exercise in urban areas. Paul MacAvoy, a professor of economics at Yale and a member of the Council of Economic Advisers under President Ford, asks, "Would it not be better to close the EPA and buy each person sensitive to carbon monoxide a condominium in Key West?" The Business Roundtable, the American Petroleum Institute, and the National Coal Association all want EPA to abandon its concern for such subgroups and set standards that protect only against significant risk of adverse effects in the general population. The EPA, under the direction of its new administrator Anne Gorsuch, is considering the idea, along with a number of other ideas, and the change may be incorporated in the Administration's forthcoming clean air proposal to Congress. Another idea reportedly floated by the Office of Management and Budget is simply to turn the entire standard-setting process over to individual states.

"Should the entire populace assume the burden of preventing aggravation of a disease in a relatively small group of people who unfortunately live in large cities?"

The switch will be vigorously resisted by environmentalists and groups such as the American Lung Association, that strongly supported the original language in the bill when it was passed in 1970. The Senate committee that wrote the legislation specified then that the standards must protect *anyone* exposed in the course of normal daily activity, giving as the sole exceptions patients in intensive care units or newborn infants in nurseries. EPA has construed this language broadly, although it has typically not chosen the smallest, most unusual group of those who qualify as specially sensitive. In its standard for exposure to ozone, for example, EPA selected exercising children, asthmatics, and victims of emphysema as the most sensitive populations, turning aside requests from the Environmental Defense Fund that it consider people with vitamin E deficiencies or those with cystic fibrosis.

Environmental group representatives will testify this week that tightening the standards at occasionally great cost is worth it if the discomfort of those with respiratory diseases is significantly lessened. Air pollution is obviously the most difficult environmental insult to flee. Most supporters of the act admit that adverse health effects from common air pollutants can occur at low levels, and that assuring "an adequate margin of safety" for an extremely sensitive population may therefore be impossible. But they insist that the current requirement is needed if industry is to eliminate as much pollution as possible. Last March, the National Commission on Air Quality, a congressionally chartered group of four congressmen and nine others representing a broad spectrum of views, also suggested that the current provisions be left unchanged.

The dispute is particularly thorny in the instance of sulfur dioxide, because of growing evidence that healthy nonexercising individuals are not sensitive to the levels of pollution now common in urban environments, at least in the short term. John Bachmann, an EPA researcher working on the agency's revised standard, says that a number of clinical studies show that most of the pollutant is removed in the upper respiratory tract before it gets to the lungs, where it has the greatest negative effect, unless it gets attached to other particles or a person breathes through their mouth. Evidence on long-term effects, such as the possibility that sulfur dioxide may be a mutagen or a cocarcinogen, remains by most interpretations equivocal or at least controversial. Bachmann also says that some recent reanalysis of studies conducted during pollution episodes in London and New York City had suggested that sulfates and particulates may be more worrisome than the precursor sulfur dioxide, a finding that could result in less stringent pollution requirements in areas where sulfates or particulates are not present. On the strength of such evidence, the industry had anticipated that the current air quality standard for sulfur dioxide would be eased somewhat.

This explains the vigorous attempts to refute Sheppard's results or alter the law. Victims of asthma in the studies had difficulty breathing during exercise on a bicycle in an atmosphere of sulfur dioxide at or below the level now permitted for once-a-year peak concentrations. The concentration was well above that permitted as an annual average, but the standard might still have to be lowered to ensure an adequate margin of safety.

Some of the debate centers on whether breathing difficulty that is short of asthmatic wheezing constitutes a serious adverse health effect of the type covered under the act. Minor throat constriction occurred at extremely low levels in Sheppard's studies. The Utility Air Regulatory Group and the American Petroleum Institute, in long pleadings filed with EPA, have argued that anything short of debilitating or irreversible effects should not be the EPA's concern. Sheppard, on the other hand, says they should be.

The issue will eventually be resolved by EPA's scientific advisory committee on air pollution, although the committee will not be confronted with it until the additional studies are complete. Edward Tuerk, EPA's acting assistant administrator for air, noise, and radiation, says it is too soon to predict what form the lower standard might take, even if one is warranted. "But these results could be the linchpin behind a standard at least as stringent as the current one." He speculates that EPA might have to write an ambient air quality standard requiring a lower peak sulfur dioxide concentration, as well as a shorter time period for the peak to occur. The states would apportion the reductions among individual industrial plants.

The issue of sensitive populations is not the utility industry's sole concern in the Clean Air Act debate. In light of increasing concern about the health effects of small particulate matter and the fact that both sulfur dioxide and nitrogen oxides contribute to acid rain, Congress is being pressured to require that EPA write stricter standards for these pollutants. Consequently, the utilities invested heavily during the 1980 elections, giving $60,000 to members of the Senate Committee on Environment and Public Works and $34,000 to the House Subcommittee on Health and the Environment, according to a recent report by Common Cause. An additional $1 million was given to the members by petroleum, steel, chemical, mining, and automobile corporations and trade associations, although the clean air debate was surely not the only cause of such largesse.

—R. JEFFREY SMITH