CHAPTER 3

Organized Modes of Assessment

Everyone assesses risk as an individual, many as part of a group undertaking. Organized modes of assessment of varied intellectual origin have arisen in response to diverse societal needs and new technological problems. These modes can be characterized in three ways: (1) by the different roles, responsibilities and interests of the people and organizations that undertake risk assessment; (2) by the stylized, structured and increasingly standardized methods of assessment that have evolved; and (3) by the interactive group processes employed in making societal judgements.

3.1 ROLES AND RESPONSIBILITIES

There are many ways of viewing the 'cast of characters' in any societal play. The most common, of course, is to dichotomize by drawing distinctions between one's own group and others. Frequently this is perceived as 'they and us', with 'they' being variously: the society, the public, the decision-makers, the special interests, and the like. More elaborate classifications may distinguish between planners: technical or scientific; administrators: implementors, regulators, or civil servants; decision-makers: executive, industrial, judicial, or legislative; interest groups: venal or righteous; and the public: general or specialized. An alternative to designating roles in any given analysis is to allow the case to define itself and Kirkby (1973) has developed techniques for this purpose, allowing individuals and groups to self-designate their roles.

Most of these descriptive devices are employed for more general social analysis than just risk assessment. Otway et al. (1975) have specifically identified three social groups with critical roles in the risk assessment process. They are 'the sponsors who propose a technological development, the public for whom the benefit is intended, and the regulator who has the responsibility of balancing the needs of both groups.' Absent from this grouping is the clear responsibility for hazard-making and the distinction between assessor and regulator. Thus in terms of assessment it may be helpful to have a sharper focus on four archetypal risk assessment roles: hazard-makers, risk-takers, guardians, and assessors. In so doing it should be readily recognized that these are not mutually exclusive categories. In the play of the world, human beings are remarkably versatile — people of many parts.

3.1.1 Hazard-Makers, Risk-Takers, Guardians and Assessors

Hazard-Makers The intentionally made hazards of the environment are often social: arising from war, crime and civil and social disorder. One of these, global nuclear war, poses perhaps the most serious of all environmental threats (National
Academy of Sciences, Worldwide Effects of Multiple Nuclear Detonations Committee, 1975). For various reasons, the intentional hazard-makers are the most difficult to study. Most of their activity is shrouded in secrecy, either in the name of national security or because of its illegality or anti-social nature. The threat posed by such hazard-makers remains understudied and underassessed. For example, enormous difficulty was encountered in assessing the hazard in Vietnam from the widespread use in the war of herbicides and defoliants, the intentional modification of the weather, and the unprecedented use of artillery shells and bombs (Shapley, 1974; Worldwide Effects of Multiple Nuclear Detonations Committee, National Academy of Sciences, 1975; Ambio, 1975). How then to assess the more shadowy forces that may threaten the diversion of commercial nuclear materials or the safety of the water supplies of great cities? In light of such uncertainty, the threat of the intentional hazard-maker may be both enlarged and diminished by its shadowy substance.

Most environmental threat, however, arises from accidental and incidental hazard-makers. The distinction between accident and incident may be a trivial one, but there is perhaps some worth in distinguishing between the accidental, the unintended direct failure of a device, a technique or its practice, and the incidental, the threat posed by the hazard-maker engaged in some activity functionally unrelated to the threat. It appears easier to recall potentially defective automobiles than to recall their pollutants. But just as notions of Acts of God and Acts of Man coalesce, so do these distinctions between intention, accident and incident – at least for the knowing hazard-maker. The manufacturer who accepts a quality-control inspection scheme designed for a 99.5 percent success rate or the dam designer whose spillway can cope with the 200-year flood but not greater, has in effect become a rare, but intentional hazard-maker. And in daily life, all are hazard-makers – in their homes, work or on the highway.

Risk-Takers All are risk-takers as well. As risk-takers, to continue the stage metaphor, people may be active members of the cast, willing audience participants as in the avant-garde theatre, or an unwilling captive audience. Starr's (1972) distinction between voluntary and involuntary participants is helpful; but, as he notes, these distinctions change over time. The distinction also dissolves when considered from the view of the person. Studies of individual risk-taking have failed to disclose a general risk-taking or risk-aversion propensity. Even studies of high risk-takers, namely, those engaged in a sport or an occupation with a higher than average mortality rate, fail to disclose such propensities (Klausner, 1968). Risk-takers in such endeavours depend heavily on skill, caution, distorted perception, or luck to provide for themselves favourable personal odds not excessive by their own risk calculus. At best, such distinctions as voluntary or involuntary, risk-taker or risk-avoider, and stress-seeker or stress-reducer, may be helpful as relative but not absolute concepts. At worst, they are misleading.

Guardians Even in the simplest of social orders, there are guardians of the folk, serving to protect and ward off the myriad threats of man, nature and the supernatural. Such guardians are not necessarily human but often are. Thus the seeming proliferation of specialized guardians characteristic of our time is not simply a response to the complexity of modern life. For all are guardians in their
home, particularly of their children, and occasional guardians in the neighbourhood or workplace. In addition, there are official guardians who watch over the water supply, the construction of buildings, the quality of air, the reliability of products. The official guardian is watched by a shadowy cabinet of unofficial guardians, the numbers of which seem to proliferate when threat is high, distrust is great, or guardianship is in fashion. Again, voluntary guardians are not necessarily a new phenomenon; indeed, the forerunners of many groups of official guardians were voluntary associations. Watchmen of the night or of the gates have long been yeomen, professionals or mercenaries.

Assessors The role of assessor is also not a new one, nor a specialized one. Everyone makes assessments of risk, and there are both striking differences and similarities between these lay assessments and those of the scientific-technical community. As risk assessment becomes formalized and structured, professional assessors, associations, journals and congresses can be expected to emerge. Indeed some of this has happened already. But assessing is also a part-time pursuit, partly because it involves many specialized skills, and partly because it is embedded into ongoing research, development, consulting, and guardianship activities.

3.1.2 Case Study: Actors in the Mercury Pollution Controversy in Sweden

The thrust of the foregoing analysis is that while it is useful to distinguish between roles and sub-roles, the distinctions are not strong ones and all people in both their professional and private lives are called upon to play many parts.

But all plays are not the same, nor are the casts appropriate, competent or inspired. It is an important consideration in risk assessment to inquire not merely as to method but also as to context. Are assessors more effective in one organizational setting or another, assessments more reliable in one methodological form than another, more believable when independently made than when clearly linked to hazard-makers, risk-takers, or guardians?

In the following excerpts from Lundqvist’s (1974) study of the mercury controversy in Sweden, the various actors are identified, revealing a complexity of the scientific and technical roles and their intermixture with other interests. In particular, a comparison of the organizational charts (Figures 3.1 and 3.2) for the two controversies demonstrates how intermixed in the real world are the archetypal roles of hazard-maker, risk-taker, guardian and assessor.

THE CASE OF MERCURY POLLUTION IN SWEDEN
Lennart J. Lundqvist

Mercury pollution has gained the dubious honor of being the first large biocide problem in Sweden. During the 1960's, there were two distinctive cases of mercury contamination, one concerning birds and eggs, the other concerning fish. The two cases differ in many crucial aspects, and they therefore constitute an interesting opportunity for comparison of the factors affecting the relationships between scientific information and public response.

The case of mercury in birds did not affect the average citizen as a consumer. The severity of the issue was therefore mostly limited to
1. SCIENTISTS

| National Institute of Veterinary Medicine | Scientists representing different seed grain treatment producers, e.g. AB Casco |
| Institute of Occupational Medicine | |
| National Museum of Natural History | |
| Royal Institute of Technology | |
| Others, e.g., Natural Resources Committee | |

2a. PUBLIC AUTHORITIES WITH SCIENTIFIC COMPETENCE

| National Plant Protection Institute/Central Seed Control Institute |
| National Institute for Public Health |

2b. PUBLIC AUTHORITIES WITH DECISION-MAKING OR OTHER COMPETENCE

| Ministry of Agriculture |
| National Poisons and Pesticides Board |
| Royal Commission on Environmental Research |

3. INTEREST ORGANIZATIONS AND GROUPS

| Swedish Society for the Conservation of Nature | Agriculture and Farmers' Organizations |
| Swedish Ornithologist Association | Seedgrain Treatment Producers' Association |
| Seedgrain Treatment Workers' Unions (after 1966) | Swedish Federation of Egg Dealers |

Some actors in the controversy over mercury in birds.

Figure 3.1 Source: Lundqvist, 1974, p. 13
1. SCIENTISTS

- Institute of Occupational Medicine
- Royal Institute of Technology
- National Museum of Natural History
- Stockholm University/mixed departments
- Karolinska Institute
- International Meteorological Institute

2a. PUBLIC AUTHORITIES WITH SCIENTIFIC COMPETENCE

- National Institute for Public Health
- Royal Commission on Natural Resources and Environmental Research

2b. PUBLIC AUTHORITIES WITH DECISION-MAKING OR OTHER COMPETENCE

- Ministry of Agriculture
- National Veterinary Board
- National Board of Medicine
- National Environment Protection Board
- National Fisheries Board
- National Poisons and Pesticides Board

3. INTEREST ORGANIZATIONS AND GROUPS

- Inland Water Fishermen's Associations
- Pulp and Paper Industry Associations
- Coastal Water Fishermen's Associations
- Chlorine-alkali Producers AB
- Other Fisheries Organizations

1) From 1968, the National Board of Social Welfare

Some actors in the controversy over mercury in fish.

Figure 3.2 Source: Lundqvist, 1974, p. 27
conservancy and ecological aspects, which by the mid-1960’s were not very well known to the public and the decision-makers. But the conservationists and the ecologists had a very visible target: the Swedish farmer. Backed by plant protectionists and agricultural scientists, the farmers could make a strong economic case for the continuation of the practice of treating seedgrain with alkyl mercury compounds to protect the crops against parasitic fungi. The question of administrative responsibility was also quite clear. The National Poisons and Pesticides Board had a clearly recognized authority to decide whether the agricultural practice of treating seedgrain with alkyl mercury compounds should or should not be allowed to continue.

The case of mercury in fish affected the general public directly as consumers, since Swedes have fish at least once a week. Gradually the research began to point towards far-reaching ramifications to public health, ramifications which increased the demand for swift political and administrative action. However, the issue never became a clear-cut issue against the polluters. The industries found responsible for the emissions of mercury into Swedish waters – the pulp and paper and the chlorine-alkali industries – never became as visible as 'scapegoats' as did the farmers and the seedgrain treatment producers in the bird issue. Regulation of pulp and paper industries' use of mercury was smoothly obtained, and the case of the chlorine-alkali industry to some extent became 'buried' in the unclear administrative situation at the time of the controversy. The group most affected by the scientists' information therefore was the fishermen, who did not pollute the waters, but who brought the contaminated fish products to the market. Lacking scientific support, and heavily affected by plunging fish sales, this group turned against the scientists when the agencies’ decision came to black-list certain waters. These administrative decisions were severely hampered by the multitude of agencies with some kind of responsibility for the regulations of public health and of substances in food products.

The two cases also differed with respect to techniques of disseminating scientific information. Although the same scientists were involved – some representing research institutions, others speaking for affected interests, and still others representing responsible authorities – they differed in dissemination techniques between the two cases. Thus, during the most intensive stages of the mercury-in-fish issue, the press, radio and television were intensively used by the scientists, both to publish research reports, and to attack each others' statements. This is all the more important with regard to public response, since the general awareness of environmental problems had increased considerably from the first, little noticed reports on the silencing of birds to the final alarming reports on mercury in fish, where even a 'forgotten footnote' would create a stir.

*The Actors in the Mercury-In Birds Controversy*

The gathering, publication and discussion of scientific information concerning mercury in birds seems to have had three distinctive stages, each with a different setting of scientific actors (see Figure 3.1). In the first stage, from 1957 to 1962, the focus was on the National Veterinary Institute, where investigations are carried out on wildlife found dead in the environment. At the Institute, Dr. Karl Borg became the central person in the unveiling of the mercury drama. Around 1962, however, other scientists began active research on these problems, many of them sponsored by the newly established Natural Resources Committee of the Swedish Natural Science Research Council. The Secretary of the committee, Dr. Bengt Lundholm, was to become one of the most important scientific actors on biocide problems in Sweden for the rest of the decade. During 1963, Dr. Gunnar Otterlind at the Sea Fisheries Laboratory, whose biocide research was...
sponsored by the Ornithologist Association, took a very active part in the
intensive output of scientific information of that year. When the third phase
began in 1964–65, all these actors were joined by other scientists, e.g., Dr.
Stig Teijning at the Institute of Occupational Medicine in Lund, Dr. Torbjörn
Westermark at the Royal Institute of Technology, and Alf Johnels at the
National Museum of Natural History. All these men held a dominant position
in the mercury debate in the following years.

All these scientists were revealing facts about the correlation between the
level of mercury in birds and the treatment of seed grain with alkyl mercury
compounds. On the other side of the fence, scientists from the National
Institute for Plant Protection, e.g., Dr. D. Lihnell, questioned these
correlations, and defended 'scientifically founded' practices in agriculture. In
1965, when there was a controversy over mercury in eggs, the scientists at the
National Institute for Public Health (NIPH) also came into focus. Throughout
the mercury controversy, the NIPH scientists found themselves in a peculiar
double role, acting both as responsible scientists and as representatives of an
administrative agency, in which position they seemed to have trouble in
deciding the criteria according to which they would make their recommenda-
tions.

Among public agencies, the National Nature Conservancy Agency at that
time did not have any responsibilities in the field of wildlife management.
The National Poisons and Pesticides Board had certain administrative
responsibilities concerning the use and handling of potentially hazardous
products. On the agricultural side, the National Plant Protection Institute and
the Institute for Seed Control were the most visible actors. On the issue of
hazards in food, the NIPH acted as an investigatory body, and was to make
recommendations concerning mercury levels to the deciding agencies, the
National Veterinary Board and the National Board of Medicine.

Thoroughly organized as Sweden is, it is only natural that much of the
action among the public came from interest-group organizations. The natural
focus was on the Swedish Society for the Conservation of Nature and its
affiliate, the Swedish Ornithologist Association, where the fate of the birds
was very early recognized. But also such interest groups as the Swedish
Hunters' Association and the Swedish Society for the Protection of Animals
were active in the controversy. On the other side of the fence, action was
with, e.g., the Swedish Association of Seed-Grain Producers. It should be
mentioned here that farmers' organizations showed a surprisingly low activity
during the controversy, given the ramifications a possible mercury prohibition
could have for agricultural practices.

The Actors in the Mercury-In-Fish Controversy

With the issue of mercury in fish, the problem of environmental hazards
shifted from diffuse and complex ecological issues to a very concrete matter
of public health. This can be seen in the appearance of several new actors,
compared to the issue of mercury in birds (see Figure 3.2). In the early stages
of the debate, the scientists from the Natural Resources Committee, the
National Museum of Natural History, and the Royal Institute of Technology
had a very prominent position. Already during the two 1963 conferences on
mercury in birds, they began discussions concerning what would happen if
mercury used in agriculture would somehow find its way into the freshwater
systems. From spring 1964, this group began taking samples of fish from
several Swedish freshwater bodies.

When the results began to come in, it became clear that here was another
environmental threat. The scientists therefore called upon the National
Institute for Public Health. As a public agency, one of the Institute's tasks
was to make scientific investigations and research concerning poisonous or
otherwise inappropriate substances in food. The Institute therefore started several investigations concerning the mercury levels in fish. Furthermore, it came to play a central role in the issue of determining the type of toxicity of the mercury found in freshwater fish. With respect to the determination of the type of mercury, the newly established Industrial Water and Air Protection Research Institute also played a very crucial role. On the matters of toxicity and effects on human beings, several departments at the University of Stockholm made important contributions to scientific knowledge. Throughout the controversy, Dr. Tejning at the Institute of Occupational Medicine in Lund provided important reports on these aspects. With respect to the circulation of mercury in the environment, the International Meteorological Institute carried out crucial research.

At a very early stage of the information process, it was clear that the mercury was emitted into Swedish waters from mainly three sources. The paper mills used phenyl mercury to prohibit the formation of mucus in the paper machines. The pulp industry used phenyl mercury to protect wet mechanical wood pulp against attacks by mould fungi. Thus, pulp and paper industry associations were involved in the issue. The National Poisons and Pesticides Board had the competence to regulate the activities in these two cases, which both concerned the use and handling of pesticide products. The third case of mercury emission, however, concerned the chlorine-alkali industry, where mercury is used as an active ingredient in the production process. It was therefore a matter for the National Environment Protection Board and the Franchise Board for Environment Protection. However, until the new Environment Protection Act became law in July 1969, the chlorine-alkali producers could be expected to respond only voluntarily to administrative advice.

If the National Institute of Public Health found dangerous concentrations of hazardous substances in food products, it was to inform the authorities responsible for administrative decision concerning food substances and matters of public health. The Institute was also to give policy recommendations to these agencies, i.e., to the National Veterinary Board (for substances in food) and the National Board of Medicine (for matters of public health; cf. Figure 3.2). The final decision on maximum allowable concentrations of mercury in food thus had to be taken jointly by these two agencies.

However, such decisions would involve the fate of the Swedish fishermen. Throughout the controversy, one finds that the fishermen’s associations were vehemently questioning the accuracy of the scientific information, and accusing the scientists of spreading panic among the public. Since the issue of mercury in fish touched directly upon the fate of the Swedish fisheries, the National Fisheries Board was heavily involved. (Lundqvist, 1974, pp. 10–28)

As the first major environmental hazard problem of technological origin in Sweden, the methods of risk assessment (as differentiated from the scientific research) appear uncertain and improvised. With the recurrence of such problems, there are efforts to standardize assessment and evaluation.

### 3.2 STRUCTURED METHODS

With the increase in the roles and responsibilities of assessors, interest has developed in structured methods of assessment, some related to general improvement in judgement processes and others related to assessing specific hazard potential.
3.2.1 Judgement Processes: Divining, Judging and Decision-Analysis

Divining, the most ancient of judgement processes, is still relevant today. As Cohen (1960), who has compiled a list of some 61 means of artificial methods of divination, observes:

The rationale for formal or institutionalized guessing derives from the effort required to exert some measures of control over life's uncertainties: on the one hand, firmly to grasp the wheel of good fortune and, on the other, to protest against unknown hazards. Life's innumerable uncertainties are not reduced as societies move from a primitive to a more advanced state; they change, if at all, only in content. Hence attempts to overcome them do not diminish in intensity. (Cohen, 1960, p. 52)

Jahoda (1971) has analyzed the persistence of the classical into the modern. For example, he notes the widespread influence of astrology, which is followed (at least occasionally) by up to two-thirds of the groups studied in Europe and found credible by a third to a fifth of the studied samples. Another persistence of divination, locating sources of underground water, has been most carefully studied by Vogt and Hyman (1967). Despite the excellence of the United States geological surveys, they estimate 18 water diviners per 100,000 population per year over 40,000 water 'witches' in the United States, mainly in areas in which ground water is hard to find.

The rising interest in futurology and futuristics in many industrialized nations, while ostensibly scientifically rooted, would seem to share some common features with divination. In function, it shares with divination a need to reduce the anxiety of the times that arises from uncertainty. And in method, the use of Monte Carlo simulation to explore possible outcomes is very similar to the underlying rationale for divination methods that rely on some randomized pattern of bones, entrails, ashes, cards and the like.

While divination persists, the responsibility for most judgement has shifted from the Gods to Humankind, encouraging a search for ways of improving the making of judgements. How well it can be done is itself a matter of judgement. 'Judgment, it seems, is an ultimate category, which can only be approved or condemned by a further exercise of the same ability.' (Mack, 1971, from Vickers, 1965). Thus, it may be just good judgement to attempt to structure judgement in various ways. Two common ways of structuring are to reduce the magnitude of the judgement required and to increase the number of judges - small judgements and many judges.

Reducing large complex judgements to smaller ones is a key way of structuring judgement. Legislation is often voted upon by paragraphs or even sentences, crimes are described as a series of individual illegal or antisocial acts on which juries render individual verdicts, school or work performance is assessed by multiple criteria in evaluative reports. Implicit is the notion that it is not only easier to make many small judgements than a few large ones, but that biases introduced may be offsetting, and that data unavailable to aid in large judgements may be available for smaller ones. Since it is thought that judges often employ such methods of fractionation or reduction anyway, it then helps to make these specific and
Figure 3.3 Decision tree for hurricane seeding. Source: Howard, et al., 1973, p. 35.

reproducible. Multiple regression techniques, some using instant visual computer displays, are now available to help judges become aware of the implicit criteria they and others use to formulate judgements (Hammond and Adelman, 1976).

A second approach is to multiply the judges and there are many formal and informal ways of doing this, the committee or jury panel being major examples. Whether groups are consistently biased in one direction has been, as noted, a preoccupation that has captured the interest of a large number of psychologists (as noted on page 50). The Delphi technique seeks to combine individual and group judgements in a structured recursive process and has been widely applied to oracular judgements of the future (Pill, 1971).

Many aspects of judgement come together in decision-analysis, a multiple technique for making choices under uncertainty and for structuring subjective judgements, scientific research, assessment studies and the like in an orderly, quantifiable and comparative framework (Raiffa, 1968). As one example, there is the widely cited decision-analysis related to the seeding of a hurricane in order to reduce its hazard potential (Howard et al., 1973). This analysis considers the tree of consequences, in terms of property damage and government responsibility, for
inadvertent increase in damage of seeding versus non-seeding of hurricanes. The two alternatives are considered in terms of a range of changes in possible maximum sustained surface winds (Figure 3.3). While this particular analysis has led to questions as to its completeness and possible abuse (Kates, 1973), the technique is highly valued by the authors and many others because of the hope that structured explicit judgements are superior to implicit ones. As the authors observe:

Decision analysis separates roles of the executive decision-maker, the expert, and the analyst. The analyst’s role is to structure a complex problem in a tractable manner so that the uncertain consequences of the alternative actions may be assessed. Various experts provide the technical information from which the analysis is fashioned, but it is the decision-maker who acts for society in providing the basis for choosing among the alternatives. The analysis provides a mechanism for integration and communication so that the technical judgments of the experts and the value judgments of the decision-maker may be seen in relation to each other, examined, and debated. Decision analysis makes not only the decision but the decision process a matter of formal record. For any complex decision that may affect the lives of millions, a decision analysis showing explicitly the uncertainties and decision criteria can and should be carried out. (Howard, et al., 1973, p. 52)

3.2.2 Assessing Hazard Potential: Environmental Monitoring, Health Surveillance, Environmental Impact and Technology Assessment, Standard Setting

Monitoring and Health Surveillance Monitoring and health surveillance programs are in themselves a structured form of continuing risk assessment. They require a preliminary identification of events to be monitored or of the consequences to be examined, and are intended to provide frequencies or other measures for estimation of the risk. Given the limits of societal monitoring ability, there is also an implicit or explicit comparative evaluation of risk by the choice of item to be monitored. Such comparative evaluations seem to have been made in the priority rankings for the Global Environmental Monitoring System (Table 2.2).

The technical capabilities of the monitoring system frequently set the actual level of risk accepted. Monitoring pesticides was initially limited by technologies capable at best of measuring parts per million. Thus, despite zero tolerance requirements, food containing parts per billion of carcinogens or pesticides were approved for use until the development of more sensitive instrumentation. And currently, the Climatic Impact Assessment Program Study (National Academy of Sciences, 1975) suggests a permissible diminution of ozone of .005 as the basis for international standards, this being the estimate of the minimum decrease observable against the background of natural variation with the most advanced monitoring system.

In the past, this conception of monitoring and surveillance programs as risk assessments was mostly implicit, a-theoretical, and linked to historic disciplinary or professional organization concerns. Now, as scientific and managerial efforts that transcend parochial interests expand, there will be a shift in focus. The quality of earthwatch needs to be scrutinized, rather than the intellectual origin or institutional loyalty of the watcher. Such a shift will bring more structure to monitoring and surveillance, relating programs to hazard consequences, coping
measures, costs, and theory. And monitoring and surveillance will be encouraged by the need to predict future impacts, a need inherent in the rapid growth of environmental impact assessment and the interest in technology assessment.

**Environmental Impact** Environmental impact assessment was defined by the recent SCOPE workshop (Munn, 1975a) devoted to it as 'an activity designed to identify, predict, interpret, and communicate information about the impact of an action on man's health and well-being (including the well-being of ecosystems on which man's survival depends).’ Such actions include: 'any engineering project, legislative proposal, policy, programs or operational procedure with environmental implications.' For such assessments the Workshop report recommends the following:

1. a description of the proposed action and of alternatives;

2. a prediction of the nature and magnitude of environmental effects (both positive and negative);

3. an identification of human concerns;

4. a listing of impact indicators, as well as the methods used to determine their scales of magnitude and relative weights;

5. a prediction of the magnitudes of the impact indicators and of the total impact, for the project and for alternatives;

6. [optional] recommendations for acceptance, remedial action, acceptance of one or more of the alternatives, or rejection;

7. recommendation for inspection procedures.


Impact statements were first required in the United States in legislation enacted in 1970 as a way of broadening the decision information for public actions from the narrow instrumental and economic analysis that had characterized most project planning and even the best of benefit-cost analysis up to that time. Within the environmental impact statement, risk assessment is one of a set of analyses to be provided for that purpose, but the overall environmental impact assessment may be too crude to serve as an adequate risk analysis. The SCOPE Workshop report finds that three current methods of environmental impact assessment — the Leopold Matrix (Leopold, et al., 1971) Overlays (McHarg, 1969) or the Battelle Environmental Evaluation System (Dee, et al., 1973) — are not effective for risk assessment. And in their risk assessment, the handling of uncertainty is particularly weak and in need of improvement (Munn, 1975b).

**Technological Assessment** An even more ambitious form of assessment than
that of assessing a project is to assess a technology. Coates has succinctly described its functions.

Technology assessment ... is the name for a class of policy studies intended to anticipate and explore the full range of consequences of the introduction of new technology or the expansion of an old technology in new and different ways. Men have always been interested in the consequences of technological development. One might reasonably ask, therefore, 'What's new about technology assessment?' Several things are new. First is the attempt to expand the study of the anticipated consequences well beyond the conventional considerations of cost and benefits, or immediate implications for the perpetrator or user of technology ... The second feature of technology assessment is its focus as a policy study on informing the interested publics and the decision-makers of the possible ranges of consequences for new actions ... A third aspect of technology assessment is the attempt to organize and draw policy guidance both from what is known with some certitude and what is not known. Normally one anticipates that policy flows out of knowledge, but in the effective management of technology, viable policies must flow out of both what we know and what we do not know. (From Harvey and Menchen, 1974, pp. iii, iv)

As with environmental impact assessments, overall assessment of technology may not give sufficient attention to risk assessment because of its broad brush approach, but clearly risk assessment is a major element of any technology assessment.

Critics who question the predictive qualities of technology assessment may find value in its retrospective aspect or in technology reassessment. Such reassessments are less structured and are widely scattered in the literature. One major effort at reassessment was the bringing together of many studies on the impact of technology on ecosystems in developing countries (Farvar and Milton, 1972).

Standard-Setting: All of the foregoing structured methods, although they are implicitly related to action, are still distinct from action. They are all in the realm of study. In contrast, one structured form of risk assessment intimately bound up with action is standard-setting. Such standards may be suggested, encouraged or mandated by any or all of the group processes discussed in the following section.

Standard-setting relies on all the varied methods of risk assessment and covers so many fields that it is difficult to generalize about the process. Standards in historical perspective appear to be social judgements first and professional judgements second. As social judgements they reflect differences in social philosophy and ideology and in their historical evolution a trend to higher levels of societal concern for the well-being of people. As professional judgements they reflect the intellectual and technological history of professions.

Thus international differences such as those for chemicals in the workplace (Table 2.8) probably reflect differing social concerns, institutions and professional influence. International comparisons of standards need to be assembled and widely disseminated as they serve as a healthy corrective to social scientific or institutional parochialism.

To draw upon the best of international scientific understanding has been the worthy goal of efforts at setting international standards, for example, by the
International Commission on Radiological Protection. While highly desirable in many fields, they may tend to obscure important and valid value considerations. For example, when water quality standards of industrial countries are transferred to developing countries, a frequent outcome has been that an excellent supply was provided to a small urban minority while many rural millions were left to fend for themselves, since meeting the standard for them is costly and exceeds the capability of most nations (White, 1974). Paradoxically a different, perhaps, weaker, standard might provide greater overall protection.

3.2.3 Case Study: Chemical Substances in the Work Environment: Some Comparative Aspects of U.S.S.R. and U.S. Hygienic Standards

As with historical perspectives, standards may reflect differential social and professional values between industrial countries. In the case study that follows, the disparity in standards between the U.S.A. and the U.S.S.R. in occupational protection is evaluated from the perspective of two professionals based in the U.S.S.R. (A U.S. professional's perspective is found in Magnuson, 1964; 1965).

As they point out, the standards differ substantially between the U.S. and the U.S.S.R. The differences are partly societal – the acceptance of greater risk in the U.S. case; partly professional – the use of different evidence (behavioral versus physiological); and partly judgemental – some standards are lower or higher, not necessarily in a consistent way. Other factors may also be at work: the longer tradition of industrial hygiene standard setting in the U.S.S.R., the influence of trade unions and socialist philosophy, and the perceived relationship between the severity of the standards and the degree of enforcement.

CHEMICAL SUBSTANCES IN THE WORK ENVIRONMENT:
SOME COMPARATIVE ASPECTS OF U.S.S.R. AND U.S.
HYGIENIC STANDARDS
Alexander V. Roschin and L. A. Timofeevskaya

Thirty years ago there were no more than a few score of chemical compounds capable of causing occupational poisonings and diseases in workers.

Today, such industrial poisons are numbered by the hundreds. At the same time, there exist a vast number of toxic substances that, thanks to preventive measures undertaken in the industry, do not cause any poisoning effect, but, nonetheless, are potentially hazardous to health.

In the face of the impossibility of fully protecting the environment against chemical contaminants, it is our duty to determine the maximum degree of pollution that can be permitted without causing any harmful after-effects on health. Thus, life functions are the basis for the establishing of hygienic standards for chemical contaminants in the human surroundings and, particularly, in the industrial environment, as concentrations of noxious substances therein may be quite considerable.

The establishment of the maximum permissible content of harmful substances in the environment is of immense importance, since it forms a backbone for the environmental protection against pollution. The maximum permissible concentrations (MPCs) enable one to adopt a proper attitude toward and to assess the significance of environmental pollution for health, to forecast its effect on health, and to determine the effectiveness of measures taken for the protection of the environment against contaminants.
The Development of Hygienic Standards

In the USSR the first maximum permissible concentrations were set up as far back as in 1922. Initially, they covered sulfurous gas, hydrogen chloride, and nitrogen oxides. In 1924, MPCs were fixed for gasoline. In 1930 the standards embraced 25 industrial poisons and in 1939 the approved State standards for MPCs covered as many as 40 substances. In 1941 the scope of these standards was broadened by the inclusion of the MPCs for 'non-toxic dusts'.

A gradual increase in the number of the MPC items was paralleled by further theoretical research work in the domain of hygienic standardization. Thanks to works by N. V. Lazarev and N. S. Pravdin the establishment of MPCs within the workroom area proceeded ever more intensively in the subsequent years.

Since 1956, a special commission headed by Z. B. Smelyansky and Z. I. Izraelson, regularly engaged in determining the MPCs in the air of the workroom area, has been functioning at the Ministry of Public Health of the USSR.

It can be seen from the available literature sources, that the establishment of allowable levels of noxious substances in industry began at a later date in the USA, and it was not until the 1950s and 1960s that there was notable progress in the standardization work.

Present Standards

At present the greatest number of standards are in the USSR and the USA. The nomenclature of the USSR lists over 750 MPC items and that of the USA, over 550.

The rising commercial production of chemicals requires still more intensive work on the development of standards for chemical substances in the industrial environment. Research in this field has been more active in recent years; this is also the case in a number of other countries.

An analysis of the basic principles used in the establishing of standards bears witness to substantial differences that are most spectacular as regards two countries – the USSR and the USA.

The recommended MPC values in the USSR are lower than in the USA, this being borne out by the relation between the Threshold Limit Values (TLVs) used in the US, and the MPCs applied in the USSR. If one considers 167 identical substances in the lists for 1973 of both the USSR and the USA, the relation between the TLVs and the MPCs is as shown in Table 3.1.

In the USSR the MPC equals 100 percent or more mg/m³ for only 6 percent of the substances. The respective figure for the USA is 26.5 percent. A more detailed scrutiny of the MPC and the TLV has demonstrated that 19 substances have the same standard values, 32 compounds differ by a factor of two or less, the standards for 12 substances have a higher standard value in the USSR, while 18 MPC values stand at a level more than 50 times below that of the TLV.

There are extreme differences in the values for propylene oxides (TLV/MPC = a 240-fold difference) and cobalt and its oxides (MPC/TLV = a 5-fold difference).

A detailed consideration of the list of standards revealed differences in individual classes and groups of chemical substances. For a number of irritating poisons the difference between the MPC and TLV levels is insignificant, the only substantial divergences being in the case of acetaldehyde and of formaldehyde (72-fold and 6-fold).

In addition to the differences with regard to irritants, there are, in a number of instances, significant differences between the MPC and TLV values
### TABLE 3.1 Relation between TLV and MPC Values

<table>
<thead>
<tr>
<th>TLV/MPC ratio</th>
<th>Number of substances</th>
<th>Percent of the total number</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.20–0.49</td>
<td>1</td>
<td>0.6</td>
</tr>
<tr>
<td>0.50–0.99</td>
<td>11</td>
<td>6.6</td>
</tr>
<tr>
<td>1.0</td>
<td>19</td>
<td>11.4</td>
</tr>
<tr>
<td>1.01–2.00</td>
<td>21</td>
<td>12.6</td>
</tr>
<tr>
<td>2.01–5.00</td>
<td>32</td>
<td>19.1</td>
</tr>
<tr>
<td>5.01–10.00</td>
<td>25</td>
<td>14.9</td>
</tr>
<tr>
<td>10.01–20.00</td>
<td>22</td>
<td>13.2</td>
</tr>
<tr>
<td>20.01–50.00</td>
<td>18</td>
<td>10.8</td>
</tr>
<tr>
<td>50.1–100.00</td>
<td>13</td>
<td>7.8</td>
</tr>
<tr>
<td>100.01–200.00</td>
<td>4</td>
<td>2.4</td>
</tr>
<tr>
<td>200</td>
<td>1</td>
<td>0.6</td>
</tr>
</tbody>
</table>


### TABLE 3.2 MPC and TLV Values for Some Metals, Metalloids and Their Compounds

<table>
<thead>
<tr>
<th>Substance</th>
<th>MPC mg/m³</th>
<th>TLV mg/m³</th>
<th>TLV/MPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beryllium and its compounds</td>
<td>0.001</td>
<td>0.002</td>
<td>2</td>
</tr>
<tr>
<td>Vanadium and its compounds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vanadium pentoxide fumes</td>
<td>0.1</td>
<td>0.05</td>
<td>0.5</td>
</tr>
<tr>
<td>Vanadium pentoxide dust</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Ferrovanadium</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Cadmium oxide</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Manganese</td>
<td>0.3</td>
<td>5.0</td>
<td>16.6</td>
</tr>
<tr>
<td>Molybdenum (soluble compounds)</td>
<td>4</td>
<td>5</td>
<td>1.25</td>
</tr>
<tr>
<td>Molybdenum (insoluble compounds)</td>
<td>6</td>
<td>10</td>
<td>1.66</td>
</tr>
<tr>
<td>Nickel, metal and soluble compounds (as Ni)</td>
<td>0.5</td>
<td>1.0</td>
<td>2</td>
</tr>
<tr>
<td>Metal mercury</td>
<td>0.01</td>
<td>0.05</td>
<td>5</td>
</tr>
<tr>
<td>Lead and its inorganic compounds</td>
<td>0.01</td>
<td>0.15</td>
<td>15</td>
</tr>
<tr>
<td>Antimony regulus in the form of dust</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Tellurium</td>
<td>0.01</td>
<td>0.1</td>
<td>10</td>
</tr>
<tr>
<td>Titanium oxides</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Chromic oxide, chromates, bichromates (calculated to the value of Cr O₃⁻)</td>
<td>0.01</td>
<td>0.1</td>
<td>10</td>
</tr>
<tr>
<td>Zinc oxide</td>
<td>6</td>
<td>5</td>
<td>0.84</td>
</tr>
<tr>
<td>Metallic zirconium and its insoluble compounds</td>
<td>6</td>
<td>5</td>
<td>0.84</td>
</tr>
</tbody>
</table>

TABLE 3.3 MPC and TLV Values for Some Chlorinated Hydrocarbons

<table>
<thead>
<tr>
<th>Substance</th>
<th>MPC</th>
<th>TLV</th>
<th>TLV/MPC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mg/m³</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzyl chloride</td>
<td>0.5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Vinyl chloride</td>
<td>30</td>
<td>510</td>
<td>17</td>
</tr>
<tr>
<td>Dichlorobenzene (ortho)</td>
<td>20</td>
<td>300</td>
<td>15</td>
</tr>
<tr>
<td>Ethylene dichloride</td>
<td>50</td>
<td>790</td>
<td>15.8</td>
</tr>
<tr>
<td>Dichlorethane (1,2)</td>
<td>10</td>
<td>200</td>
<td>20</td>
</tr>
<tr>
<td>Methylene chloride</td>
<td>50</td>
<td>890</td>
<td>17.8</td>
</tr>
<tr>
<td>Methyl chloride</td>
<td>5</td>
<td>210</td>
<td>42</td>
</tr>
<tr>
<td>Tetrachlorethylene</td>
<td>10</td>
<td>670</td>
<td>67</td>
</tr>
<tr>
<td>Trichlorethylene</td>
<td>10</td>
<td>535</td>
<td>53.5</td>
</tr>
<tr>
<td>Chlorobenzene</td>
<td>50</td>
<td>350</td>
<td>7</td>
</tr>
<tr>
<td>Chloroprene</td>
<td>2</td>
<td>90</td>
<td>45</td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>20</td>
<td>65</td>
<td>3.3</td>
</tr>
<tr>
<td>Ethyl chloride</td>
<td>50</td>
<td>2600</td>
<td>52</td>
</tr>
</tbody>
</table>


for aerosols of metals, metalloids and their compounds. In the list of substances in Table 3.2 for example, the divergences are significant in the case of such industrial compounds as lead, manganese, chrome and tellurium.

The greatest divergences between the MPC and TLV values (up to 63-fold difference) occur in the series of chlorinated hydrocarbons (Table 3.3).

In the solvents group, the discrepancies are somewhat less marked. But here, too, the MPCs for such compounds as benzene and acetone are 16 - 12 times as low as the TLVs.

The tendency towards reduction of the TLV values that has been prevailing during recent years deserves special attention.

And then, as a rule, the new USA standards approach the Soviet ones and because of this the number of coinciding MPC and TLV values increases every year.

Thus, during the last 10 years, 59 of the US standards have been subject to change; and of the substances of this list, the TLV levels of 27 were reduced within the first 6 years, while in the last 4 years the corresponding number was 32. In our opinion this last circumstance forms a basis for establishing uniform international standards.

Differences in Definitions

The divergence between the MPC and TLV values should be attributed largely to the fundamental differences in the concept of 'maximum permissible concentrations'.

In the Soviet Union the MPC means the concentrations which, with a workday of not more than 8 hours throughout the whole of the service record, do not cause any diseases or have other adverse effects on the health status of the workers that could be detected by modern methods of investigation, either directly in the course of work or at later dates.

The official preamble to the list of threshold limits, as well as works of pertinent authors contained statements to the effect that the TLV determine conditions to which workers can be exposed day after day without any adverse effect. However, because of the wide variations in sensitivity of
exposure to chemicals at the level of the TLV or below it, a small percentage of workers may feel discomfort, and a still smaller percentage of individuals may demonstrate more serious effects, such as an exacerbation of an already existing pathological condition or the development of an occupational disease.

Hence, the hygienic standards established for chemical compounds in the air of the workplace area in the USA admit the possibility that the health status in some of the operators might be negatively affected.

Furthermore, the Soviet MPCs are, according to the legislation in force, maximum single-time ones, whereas most of the American TLVs are weighted mean concentrations and only compounds marked 'C' are in the category of the maximal ones.

Establishing the Standards

The setting of standards for industrial substances in the USSR is effected in three stages.

The first stage — determination of tentative MPC — is at the period of laboratory development of new compounds; the second involves substantiation of the MPC in animal experiments, pilot tests and production planning; the third stage includes correction of the experimental MPC through comparisons of work conditions as against the health status of the workers and continues for 3 years from the date of commissioning the industrial plant.

The substantiation of the TLV provides for no such stagewise investigations. At the same time the basic principles and methods of obtaining data for substantiation of threshold limit values in the air include two sections, namely: 1) principles and methods of animal experiments, and 2) an analysis of information derived from studies on humans.

And while the first section of procedures practiced in the USA includes investigations on animals, the second one is made up of a number of independent items. Thus, for example, it includes experiments with human volunteers aimed at eliciting irritative, narcotic and sensitizing effects. Moreover, it involves hygienic investigations of the operators, and the main program of the investigators calls for classification of workers from the medical standpoint; a technical program of examining the atmospheric environment of industrial plants is also set forth.

A detailed study of a draft for basic principles and methods of obtaining TLV points to the presence of many differences in approaches to the substantiation of the MPC in animal experiments. For instance, in the USSR the establishment of the acute action threshold is obligatory, while in the USA it is not.

One should dwell on the research into the chronic action of poisons, in particular. At present, according to methodological directives, the American toxicologists consider it necessary to go on with experimental work for 2 years in order to establish the threshold of chronic effect. Earlier, however, such investigations were not undertaken even in the case of compounds with chronic effects. Thus, for example, H. Stokinger pointed out that only 20 percent of the substances on the TLV list were substantiated on the basis of chronic investigations.

Note should be taken of a high level of research work done in the USA in ascertaining the fate of metabolism of industrial poisons in the organism. Tests of this kind form an integral part of investigations into the acute action of the poison. The methodological directives in the USA attach great importance to determination of the substance passed with the expired air and with urine by comparison with its blood content in the case of volatile solutions and also to the distribution in the body and detection of major metabolites of substances of low volatility.
Research workers of a number of countries, including the American ones, pay particular attention to the differences in the sensitivity of methods used in substantiating the MPC and TLV, referring in this connection to the examinations of the nervous system with the aid of the conditioned reflexes method. It should be noted that the frequent application of this method in the USSR is one of the reasons for the divergence between the MPC and TLV.

And, indeed, in a number of American research works use is made of less sensitive methods. In our investigations the application of the conditioned reflex method is, however, not mandatory. In the USSR, the establishing of a standard is effected with reference to a complex set of factors by taking due account of their hygienic significance, the choice of the factors being strictly substantiated by the nature of the action exerted by the substance.

It may also be that one of the reasons for such substantial discrepancies between the MPC and TLV values is differences in the methods of chemical analysis applied by both parties and differences in the sensitivity of these methods. This question, however, requires special consideration, with the participation of specialists on matters of industrial sanitary chemistry.

*Practical Aspects*

One of the principal differences in the approach to the establishment of the MPC in the USSR and the USA is the requirement of 'technical feasibility.' While in the USSR the basic principle in approving the MPC is based on medical indications, in the USA economic and technical considerations appear to be more important.

Thus, for example, Professor Magnuson (1965) is of the opinion that excessive control over the innocuous action produced by highly toxic compounds is a waste of human resources and may hinder proper utilization of chemical substances and processes that may by themselves be of immense importance for our social, economic and physical health.

We, for our part, believe that the existing extraordinarily broad possibilities of engineering and technology, and their rapid progress, permit them to overcome the difficulties of the past. This point of view is supported by improvements in working conditions and by reduced concentrations of noxious substances at many plants of the chemical and other branches of industry.

In the USSR the purpose of hygienic standardization is the creation of safe working conditions, securing the good health of the operators not only during their employment in a given industry, but also later in their lives.

The fact that it is not always that all the standards are actually observed in industry does in no way prejudice their vast importance for the whole cause of protecting the environment against all sorts of pollution. It is only the existence of standards that makes it possible to evaluate the environmental contamination from the viewpoint of its hazard to health, and the effectiveness of measures and methods (sometimes very costly and complex) that each country must put into effect to secure the well-being of the people.

In the USSR the health of man is regarded as a priceless treasure, the loss of which cannot be compensated by anything, least of all by material wealth. And this is the reason why the basis of establishing hygienic standards should be the complete preservation of health, even if considerable expenditures may be involved in maintaining the standards. (Reprinted and condensed from *Ambio*, Volume IV, Number 1, 1975, pp. 30–33)

The differences in risk assessment that underlie the standard-setting of the U.S.S.R. are differences in experience, technique and values. Such differences occur
not only between countries but within countries and within activities among assessors. Almost always such differences require resolution through a group process.

### 3.3 GROUP PROCESSES

The structured methods of risk assessment often serve as input to further evaluative effort made in the context of an interactive group process. These processes are part of and in some ways indistinguishable from the major forms of the political and economic process.

#### 3.3.1 Political processes: Administrative, Adversary, Commission of Inquiry

The most common process is the administrative one, focussed usually on the regulation of some ongoing activity, process or product and the licensing of new ones. The basis of administrative process requires that there exist some legislated or decreed guidelines, and the administrative role is to apply these to new situations or to monitor their application to the ongoing and continuing. Such administrative activities might rely solely on executive judgement for assessment of risk, but more often than not may include quasi-judicial hearings, reviews, and advisory commissions of inquiry.

The most common adversary process is judicial review, where under the formalized rules of a courtroom, conflicting assessments of risk can be scrutinized through examination and cross-examination. Traditionally courts were drawn into such reviews as a result of a liability litigation, and increasingly as a result of judicial review of administrative behaviour. Such reviews are often solely procedural, examining claims and disputes as to the bias, good faith or diligence of the reviewed regulatory or licensing group involved. Where an actual risk assessment is judicially made, the courts may need independent assessors or similar devices (Plohert, et al., 1974) or alternatively there may be a need for a scientific court (Kantrowitz, 1975).

Less structured adversary processes also take place in public—formal, staged debates, testimony before commissions of inquiry or regulatory hearings, and the informal processes of debates in media and public gatherings.

The Commission of Inquiry takes many forms: ad hoc groups specially appointed by government or non-governmental organizations to conduct or evaluate risk assessments; ad hoc or regular legislative committees exercising oversight for some particular area of hazard; and expert panels of scientific and technical appraisers. Some may have quasi-judicial power, others exercise their special competence. All depend on prestige and public acceptance for the weight of their findings. Administrative and judicial procedures have been widely studied by scholars of law and public administration. But it is only recently that the competence in risk assessment has been examined. Wraith and Lamb (1971) find the British ‘Public Inquiry,’ the unique ministerial hearings for appeals, objections, investigations, and post-mortems, a poor instrument for considering highly technical matters. Boffey (1975) finds that in the past the National Academy of Sciences’ ‘advisory reports have often fallen short of the very high quality one would expect from the nation’s preeminent scientific organization; many, in fact, are mediocre or flawed by bias or subservience to the funding agencies.’ (Boffey, 1975, p. 246). And the U.S. Congress
recently requested that the same National Academy review the decision process of risk assessment of the major U.S. administrative agency, the Environmental Protection Agency (National Academy of Sciences, Committee on Environmental Decision-Making, forthcoming).

The foregoing group processes all have strengths and weaknesses. None are pure forms; almost all involve an admixture of administrative, adversary and inquiry processes. But a rough division of labor can be suggested. The identification of risk requires the continuing overview of administrative guardians, estimating risk may require special study conducted by an expert commission, while evaluation, the formulation of comparative judgements of risk, may be helped by the pushes and pulls of the adversary process.

3.3.2 Economic Markets: Commodity, Insurance, Gambling

An alternative to political process is the invisible hand of the free market, three sectors of which are active assessors of risk. Many agricultural products have their seasonal weather and disease risk assessed in the futures market, where commodity speculators share the risk of excessive price fluctuation and provide a hedge for producers. A market for insurance also exists, particularly for those risks affected by natural or low-probability events. Similarly gambling, particularly where legal and well organized, provides a way of assessing some risks.

Admirers of markets often seek to introduce some aspects of such self-regulatory assessments into the other group processes. They argue that for many 'voluntary' risks, information in the form of detailed labels, or warnings, should suffice. With such information, accepting or declining purchase of the product or participation in the activity becomes, in effect, an act of individual risk assessment.

3.3.3 Case Study: Iron Ore, Asbestos, and Drinking Water (USA)

The efforts to stop taconite pollution of Lake Superior contains major elements of almost all the group processes described including a major judicial risk assessment and a continuing classic conflict over immediate economic values and significant but indefinite and diffuse health threats.

POLLUTION AND PUBLIC HEALTH:
TACONITE CASE POSES MAJOR TEST
Luther J. Carter

Some bad problems of industrial pollution have a way of dragging on year after year, with little or no progress made toward abatement. The pollution of Lake Superior by the Reserve Mining Company, a matter first taken up in federal-state abatement proceedings in 1969, has fallen squarely in that category. For more than a decade, Reserve has been dumping into the lake each day about 67,000 tons of tailings, the residues from the grinding and magnetic separation process used to extract magnetite or iron oxide from taconite, a low grade of iron ore. And, even with the trial judge warning of a possible calamity and severely denouncing the defendants, the massive discharge of tailings may continue for several more years.

The Reserve Mining case poses two questions of over-riding urgency and importance: First, how clear must the scientific evidence be for a court to
find that pollutants from an industrial plant represent a threat to public health? Second, how great must that threat be for the court to close a plant, particularly one that is important to the local economy?

In this instance, especially, these questions cannot be answered lightly. The Reserve plant employs some 3200 workers — virtually all of the breadwinners of the town of Silver Bay, Minnesota — and represents a capital investment of several hundred millions of dollars.

After hearing more than 100 witnesses during a 139-day trial and reviewing over 1600 exhibits and 18,000 pages of testimony, Judge Lord made his decision. He held unequivocally that the 200,000 people who live along the western arm of Lake Superior are endangered by asbestos — or asbestos-like — fibers in the taconite tailings. Some are also threatened, the judge held, by fibers in the emissions from the Reserve plant's stacks. As the judge noted, asbestos is a proven human carcinogen, although its effects remain latent for 20 to 30 years or longer before cancers begin appearing among persons who have been exposed. Judge Lord ordered that the Reserve plant be closed — and remain closed until Reserve has prepared an on-land disposal basin to receive the taconite tailings and has stopped emitting fibers into the ambient air.

This shutdown order, which made sensational news when issued last April, was in effect for only 2 days. It was stayed by a three-judge panel of the U.S. Court of Appeals for the Eighth Circuit, and the Supreme Court subsequently refused to vacate the stay.

The panel, in a preliminary ruling reached after a quick analysis of the massive trial record, had concluded that Judge Lord's finding that the public health was endangered was not supported by the evidence.

Before looking more closely at the question of whether the taconite plant should be closed, consider some of the circumstances of the Reserve mining case.

First, there is the fact that two immensely important natural resources are involved — Lake Superior on the one hand, and the Mesabi Range of northeast Minnesota on the other. A half century ago, the Mesabi was one of the world's greatest iron mining regions. But its once abundant and easily mined deposits of rich iron ore have now long since been depleted. The Mesabi remains an important domestic source of iron only because of its taconite rock, which the Reserve Mining Company, beginning its operations in 1955, was the first to exploit.

This initial taconite mining venture was eagerly encouraged by state officials, and Reserve had no trouble obtaining permits to dump the tailings into Lake Superior.

Lake Superior, used for the past 18 years as a dump for Reserve's wastes, is the largest body of freshwater on earth — 563 kilometers long, 257 kilometers across at its widest point, and up to 406 meters deep. The lake water has, until recently, been considered of such purity that Duluth and most other cities have used it freely for drinking, without filtration or treatment.

Huge though it is, Lake Superior is by no means large enough to assimilate Reserve's discharge of taconite tailings, this being true from an aesthetic and ecological standpoint as well as from a public health standpoint. The discharge is fivefold greater than the 12,000 tons of solid generously estimated to enter the lake naturally each day from the inflow of some 200 rivers and the erosion of many hundreds of kilometers of shore-line. Indeed, this discharge of polluting solids is much greater than any other in the United States and possibly greater than any other in the world.

At its outset, the suit brought against Reserve in federal court had to do with the kind of aesthetic and ecological pollution problems just described. What gave the federal suit a new thrust was the discovery last year that tailings fibers indistinguishable from amphibole fibers were present in the drinking water of Duluth and other communities.
The discovery came about largely by chance. One evening in December, 1972, Arlene Lehto, a Duluth woman who organized the Save Lake Superior Association, was attending a meeting when she happened to fall into conversation with Joseph Mengel, a geologist at the University of Wisconsin-Superior, whom she had never before met. Mengel mentioned that the asbestos fibers suspected of causing a high incidence of stomach cancer in Japan (the talc-dusted rice popular in Japan has asbestos contaminants) were similar to the fibers in the taconite rock.

Knowing that she was to speak the next day at a meeting of the International Joint Commission (a U.S.-Canadian pollution advisory body), Lehto stayed up well into the night looking up information about asbestos and its health effects. Her talk at the commission meeting had a seminal effect.

On 15 June 1973, the Environmental Protection Agency announced that high concentrations of asbestos fibers had indeed been found in the drinking water of Duluth and other communities. Further, the agency, while not having yet concluded that the water was unsafe for human consumption, said that “prudence dictates that an alternative source of drinking water be found for very young children.” Meanwhile, scientists of the Minnesota Pollution Control Agency had found asbestos fibers in the ambient air of Silver Bay.

Epidemiological studies conducted in countries such as the United States, Finland, and South Africa have established that a high incidence of cancer occurs both among persons exposed to asbestos in their jobs and among those exposed only environmentally. Forty-five to 50 percent of asbestos workers have been found to die of cancer, whereas among the general population cancer deaths represent not more than 15 to 20 percent of mortalities.

No safe level of exposure to asbestos has been established. Scientific proof is, however, lacking with respect to whether a high incidence of cancer will result from the ingestion (as opposed to the inhalation) of asbestos fibers.

Before concluding that there is a substantial cancer risk, Judge Lord made an unusual effort to assemble and analyze the available evidence. To ensure that all aspects of the case would be presented, he had some court-appointed witnesses testify in addition to the large number of witnesses put on by the plaintiffs and the defense (the trial is estimated to have cost some $5 million to each side).

Irving J. Selikoff, director of the environmental sciences laboratory at the Mount Sinai School of Medicine, New York, was a principal witness for the plaintiffs on the hazards of asbestos fibers in occupational settings and the environment. Others who testified came from a variety of institutions such as Mount Sinai, the Mayo Clinic, the University of Wisconsin School of Medicine, The Johns Hopkins School of Medicine.

Virtually every issue in the case was contested. For example, Reserve witnesses sought to show that the tailings disposal plan had not failed and that the tailings were not widely diffused; and, further, that the fibers in municipal water supplies were not identical to asbestos and hence could not be classified as a carcinogen.

Judge Lord intervened vigorously in the proceedings, questioning and challenging witnesses whenever he felt it necessary. Lord sometimes made his own independent analysis of technical evidence, as in personally studying a large number of transmission electron photographs and challenging Reserve’s witnesses to point out how the morphology of the tailings fibers was distinguished from that of asbestos fibers. In this instance and in nearly every other, he concluded that the plaintiffs had made the more convincing argument.

In its preliminary review of the case, the three-judge panel of the court of appeals concluded that Judge Lord’s “resolving all doubts in favor of health safety represents a legislative judgement, not a judicial one.” The panel further stated that, as in the case of an inconclusive study of tissue taken from
recently deceased residents of Duluth, the district court had chosen to
disregard or downplay some important evidence undercutting the argument
that a compelling health hazard exists.

The court of appeals panel, although blandly saying that there are “neither
heroes nor villains” in the Reserve Mining case, has held that Reserve must
switch to an on-land disposal system.

In the short run, there is no generally acceptable compromise solution
available. If municipal water supplies could be effectively filtered pending the
change to an on-land disposal system, that would help to resolve the dilemma.
But, to take the case of Duluth, some 2 years would be required to build a
filtration system – nearly as long as it will take to build a tailings disposal
basin.

In sum, there is a very real prospect that the discharge of tailings into Lake
Superior will not cease until late in this decade, with the citizens of Duluth
and other communities having to ingest asbestiform fibers along with their
drinking water for another several years. (Reprinted and condensed from
Science, Volume 186, 4 October, 1974, pp. 31–36. Copyright 1974 by the
American Association for the Advancement of Science.)

In assessing the environmental threat of ingested asbestos, the judges made
widely differing assessments. In so doing, they mirrored trends and attitudes
prevalent in society as a whole.