9. *Local Control of Research Involving Chemical Warfare Agents*

SHELDON KRIMSKY

The U.S. Department of Defense (DOD) continues to support an active chemical warfare research and development program. DOD funds research in new chemical weapons and their deployment systems,[1] methods for protecting soldiers exposed to conventional chemical warfare agents, and procedures for detoxifying stockpiles of chemical agents when they are no longer needed.[2] To accomplish its R&D objectives, DOD transports quantities of chemical nerve and blister agents to contractees at research facilities in different parts of the country.

In Cambridge, Massachusetts, a highly-regarded consulting firm, Arthur D. Little (ADL), spent over $800,000 to construct a laboratory designed to meet DOD safety requirements for handling chemical nerve and blister agents. Several months after the Cambridge City Council became aware of the type of tests taking place at the facility, the local public health commissioner ordered the firm to cease storing and testing the chemical warfare agents in the city. Subsequently, a committee of scientists and citizens was convened to assess the public health risks of research with highly toxic chemical agents and to advise the city on managing the risks. ADL contested the city's authority to interfere with its DOD contract.

This chapter examines the origins of the controversy, the risk assessment review process, and the constitutional issues underlying the litigation of this case. The central conflicts involve local accountability for potentially hazardous defense contracts, and the preemptive authority of the national government on health and safety issues pertaining to federally-sponsored research.

Like the genetics debate that erupted nine years ago in Cambridge,

the controversy over research with chemical warfare agents raises questions about the role of cities and towns in regulating, restricting, or proscribing scientific research and technological development. Comparisons and contrasts between the genetics and chemical weapons debates are also discussed in the chapter.

THE GENESIS OF CONCERN

In 1982, ADL began planning for the renovation of an existing laboratory to conform to DOD specifications for work with "chemical surety materials," a euphemism for chemical warfare agents. ADL invested over three-quarters of a million dollars in establishing the Philip L. Levins Laboratory to meet state-of-the-art requirements for handling supertoxins. In January 1983, the firm notified Cambridge city officials of the plans for a new laboratory designed for research on highly toxic materials. The city manager, police chief, and fire chief were given a briefing about the new testing facility when ADL applied for a building permit. It is unclear how much these individuals knew, at that time, about what was going to be tested in the laboratory. Beyond the minimal disclosure ADL made to selected municipal officials, the full nature and purpose of the facility were not communicated to members of the Cambridge City Council or the public prior to or during the construction of the laboratory.

Between late September and early October 1983, ADL notified selected officials in the neighboring towns of Arlington and Belmont that its new chemical testing facility was completed. A few town officials toured the laboratory and were asked to keep its use confidential. After the tour, Arlington's town manager informed ADL that he could not in good conscience withhold information about the lab's new capabilities from town residents. He planned to raise the issue of the laboratory at the next meeting of his town's selectmen. On that same day, ADL issued a news release announcing the opening of a high-security laboratory for the testing and analysis of toxic materials. The news release was skillfully written and avoided any mention that the facility would be handling chemical warfare agents or that the research undertaken there would be defense-related.

A few days later, on October 17, ADL officials met with the Arlington Board of Selectmen at a public hearing, "but revealed only limited information about the lab and its operations."[3] According to a story

in the *Arlington Advocate*, "Their [ADL's] answers did not seem to fully satisfy board members who voted unanimously to contact the state Commissioner of Public Health and the city council of Cambridge. . . ."[4]

On October 20, the *Arlington Advocate* carried a front-page banner headline: "A.D. Little Toxic Chemical Testing Surprises Town." On that same day a story also appeared in the *Boston Globe*. At first, citing the classified nature of its research, ADL declined to discuss specific activities carried out at the facility. The *Boston Globe* report speculated that "it might involve research on means to detoxify old stocks of nerve gas for the army."[5]

Concerned about what they had read in the newspapers, neighborhood residents aroused members of the Cambridge City Council, who called a public hearing on October 24 to air the issues. ADL's DOD-funded research on chemical warfare agents was already under way in early October.

Spokespersons for ADL who attended the public meeting tried to assure the council that its facility had been designed with the most advanced safeguards for handling chemical toxins. But the council wanted more assurance than the company could offer. It passed an order creating a scientific advisory committee, the purpose of which was to advise the city council and the commissioner of health and hospitals on issues of public health and safety related to the environmental hazards of ADL's research with chemical warfare agents. The Scientific Advisory Committee (SAC), formally established in fall 1983, was not in operation until the following spring. The city fathers fashioned SAC after the Cambridge Experimentation Review Board (CERB), a committee of local citizenry that had helped resolve the controversy over genetics research that had erupted in 1976.[6]

At this stage, community involvement was minimal, limited to a few articulate and persistent spokespersons who followed the issue from its inception through the deliberation process. Mass community organizing did not come until months later.

Between fall 1983 and winter 1984, individual city councillors introduced orders requesting a moratorium on testing of nerve and blister agents until SAC was appointed and completed its evaluation of the risks. Orders voted on by the city council are effective only if acted upon by the city manager. In February 1984, Councillor Alfred Vellucci, who had spearheaded the city's oversight of gene-splicing research and transformed the recombinant DNA controversy into a populist issue, called for a ninety-day moratorium on the testing of chemical warfare

agents. The purpose of the moratorium was to give the city time to study the issue. A month later, on March 13, the city's chief public health official, Commissioner of Health and Hospitals Dr. Melvin Chalfen, issued an emergency regulation that prohibited "testing, storage, transportation and disposal of five specified nerve and blister agents within Cambridge, until the SAC and an independent hazard assessment has been completed and these recommendations have been reviewed by the Health Commissioner's office."[7]

On March 16, ADL filed suit against the City of Cambridge, requesting that the commissioner's order be enjoined. The court offered relief to the plaintiff by issuing a temporary restraining order that remained in effect through summer 1984, enabling ADL to continue its testing of the chemical warfare agents.

Meanwhile, the city developed a two-part strategy in response to the litigation. It decided to convene SAC and await the committee's evaluation of the research before pressing on with the legal case. The city solicitor needed that independent evaluation to demonstrate to the court that the emergency order was not arbitrary and capricious. Second, the commissioner of health contracted with an independent scientist to undertake a risk assessment. The scientist, representing the firm TRC Environmental Consultants, Inc., of Hartford, Connecticut, was asked to evaluate the public health risks of five chemical warfare agents being tested at ADL. On recommendations from the city council, in March the city manager appointed members to SAC, with the commissioned risk assessment study already underway. SAC held its first meeting on April 12, 1984. Frequent exchanges took place between the outside consultant and SAC up until the commissioned risk assessment was completed.

In late April, the city petitioned the court to remove the temporary restraining order, introducing the preliminary results of the TRC report as new evidence. However, the TRC risk assessment did not provide sufficient grounds for the court to overturn the order. The concluding paragraph in the affidavit filed by the risk assessment consultant on behalf of the city illustrates the consultant's lack of conviction concerning a research ban.

> In summary, accidental or intentional release of nerve gas to the environment is very unlikely but not impossible. If the amount of concentrated nerve gas maintained at Arthur D. Little is less than 100 milliliters, and the experiments do not change to involve intentional aerosol generation or large quantities of explosives, there is little chance of fatalities at a dis-

> tance of the nearest residences even in the event of a release. There is a chance of fatalities, but not a large number, at a distance of Route 2 if more than 10 milliliters of nerve agent is released. Fatalities might involve the curious drawn to the accident. The absence of an emergency plan for the community in terms of cordoning off areas, halting traffic, or obtaining decontamination aid increases community risk. An emergency plan would need to be kept up to date particularly if experiments at Arthur D. Little changed to involve greater quantities of more toxic materials.[8]

On May 2, the court again ruled in favor of ADL and extended the temporary restraining order. Ironically, ADL's early legal defense was built on the summary of the TRC report. In its brief, ADL argued that the independent risk assessment supported the firm's contention that prohibition of its research was unwarranted. A trial date, initially set for early June, was postponed to the fall. The postponement gave the city time to hear from the Scientific Advisory Committee before continuing its litigation.

A CITIZEN-SCIENCE COMMISSION

The troubled city council, having reacted on the basis of intuitive and popular concerns over the hazards of chemical nerve and blister agents, failed to stop the research by order of the chief health officer. Since the consultant's affidavit did not overturn the restraining order, considerable attention was directed to the work of SAC.

While the order for establishing SAC came from the city council, its size and membership were determined by the city manager. Initially, the committee contained seventeen members. After several meetings one member, unable to meet the time commitments of the committee's schedule, resigned. Table 9.1 shows the membership of the committee by occupation, institutional affiliation, and residence when it was stabilized at sixteen.

Upon receiving its charge from the city manager, the committee assigned itself three distinct functions: (1) assessing the risks of the current or planned research at the ADL facility, (2) deciding whether or not the risks were acceptable, and (3) recommending a risk management plan to the city for all forms of research involving highly toxic agents.

The composition of SAC reflects an interest of city officials in combining, within a single process, the technical and policy dimensions of

TABLE 9.1. Composition of the Cambridge Scientific Advisory Committee by Occupation, Institutional Affiliation, and Residence

Occupation	Institutional Affiliation	Cambridge Residence
Physicist/ Risk Assessment	Harvard University	No
Biochemistry/ Pharmacology	Tufts University	No
Community Organizer/ National Toxics Program	Nat'l Project on Neighborhood Health & Safety	Yes
Biology/Oceanography	New England Fishery Management Council	Yes
Chemical Engineering/ Industrial Hygiene	Harvard University	No
Physical Chemist/ Environmental Measurements	Consulting Firm	No; adjacent town of Arlington
Philosopher/ Social Scientist	Tufts University	Yes
M.D./Public Health/ Epidemiology	Boston University	Yes
Architect	Architectural Firm	Yes
Ph.D. Chemist	Private Sector	Yes
Public Health	Town of Belmont	No; adjacent town of Belmont
Molecular Biologist	Harvard Med. School	Yes
Restauranteur	Cambridge Restaurant	Yes
Electrical Engineer	Private Sector	Yes
Social Service Administrator	Cambridge Committee of Elders	Yes
Occupational Health	Harvard University	Yes

this issue. Science/technology policy debates have addressed the advantages and disadvantages of establishing separate decision-making processes for the technical and value components of an issue.[9] Within the science policy field one may find positivists who believe that normative/value issues may be isolated from technical questions and non-positivists

who contend that the separation is not possible. The widely debated "science court" proposal for resolving disputes among experts is a reflection of the former view, while the "citizen court" proposal is a reflection of the latter.[10]

Risk assessment is primarily a technical matter, although there are a number of windows through which values may enter into the scientific analysis. (See Chapter 2 of this volume.) In contrast, the determination of acceptable risks is largely value-laden. There are norms one can use in such cases, but they are not based on scientific fact or theory. Considerations may be given to psychological factors, benefits versus costs, the historical circumstances, and where one is situated with respect to the risks and benefits.[11].

Finally, decisions on risk management involve science and technology, the allocation of resources, and sociopolitical institutions. In some cases where public consensus exists that certain risks are unacceptable, there may be a lack of expertise as to how to manage those risks.

THE PROCESS OF INQUIRY

The early meetings of SAC were devoted to unstructured interrogation. Representatives of ADL responded to a series of disjointed free-form questions raised by SAC members. The committee's appetite for information, in both breadth and detail, seemed insatiable. To help structure its inquiry and set priorities on the use of its technical and intellectual resources, SAC developed a framework for classifying its information needs (see Table 9.2).

For each category in the classification, committee members were asked to provide a fine structure of questions they considered relevant to the decision-making process. To answer all the suggested questions would have been a sizable task. Aware of its limited resources, SAC set priorities for the principal categories in the Classification of Information Needs and formed subcommittees to report on each area. While this was taking place, TRC's consultant to the city, Dr. Brian Murphy, met with SAC on several occasions to discuss his risk analysis.

Murphy's task was limited to assessing the potential public health hazards involved in ADL's storage and use of chemical warfare agents. For his basic methodology, he chose the analysis of worst-case scenarios. In this context, a "worst case" was interpreted to mean a release into public spaces of the most hazardous agents handled by ADL. The

TABLE 9.2. Classification of Information Needs as Determined by the Cambridge Scientific Advisory Committee

A.	Physical, Chemical, & Toxicological Characteristics of Chemical Warfare Agents
B.	Internal Emergency Procedures and Planning
C.	Laboratory Facilities
D.	Risk Scenarios
E.	Comparative Risks
F.	Physical Surroundings
G.	Scope of Present ADL Activities and Constraints
H.	Operational Procedures of Inspections
I.	Life Cycle of Materials
J.	Regulations in Effect at All Political Jurisdictions
K.	Future Activities of the ADL Laboratory

consultant's job was aided by the availability of published information on the physical and chemical properties of the chemicals.[12]

In his analysis, Murphy applied standardized dispersal models that describe how gases or volatile liquids are carried through the air. Four types of releases were addressed in his study: (1) evaporation from a spill, (2) sudden release by evaporation or impact, (3) release in a fire, and (4) intentional release.

In his report, the consultant discussed the limitations and boundaries of his study. First, only hazards to the general public and not hazards to ADL employees were addressed. Second, only work currently under contract at ADL, and not anticipated work that might involve different experiments, was considered. Third, no probability values were assigned to any of the hypothetical worst-case situations cited in the study. Fourth, the consultant made no judgments about whether the risks were acceptable or unacceptable.[13]

But the TRC consultant did not explain a critical trans-scientific judgment in the study: to use worst-case scenarios as the preferred method of risk analysis. There is no single approach to risk assessment. An alternative to the analysis of worst cases is to examine the most probable scenarios for accidental release. Worst cases and most probable cases are rarely ever the same. Safety requirements for the former can be significantly greater than what would be considered reasonable safeguards for the latter. Still another approach involves examining the con-

ditions of a facility, both physical containment and laboratory practices, and comparing those to the state of the art for handling equivalent substances.

SAC followed the same basic methodology chosen by the TRC consultant. The committee analyzed the public health effects of several worst-case scenarios. If such cases revealed insignificant public health risks, SAC was prepared to examine potential impacts of lesser consequence. By choosing this methodology, SAC was looking for limits of the possible. If one hundred milliliters of nerve agent were released into the environment, lethal doses would be carried over certain distances and some number of people would be exposed to these. The committee wished to know the details of these scenarios. Once the worst cases were modeled, there were several options available to SAC. It could proceed to estimate the probability that one of the scenarios would take place. Or, it could examine ways to reduce the probability of such an occurrence. To build a risk management policy on the basis of worst-case scenarios, without an analysis of the probability of occurrence, is predicted on the idea of minimizing regret. In other words, if there is an outcome that is possible and deemed unacceptable under any foreseeable circumstances, minimizing regret means eliminating the conditions that make the outcome a possibility, regardless of the value of the occurrence probability. This approach is consistent with public attitudes toward low-probability catastrophic events.[14]

SAC developed its information base around the issue of worst-case analysis. The committee reviewed and commented on early drafts of the TRC report. The physical models incorporated into the TRC report were acceptable to SAC. Building on the consultant's report, SAC pursued additional queries. Other than ADL employees, how many people might be exposed to lethal doses of chemical warfare agents in the event of a major accident involving a release of those agents into the environment? How does the risk of such accidents compare with other hazards facing city residents? In terms of toxicity, how do other chemical agents that are used for research in the city compare to the nerve and blister agents handled at the ADL testing facility? These questions brought the committee into an extended debate over the manner and means of regulating "supertoxins," the term given to chemicals of toxicity comparable to some of the most dangerous of the chemical warfare agents.

REGULATING SUPERTOXINS: TWO APPROACHES

According to a U.S. Army contract made available to SAC,[15] the chemical warfare agents tested at the ADL facility included: Sarin (GB), Soman (GD), VX, Mustard (HD), and Lewisite (L). In presentations before the committee, ADL representatives contended that these chemicals or close derivatives are available from chemical houses without special licenses or restrictive uses. They also claimed that chemicals of equal or greater toxicity and with similar effects on humans are used in commercial and household products such as pesticides.

Of the five chemical warfare agents used by ADL in its R&D work, the three nerve agents Sarin, Soman and VX are the most toxic and were of greatest concern to the committee.[16] The extremely high toxicity of these chemicals confounds our intuitive ideas about small quantities. On first learning about the volumes of chemical warfare agents stored at ADL, most people are not apt to be concerned. To the layperson, a pint or a quart of a toxic chemical is not likely to be viewed as a public health hazard. Nevertheless, the toxicological properties of these agents are so much greater than any we might experience in ordinary life that a reorientation to a world of minute numbers is required fully to appreciate the hazards. For example, the agent VX is most toxic through inhalation as an aerosol. The lethal dose of this agent sufficient to kill 50 percent of the adults who inhale it (LD50) is a mere .3 milligrams, or one-hundredth of a drop. The other agents GB and GD are about one-third to one-half as toxic as VX by inhalation. When we consider that a liter (approximately a quart) contains about 30,000 drops, that seemingly small amount of chemical agent begins to take on a new meeting with respect to public health and safety.

A subcommittee of SAC was formed to examine comparable risks between the chemical warfare agents and other toxic chemicals used in the city. Since large amounts of chlorine are stored to purify the city's drinking water, the Comparative Risks Subcommittee drew comparisons between the two toxic compounds.[17]

> VX has an LD50 of about 30 mg-min/m3, whereas chlorine has an LD50 of about 30,000 mg-min/m3 (possibly lower). To get the same ratio of M/D [Mass to Dose ratio], when D is the LD50, we see that the mass of chlorine has to be 1000 times larger than the mass of VX. Thus, 1000kg of chlorine (1 ton) is approximately equivalent to 1kg of VX, in that these quantities of the different agents will result in the same size and shape of the area in which the total dose exceeds the LD50.

As a first approximation, 1000kg (about a ton) of chlorine released into the environment would have the same lethal effects as 1kg (about a quart) of VX.

This type of information stimulated two kinds of discussions within the committee. First, there was a lengthy debate over the role of comparative risk analysis. Second, there was a protracted discussion over whether it was reasonable to classify a special group of chemicals as supertoxins for the purpose of regulation.

The logic underlying comparative risk analysis can be very compelling. Its basic idea may be summarized as follows: activities involving risks no greater than those with which we ordinarily live are rationally acceptable. There is, however, a glaring problem with this approach. Gertrude Stein might have said, "A risk is a risk is a risk." But decisions on acceptable risk inevitably involve a consideration of benefits. As a result, the tolerance for situations of comparable risk may vary considerably.

Building on the distinction between risk and risk-benefit, some members of SAC considered it fallacious to compare the risks of research involving VX with those of chlorine storage tanks in the city. The tanks are considered an essential asset to community health since the chlorine is used to purify the Cambridge water supply. SAC did not view the research with chemical warfare agents as providing any benefits to the city. A few members of the committee had serious reservations about the benefits of the research to the country as a whole.

Comparative risk analysis was also criticized for failing to take account of the critical distinction between voluntary and involuntary risks. In cases where two activities involve about the same actuarial risk, there may be vastly different public perceptions of acceptable risk, for example, if one of the activities is freely chosen and the other is externally imposed.

SAC also struggled with the issue of defining a class of chemicals called "supertoxins." Once the committee recognized that chemicals of toxicity comparable to the nerve agents were not regulated by federal and state health and safety laws, it investigated the number of such chemicals in common use. If Cambridge were to establish regulations for highly toxic chemicals, SAC wished to know how many compounds the health commissioner would have to oversee. Would it be a dozen, hundreds, thousands, or tens of thousands? A Data Search Committee was formed to answer these questions. The committee undertook a com-

puter search of two registries of chemical compounds: the Registry of Toxic Effects of Chemical Substances (RTECS) and data base of the National Institutes of Environmental Health and Safety (NIEHS).

In the RTECS registry there were 66,954 substances listed, and 50,811 (76 percent) reported at least one LD50 (lethal dose to 50 percent of an exposed population) in any model. Using a threshold LD50 of 2 mg/kg, the estimated LD50 of ethyl parathion, a highly regulated anticholinesterase organophosphate widely used as a pesticide, the search identified 295 substances with an LD50 less than or equal to the threshold. In the LD50 range of 2–10 mg/kg the search revealed 1,354 substances. Ironically, the nerve agents used by ADL under its DOD contract were not listed in the chemical registries.

The NIEHS data base is similar to RTECS, but smaller. The search located about 300 substances with an LD50 of 1 and 2mg/kg. This search was more restricted since it only yielded LD50 values that were integral numbers and ignored intermediate values.

This data base search of very low LD50s (high toxicity) proved useful in that it gave SAC an estimate of how many chemicals of toxicity comparable to the chemical nerve agents would be covered by a municipal ordinance regulating supertoxins. The implementation of a city ordinance might be impractical if more than a few hundred compounds were targeted by the regulation. Several other considerations were raised in discussions about a municipal ordinance.

1. Currently, whether used in industry, R&D firms, or university research, the class of supertoxins is regulated neither by public nor occupational health legislation at the state or federal level. From a health and safety standpoint, DOD is the primary overseer of ADL's handling of chemical warfare agents. The same agency is, therefore, responsible for both promoting and regulating research with very hazardous materials.
2. If SAC were to come up with a regulation that covers the use of the supertoxins in R&D activities, members of the committee posed the following questions. Should it be targeted exclusively to firms like ADL, in other words, the for-profit sector, or should it also cover university research? For the purpose of regulation, should all supertoxins be treated equally? Or should the intent of the research and the uses of its results be considered in an ordinance? Some members of SAC argued persuasively for equal treatment. The local control of supertoxins, they held, should not depend on whether the sub-

stances are used for cancer treatment in a university medical complex or by a for-profit firm under contract with DOD in the form of chemical warfare agents.

Considerable opposition came from some SAC members to the suggestion that all supertoxins be treated the same from a regulatory standpoint (supertoxin equity rule). Since "acceptable risk" considers the benefits as well as risks, they argued that an ordinance designed to manage the risks should distinguish supertoxins by type of use. Some members of SAC believed that the DOD work with chemical warfare agents was of dubious value to society and may be even part of a new escalation in chemical weapons development. Others believed that the appropriate way to regulate these substances was by toxicity and volume, without reference to the intentionality of the work on the source of funding. They supported the supertoxin equity rule and argued that the work at ADL should be restricted because the volumes of supertoxins used pose a hazard to the community. The same substances used in micrograms (millionths of a gram) would pose no hazards beyond those to the investigators.

After weeks of debate, two distinct positions emerged. The first held that if supertoxins were to be regulated, then the rules should cover all such chemicals, regardless of (1) the nature of the application, i.e., whether it is pure research or development; (2) the institutions involved, i.e., whether profit, nonprofit, public or private; or (3) the source of funding for the research, i.e., public or private. This "supertoxin equity rule" requires that all supertoxins be treated on an equal basis for purposes of regulation.

The second position called for rigorous regulation of chemical warfare agents as a distinct class of chemicals. These agents would be defined by the purpose of the research. Since the military publishes a list of chemical warfare agents, any institution working under DOD contract and using one of the designated agents would fall under the city ordinance. The same substances used for biomedical research under contract from the National Institutes of Health (NIH) might not be covered by such a regulation. This second position is referred to as the "supertoxin intentionality rule."

A consensus was finally reached by SAC on one of the two approaches to regulating research with supertoxins. The final outcome was not a compromise of the two positions. Advocates for the "supertoxin intentionality rule" won the debate by sheer persistence. Others, somewhat reluctantly but in a spirit of cooperation, joined to make the final deci-

sion of SAC unanimous. (At the meeting where the final vote was taken, thirteen members present voted in favor of the final recommendations.)

THE DECISION

The final report of SAC contained discussions for each of the three areas pertaining to risk: risk assessment; acceptable risk; and risk management. Building its analysis of risk on the consultant's worst-case model, SAC concluded that releases of 100ml of VX into the air could expose people to substantial lethal doses of the nerve agent approximately 300 feet away at a bowling alley and a major highway. For a release of 500ml of the same compound, substantial lethal doses could reach a 500-foot radius, within which is located a motel and a large athletic field where tournament games are played. Much smaller lethal doses of the nerve agent could enter residential neighborhoods. The report stated that "an accident in which chemical warfare agents are released from the ADL facility is unlikely but not impossible."[18] SAC did not attempt to quantify the probability of a worst-case accident. Such calculations are very complex, involve many assumptions, and result in a considerable margin of error.

On the issue of acceptable risks, SAC concluded that:

> the benefits of research with these chemicals do not justify lethal risks to the general public. For this reason, the SAC believes that storage and testing of these chemical warfare agents within the densely populated city of Cambridge in the quantities and concentrations used by ADL is inappropriate. Furthermore, the majority of the SAC members judge the risks associated with any such work to be unacceptable.

Although the committee was divided on the question of acceptable risks, the split had little effect on its recommendation to the city. There was a consensus that the quantities of nerve agents stored at the ADL facilities were unacceptable. However, a few SAC members seemed willing to accept a testing program involving very small quantities of those agents. Nevertheless, a substantial majority of the committee did not feel there was justification for a single lethal exposure of the public to these chemicals in the name of chemical weapons research.

Finally, the committee developed a plan for the city to regulate research with supertoxins. The risk management plan introduced by SAC contained the following provisions.

1. Certain designated hazardous materials proposed for testing, use, storage, or disposal within the city must be reported to the commissioner of health and hospitals at least three months prior to the date of planned entry into the city.
2. The substances designated for reporting include: chemical warfare agents (as provided in a list); other nerve agents of chemical structures different from those listed, when used in chemical weapons R&D; biological warfare agents; and other highly toxic agents as may be designated by the commissioner.
3. Each proposed use of regulated agents must be reviewed by the commissioner and given a site evaluation in writing after appropriate information is provided. Any citizen of the city may petition for a public hearing.
4. If the commissioner finds that the use of the regulated chemical agents presents an unacceptable hazard to public health or safety, then a site assignment shall not be given and the use of such materials by the petitioner shall be prohibited.
5. In addition to chemical warfare agents, the City of Cambridge shall develop policies to regulate other supertoxins.

The final recommendations of SAC were predicated on the "supertoxin intentionality rule" discussed in the previous section. At this stage in the committee's deliberations, the primary distinction for the regulation of supertoxins was not based on toxicity or volume but on the use for which the chemicals of the research were designated. The final report stated:

> Chemical warfare agents are of a particular concern as a separate class of hazards because of their nature and purpose. They are highly toxic, designed for ready dispersal, and are intended to kill great numbers of people. Currently, these agents are largely unregulated by local, state or federal statues.[19]

SAC did not introduce small-volume exclusions into its recommendations. It left that to the discretion of the commissioner. However, it did exempt from the reporting requirement any retail products, pharmaceuticals available at drug stores, and materials used in a therapeutic setting by a physician.

UNCERTAINTIES IN THE REGULATORY AGENDA

Despite the long deliberations that went into the final report, there were a number of unresolved questions. SAC did not provide a carefully

worded definition of a chemical warfare agent. For purposes of regulation, it is unclear whether a substance has to appear on a designated list or simply be an essential ingredient in chemical weapons research. Also, the committee did not address the question of concentrated versus dilute agents. In assessing the risks of toxic chemicals, there is a tradeoff between volume and concentration. A small volume of highly concentrated nerve agent may be as hazardous as a large volume of dilute material. However, highly dilute solutions of nerve agents are used in a variety of circumstances that may already be regulated.

To turn SAC's recommendations into a municipal ordinance, several problems must be resolved. For example, suppose an academic scientist is planning to study the properties of a highly toxic compound that does not appear on the city's list of regulated substances but is used in research funded under DOD contract. SAC's recommendations do not make it clear whether this situation would fall under "chemical weapons research."

In another hypothetical case, a university scientist is using extremely small quantities (micrograms) of a nerve agent that is on the DOD's inventory of chemical warfare agents. It is not clear whether the committee intended such uses to fall under the reporting requirement. It would seem so, although the intention of the committee is not to obstruct such research, only to have the city make note of it.

The SAC report has important implications for Harvard and MIT scientists who work with supertoxic agents. First, it requires the universities to take account of the chemicals in use. Second, DOD-funded research involving supertoxins must be reported to the commissioner of health and hospitals. At a time when Massachusetts universities are seeking exemptions from a state "right to know" law requiring disclosure to workers about chemical exposures, researchers and administrators are not eager to face another layer of local regulations of toxic substances.

JUDICIAL PROCESS

With the completion of SAC's report in September 1984, the city had two risk assesssment documents to present to the court. The judge's order, enjoining the city from enforcing its prohibition against research with the nerve and blister agents, was still in effect. The case was heard by a circuit judge in Superior Court of Massachusetts. After an initial hearing, the judge divided up the legal issues into two parts. First, he

wanted to hear briefs on the question of supremacy. ADL claimed the city had no legal right to prohibit its experiments since they were funded by DOD and the chemical agents were owned by the federal government. The city's regulation prohibiting ADL from conducting defense-related testing of chemical warfare agents, the argument continued, imposes a clear conflict with the federal interest. In such conflicts, the federal role takes supremacy over local interests. Second, if it were found that supremacy does not stand, the judge agreed to hear arguments on the reasonableness of the city's order to proscribe the testing of the five chemical warfare agents in question.

Arguments on the supremacy issue were presented to the court in mid-November 1984. Counsel for the City of Cambridge (defendent in the case) argued that, for federal supremacy to hold, one of two conditions must be satisfied. Either the federal government has preempted the field of toxic substances regulation, or a fundamental conflict exists between the federal and local governments on the regulation of these substances. The defense counsel maintained that neither condition is satisfied. Congress has never stipulated that testing of toxic substances would be exclusively occupied by the federal government. Under the Federal Hazardous Substances Act, as a general rule, defense contended, local governments may regulate non-manufacturing activities. On the issue of conflict between federal and local laws, defense counsel cited the following points:

1. Language in the DOD contract states that the contractee must follow all local and state laws in addition to DOD regulations. This implies that no fundamental conflict exists among political jurisdictions.
2. The government could always do the testing on federal property; the facts do not show that there is an actual conflict.
3. Under the municipality's police powers it may alter a previously established contract.

Counsel for ADL raised the following points in building an argument for federal preemption over the city's action:

1. Congress has authorized DOD to establish a chemical warfare program, and this includes regulations for handling, use, and disposal of the agents.
2. The framers of the U.S. Constitution as well as Congress intended the federal government to have exclusive responsibility for national defense. The city's regulation prohibiting ADL from conducting defense-related testing of chemical warfare agents is tantamount to

interference with governmental functions and represents a clear conflict with the federal interest.

3. If Cambridge is free to prohibit such work, then so too is any other community. If all jurisdictions followed Cambridge's lead, federal programs in chemical warfare research would be frustrated.
4. Since ADL is a contractor of the government, the firm is invested with "derivative sovereign immunity" which allows the supremacy clause of the Constitution to apply to it with equal force as to the federal government. Council for ADL contended that reasonable additions to the safety regulations of DOD do not represent a fundamental conflict between the city and the federal government. The conflict arises when the city's regulation effectively prohibits ADL from performing its contracted work for DOD.

The decision on the supremacy question was entered by the court in a twenty-one-page brief on December 14, 1984. The ruling stated, "The Cambridge ordinance does not run afoul of the Supremacy Clause nor is it preempted by federal law."[20] The judge reasoned that this was not a case in which Congress left no room for state and local governments to supplement federal regulations. Furthermore, the local regulation is not an obstacle "to the accomplishment of the full purpose of Congress."

Two months later, on February 26, the Superior Court ruled on the second part of the issue declaring that there was no procedural defect in the city's order prohibiting use of the chemical agents. The following day, the judge declared the September 1985 order "valid and enforceable." However, the judge filed an unusual addendum to his decision which stated his personal belief that ADL was not treated fairly in this process. He expressed his hope that the appellate courts or the state legislature will change the current law that guided his decision.

ADL appealed the case to the Massachusetts Appeals court on March 12, 1984. The court gave the company immediate relief by reinstating the injunction against the order pending the outcome of the appeal. In response, the city petitioned the Supreme Judicial Court (SJC) and asked that it take the case over from the Appeals Court. The SJC agreed with the city's petition, heard the case on April 4, 1985 and issued its ruling four months later on August 1.

The SJC found that the commissioner's order was a permissible attempt by the city to protect its inhabitants under the local police powers. It rejected arguments by ADL that the order violated the firm's right to due process or constituted an unjustified interference in its contract

with DOD. The SJC also failed to find within federal statutes congressional intent to preempt local communities from passing health and safety regulations for chemical warfare agents. The court affirmed the right of local health authorities to prohibit activities so long as the regulations are not "unreasonable, whimsical, or capricious." ADL chose not to appeal the SJC decision to the U.S. Supreme Court. The experiments on the chemical warfare were halted and, subsequently, the agents were transported out of the city.

GENETIC RESEARCH AND CHEMICAL WARFARE AGENTS: CONTRASTING ISSUES

To many observers, the ADL affair conjures up memories of the recombinant DNA (rDNA) controversy that took place in Cambridge in 1976. There are similarities, but equally important are the differences between the two episodes. Nine years ago, the Cambridge City Council was confronted by a scientific community polarized over the issue of the safety of gene-splicing research. To resolve the local controversy, the council created a committee called the Cambridge Experimentation Review Board (CERB). As in the conflict over chemical weapons research, the event that precipitated local concern in the rDNA episode was the construction of a laboratory designed for hazardous experiments. Basic research in molecular genetics was at issue. In contrast, the testing done at ADL involves applied research. It is designed with a particular end-product in mind, i.e., detection kits for nerve agents, or methods of detoxifying chemical weapons. The salient comparisons between the two episodes are outlined in Table 9.3.

The grassroots public reaction to the testing of chemical warfare agents was considerably more intense than the response of the Cambridge non-academic citizenry to the genetic debate. However, the response by public officials to both controversies was about the same. In the genetics controversy, scientists brought the issue to the attention of the city council. Their concern about the postulated risks of gene-splicing research was a critical factor in convincing the council to take action. The issues rDNA research were obscure and esoteric to members of the council, whereas experiments with chemical warfare agents are much more comprehensible to the ordinary citizen. Since such agents are designed as instruments of death, the hazards of these agents are not hypothetical or mysterious. During the rDNA debate much was un-

TABLE 9.3. Comparisons and Contrasts in Debates Over Genetics Research and Testing of Chemical Warfare Agents in Cambridge, Massachusetts.

Category of Issue	Genetics Research (1976)	Chemical Weapons Research (1984)
Type of Research	New technique in molecular genetics; basic science	Applied chemical-engineering research
Origins of Controversy	Initially national in scope and centered within the scientific community	Local in nature and centered on a city and two towns
Origins of Local Involvement	Newspaper story about plans for renovation of a Harvard lab for high containment genetic experiments	Newspaper story on newly renovated lab for testing chemical warfare agents
Nature of Risks	Hypothetical; possibility of creating a pathogen from mixing genetic information	Proven hazards of chemical warfare agents; main problem is containment
City Response	Public hearing; Call for a good-faith 3-month moratorium on certain types of gene-splicing experiments; Established citizens panel—8 members chosen with ethnic, m/f, racial mix	Public hearings; Call for a moratorium on testing nerve & blister agents; Convened science-citizens—15m/1f, no members panel of 16 ethnic, racial mix Emergency ban issued by health commissioner
Response to City Council Action	Universities accept moratorium on research	ADL seeks court order restraining city ban on testing chemical warfare agents
Outcome of Review Process	Research can continue with some additional safeguards; ordinance recommended to cover all rDNA research	Testing of chemical warfare agents deemed inappropriate; it should not continue; ordinance recommended covering use of supertoxins for chemical warfare agents
Legal Process	No legal test of rDNA ordinance or city moratorium on research	Legal test of city directive banning use of chemical warfare agents
Community Involvement	Primarily from academic sectors; no grassroots organizing; some organized opposition from young scientists, Ph.D. candidates, and post-docs	No community groups organized at the early stages; some community activism begins after SAC report is released; intense organizing in Oct-Dec. 1984

known; for example, few of the postulated risk scenarios had been tested, and none had been confirmed. With respect to chemical warfare agents, however, not only is there an informative literature about their toxicological properties, but there are reliable models that describe how those agents would behave when released into the environment. Moreover, past accidents involving nerve agents provide useful information about risks.[21]

Another striking difference in the two controversies is in the response to the city's action by the research institutions involved. During the gene-splicing debate, both Harvard and MIT accepted a good-faith moratorium on certain types of experiments until the city could complete its assessment of the risks. In contrast, when ADL was asked to accept a moratorium on its research with chemical warfare agents, it refused. The company initiated litigation as soon as the commissioner of health issued a cease-and-desist order.

The gene-splicing moratorium applied only to a restricted class of experiments, and the impediment to research in Cambridge was minimal. The research affected by the moratorium was of a basic nature, funded primarily by NIH. The research ban affecting ADL was restricted to a group of experiments, namely, those involving the use of five chemical warfare agents. But unlike the genetic experiments, ADL's research on chemical warfare agents is more typical of engineering work than applied science. As a consequence, scientists did not view the city's research ban as a threat to scientific inquiry. No scientists or R&D companies came to the side of ADL in a public forum.

CONCLUSION

This case illustrates the exercise of power by a local government to restrain federally-funded research in a private facility. The salient focus here is the shared powers of federal and local jurisdiction to protect public health and safety. The right of a local jurisdiction to impose limits on R&D activities involving highly toxic substances is protected when the following conditions are met: (1) Congress has not explicitly preempted such activities, (2) the actions taken do not thwart the federal government from exercising its functions, and (3) there is reason to suspect that the research may have an adverse impact on public health or safety. The response to potential or actual risks must not be arbitrary and capricious.

Following Loren Graham's taxonomy of public concerns over science and technology,[22] testing of chemical warfare agents fits most appropriately in the category "accidents in science." Certainly that was the basis upon which the city acted. But just as in the rDNA controversy, where there were underlying issues such as ethical problems with genetic engineering, the testing of chemical warfare agents also carries with it concerns other than public health hazards.

During their deliberation, members of the Cambridge Scientific Advisory Committee discussed the ethics of research with chemical warfare agents. Some individuals were suspicious of the putative values behind the research. ADL described the research as fundamentally humanitarian and strictly a defensive nature. But taken in the context of other national trends, such as increased spending for chemical warfare programs and military plans to restockpile the U.S. chemical weapons' arsenal, some SAC members were skeptical about the role ADL's research played in the military total picture. It is quite likely that if the research had been considered unambiguously humanitarian, both the city council and the citizen-science advisory committee would have approached the issue differently. But this research is viewed as neither basic nor neutral in the current political landscape. Furthermore, it is shrouded in secrecy and cloaked in military euphemisms that offend people's sensibilities. The planning and construction of the ADL laboratory for this research was also kept secret for at least a year after it was conceptualized. The type of research planned for the facility became public when it was no longer possible for ADL to obtain promises of confidentiality from local officials. Finally, some SAC members did not look favorably upon the idea that DOD both funds the research and also regulates the use of the chemical warfare agents. Cambridge passed its own recombinant DNA ordinance when it considered the dual roles of the NIH as both promoter and regulator of genetics research to be in conflict. The combined effect of these factors made the type of research undertaken at ADL particularly vulnerable to regulation by the City of Cambridge.

While local control of DOD-sponsored chemical weapons research at a private firm seems far removed from academic science, there are some potential points of intersection. First, universities may accept classified research involving chemical warfare agents. Second, there are chemicals found in university warfare agents. Second, there are chemicals found in university laboratories with toxicities equal to or greater than the chemical warfare agents. When concentrations and volumes

of these chemicals are factored into a risk assessment, a local community may find a compelling case to regulate their use in research.

The control of scientific research, whether publicly or privately funded, whether in academia or private industry, is still under negotiation.[23] The regulation of supertoxic chemicals is the latest in a series of federal and local interventions into science, joining human and animal experiments, fetal research, gene splicing, and control of radioactive materials. Each of these cases establishes a delicate balance point between the autonomy of the research community and the social accountability of science and technology. The negotiated balance for research with supertoxins, called into question by the City of Cambridge, is very much in flux.

NOTES

1. Stephen Hilgartner, "The Binary Weapons Controversy," in *Controversy: The Politics of Technical Decisions*, ed. Dorothy Nelkin, 143–58.

2. U.S. Army, Contract to Arthur D. Little, Inc., No. DAAK11-82-C-0065 (22 Aug. 1983). The contract objectives include developing methods for increasing the sensitivity of detection tests for chemical warfare agent testing kits.

3. A.M. Reidy, "A. D. Little Toxic Chemical Testing Surprises Town," *Arlington Advocate* 111 (20 Oct. 1983): 1, 26.

4. Ibid.

5. Paul Hirshon, "Arthur D. Little Opens High Security Lab in Cambridge to Test Hazardous Chemicals," *Boston Globe*, 20 Oct. 1983.

6. Sheldon Krimsky, "Local Initiatives for Regulation," in Krimsky, *Genetic Alchemy* (Cambridge: MIT Press, 1982), 295–311.

7. Melvin Chalfen, commissioner of health and hospitals, City of Cambridge, "Order on the testing, storage and transportation of chemical nerve and blister agents" (13 Mar. 1984).

8. TRC Environmental Consultants, Inc., *Community Risks from Experiments with Chemical Warfare Agents at Arthur D. Little*, Project No. 2631-N81, Hartford, Conn. (5 June 1984).

9. See, for example, Sheldon Krimsky, "Social Risk Assessment and Group Process," in *Group Decision Making*, ed. Walter C. Swap, 151–80 (Beverly Hills: Sage, 1984); and Harvey Brooks, "The Resolution of Technically Intensive Public Policy Disputes," 39–50.

10. Sheldon Krimsky, "A Citizen Court in the Recombinant DNA Debate," *Bulletin of the Atomic Scientists* 34 (Oct. 1978):37–43.

11. Social and cultural aspects of risk assessment are discussed in Mary Douglas and Aaron Wildavsky, *Risk and Culture* (Berkeley: Univ. of California Press, 1982); and William Lowrance, *Of Acceptable Risk* (Los Altos, Calif.: William Kaufmann, 1976).

12. Matthew Meselson and J. P. Robinson, "Chemical Warfare and Chemical Disarmament," *Scientific American* 242 (Apr. 1980):38–47.

13. TRC Environmental Consultants, *Community Risks*, 1.

14. Baruch Fischhoff, Paul Slovic, and Sara Lichtenstein, "Lay Foibles and Expert Fables in Judgment about Risk," *American Statistician* 36 (Aug. 1982): 240–55.

15. U.S. Army, contract to Arthur D. Little.

16. For a discussion of the toxicological properties of chemical warfare agents, see John Cookson and Judith Nottingham, *A Survey of Chemical and Biological Warfare* (New York: Monthly Review Press, 1969).

17. The measurements of LD50 toxicity are in units of either mg-min/m^3 (vapor inhalation) or mg/kg (intake in liquid or solid state). Cambridge Scientific Advisory Committee, "Comparative Risks Subcommittee report," *Report to the City Manager* [on testing of chemical warfare agents at Arthur D. Little, Inc.], Sept. 1984.

18. Ibid.

19. Ibid.

20. Robert J. Hallisey [Superior Court Judge of Massachusetts], *Memorandum of Decision on Severed Issue*, Arthur D. Little, Inc. v. Melvin H. Chalfen, Civil Action, 84–1529, 13 Dec. 1984.

21. In March 1968, VX leaked from a F4 Phantom jet at the Dugway Proving Ground in Utah. The cloud of VX was carried twenty miles and killed an estimated six thousand sheep. See S. Murphy, A. Hay, and S. Rose, *No Fire, No Thunder* (New York: Monthly Review Press, 1984), 17.

22. Loren R. Graham, "Concerns About Science and Attempts to Regulate Inquiry," *Daedalus* 107 (Spring 1978): 1–21.

23. Dorothy Nelkin, "Threats and Promises: Negotiating the Control of Research," 191–209.