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WORKER/PUBLIC PROTECTION

The Double Standard

Patrick Derr
Robert Goble
Roger E. Kasperson
Robert W. Kates

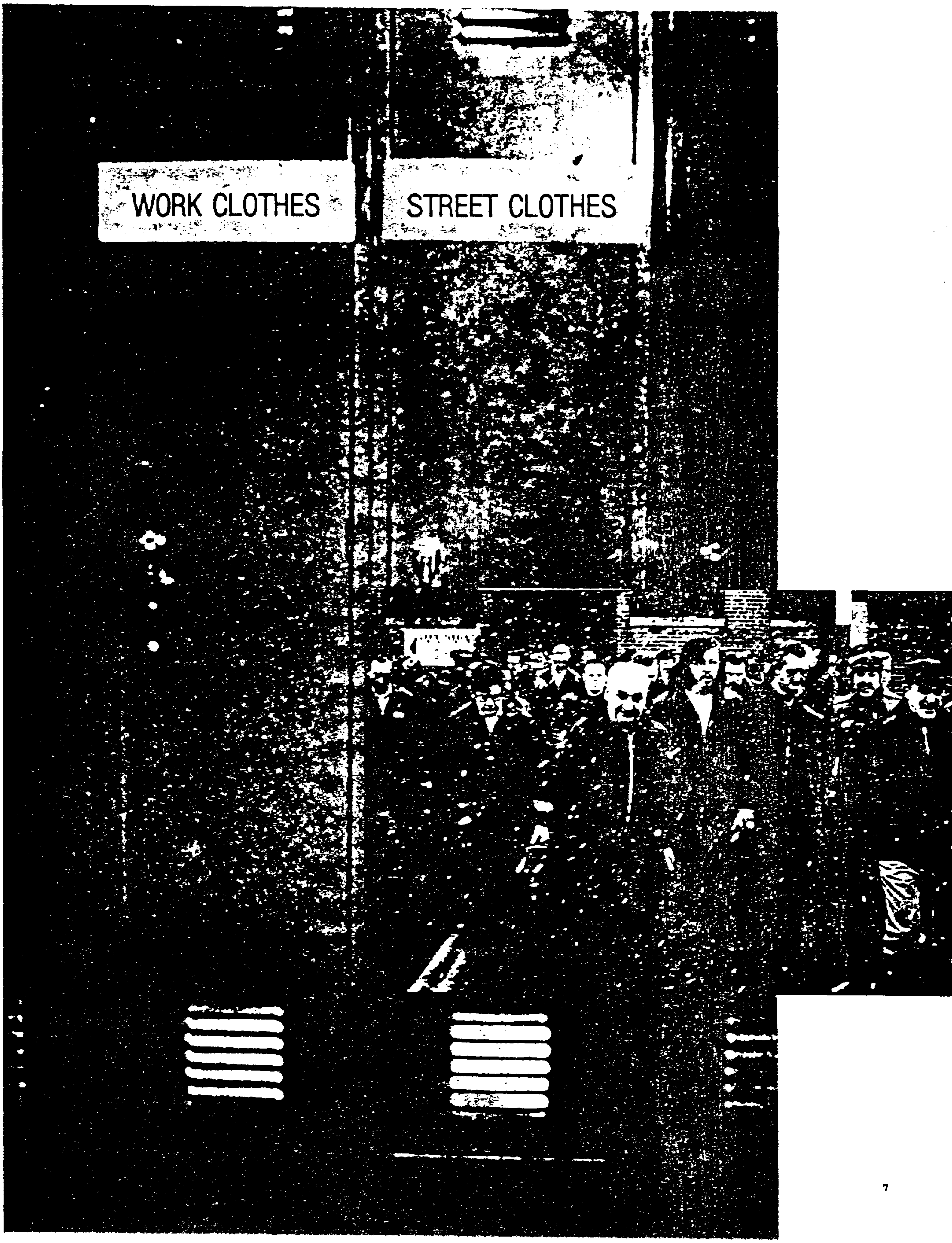
This article is the first in a series which will explore the differences in protection from hazards provided to workers and the general public. In this article, the authors explore the extent of this differential exposure to the hazards of technology, its institutionalization in government standards in the United States and abroad, its health implications, and the justifications offered to support its practice. Subsequent articles will explore in detail the arguments for and against differential protection in the context of case studies of pesticides, lead, and nuclear power. Future articles will also evaluate the soundness of the moral arguments and will examine the ways in which society can respond to inequities and policy issues. Most of the work on which this series is based has been conducted at the Center for Technology, Environment, and Development at Clark University or by individuals associated with the Center. Roger E. Kasperson and Robert W. Kates of Clark University are co-editors of the series.

George Moore, a glass blower in a Connecticut factory, was worried by newspaper stories that his small town had exceeded standards of the U.S. Environmental Protection Agency (EPA) for nitrogen oxides in the past year, and that most of this air pollution came from the New York metropolitan area. A fellow worker told him: "Forget it; you breathe it everywhere. What do you think is in the air here in the factory?" George went to the superintendent, who assured him that nitrogen oxide levels within the factory were well within the government-prescribed "safe limits." Comforted, George wrote an angry letter to a New York newspaper calling upon the city to keep its smog to itself, unaware that his workplace exposure was nearly 25 times greater than it was outside the factory and was significantly above the level at which harmful medical effects would be expected.

John Mill is a member of a citizens group which, in the aftermath of the Three Mile Island accident, has opposed the release of contaminated water to the Susquehanna River. His father James has applied for a job readying the wastes for shipment for outside storage. When his father was asked about John's activity, he replied that, of course, the public has to be protected. Indeed, it is partly for this reason that he wants the job. In parting, James observed that his son is a real coward about radioactivity. "Certainly," James said, "the government's levels are safe enough." What he does not know is that the U.S. Nuclear Regulatory Commission has concluded that the major health impact of the accident will be the exposure of workers involved in decontaminating the reactor.[1]

When Adam Smith of the U.S. Embassy in Moscow made a formal complaint that the embassy was being bombarded with microwaves at a level nearly twice that permitted for occupational exposure in the Soviet Union, he was unaware that this level was 1/500th of the U.S.-permitted level of exposure.

When we worry about a hazard in our environment we are apt to think, "Somebody ought to do something about it"; or, "If government regulations were only enforced, things would be all right"; or, more pessimistically, "Nothing can be done about it—we'll just have to live with it." We tend to be even less aware of the distribution of risks in our society than of the distribution of wealth, the


WORK CLOTHES
STREET CLOTHES

distribution of political power, or the distribution of opportunities for education.

Awareness arrives quickly when a toxic waste disposal site or new power plant is planned for our neighborhood, but the siting of noxious facilities is only a small part of the pervasive problem of inequitable risk distribution in our society. As the examples cited above suggest, the management of occupational risks also raises serious questions of equity. Even a cursory study of the problem reveals that permitted levels of occupational exposure to hazardous materials are generally much higher than the level permitted for the general public, and that, in some circumstances, increasing protection for the public can lead to greater exposure of workers. Furthermore, although there are wide discrepancies between *the absolute levels* of the public and occupational standards set by different countries, *the differential* between permitted worker exposure and public exposure is relatively constant.

These differences between worker and public exposure standards for identical hazards raise a question of fairness: Why *should* a worker's exposure be much higher? A number of justifications have been advanced. Some would argue that the differential is necessary for the well-being of society. Others claim that workers are better able to bear such risks than the general public; still others hold that workers are paid to take risks and have voluntarily consented to accept the risks. These are all moral arguments, and as such they require careful examination using the tools of moral analysis. But they also depend on the truth of their empirical premises: *Is* society actually better off? *Are* workers really compensated for their risks? *Do* they consent to them? *Can* they better bear the risks? Such questions require careful appraisal.

In this article we explore the issues raised by this apparent double standard, arguing that (*1*) the inequities in exposure are associated with substantial human misery in the form of illness and death; (*2*) the inequities are apparent in relation to a very wide range of hazards; and (*3*) a double standard of protection is characteristic of governmental regulation, both in the United States and abroad. We then discuss the principal moral justifications (explicit or implicit) offered for these inequities, and identify the principal empirical and moral issues at stake.

The Human Toll

There are now 220 million persons living in the United States. Of these, almost 2 million will die this year—mostly from heart disease, cancer, stroke, and accidents. Seventy-five million people will be injured, and 25 to 30 million will suffer some long-term disability from a chronic illness or as the result of an injury.[2] Almost all will suffer some acute condition: more than two such acute conditions per person per year are reported, and half of these are serious enough to result in the loss of at least one day of work or other activity.

Of these same 220 million Americans, about 97 million will be employed this year for money; 7 million more will be looking for work; and about 18 million will be retired. What proportion of the burden of death, disease, injury, and pain noted above originates in the work experience?

Although there is no certain answer to this question (the reasons for the uncertainty range from persistent underreporting of occupational illness to major scientific questions about the origins of cancer and heart disease), a starting point can be found in some work of Clark University's Center for Technology, Environment, and Development published in this journal in 1979.[3] The authors attempted to identify the fraction of U.S. deaths that could be associated with technological development and concluded that 15 to 25 percent of deaths (those of 270,000-480,000 people per year) were related to technology, and that the link between technology and mortality was clearest for two major causes of deaths (accidents and cancer).

It is much easier to determine the proportion of accidents than the proportion of cancers which are work-related. The bodily harm caused by an accident usually appears immediately, and the location and cause of the accident are apparent. Cancers, by contrast, tend to appear 20 or more years after exposure to the carcinogen, often lack any signature that identifies the cause, and characteristically have multiple causes. Estimates of the proportion of occupationally induced injuries (and other acute consequences) can be based directly on medical reports and surveys of patients. Estimates of the proportion of occupationally induced cancers (and other chronic diseases), however, must be based almost entirely on statistical inferences from epidemiological data. As might be expected, controversy abounds (see "The Great Cancer Controversy," p. 10).

There are six major sources[4] for data on the health status of the American people and on the proportion of illness and injury borne by workers:

- the reporting system by physicians, death certificates in all states,[5] and the California "first report of injury or illness"[6] for causes with possible workplace origin;
- the U.S. Public Health Service biennial health surveys of civilian households (41,000 in 1977);[7]
- the Bureau of Labor Statistics' Annual Survey of Occupational Injuries and Illnesses, collected for private sector employers and required by the U.S. Occupational Safety and Health Administration (OSHA);[8]
- the National Safety Council, with its own set of industry reporters and somewhat different definitions of injury than the foregoing sources;[9]
- the compensation system, including workmen's compensation by states[10] and the federal social security administration, which provides assistance to disabled individuals;[11] and
- the scientific literature, particularly in epidemiology or toxicology, and including especially commissioned reports on occupational hazards.[12]

None of these provides a truly satisfying answer to our questions. From them we have an accurate count of deaths—and a fierce dispute as to the proportion attributable to the workplace. The physician-based sources, while probably the most reliable, are limited by the lack of training and knowledge that primary-care physicians have in occupational disease. The house-hold and disabled surveys provide the best overall estimate of illness and injury but, as in all such systems relying on individual recall, they best describe acute episodes, particularly work-based injuries.

Table 1

HEALTH-LOSS ESTIMATES FOR TOTAL U.S. POPULATION AND PERCENT WORK-RELATED

HEALTH LOSS (Year Estimate)	NUMBER PERSONS (CASES) IN U.S. POPULATION	% WORK RELATED[a]
Death: (1977)		
Total:	1,899,597[b]	0.4[f]– 5.0[g]
Cancer	386,686[b]	1.0[h]–38.0[h]
Accident	103,202[b]	11.6[c]
Injury: (1977)		
Total:	73,297,000[c]	7.3[d]–15.4[d]
"Bed-disabling"	17,801,000[c]	13.4[d]
"Disabling"	10,600,000[d]	21.7[d]
"Permanent impairment"	390,000[d]	22.2[d]
Illness: (1977, 1981)		
"Acute conditions"	(386,959,000)[c]	0.04[f] – 2.7[i]
Cancer incidence	(1,260,000)[b]	1.0[h] –38.0[h]
Disability (1974)		
"Adult disability"	15,378,000[e]	17.6[e]

[a]Sources cited below usually refer to absolute estimates. Percentages of work-related mortality have been calculated by the authors employing appropriate estimates of work force size and population for year in question.

[b]E. Silverbay, "Cancer Statistics, 1981," *Ca—A Cancer Journal for Clinicians* 31 (Jan.-Feb. 1981): 13-28.

[c]U.S. Department of Health, Education and Welfare, Public Health Service, *Current Estimates from the Health Interview Survey, United States 1977*, Washington, D.C., 1978.

[d]National Safety Council, *Accident Facts, 1978 Edition*, National Safety Council, Chicago, 1978.

[e]U.S. Department of Labor, Asst. Sec. for Policy, Evaluation and Research, "An Interim Report to Congress on Occupational Diseases," Washington, D.C., 1980.

[f]U.S. Department of Labor, Bureau of Labor Statistics, *Occupational Injuries and Illnesses in 1977: Summary*, Washington, D.C., 1979.

[g]Public Health Service estimate cited by N. Asnford, *Crisis in the Workplace*, MIT Press, Cambridge, 1976, p. 93;

[h]Various scientific literature, see Box on Cancer Controversy.

[i]Extrapolated from various surveys including California's Physician Surveys and D. P. Discher, et al., "Pilot Study for Development of an Occupational Disease Surveillance Method," HEW Publ. (NIOSH) 75-162, Rockville, Md., 1975; and other scientific literature (see "The Great Cancer Controversy," p. 10).

The employer-based and compensation-based reporting systems contain a built-in conflict of interest related to insurance and liability, which leads to under-reporting of minor injuries and in a reduction in work-lost injuries by reassignment of injured employees to "light" work. Illnesses appear to be grossly under-reported, with only 148,000 work-related illnesses reported by the Bureau of Labor Statistics (BLS) in 1979.[13] The California physician "first reports" listed 33,000 illnesses in 1975;[14] if all U.S. workers had been ill in equal proportion, there would be twice the BLS-reported number of worker illnesses for the country as a whole. And a pilot study of 907 workers in hazardous occupations in Washington found probable occupational origin in 31 percent of 1,116 medical conditions.[15]

Despite these weaknesses, the various reporting systems do provide a range of work-related health-loss estimates (see Table 1). The major uncertainty in the estimate of job-induced mortality is in cancer incidence, for which, as discussed on page 10, there is controversy between those who believe the occupational fraction is under 5 percent and those who believe it to be of the order of 20 percent or larger. If the larger figure is used, then job-induced mortality is a sizeable fraction—20 to 30 percent of the mortality associated with technology and is the cause of perhaps 75,000 deaths per year. By any estimate the annual toll is heavy—10 million injuries, 30 million separate bouts of illness, between 20,000 and 75,000 deaths and, cumulatively, 2 million disabled.

Differences in Exposure

To what extent can this injury, illness, and death be attributed to inequities in exposure to technological hazards? The Center for Technology, Environment, and Development at Clark University has compiled information on 93 technological hazards. The list is diverse, including such hazards as skateboards, liquefied natural gas, saccharine, collapsing dams, microwave ovens, and contraceptives. The Clark group is using these data to classify hazards according to their biophysical characteristics.[16] The goal is to improve the management of hazards by providing a method for the systematic comparison of hazards and for relating types of hazards to public perceptions of them.

In this study we have used this hazard inventory and related data to answer two questions about the differential exposure of workers and the general public to technological hazards. These questions are: *(1)* Are most hazards in the inventory mainly occupational, mainly environmental, or a combination of both? *(2)* For those hazards that threaten both workers and public, are there systematic differences in the exposure to risk?

Of the 93 hazards, we have identified nine as strictly occupational in nature, 44 as strictly environmental, and 40 as involving a significant risk to both workers and the public.

In the following sections we consider only hazards carrying a risk to both workers and the public. Clearly these do not include all inequities of exposure; purely occupational hazards may seem on the face of it even more inequitable.

THE GREAT CANCER CONTROVERSY

It is 206 years since Percival Potts reported on the first diagnosed case of occupational cancer—cancer of the scrotum in chimney sweeps. Yet estimates of the fraction of cancer attributable to occupational exposures have only been made within the last dozen years. Nine of these estimates are plotted on a graph (see figure) marking the passage of time; they range from less than 2% in 1969 to a peak estimate of 20-38% in 1978. At the moment, reputable scientists are polarized between those who think the fraction is as high as 20% and those who argue for 5% or less. Translated into current rates of cancer deaths or incidence, the differences amount to 58,000 deaths or 154,000 new cases each year. To understand the scientific basis for these differences requires a bit of knowledge, first about the ways in which occupational fractions are calculated and then about the broader issues involved in the way questions of occupational exposure are posed relative to current theories of cancer development.

Most of those who calculate the fraction of cancer incidence due to occupational exposures attempt to add up the excess cancers observed in workers exposed to known carcinogens. The calculation by a group from the National Institutes (see first 1978 estimate) is a good illustration. They considered occupational exposure to six important substances: asbestos, arsenic, benzene, chromium, nickel, and petroleum distillates. These substances, except for benzene, have been implicated principally in cancers of the respiratory system. Their calculations for respiratory cancers are presented in the following table.

SAMPLE CALCULATIONS FOR LUNG OR RESPIRATORY TRACT CANCERS ASSOCIATED WITH HIGH-EXPOSURE OCCUPATIONAL SUBSTANCES

SUBSTANCES	RISK RATIO (R) (Worker/general population)	INCIDENCE (I) (Age-adjusted per 100,000 males > 20 yrs)	WORKERS EXPOSED (N) (1972-74 Survey)	EXPECTED CANCERS PER YEAR
Asbestos	6.6	116	1.6 million	10,400
Arsenic	4.7	131	1.5 million	7,300
Chromium	5.0	131	1.5 million	7,900
Nickel	5.0	131	1.4 million	7,300
Petroleum	3.0	116	3.9 million	9,100

SOURCE: Compiled by the authors from U.S. National Cancer Institute et al., **Estimate of the Fraction of Cancer in the United States Related to Occupational Factors**, September 15, 1978.

The workers exposed to these five substances that affect the lung or respiratory tracts are unintentional participants in an irregular human experiment. By "observing" them, either through studies that follow them over a number of years or through studies that go back in time following a cancer diagnosis or death, an estimate is made of the Risk Ratio (R), a measure of the greater risk to an exposed worker compared to an unexposed person (usually in the general population of appropriate age). Thus, for asbestos the sample calculation used 6.6 as the lung cancer risk ratio, selected from reported ratios of 1.5 to 12 in the literature. To subtract for "ordinary" cancers expected in the absence of exposure, the ratio of (R−1) is used in the calculation. This risk ratio (R−1) is then multiplied by the appropriate age-adjusted expected incidence (I) figure for the general population for newly diagnosed lung or respiratory tract cancers obtained from the most recent incidence survey; this figure then is multiplied by the numbers of exposed workers (N) derived from a 1972-74 national survey of maximum potential number of workers exposed in the workplace. The final column gives the expected annual number of new cancers over the lifetime of the exposed group. For these five examples only, the total is 42,000, some 13% of current cancer rates. Adding in other sites of asbestos-related cancers and the effects of benzene on the blood system, these six substances provided the basis for the National Institutes' controversial estimate that 20-38% of cancer in the near future would be caused by occupational exposure.

Because the National Institutes' estimate of the occupational fraction essentially doubled previous estimates and was made by reputable government scientists, the report was seriously studied and widely critiqued by industry sources, consultants, and independent scientists, who made and continue to make estimates of occupational fractions on the order of 5% or less. Each of the elements in the table above came under attack by those who argued that the report was an overestimate. The *risk ratios* were attacked as too high since they were based on past studies, and past patterns of exposure could have been higher than at present. The *incidence data* were used to forecast deaths, but not all cancers are lethal. The *number of exposed workers* was criticized as too high since the survey included all workers who might be exposed, regardless of the actual extent of exposure. Finally, in special cases (such as asbestos-caused mesothelioma) the report predicted more cancer than the total actually observed.

It has also been argued, however, that the report underestimated occupationally induced cancer. Only 6 substances were considered out of a list of 33 known occupational carcinogens, 12 suspected carcinogens, and an unknown but probably large list of carcinogens whose hazard has not yet been documented. The argument is strengthened by the appearance of an upturn in the latest cancer survey. Two industry consultants (Stallones and Downs, second 1978 estimate) were quite critical of the National Institutes report, but they concluded "that a point estimate of the proportion of total cancer attributable to occupational exposure of 20% is a reasonable one . . . and the full range, using multiple classifications, may be from 10 to 33% or perhaps higher if we had fuller information on some other potentially carcinogenic substances." At the same time, the founding director of the World Health Organization's International Agency for Research on Cancer and the author of the first major estimate of the occupational fraction 1-3% in 1969 (the first estimate in the figure) revised upward his estimate in 1979—2% for women, 6% for men. (See also the revised NIOSH estimates in "Cancer in the Workplace," *Environment,* July/August 1981.) The great controversy continues!

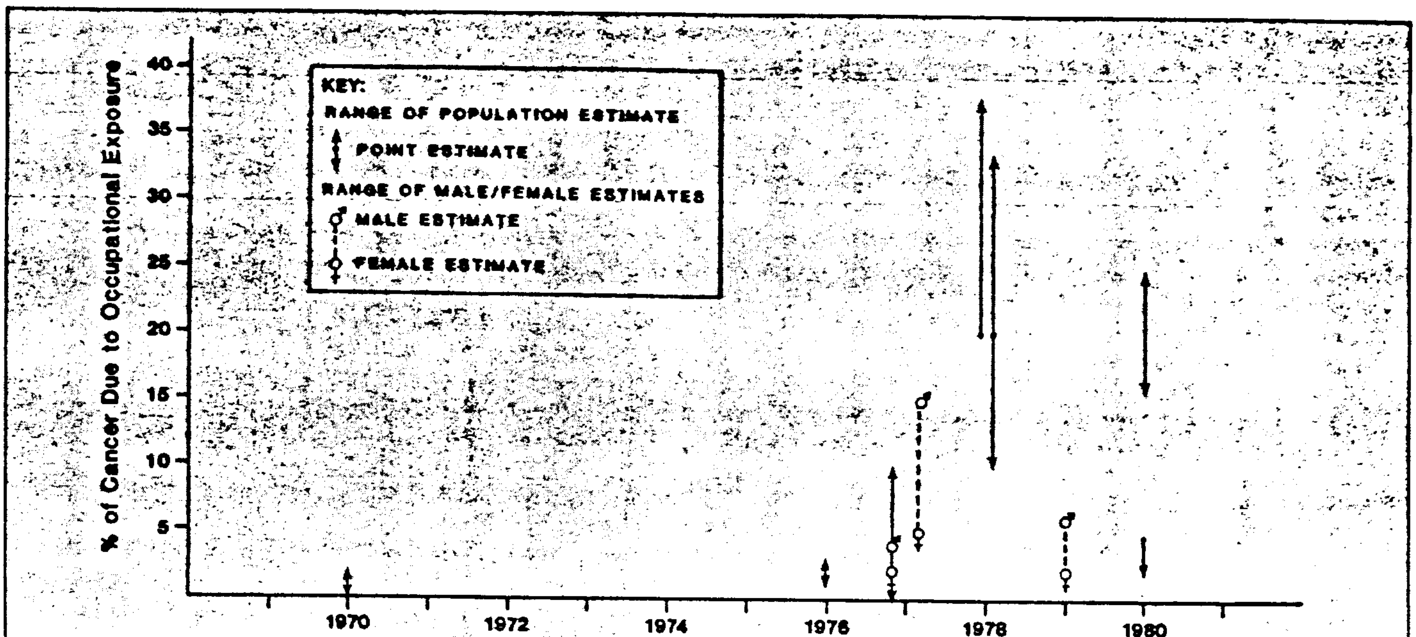


FIGURE 1. Occupational cancer estimates.

SOURCES:

For 1969, early 1976, and 1979 estimates: J. Higginson, "Present Trends in Cancer Epidemiology," *Proc. Canadian Cancer Congress* 8 (1969): 40-75; "A Hazardous Society? Individual versus Community Responsibility in Cancer Prevention," *Amer. J. Public Health* 66 (1976): 359-366; T. H. Maugh II, "Cancer and Environment: Higginson Speaks Out," *Science* 205 (28 September 1979): 1363-66.

For second 1976 estimate: E. L. Wynder and G. B. Gori, "Guest Editorial: Contribution of the Environment to Cancer Incidence: An Epidemiological Exercise," *J. National Cancer Institute* 58 (1977): 825-832.

For 1977 estimate: P. Cole, "Cancer and Occupation: Status and Needs of Epidemiologic Research," *Cancer* 39 (1977): 1788-1791.

For first 1978 estimate: U.S. National Cancer Institute, National Institute of Environmental Health Sciences, National Institute for Occupational Safety and Health, *Estimate of the Fraction of Cancer in the United States Related to Occupational Factors*, Washington, D.C., September 15, 1978.

For second 1978 estimate: R. A. Stallones and T. Downs, *A Critical Review of: "Estimates of the Fraction of Cancer in the United States Related to Occupational Factors,"* circulated, 1978.

For higher 1980 estimate: Unspecified NIH panel, cited in P. J. Barth, *Workers' Compensation and Work-Related Illnesses and Diseases*, MIT Press, Cambridge, 1980, p. 18.

For lower 1980 estimate: J. A. Cimino and H. B. Demopoulos, "Introduction: Determinants of Cancer Relevant to Prevention, in the War on Cancer," in H. B. Demopoulos and M. A. Mehlman, eds., *Cancer and the Environment*, Pathotox Publishers, Park Forest South, Ill., 1980, p. 1.

However, our concern is to identify systematic differences in the way society treats occupational and public exposure to hazards and to examine the moral justifications for those differences. For these purposes, we think the issue may best be understood by looking at the way society treats the same hazard for workers and for the general public.

We begin with a general survey of worker and public exposure using the 40 hazards (Table 2) for which we can compare occupational and public exposures. We have applied five measures of hazard exposure: the magnitude of the population at risk, the maximum number of people who might be killed in one incident, the estimated annual mortality due to the hazard, the maximum concentration of material or energy to which a person might be exposed in an incident, and average annual exposure to the hazardous material or energy (annual dose). For each measure we have asked whether the exposure of workers is greater than ten times that of the public, less than a tenth that of the general public, or equal, within a factor of ten, to the exposure of the public. We consider only substantial differences in exposure, greater than ten-fold or less than one-tenth.

The results, expressed as a percentage of the 40 hazards falling into each range, are shown in Figure 2. For most hazards the size of a catastrophe, the annual mortality and the maximum one-time exposure for workers and the public are equal within an order of magnitude. However, most hazards expose many more members of the general public than workers, while workers are usually exposed to a much higher dose of the hazard.

It is possible to estimate the difference in annual risk between workers and the public for the 40 hazards by dividing the estimates of annual mortality by the population at risk. These are shown in Figure 3, with the probability of death in any given year for workers shown on the horizontal axis and for the public on the vertical axis. Almost all of the hazards fall below the diagonal of equal risk, clearly demonstrating the tendency for greater worker risk and posing significant questions of equity.

Differential Protection in the U.S.

In the United States, OSHA is the primary regulator of occupational hazards, whereas the Environmental Protection Agency (EPA) is the primary regu-

Table 2

FORTY HAZARDS WITH BOTH WORKER AND PUBLIC EXPOSURE

ENERGY HAZARDS	MATERIALS HAZARDS
Nuclear warfare—blast	Automobiles—CO pollution
Handguns—shooting	Recombinant DNA—harmful release
Commercial aviation—noise	Alcohol—accidents
SST—noise	Smoking—chronic disease
Motor vehicles—noise	Pesticides—ingestion
Smoking—fire	Nuclear reactors—high level radiation
Trains—collisions	Nerve gases—accidental release
Microwave ovens—radiation	PCB—dispersion
Automobiles—collisions	Cadmium—dispersion
LNG—fire and explosions	Automobile—air-borne lead
Medical x-rays—radiation	Mercury usage—dispersion
Home appliances—fire	Radwaste—accidental release
General aviation—crashes	Mirex (pesticide)—dispersion
Commercial aviation—crashes	PVC—air emissions
Power mowers—accidents	DDT usage—dispersion
Chainsaws—accidents	Nuclear war—radiation
Elevators—falling	Nerve gas—wartime use
Motor vehicle racing—accidents	Chlorination of drinking water
Skyscrapers—fires	2,4,5-T—toxic effects
	Taconite mining—ingestion, breathing
	Spray asbestos—inhalation

lator of hazards to the general public. There are, of course, other agencies whose regulations are important for special groups of workers (for example, miners), particular classes of hazards (consumer products), or special types of hazards (such as radiation), but OSHA and EPA have primary responsibility, respectively, for most occupational and general environmental hazards.

Most OSHA standards regulating exposure to hazardous substances are limitations on the concentration of a substance in the air (typically averaged over an eight-hour shift) since respiration is the most likely pathway for the hazard and since, at least in principle, it is not too difficult to monitor exposure levels. EPA regulations for most substances, on the other hand, limit emissions, the rate at which the substance can be discharged into the air or the water. Hazard management through emission control is natural since the population at risk and

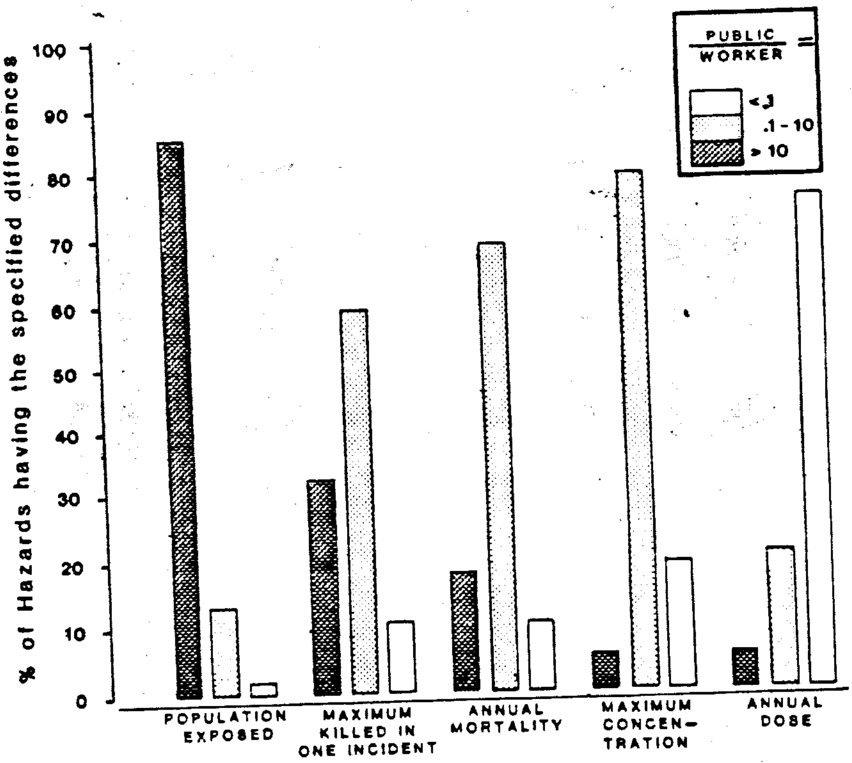


FIGURE 2. A survey of public/worker differences for 40 technological hazards.

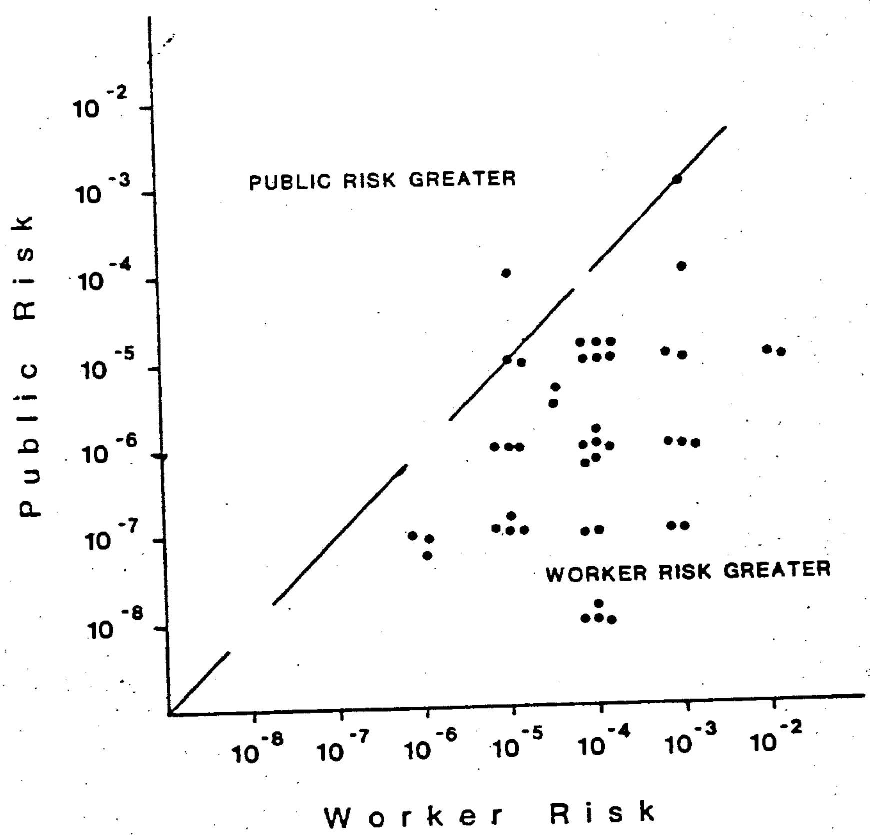


FIGURE 3. Public/worker risk compared for 40 technological hazards.

Table 3

COMPARISON OF OCCUPATIONAL AND ENVIRONMENTAL STANDARDS

MATERIAL OR PRODUCT	EPA STANDARD[a]	OSHA STANDARD[b]	NATURAL BACKGROUND	LEVEL AT WHICH HEALTH EFFECTS OBSERVED	HEALTH EFFECTS
Carbon monoxide (CO)	9 ppm (8 hrs) 35 ppm (1 hr)	50 ppm (8 hrs)	.1 ppm[c]	35 ppm (1 hr)	5% carboxy hemoglobin in blood: heart patient symptoms, changes in oxygen intake[d]
Nitrogen oxides (NO_x)	.05 ppm (1 yr) (.25 ppm [1 hr] California)	5 ppm (8 hrs) (NO_2)	.004 ppm[e]	1.5 ppm	Increased airway resistance, respiratory irritation[f]
Ozone (O_3)	.12 ppm (1 hr)	.1 ppm (8 hrs)	.05 ppm[g]	.1 ppm	Increased airway resistance, respiratory irritation[h]
Sulphur dioxide (SO_2)	.14 ppm (24 hr) .03 ppm (1 hr)	5 ppm (8 hrs.)	——	1 ppm	Respiratory irritation[i]
Hydrocarbons (HC)	.05 ppm (guideline)	500 ppm	——	500 ppm	Neurological damage[j]
Lead (Pb)	1.5 $\mu gm/m^3$ (30 days)	200 $\mu gm/m^3$ (8 hrs)	——	30 $\mu gm/m^3$	Changes in blood and urine chemistry, anemia in children[k,l]
Beryllium (Be)	.01 $\mu gm/m^3$ (30 days)	2 $\mu gm/m^3$ (8 hrs)	——	2 $\mu gm/m^3$	Lung disease observed;[m] observed cancer induction[n]
Radon (Rn)	.015 working levels (levels for remedial action)	.33 WL (¼ yr) NRC	.003 WL[o]	25 WL	Observed cancer[p]
Noise	70 db[q] (guidelines)	90 db	50 db	85 db	Hearing loss[r]
Ionizing Radiation	.5 rem (yr) NRC	5 rem (yr) NRC	.15 rem (yr)[s]	2.5 rem (yr)	Observed cancers[t]

[a] *Environment Reporter*, Bureau of National Affairs, August 29, 1980, pp. 121:0101-121:0381 and 121:0461-121:0701.
[b] *Environment Reporter*, Bureau of National Affairs, June 20, 1980, pp. 115-1551, 115-1600.
[c] NAS, *Carbon Monoxide*, Washington, 1977, p. 29.
[d] Ibid., pp. 65, 166.
[e] H. S. Stoker, and S. L. Seager, *Environmental Chemistry*, 1972, p. 27.
[f] NAS, *Nitrogen Oxides*, Washington, 1977, p. 282.
[g] E. Calabrese, *Methodological Approach to Deriving Environmental and Occupational Health Standards*, 1978, p. 293.
[h] Ibid., p. 295.
[i] NAS, *Sulphur Oxide*, Washington, 1978, p. 166.
[j] NIOSH, *Occupational Exposure to Alkanes*, Washington, 1977, p. 68.
[k] NAS, *Lead*, Washington, 1972, p. 63.
[l] EPA, *Air Quality Criteria for Lead*, Washington, 1977, pp. 1-13.
[m] NIOSH, *Criteria for a Recommended Standard Occupational Exposure to Beryllium*, Report = 22-10260, Washington, 1972.
[n] *Science* 190 (1975): 896-899, and 201 (1977): 298-300.
[o] NRCP Report =45, *Natural Background Radiation in U.S.*, 1975, pp. 78-87.
[p] NAS, *The Effects on Population Exposed to Low Levels of Ionizing Radiation*, 1980, pp. 383-384.
[q] A. J. Meyer, "Noise Control at the Federal Level," *Environmental Science and Technology* 9 (1975): 1020.
[r] EPA, *Toward a National Strategy on Noise Control*, 1977, p. 66.
[s] NAS, *Effects on Population Exposed to Low Level of Ionizing Radiation*, 1980, p. 13.
[t] Ibid., p. 187.

the environment in which exposure to the substance occurs are likely to be difficult to characterize. Direct comparison with OSHA regulations is therefore difficult, and we have not yet attempted to make an overall comparison.

Instead, we have looked at the small but important class of substances that are emitted in sufficiently large volume and by sufficiently dispersed sources that EPA has deemed it practical to establish standards for ambient concentrations. Even for these substances, the comparison with OSHA standards has its problems: the time periods over which concentrations are to be averaged are frequently different, and uncertainties in dose/response information make it difficult to determine whether a short exposure to high concentrations is better or worse than a long exposure to lower concentrations. Although we have not yet considered enforcement practices, it is clear that an environmental standard that limits concentrations from many disparate sources encounters greater enforcement problems than an occupational standard.

Despite these difficulties, we list in Table 3 the substances for which we can

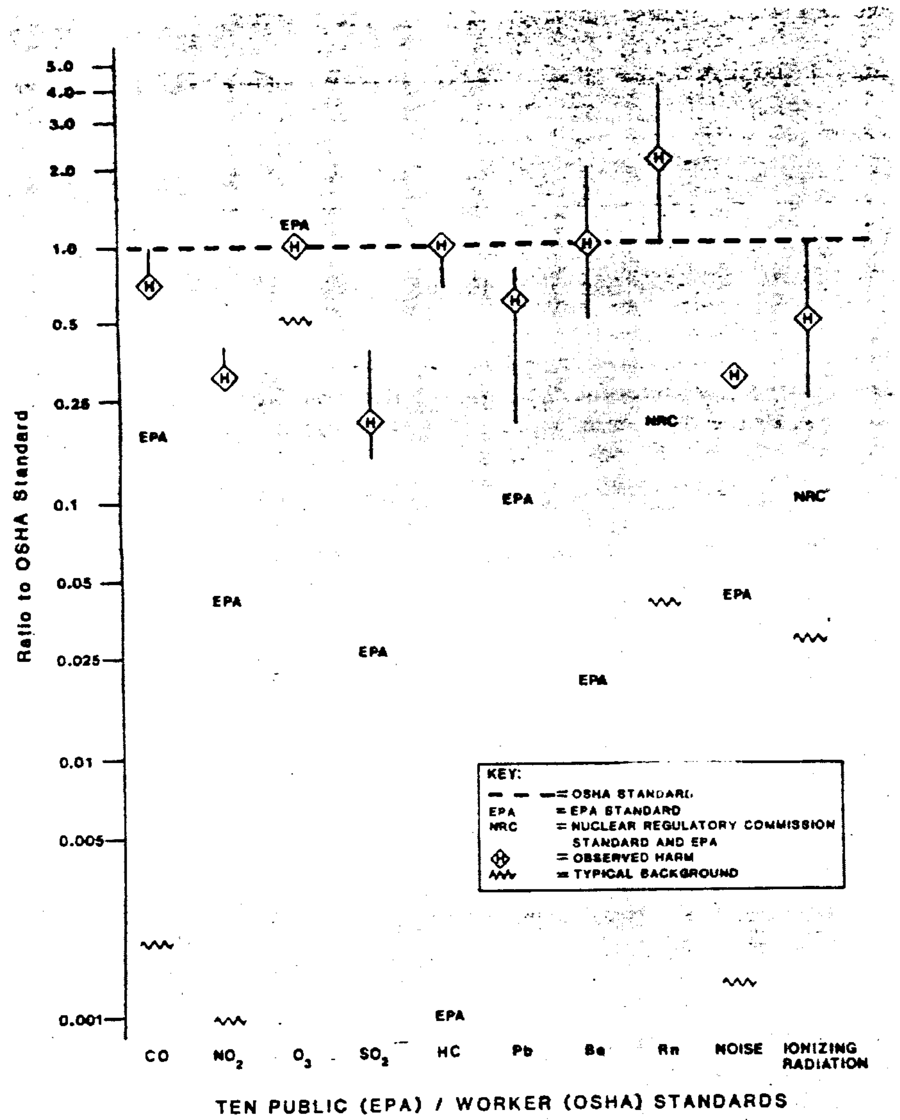


FIGURE 4. Public (EPA) standards and worker (OSHA) standards for ten hazards, levels of observed harm, and normal background levels.

compare limits on concentration, the current EPA and OSHA standards, and information on medical effects and background level. In addition, Table 3 lists two energy hazards, noise and ionizing radiation, for which there are both occupational and environmental standards. The box on this page provides a sample calculation illustrating how one can compare standards for different time periods.

Figure 4 provides a graphic summary of this information. For each hazard the ratio of the environmental standard to the occupational standard is shown. Except for ozone and carbon monoxide, for which there are only short-term standards and for which the primary health concerns are short-term stresses, the comparison is based on the limits the standard imposes on the cumulative annual dose.

Table 3 and Figure 4 also show two quantities useful in characterizing each hazard: the natural background level for the hazard and the lowest level of concentration at which adverse human health effects have been observed. The second item is, of course, controversial for most hazards. We have done our own crude weighting of the relevant studies, preferring studies which document physiological change, and have used a bar to denote the range of such observations.[17] All of these items are expressed as ratios to the OSHA standards.

It is apparent in Figure 4 that regulators afford a greater measure of protection to members of the general public than to workers. While one might expect that standards for both groups would be set at or below the point at which measured harm occurs, this is not the case. While general environmental standards are set below levels of measured harm, workplace standards tend to be set above that level. Further, ratios for the level of observed harm to

COMPARISON OF EPA AND OSHA STANDARDS FOR SULFUR DIOXIDE

OSHA standards for occupational exposure and hazardous materials are for concentrations averaged over a normal 8-hour shift. EPA standards for public exposure are for concentrations averaged over various time periods—1 hour, 8 hours, 24 hours, or 1 year (8,760 hours). Depending on the time period, the ratio of permitted doses can vary. We illustrate this by comparing the *maximum annual* doses and *maximum daily* (24-hour) doses permitted by EPA and OSHA for sulfur dioxides (SO_2).

The OSHA standard for exposure to SO_2 in the air is 5 parts SO_2 per million parts of air (ppm) averaged over 8 hours. EPA has two standards: .03 ppm averaged over a year and .14 ppm averaged over 24 hours. We can make two comparisons: the annual dose permitted by each agency, and the 24-hour (or 8-hour) dose permitted.

The maximum annual dose permitted by EPA is .03 ppm X 8,760 hours. The maximum annual dose permitted by OSHA is 5 ppm X 50 weeks X 40 hours/week = 5 ppm X 2000 hours. The ratio is (.03 X 8760)/(5 X 2000) = .026, about a factor of 40. The maximum 24-hour dose permitted by EPA is .14 ppm X 24 hours. The OSHA-permitted dose is 5 ppm X 8 hours. The ratio is (.14 X 24)/(5 X 8) = .08, about a factor of 12.

the OSHA standards center around 0.7 and range from 0.2 for sulfur dioxide to 2.0 for radon. This means that the OSHA standards are set at about the level of observed harm in four cases, at two times higher in two cases, and at four times higher in three cases. In only one case, radon, is the standard below the level of observed harm.

Clearly, safety factors are not automatically built into OSHA regulations. Assuming that OSHA's charge is to ensure a safe working environment, the spread of the ratio between OSHA standards and observed harm should presumably be accounted for by some combination of: uncertainties in the interpretation of measured harm (the choice we have made is subjective but presumably has a consistent bias); time delays between measurements and the establishment of new regulations; the extent to which (as in the case of benzene) cost/benefit considerations or political considerations have applied; or failure in administering the legislation.

If the standard of protection were equal for the public and for workers, EPA (or NRC)/OSHA ratios would be one. Yet Figure 4 shows that the ratios are strikingly smaller than one, ranging between .03 (for noise and sulfur dioxide) to 0.3 for radon. The two exceptions to this pattern are ozone (where the standards are approximately equal and for which background is already one-half of the threshold for harm) and hydrocarbons (where the EPA level is only .001 of the OSHA level but is set to protect the public against another hazard). Put another way, these standards generally reflect the assumption that workers may be exposed to hazards between 10 and 100 times the level we consider to be unsafe for the public.

The reasons explicitly cited by EPA for setting standards lower than the threshold for harm include: the need for safety margins; the protection of sensitive population groups (for example, children, in the case of lead); consideration of other exposure to the hazard; and impacts on related forms of pollution (for example, hydrocarbons associated with smog, sulfur dioxide with sulfates, and lead with the use of catalytic converters by automobiles). Unresolved, however, is why workers should be exposed at much higher levels and why several of these considerations, especially the first and third, should not apply equally to the workplace.

The International Context

It may be helpful to place the situation in the United States in an international context in order to determine whether the patterns observed are specifically related to a particular nation and ideology or whether they are more commonly shared in the international community.

The United States does not possess the most stringent standards for the protection of workers. Table 4 shows comparative occupational standards for some 12 airborne toxic substances in 13 industrialized countries. There is a general East-West dichotomy, with the Soviet Union and East European countries exhibiting the greatest stringency in standards and the United States the greatest permissiveness. While most of the differences are within an order of magnitude, factors of 20 or more appear for heptachlor, lead, and parathion. A transnational analysis of some 169 workplace standards found that only 19 were most stringent in the U.S. whereas some 147 (87 percent) were most stringent in the U.S.S.R.[18] The reasons for the differences between U.S. and U.S.S.R. standards are both historical and ideological, and are described in the box on page 31.

But, given these major differences, it is remarkable that a double standard of protection of workers and the public is tolerated no less in the Soviet Union than in the United States. Comparing some nine technological hazards (see Table 5), we find that differential protection is the rule in both countries, with permissible exposure levels for the public and for workers varying by factors of 5 to 200. Nor is the level of differential protection in a socialist society less than that for a capitalist society.

(continued on page 31)

Table 4

INTERNATIONAL COMPARISON OF OCCUPATIONAL STANDARDS (all standards in milligrams per cubic meter mg/m^3)

Countries	Benzene	Cadmium Oxides	Carbon Monoxide	DDT	Heptachlor	Lead	Beryllium	Mercury	Nickel	NO_X	Ozone	Parathion
Belgium	30	0.05	55	1	0.5	0.15	0.002	0.05	0.1	9	0.2	0.1
Finland	32	0.01	55	1	0.5	0.15	0.002	0.005	–	9	0.2	0.1
German Democratic Republic	50	–	35	1	–	0.15	0.002	0.1	–	10	0.2	–
Federal Republic of Germany	50	0.1	55	1	0.5	0.2	–	0.1	–	9	0.2	0.1
Italy	20	0.01	55	1	–	0.15	0.002	–	1	5	0.2	0.1
Japan	80	0.1	55	1	–	0.15	0.002	0.05	1	9	0.2	0.1
Netherlands	30	0.05	55	1	0.5	0.15	0.002	0.05	0.1	9	0.2	0.1
Romania	50 (max)	0.2 (max)	30	0.7	0.3	0.1	0.001 (max)	0.05	–	10 (max)	0.1	0.05
Sweden	30	0.02	40	1	–	0.1	0.002	0.05	0.01	9	0.2	–
Switzerland	32	0.1	55	1	0.5	0.15	0.002	0.05	–	9	0.2	0.1
USSR	5	0.1	20	0.1	0.01	0.01	0.001	0.01	0.5	5	0.1	0.05
Poland	30	0.1	30	0.1	–	0.05	0.001	0.01	–	5	0.1	–
United States	30	0.1	55	1	0.5	0.2	0.002	0.05	1	9	0.2	0.11

SOURCE: International Labor Office, Occupational Exposure Limits for Airborne Toxic Substances, ILO, Geneva, 1977.

The Double Standard

(continued from page 15)

Examination of data for other countries replicates the pattern found in the U.S. and the U.S.S.R. Across political systems, economies, and ideologies, societies tolerate a double standard for the protection of workers and the public.

Justifications

Thus far we have observed a clear double standard embodied in regulations designed to protect workers from hazards in the workplace and in those designed to protect members of the general public. We have also observed that differences in exposure occur for a wide range of hazards and that the increment of occupational exposure to hazardous substances produces a great deal of human misery. Finally, we have seen that a double standard appears in other societies with other ideologies.

That the differential protection of workers and publics is morally justified has been more frequently assumed than argued. Explicit defenses of a double standard as equitable are difficult to find, rarely provide detailed argument from principles, and sometimes end up assuming what they are supposed to demonstrate. Those arguments that can be found, however, rely almost exclusively upon tacit appeals to four widely accepted principles of justice. We summarize those principles in the box on page 33. Although the four appeals are often intertwined, we separate them here for the sake of clarity. (The cases used to illustrate these principles are those described at the beginning of this article.)

Utility. The exposure of glassblower George Moore to nitrogen oxides is adequately justified, according to the utility principle, by the fact that the resulting benefits to society at large more than outweigh the particular harm which may be inflicted upon Mr. Moore. The morally relevant costs of reducing Moore's risk might include higher costs for glassware, reduced employment security or opportunity for Moore and his neighbors, possible new or substitute hazards, and so forth. These costs would represent a far larger burden on the total community welfare than any of the present or foreseeable consequences of Moore's exposure. Accordingly, in terms of this analysis, it would be morally indefensible to decrease the welfare of the general community in order to provide the much smaller benefit to Moore.

It is this kind of ethical reasoning which underlies such published claims as "becoming richer is becoming safer."[19] The inference is that the net overall well-being of the community is best served by concentrating on those risks which can be reduced most sharply, while continuing to increase the total community's affluence. This increased affluence will, in turn, result in such additional benefits as better nutrition, improved medical care, and increased recreation. New investment following such affluence

DIFFERENCES IN U.S.-U.S.S.R. OCCUPATIONAL STANDARDS

The vast majority of research conducted on occupational standards in the world is done in the Soviet Union and the United States. The contrast in stringency of standards in the two countries reflects an underlying difference in approaches to health and safety, both in the workplace and the general environment.

In the Soviet Union the "maximum permissible concentration" (MPC) of any hazardous substance refers to the concentration which, with a work-day of 8 hours over the work-life of the worker, will not cause any disease or have any other adverse effect on the health status of workers, either in the course of work or at any later date.[1] Unlike the American approach to standard-setting which assumes the existence of a healthy environment for workers, uses time-weighted averages, and waits for death, disease, or injury to be demonstrated, the Soviet approach proceeds from zero-dose and an initial characterization of baseline physiological and biochemical characteristics in experimental individuals.[2] The MPC is then set at the lowest level that causes any statistically significant deviation in extremely sensitive indicators of behavioral or biochemical responses.[3] Finally, Soviet standards are based strictly on medical considerations whereas, characteristically, U.S. standards (especially now with the Reagan Administration indicating its intent to extrapolate from the Supreme Court decision on benzene) take into account "available control technology," "economic feasibility," and "ability in practice to measure concentrations."

The Soviet approach to health standard-setting reflects, of course, ideological differences with the United States. Soviet medicine has historically emphasized the prevention of disease. The Russian hygienist, S. P. Botkin, in the 19th century defined social diseases as diseases of a common source that preferentially affected those in the lower strata of society. The basic Soviet approach has been to change the environmental factors that influence disease among the previously oppressed classes.[4] It is not surprising, then, that the Soviet Union has been a leader both in setting new workplace standards and in developing workplace standards of greater stringency.

It is one thing, however, to set standards and another to enforce them. Generally it is not known how well the Soviets enforce workplace standards, although the same questions could be asked of the U.S. government. It is likely that, because of their large number and stringency, environmental standards are often impossible to enforce in the U.S.S.R.[5] What is important, however, in studies of equity is that standards, however enforced, still represent society's judgments as to what is appropriate, the goals to which society should aspire.

[1] A. V. Roschin and L. A. Timofeevskaya, "Chemical Substances in the Work Environment: Some Comparative Aspects of U.S.S.R. and U.S. Hygienic Standards," **Ambio** 4, No. 1, p. 32.
[2] B. D. Dinman, "Development of Workplace Environmental Standards in Foreign Countries, Pt. 1: Historical Perspectives; Criteria of Response Utilized in the U.S.S.R.," **Journal of Occupational Medicine** 18 (June 1976): 409-417.
[3] E. J. Calabrese, "Comparison of U.S. and Foreign Standards with Emphasis on Soviet Approaches," in **Methodologic Health Standards**, Wiley, New York, 1978, pp. 322-350.
[4] R. I. Glass, "A Perspective on Environmental Health in the U.S.S.R.: Research and Practice," **Archives of Environmental Health** 30 (August 1975): 391.
[5] Ibid., 395.

Table 5

A COMPARISON OF U.S. AND U.S.S.R. WORKPLACE AND ENVIRONMENTAL STANDARDS (mg/m³)

	BENZENE	CARBON MONOXIDE	LEAD	MERCURY	NITROGEN OXIDES	OZONE	SULFUR DIOXIDE	HYDRO-CARBONS	PARTICU-LATES
UNITED STATES									
Workplace	30	55	0.05	0.05	9	0.2	13	500 or 1000 ppm	—
Environment	—[a]	10[c]	0.0015	—	0.1[e]	0.235[f]	0.08[e]	0.016[g]	0.0075[h]
U.S.S.R.									
Workplace	5	20	0.01	0.01	5	0.1	10	300	—
Environment	0.8[b]	1.0	0.0007	0.0003[d]	0.085	no standard	0.05	—	0.05

[a]emission standards only
[b]averaged over 2 hours
[c]averaged over 8 hours
[d]averaged over 24 hours
[e]averaged over 1 hour
[f]mean for 1 year
[g]averaged over 3 hours
[h]annual geometric mean

SOURCES: D. R. Greenwood, G. L. Kingsbury, and J. G. Cleland, *A Handbook of Key Federal Regulations and Criteria for Multimedia Environmental Control*, EPA-600/7-79-175, Washington, 1979; International Labour Office, *Occupational Exposure Limits for Airborne Toxic Substances* Occupational Safety and Health Series No. 37, Geneva, 1977.

accelerates plant improvements and technological developments which, again, tend to reduce occupational risks since newer plants are almost always cleaner, safer, and healthier than those they replace. In sum, greater wealth contributes directly and indirectly to increased health and safety.

A slightly different version of the utility argument uses the vocabulary of necessity, pointing out, for example, that societies have always found it necessary (for the sake of their continued or increased well-being) to allow certain of their members to assume relatively higher risks. Thus, nations send soldiers to war, firemen to fires, nurses to epidemics, and the like. Despite this different vocabulary, the underlying argument is similar: at its heart is the claim that exposure to workplace hazards is justified because it maximizes the public good by providing access to an ever larger supply of goods and services. As one analyst notes, it is "important to recognize that while part of social justice is [served by] protecting the health of our citizenry, another part [involves] protecting other areas of their preferences, including their pocketbooks."[20]

Ability. Under this approach, the justification for the differential exposure of Moore to nitrogen oxides and of James Mill to radiation resides in the fact that they are more able to bear their risks than are random representatives of society at large. This may be likened to the argument for progressive tax structures, whose justification is typically sought in the fact that the wealthy are more able to bear high rates than are random representatives of society at large.

It is important to note that this argument appeals to two different types of ability with two different empirical bases. The first type of ability is inherent: the middle-aged are less susceptible to radiation than the young and healthy; young workers can better handle nitrogen oxides than can children, the elderly, or the infirm. Since those persons with least resistance to most hazards (the weak, the ill, the aged, the very young) are essentially excluded from the workforce, it is plausible to argue that exposure to occupational hazards will automatically be concentrated on those best able to bear the hazards. This argument is made even stronger when special efforts are made to avoid assignment of especially vulnerable persons to particular occupational tasks, such as fertile women to the Three Mile Island clean-up force.

The second type of ability is acquired. James Mill will receive special training in radioactive waste packaging which will enable him to minimize his actual exposure and risk. Moreover, as experience is accumulated in working with hazardous material, so ability increases in detecting and responding to the risks. Furthermore, Mill's exposure will be constantly monitored, and, if it approaches or exceeds regulatory standards, he will be transferred to an exposure-free task. Such monitoring directly strengthens the ability argument by continuously proportioning risk (exposure) to ability (low prior exposure).

Compensation. Perhaps the most common response to the differential risk exposure of Moore or Mill is an appeal to the fact that, after all, they are paid to deal with their respective risks. At least three different kinds of compensation may be invoked in this analysis, and each requires consideration.

First, and most obviously, workers may be compensated for risks through their wages. This compensation may be built into the basic occupational wage, as in the case of policemen and firemen, or provided in the form of explicit risk-based pay increments, as in high steel construction work and some segments of the underground mining industry. Economists argue that employers must offer relatively higher pay in order to attract workers to relatively riskier jobs and have attempted to estimate the incremental "risk premium" required:

We have found that in today's (1978) dollars, workers had to be paid an extra $300 to induce them to take an extra risk of death of 0.001 per year. This implies that 1,000 workers would together be willing to pay $300,000 to avoid one death in their ranks.[21]

According to this line of argument, the free mechanisms of the market provide an equitable solution to a difficult problem by allowing risk-tolerant workers to seek riskier but higher-paying jobs while risk-averse workers can seek safer, albeit lower-paying jobs. Since the market also determines the "real" or "fair" value of risk-bearing, the resulting compensation fully legitimates the greater risks imposed on workers.

Second, compensation for workplace hazards may be provided by such compulsory insurance systems as workmen's compensation. If Moore is ever harmed by his exposure to nitrogen oxides and can demonstrate that fact, this system, at least in theory, would assume his medical expenses and help to protect him from some part of his lost wages. Moore cannot sue for damages under tort law, but this (it may be argued) is precisely because he has already been justly compensated for his risks.

A third sort of compensation which workers may receive for differential risk assumption is more difficult to measure. Workers involved in the first recovery efforts at Three Mile Island noted that they were gratified to be able to perform such a socially valuable function. Family farms are among the riskiest of all businesses, and are rarely lucrative; yet, the farmers themselves often claim they would not change occupations for all the gold in Fort Knox. Some kind of compensation is clearly at stake here, and provides yet another empirical basis for the justification of differential risk by appeal to differential rewards.

The argument from compensation (in any of these three forms) is very different than the argument from utility. Whereas the latter demands that total social welfare be maximized, the former demands that the individual worker be better off—whether this situation contributes to total social well-being or not.[22]

Consent. Many people would argue that the risks imposed upon Moore, Mill, or Smith are justified by the fact that they consented to accept the risks as part of their employment. "After all," one might say, "you certainly knew what you were getting into when you took the job." Glassblowing has always involved open flames and impure air. The workers at Three Mile Island surely knew, or were soon taught, that they would be handling extremely hazardous materials. Posting to the Soviet Union is certainly known to entail some risk, so Adam Smith cannot righteously protest exposure to microwave radiation.

The claim that the relatively greater risks borne by workers are justified because they are freely accepted can be defended by citing both contemporary and historical evidence. Interviews with the Three Mile Island employees who first entered the damaged reactor building, for example, indicated that the workers understood the risks and accepted them. Such responses are also typical of policemen and firefighters. Some suggest that "it has traditionally been accepted that pursuing one's trade will almost inevitably bring a particular set of risks, and further that such risks may allowably be greater than for non-occupational activities."[23]

A different version of the consent argument seeks to justify the greater protection provided to the public by appealing precisely to their *lack* of consent. Residents of Connecticut, for example, have never freely consented to breathe nitrogen oxides from New York City.

The argument from consent is particularly powerful because it addresses both sides of the worker/public differential protection—consistently ground-

FOUR PRINCIPLES OF JUSTICE

UTILITY: ***An allocation is just if, and only if, it maximizes the summed welfare of all members of the morally relevant community.*** **If "summed welfare" is understood collectively, the roots of this principle can be traced to the earliest documents of our civilization. As a concern with the "public good" it is found in the five *Books of Moses* and again in Roman law (*pro bono publico*). If "summed welfare" is understood distributively, as simply adding up individual welfares, the principle takes its classical formulation from the work of the Utilitarians, Bentham and Mill.**

ABILITY: ***An allocation of risks is just if, and only if, it is based upon the ability of persons to bear those risks.*** **Since "need for protection" mirrors "ability to bear risk," this principle is simply a special case of the more general claim that allocations are just if, and only if, they treat people according to their needs. This principle was first advanced by the early French socialists of the Utopian school, but its roots are plainly much more ancient. The special concern for widows and orphans commanded by Moses comes from this principle, as does the early Christian practice of pooling all the communities' resources and allocating strictly according to need.**

COMPENSATION: ***An allocation of risks is just if, and only if, those assuming the allocated risks are rewarded (compensated) accordingly.*** **This principle is derived from the somewhat more general one that an allocation is just if, and only if, it is made according to the actual productive contributions of persons. Risks borne would here be considered together with services rendered, capital advanced, and so forth. This more general principle has been most explicitly formulated by capitalistic theoreticians from Adam Smith to Milton Friedman.**

CONSENT: ***An allocation of risks is just if, and only if, it has the consent of those upon whom the risks are imposed.*** **Of late, explicit formulations of the principle of consent have received greatest attention from writers and groups concerned with medical experimentation. Typical formulations of the resulting principle are found in the *Nuremberg Code,* the U.S. Department of Health, Education and Welfare guidelines for experimentation on human subjects, and the World Medical Association's *Declaration of Helsinki.***

ing different levels of risk and protection in different degrees of consent. Both versions of the argument assume that free human beings can adequately consent to bear the kinds of risks in question. Supporting evidence can be found in the fact that society tolerates leisure activities which carry risk levels as much as 1,000 times greater than those found in the workplace.[24] If society recognizes Mill's right to assume such risks in his leisure, how can it deny his right to assume a thousand-fold lesser risk in his occupation?

The Questions Raised

Each of the four arguments surveyed provides a justification for differential risk exposure that seems intuitively correct. Nonetheless, each argument raises serious formal, empirical, and moral problems.

The formal problem is that the arguments are not always mutually compatible. Equitable compensation may not maximize utility, workers consenting to bear risks may not be those most able to tolerate them, and so forth. How these formally conflicting claims should be ordered and balanced raises serious moral and public policy questions. (In the final article in this series we will explore ways of resolving these problems.)

Each of the arguments also requires careful study to determine whether its empirical premises are true. Are the assumptions made about particular hazards and exposed populations actually supported by the evidence? Is differential risk systematically compensated? Are workers sufficiently informed about occupational hazards to accept them freely? Do actual differences in exposure maximize social well-being? (These questions will be considered in connection with a number of case studies in this series.)

Finally, each of the arguments raises issues about the nature of justice in the social and economic domains. Can Moore's exposure to risk be justified by reduced glassware prices? Is Smith's experience of microwave risks justified by his consent to be posted to the Soviet Union? These are fundamental public policy questions which the present article seeks to examine rather than settle.

On Utility. The problems associated with the principle of utility are legion, and often (like the principle itself) highly abstract. Two, however, are particularly relevant.

First, because it reduces questions of morality or justice to questions about the bottom line in balancing consequences, the principle of utility cannot be applied to social problems characterized by largely unknown consequences. If we do not know the significant consequences of alternate courses of action, the principle of utility can provide no basis on which to estimate their relative justice. In fact, we typically do not know with any degree of precision or completeness the total consequences of alternative risk allocations. Often, we know only a few of the shortest-term effects—and too often we have learned that the largest effects may only become apparent after the lapse of decades.

Second, the utility principle is vague until the "morally relevant community" is specified. Without such a specification it is impossible to determine which (known or unknown) consequences matter. Unfortunately, the issues which this problem raises are extremely difficult to resolve. Does the relevant community include future generations? If it does, then the first objection raised seems overwhelming; how, after all, can we ever calculate accurately the consequences of proposed actions for all generations yet to come? If it does not, then it seems that the utility principle tells us not to worry at all about the future (in storing radioactive waste, for example).

Future generations are not the only problem. One way to render the American workplace safer is to export particularly dangerous manufacturing processes to other countries. But, under the utility principle, this amounts to a decision that the welfare of the residents of Mexico and Puerto Rico should be treated differently from the welfare of those in the continental U.S. The existence of a "future-but-conceived" generation raises still different problems. Does or does not the utility principle take into account the consequences of certain workplace hazards for the unborn children of fertile female employees? These are all difficult issues. What is germane here is the fact that unless these issues are settled, the principle of utility has not even been formulated, let alone applied.

On Ability. This proposed justification for a double standard of protection raises serious questions as well. Among the most important of these are two which concern the empirical basis of the justification.

First, is it true that workers are inherently better able to cope with the risk in question? Although it is broadly true that the weak, the ill, the aged, and the very young are excluded from the workforce at Three Mile Island, for example, it is much less clear that they are excluded from the workforce exposed to agricultural pesticides or to cotton dust. Furthermore, it is not at all clear that workers are more resistant to the principal occupational hazards of accidents and carcinomas. Finally, it is questionable whether the ability argument applies equally to all segments of the labor force, an issue which will be explored in the next article in this series.

Second, the ability argument based on acquired skill may simply miss the point. For even if it is true that the skills of glassblowers permit them to reduce their exposure to nitrogen oxides, their (reduced) exposure is still much larger than that of members of the public. It is not clear how this fact can be used to justify the reduced but still large exposures.

On Compensation. This proposed justification for risk differentials faces both empirical and theoretical difficulties. On the empirical side, many economists challenge the claim that risk is systematically compensated. It can be argued, for example, that there is one segment of the labor force which is characterized by both low wages and high risk levels. (See, for example, the forthcoming article in this series by Graham and Shakow.)

Even if risk is compensated, however, one must ask whether it is justly (that is, adequately) compensated. Suppose, for the sake of argument, that Thaler's calculations are correct and that workplace risk is compensated at the rate of $300,000 per life lost (or, alternatively, that increased safety is bought at the price of $300,000 per life saved). Is this rate of compensation for risk (or of investment in safety) just? By comparison to such socially approved practices as the multimillion dollar search and rescue efforts made on behalf of lost sailors and pilots–to say nothing of lost skiers, mountain climbers, or yachtsmen–the workplace rate of $300,000 would seem pathetically inadequate. But by comparison to a wide variety of actual or suggested biomedical policies, the same workplace rate would seem exorbitant.[25] Clearly, one cannot assume that these different social contexts are morally comparable. But, just as clearly, one cannot assume that particular rates of workplace risk compensation are just and adequate.

Workmen's compensation raises a similar set of problems. Some workers who are subject to high occupational risk are simply not covered. Others would argue that their coverage, especially in case of disability, is inadequate, in turn raising the question of what might count as just (adequate) compensation for disability. Generally, full compensation is not provided even for harm which can be directly linked to workplace exposure, and much of occupational disease–that for which a source cannot be attributed–lies outside the scope of compensation.

There is a deeper theoretical issue at stake in the compensation argument as well. In a variety of contexts, compensation is regarded as an unacceptable form of coercion. For example, Smith may freely choose to give a kidney (and may be praised for his altruism in doing so), but he is forbidden to sell (that is, to be compensated for) that same kidney. The arguments typically given in defense of this policy are that the prospect of payment for the assumption of such risks is tantamount to coercion and would permit intolerable exploitation of the poor and the desperate. But, if persons in need of money are forbidden to bear risks for the benefit of those better-off than themselves even when a life is at stake (the kidney case), how is it that these same persons in need of money are allowed to bear risks for the benefit of those better-off than themselves when no more than a profit sheet is at stake (the occupational risk case)?

To pose the question is, of course, not to answer it. There are significant differences between the contexts of organ transplantation and occupational risk. But the issues raised are clearly serious and certainly require better analysis than they have so far received.

On Consent. Although analyses of consent differ in some details, there is wide agreement among philosophers, lawyers, and theologians that morally adequate consent must at least be free and informed. Criticisms of the argument from consent can, accordingly, attack the argument by claiming that such consent is neither free nor informed.

Questions of the relative freedom of a worker's consent to assume risks turn on various interpretations of coercion. It can be argued, for example, that financial need limits a worker's ability to consent to accept risky employment. "If my children are hungry," a worker might ask, "in what sense am I free to refuse this risky job [illegible] if I wish to become a supervisor someday," the same worker may ask ten years later, "in what sense am I free to protest my assignment to this dangerous repair job?" These are pointed questions. To what extent *does* lack of job mobility undercut the possibility of truly free consent to occupational hazards? In extreme form, what choice does the illegal alien have when ordered to do dangerous work in just-sprayed fields or else face deportation? (These questions form the subject of an article by Mary Melville forthcoming in this series.)

Questions concerning the extent to which workers are informed of the risks to which they presumably consent are perhaps even more difficult. In some cases, the risks themselves are poorly understood. In others, the harm may be irreversible by the time the risks are discovered. In still other cases, deliberate efforts may have been undertaken to keep workers ignorant of occupational risks.

Even if risks *are* scientifically understood, how should they be presented to the workers? Should Mill, for example, be told that he is safer packaging wastes at Three Mile Island than he would be crossing the Atlantic in a Concorde? Or would it be more helpful to inform him that scientists believe that there is no safe level of radiation and that he will be adding, however minutely, to his cancer risk? Both may be true, but the manner of conveying the same data is likely to affect the degree to which a worker's consent may be considered "informed."

Each of the justifications for a double standard encounter apparent problems in fact, in norms, or in compatibility. Yet the double standard persists, here and elsewhere in the world. It is not surprising that questions are increasingly being raised about the moral justification for the current levels of workplace hazards.

Preliminary Conclusions

From this initial analysis, we reach a number of preliminary conclusions regarding the differential protection of workers and publics from the hazards of technology:

- There is a double standard of protection for workers and publics, manifested in a significant portion of all technologies and in recently enacted occupational and environmental standards. While public protection is ordinarily set below the level of medically defined hazard, worker protection is customarily set above the hazardous level, thereby exposing workers to known dangers.
- This double standard of protection is not unique to the United States but is found to exist across a wide variety of economic, political, and ideological systems.
- Differential protection is a problem in part because of the significant, if poorly understood, health toll that it represents and in part because of the serious questions of justice which it raises about parts of our social and economic systems.
- Four major justifications–utility, ability, consent, and compensation–have been offered to support this double standard, but each is subject to questions concerning the validity of assumptions, both empirical and moral.

As the United States enters the 1980s, a new Congress and Administration have recommended or initiated a variety of actions which promise to diminish the protection of both workers and publics. The weakening of the regulatory agencies, the increasing emphasis upon "economic" considerations in occupational health standards, the emphasis upon protective clothing rather than safer work environments, the emerging conflict over clean air standards, the new role of the Office of Management and Budget as a clearing house for all protection standards—these are likely portents of things to come. The relaxation of present standards will certainly widen the gap between the United States and other countries.

Given the natural tendency for hazards to be most concentrated at the places of production, these actions are also likely to increase the extent of the differential between worker and public protection in the United States. The recent experience with asbestos, vinyl chloride, cotton dust, and lead suggests that such developments may emerge as a major area of social debate. The forthcoming articles in this series will explore the various dimensions of the differential protection problem, the forms that the double standard takes, and the particular social issues likely to prove most troublesome and difficult to resolve.

PATRICK DERR is a philosopher interested in applied ethical issues and the philosophy of science. He is Associate Professor of Philosophy at Clark University.

ROBERT GOBLE is a physicist whose research interests are in risk assessment and energy conservation. He is Research Associate Professor of Physics in Clark University's Center for Technology, Environment, and Development.

ROGER E. KASPERSON is a geographer who conducts research on environmental and technology policy. He is Research Professor at Clark University's Center for Technology, Environment, and Development.

ROBERT W. KATES is a geographer interested in risk assessment and theory of the human environment. He is Research Professor at Clark University's Center for Technology, Environment, and Development.

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NOTES

1. U. S. Nuclear Regulatory Commission, **Final Programmatic Environmental Impact Statement Related to Decontamination and Disposal of Radioactive Wastes Resulting from March 28, 1979, Accident, Three Mile Island Nuclear Station, Unit 2: Docket No. 50-320. . .** (NUREG-0683), NRC, Washington, D. C., 1981, vols. 1-2.

2. Estimates of morbidity compiled by the authors from the following sources: National Safety Council, **Accident Facts**, 1979 edition, National Safety Council, Chicago, 1979; U. S. Department of Labor, Assistant Secretary for Policy, Evaluation and Research, "An Interim Report to Congress On Occupational Diseases," U. S. Department of Labor, Washington, D. C., 1980; U. S. Department of Health, Education, and Welfare, "Current Estimates from the Health Interview Survey: United States 1977," **Vital and Health Statistics**, Series 10, No. 126, DHEW Publication No. (PHS) 78-1554, September 1978.

3. Robert Harriss, Christoph Hohenemser, and Robert W. Kates, "Our Hazardous Environment," Environment 20 (September 1979): 38-41.

4. Vernon E. Rose, **Reliability and Utilization of Occupational Disease Data**, DHEW (NIOSH) Publication No. 77-189, Washington, D. C., 1977; Peter S. Barth with H. Allan Hunt, **Workers' Compensation and Work-Related Illnesses and Diseases**, MIT Press, Cambridge, 1980; U. S. Department of Labor, note 2 above.

5. U. S. Public Health Services, National Center for Health Statistics, **Vital Statistics of the United States, Volume II Mortality, parts A & B**, Department of Health and Human Services, Washington, D. C., 1937+.

6. **Doctor's First Report of Work Injury**, State of California, Division of Labor Statistics and Research, Department of Industrial Relations, San Francisco, 1973+.

7. U. S. Department of Health, Education, and Welfare, note 2 above.

8. U. S. Department of Labor, **Occupational Injuries and Illnesses in the United States by Industry**, U. S. Department of Labor, Bureau of Labor Statistics, Washington, D. C., 1980.

9. National Safety Council, **Accident Facts**, National Safety Council, Chicago, 1979.

10. **Report of the National Commission on State Workmen's Compensation Laws**, Washington, D. C., 1972.

11. U. S. Social Security Administration, **Social Security Bulletin: Annual Statistical Supplement**, Department of Health and Human Services, Washington, D. C., annual.

12. Nicholas A. Ashford, **Crisis in the Workplace: Occupational Disease and Injury, A Report to the Ford Foundation**, MIT Press, Cambridge, 1976; U. S. National Cancer Institute, National Institute of Environmental Health Sciences, National Institute for Occupational Safety and Health, **Estimates of the Fraction of Cancer in the United States Related to Occupational Factors**, Washington, D. C., September 15, 1978.

13. U. S. Department of Labor, note 8 above.

14. State of California, Department of Health, **Occupational Diseases in California 1975**, Berkeley, 1978.

15. D. P. Discher, et al., "Pilot Study for Development of an Occupational Disease Surveillance Method," HEW Publication No. (NIOSH) 75-162, Rockville, Md., May 1975.

16. Christoph Hohenemser, Roger E. Kasperson, and Robert W. Kates, "Causal Structure: A Framework for Policy Formulation," in C. Hohenemser and J. X. Kasperson, eds., **Risk in the Technological Society** (AAAS Symposium 65), Westview Press, Boulder, Colorado, forthcoming, pp. 109-139.

17. A similar analysis of differences between environmental and occupational standards has been made by Salem, Solomon, and Yesley (Rand Report #R-2561-DOE, August 1980). The differences between their survey and ours are that they compare occupational and environmental standards only for the four criteria air pollutants and the two energy hazards, and they treat health effects in what we believe is an inconsistent manner. For the criteria air pollutants they use EPA definitions of "medically hazardous" which are based on epidemiological data and physiological evidence of the sort we have considered and represent the statistical response of sensitive populations to the hazard. For the energy hazards, however, they have chosen levels corresponding to major physical harm in the general public. For noise they take the hazardous level between the threshold for pain and for rupturing the ear drum, while we have chosen the levels at which there is documented hearing impairment after prolonged exposure. For radiation they have chosen the level at which 50% of the exposure population is experiencing radiation sickness, while we have chosen a level for which cumulative exposure leads to documented increased cancer incidence.

18. Robert W. Kates, **Risk Assessment of Environmental Hazards**, Scope #8, Wiley, New York, 1978, p. 47.

19. Aaron Wildavsky, "Richer is Safer," Public Interest 60 (Summer 1980): 23-39.

20. Richard Zeckhauser, "Utility and Risk Analysis," in J. A. Staffa (ed.), **Symposium on Risk/Benefit Decisions and the Public Health**, Food and Drug Administration, Rockville, Md., 1978, p. 36.

21. Richard Thaler, "Some Problems in Valuing Lives for Risk/Benefit Analysis," in J. A. Staffa (ed.), **Symposium on Risk/Benefit Decisions and the Public Health**, Food and Drug Administration, Rockville, Md., 1978, p. 49.

22. Present debates about the astronomical salaries for professional athletes are a perfect case of this difference. Critics attack them as not defensible under the utility principle, while agents defend them as just compensation for various risks assumed.

23. W. W. Lowrance, **Of Acceptable Risk: Science and the Determination of Safety**, W. Kaufman, Los Altos, Calif., 1976, p. 89.

24. Chauncey Starr, "Social Benefit Versus Technological Risk," Science 165 (1969): 1232-1238.

25. To note one interesting case, consider the treatment of extremely low-birth-weight infants (less than 1,000 g at birth). Including the cost of all care given to nonsurvivors and to handicapped survivors, the total investment in medical care per normal (not handicapped) survivor is $88,058; the rate per survivor (normal or handicapped) is $61,641. Pediatrics 61 (1978): 908-10: c.f., New Engl. J. Med. 301 (1979): 1162-65. These figures are much smaller than Thaler's $300,000. Nonetheless, many prominent ethicians have questioned whether they may already be unjustifiably high; see for instance, Joseph Fletcher's interesting discussion of hyperbaric chambers at page 47 of his Humanhood, Prometheus Press, 1979.

NEXT MONTH:
"Are Workers Adequately Compensated for Risks on the Job?"
by Julie Graham and Don M. Shakow