Appendix 9A. Risk assessment of terrorism with chemical and biological weapons

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I. Introduction

In the 1990s terrorism became a major security concern and several international cooperative efforts to combat it were launched.[1] With the 1994 and 1995 releases of the nerve agent sarin by the Japanese religious cult Aum Shinrikyo terrorism made a qualitative leap: for the first time a terrorist organization had discharged a so-called weapon of mass destruction.[2] While some analysts had predicted this development, the reasons why terrorist organizations should resort to chemical and biological weapons (CBW) remain unclear. Most studies focus on the potential consequences of such an attack. Relatively small amounts of chemical or biological (CB) warfare agents are claimed to be able to produce huge numbers of casualties—according to some estimates, hundreds of thousands. Because of the immensity of the envisaged consequences the political motives for such terrorist attacks appear inexplicable. Nevertheless, many studies do not view the terrorist interest in CBW as abnormal because it corresponds with increases in the lethality of individual terrorist attacks, the emergence of new terrorist organizations with vague or non-existent ideologies, and the diffusion of scientific knowledge and technological skills. The reasons why the Aum Shinrikyo sarin attacks produced relatively few casualties, why the cult was unable to produce a viable biological warfare agent or why such events did not occur earlier are currently not or only unsatisfactorily explained.

This appendix offers a multidisciplinary analysis of the factors that contribute to or inhibit the acquisition of CBW by terrorist organizations and the way these factors may influence the consequences of an attack with such agents. There are many possible scenarios—with varying degrees of plausibility—involving the release of toxic substances or pathogens by terrorists. They include tampering with food using commercially available poisons, sabotage of storage facilities for harmful chemicals, economic terrorism such as the release of pathogens with the aim to destroy crops or kill or injure livestock (rather than people), the release of lethal agents in order to cause indiscriminate casualties, and so on. In a climate of fear even hoaxes or the threat of the use of toxicants or pathogens may achieve the terrorists' goals. This analysis focuses on one scenario: the domestic development, manufacture and use of highly

[1] The United Nations General Assembly adopted the International Convention for the Suppression of Terrorist Bombings on 9 Jan. 1998. A proposal to create a NATO Centre for Weapons of Mass Destruction was also made in 1998. These and other international initiatives are discussed in Zanders, J. P., French, E. M. and Pauwels, N., 'Chemical and biological weapon developments and arms control', *SIPRI Yearbook 1999: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 1999), pp. 593–95; and in chapter 9 in this volume.

[2] Stock, T., Haug, M. and Radler, P., 'Chemical and biological weapon developments and arms control', *SIPRI Yearbook 1996: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 1996), pp. 701–704; and Zanders, J. P., Eckstein, S. and Hart, J., 'Chemical and biological weapon developments and arms control', *SIPRI Yearbook 1997: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 1997), p. 467.

lethal chemical or biological agents (such as sarin or anthrax) by a terrorist organization, which has the potential to cause mass casualties. (It does not address scenarios of states transferring CBW to such groups.) Section II defines CB terrorism and provides a historical overview of the phenomenon. Section III investigates the types of terrorist organizations that are most often associated with CB terrorism and criminality and assesses the likelihood of their developing such weapons. The processes involved in the sub-state proliferation of CBW and the prerequisites for initiating and sustaining a significant CBW programme are examined in section IV. Section V models the release of anthrax and sarin in realistic terrorist scenarios and assesses the consequences. Section VI presents the conclusions.

II. Understanding chemical and biological terrorism

In September 1984 the Rajneesh religious cult poured a solution containing *Salmonella typhimurium*, a common cause of food poisoning, in the salad bars of several restaurants in The Dalles, Oregon, causing 751 people to become ill. The attack was part of a plot to prevent the re-election in November of two Wasco County Court Commissioners, who were hostile to the cult. The Wasco County Court was blocking the cult's plan to expand the village it had founded three years earlier. It is believed that the cult carried out the trial food poisoning to determine whether it was possible to keep Wasco County voters at home on election day owing to illness. In October, however, the cult realized that the attempt to take over the county would fail and no additional attacks were conducted.[3]

On 20 March 1995 Aum Shinrikyo released sarin in the Tokyo underground system. Thirteen people died, and there were more than 5500 other casualties. Although it ostensibly was preparing CB warfare agents for 'Armageddon', the cult used the sarin to prevent police raids on its premises. On 27 June 1994, Aum Shinrikyo had conducted a less publicized sarin attack in the town of Matsumoto, resulting in 7 deaths and injuries to 600 people. That attack was directed against a dormitory housing judges who were expected to rule against the cult in a land dispute.[4]

Defining chemical and biological terrorism

The above cases are instances of the indiscriminate release of pathogens and toxic chemicals for terrorist purposes. Terrorism is a complex social phenomenon because its causative factors, nature and goals and the identity of the perpetrators vary depending on the epoch or society under consideration.[5] Generally, terrorism is an

[3] Carus, W. S., 'Bioterrorism and biocrimes: the illicit use of biological agents in the 20th century', Working Paper, Center for Counterproliferation Research, National Defense University, Washington, DC, Aug. 1998 (Mar. 1999 revision), pp. 57–66; Carter, L. F., *Charisma and Control in Rajneeshpuram: the Role of Shared Values in the Creation of a Community* (Cambridge University Press: Cambridge, 1990), pp. 201–27; and Török, T. J. *et al*., 'A large community outbreak of salmonellosis caused by intentional contamination of restaurant salad bars', *Journal of the American Medical Association*, vol. 278, no. 5 (Aug. 1997), pp. 389–95.

[4] Stock, Haug and Radler (note 2); and Tu, A. T., Untitled paper delivered at Chem-Bio '98: Combating the Terrorist Threat, organized by Jane's Information Group, Washington, DC, 6–7 Oct. 1998.

[5] Clutterbuck, R., *Terrorism in an Unstable World* (Routledge: London, 1994); Jervas, G. (ed.), *FOA Report on Terrorism* (Swedish Defence Research Establishment (FOA): Stockholm, June 1998); Jervas, G. (ed.), *NBC-Weapons and Terrorism: Two Foreign Contributions and Four Swedish Views* (Swedish Defence Research Establishment: Stockholm, Oct. 1998); Roberts, B. (ed.), *Terrorism with Chemical and Biological Weapons: Calibrating Risks and Responses* (Chemical and Biological Arms Control

extra-legal activity that uses or threatens to use premeditated violence to instil chronic fear in a victim in pursuit of strategic goals specified by the perpetrator. The types of terrorism vary depending on motive, function, effect, nature of the violence and mode of combat or strategy. On the surface, it appears that both the Rajneesh and Aum Shinrikyo cults resorted to CB terrorism to thwart attempts by law enforcement officials to interfere with their activities. However, the deeper motivations and intended outcomes were fundamentally dissimilar, which contributed to important differences in their preparations for CB terrorism and agent selection. Such differences are significant when assessing the threat and consequences of CB terrorism.

Terrorism with CB materials involves the use of a toxic substance or pathogen. Despite the fact that the nature and goals of the terrorist activity may differ considerably between two periods, terrorism with CB materials has been practised throughout history and in all types of civilization.[6] Its use has always been limited, however, because only a few people have had access to such substances and possessed the knowledge to use them. Chemicals and pathogens were used in both world wars for assassinations and sabotage.[7] Since World War II 'poison weapons' have been mostly associated with the intelligence services of certain countries.[8] Common to most attacks with CB materials is the clear mission-oriented purpose of the attacks and the discriminate use of the poisonous agents. This direct goal–instrument relationship may explain, in part, why no 'mass destruction' has resulted from such attacks.

Since the sarin attacks in the Tokyo underground system, much attention has been paid to a subset of CB materials: the chemical and biological warfare agents. These weapons are toxic chemicals or pathogens designed, developed and selected by the military to support certain missions established in the military doctrine of a state. Chemical warfare agents represent a compromise in terms of military utility:

1. A presumptive agent must not only be highly toxic, but also 'suitably highly toxic' so that it is not too difficult to handle.
2. It must be possible to store the substance in containers for long periods without degradation and without corroding the packaging material.
3. Such an agent must be relatively resistant to atmospheric water and oxygen so that it does not lose its effect when dispersed.
4. It must also withstand the shearing forces created by the explosion and heat when it is dispersed.[9]

Institute: Alexandria, Va., 1997); Stern, J., *The Ultimate Terrorists* (Harvard University Press: Cambridge, Mass., 1999); and Laqueur, W., *The New Terrorism* (Oxford University Press: New York, 1999).

[6] Lewin, L., *Die Gifte in der Weltgeschichte* [Poisons in world history] (Verlag von Julius Springer: Berlin, 1920) details many examples of poisoning for political purposes.

[7] E.g., Wheelis, M., 'Biological sabotage in World War I', eds E. Geissler and J. E. van Courtland Moon, *Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945*, SIPRI Chemical & Biological Warfare Studies no. 18 (Oxford University Press: Oxford, 1999), pp. 35–62; and Bojtzov, V. and Geissler, E., 'Military biology in the USSR, 1920–45', eds Geissler and van Courtland Moon (note 7), p. 163.

[8] Some recent cases are described in Zanders, J. P. and Hart, J., 'Chemical and biological weapon developments and arms control', *SIPRI Yearbook 1998: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 1998), p. 481; and Zanders, French and Pauwels (note 1), pp. 583–85.

[9] *Chemical Weapons: Threat, Effects and Protection*, FOA Briefing Book no. 16 (Swedish Defence Research Establishment: Sundbyberg, Sweden, 1992), p. 20.

In the past the military have had several types of chemical warfare agent at their disposal and an agent appropriate to the mission has been selected on the basis of volatility versus persistency, and lethality versus incapacitation. Candidate biological warfare agents have similarly been selected on the basis of a compromise between pathogenicity, survivability of the agent after release and controllability. Military biological warfare programmes have included lethal, incapacitating and anti-crop agents. This mission-oriented selection process has shaped the direct goal–instrument relationship. The compromise with respect to the selection of the agents in terms of their military utility may have made CB warfare agents less attractive to terrorists.

Some potential CB warfare agents (sarin, VX, anthrax, botulinum toxin, and so on) are among the most lethal substances that exist. Central to the catastrophic CB terrorism scenarios resulting in mass casualties is the focus on toxicity or pathogenicity. However, the manufacture of large batches of such agents poses technological and organizational problems. Terrorists would also have to overcome difficulties in the weaponization (i.e., preparing the agent to be delivered as a weapon) and dissemination of these agents. Aum Shinrikyo managed to overcome several of these hurdles, but the impediments are such that few other terrorist organizations would be able to replicate its armament programme in future.

III. Profiles of terrorist organizations with interest in CBW

Especially since the late 1960s several individuals or non-state groupings—autonomous organizations without formal connection to a government—have shown interest in CB materials.[10] According to the Swedish Defence Research Establishment (FOA) database of such incidents, most of the known actors behind CB-related incidents cannot be linked to a state sponsor of terrorism or to a more ‘established’ terrorist organization. Instead, they are what are called the ‘new terrorists’.[11] The only cases of large-scale terrorist use of CB agents have involved the two religious cults discussed above. Right-wing extremists, animal rights activists and single individuals are responsible for a considerable number of the remaining incidents.

General aims

Proselytization is a major aim of all religious cults, and they often attract a large following of members and sympathizers who contribute to the material wealth of the

[10] A 1995 survey of CB terrorism lists over 24 instances of terrorist use or threat of use of biological materials and a considerable number of threats and incidents involving poisonous substances. The cases range from apparently empty threats to reports of acquisition and actual discovery of possession. Nevertheless, many of the listed cases could arguably be classified as attempts at homicide, suicide or criminal extortion motivated by financial rather than political gain. Purver, R., ‘Chemical and biological terrorism: the threat according to the open literature’, Canadian Security Intelligence Service (CSIS), Ottawa, June 1995, URL <http://www.csis-scrs.gc.ca/eng/miscdocs/tabintre.html#preface>, esp. sections ‘Biological terrorism’ and ‘Chemical terrorism’. The recent spate of hoaxes in the USA has significantly increased the number of cases. For an overview, see Carus (note 3). These events should not be counted as incidents of CB terrorism because live CB agents were not involved.

[11] The FOA database places such incidents into 1 of 6 categories: (*a*) threats of use of CB agents or hoaxes without actual possession; (*b*) manufacture or purchase of CB agents but no actual use; (*c*) claimed, but not confirmed, possession; (*d*) confirmed possession; (*e*) attempt but failure to use CB agents (no casualties for different reasons); and (*f*) successful use (verified casualties). It contains approximately 350 incidents from 1969 to 1999 as well as a few earlier ones and is currently supported by approximately 1000 documents, reports, newspaper articles, etc.

cult and its leadership.[12] Some cults attempt to convert their financial strength into political power in order to consolidate their position and acquire formal legitimacy or to have some of the cult's principles adopted by the broader society. Expansion may also bring some cults into conflict with the local population and authorities, and via the electoral process they may try to influence decisions in their favour.

Many cults use physical and psychological violence within the cult, which in some cases has led to collective suicide. Cults that have a tendency to use violence internally may also use physical violence against outsiders if they feel threatened. As demonstrated by the Rajneesh and Aum Shinrikyo cults, the greater the perceived existential threat, the greater the chance that the cult will resort to extreme measures. Isolation from society also produces paranoid projections of the external threat to the cult. Destructive cults, such as Aum Shinrikyo, particularly tend to become more closed, guarded and isolated from the outside world when the perceived threat increases.[13] A cult that is interested in acquiring CB agents is likely to be violent.

The 'patriot organizations' consist of Christian identity movements,[14] branches of the Ku Klux Klan, militia groups and neo-Nazis. They are mostly based in the United States, but several are also active in Europe. They became prominent in the 1990s as the left-wing terrorist organizations declined in strength. Most of them are anti-Semitic, anti-government and xenophobic and wish to preserve the national and cultural values of their nation. There may be major ideological and social differences among the members of these organizations and the issues which they perceive as important may vary. Such differences are particularly noticeable between European and US groups.[15] There is also a strong resentment of state organs, politicians, the police force and other 'opponents', although it is expressed less clearly outside the USA. Right-wing violence is on the increase.

Animal rights activists wish to influence behaviour towards animals in captivity. In pursuit of their goals they may conduct acts of sabotage against research institutes or companies that trade products based on animal experiments with the intent of damaging them or their reputation. Since the mid-1980s some animal rights activists have threatened to use toxic substances or have claimed that they have used such substances. Some instances of tainted foodstuffs in shops have been confirmed. Animal rights activists are most prominent in North America and Western Europe.[16]

The loner often appears to be an ordinary citizen with an extraordinary idea of how to achieve his goal. In some cases the motive for his attack may be hate or revenge directed towards an individual, a person in authority or a company. Attacks on com-

[12] A cult is a religious grouping with a deviated doctrine of faith, which usually comprises a mixture of elements from different religions. A sect, in contrast, is a side branch of an established religion.

[13] Melin, L., *Kulter: Religiösa kulter och deras ledare, en beskrivning av sex kulter* [Religious cults and their leaders, a description of six cults], (Swedish Defence Research Establishment: Umeå, Sweden, 1997), p. 13 (in Swedish). Destructive cults are characterized by: (*a*) an authoritarian pyramid structure, (*b*) a charismatic or messianic leader, (*c*) deception in recruitment and/or fund-raising, (*d*) physical or psychological isolation from society, and (*e*) use of mind control techniques.

[14] This race-based theology, one of the far right's fastest growing segments, claims that white Christians are the true biblical Israelites. Flynn, K. and Gerhardt, G., *The Silent Brotherhood: Inside America's Racist Underground* (Macmillan: New York, 1989), p. xi.

[15] A detailed comparative description is presented in Laqueur (note 5), pp. 105–26.

[16] The most active groups are the Animal Rights Militia (ARM) and Animal Aid Association (AAA) in Canada and the Animal Liberation Front (ALF) in the UK and Belgium. In 1992–95 there were 5 incidents in Canada. In 1984–97, 8 incidents of alleged food poisoning occurred in the UK. Purver (note 10), pp. 37, 86; 'Thanksgiving turkeys recalled', *The Sun* (Kuala Lumpur), 14 Oct. 1996, URL <http://prn.usm.my/headline/poison/oct96.html#w310>; and Animal Liberation Frontline Information Service, 'Animal rights militia fact sheet', URL <http://www.enviroweb.org/ALFIS/index2.shtml>.

panies are often made by disgruntled employees. In several European cases the motive has been economic extortion directed at a specific company.[17] Other incidents do not appear to have a clear motive.

Structure

Religious cults often have similar structures despite varying religious views. There is always a strict hierarchic organization, and successful cults almost invariably have a strong and charismatic leader who is surrounded by an inner core of loyal followers.[18] Cults are often financially stable because most of them force their followers to donate all their assets when they join. Via the Internet they are able to market themselves, advertise their activities, sell goods and solicit donations. They recruit mostly from the middle or upper classes and often focus their efforts on well-educated young people. Aum Shinrikyo, for instance, recruited many students and researchers from university campuses. The majority of those who joined the Rajneesh cult had graduated from high school or a university.[19]

Patriot organizations are able to draw on broadly based support and sympathy for a variety of issues but are generally less tightly structured than the religious cults, smaller in size (to the point of consisting of one individual) and only loosely connected to each other. They nevertheless share certain traits with religious cults. A strong charismatic figure plays the central role, and some form of the Christian religion is important to most of the patriot associations. In some cases the centrality of religion makes them virtually indistinguishable from some religious cults. They regard the Book of Revelation as a key part of the Bible, and Identity theology, for example, claims that Armageddon is approaching, possibly in the form of a nuclear war.[20] Unlike the cults where the followers, freely or as the result of the use of force, remain with one organization, the members of patriot organizations move between different groups with the same set of values. New groups are formed as a result of internal disagreement or by splitting up established groups and changing the name. Despite the often weak institutionalized connections, right-wing extremists in the USA and several West European countries are linked to each other via computer networks, through which they share and disseminate information. They also use the Internet to solicit funds and sell merchandise. Currently, there is a trend towards the establishment of smaller leaderless cells, organized around an ideology instead of a

[17] Especially in Germany and the UK, the food industry has become a popular target for blackmailing threats. There have been several incidents in which products were poisoned with cyanide and insecticides. The food industry suffered huge losses as it had to recall tonnes of products from the supermarkets. 'German food industries targets of blackmailers', *The Sun* (Kuala Lumpur), 20 Feb. 1998, URL <http://prn.usm.my/headline/poison/feb98.html#w34>; Parkes, C., 'HP responds to the new terrorism: public management of food tampering cases', *Financial Times*, 25 July 1989; and Elliott, C., Langton, J. and Blundy, D., 'How to fight the supermarket terrorists', *Sunday Telegraph*, 30 Apr. 1989.

[18] Some well-known examples are Bhagwan Rajneesh of the Rajneesh cult, Shoko Asahara of Aum Shinrikyo, Jim Jones of the People's Temple, Sun Myung Moon of the Unification Church, Marshall Herff Applewhite of Heaven's Gate and David Koresh of the Branch Davidians.

[19] Latkin, C. A. *et al*., 'Who lives in Utopia? A brief report on the Rajneeshpuram research project', *Sociological Analysis*, vol. 48, no. 1 (1987), p. 76.

[20] E.g., the now dissolved Covenant, the Sword, and Arm of the Lord (CSA) was a violence-prone purveyor of anti-Semitism and racism under the guise of being a church; it soon also became a military encampment of survivalists waiting for Armageddon. Many active organizations are also convinced that a holy racial war is coming, which is, in part, described in the literature popular in these circles. Some of the most popular books are *The Turner Diaries* and the sequel, *Hunter*, by William Pierce; *A Candidate for the Order* by Michael A. Hoffman; and *The March Up Country* by Harold Covington.

leader. These cells are able to plot terrorist attacks with reduced risk of infiltration by law enforcement officials. Like the cults, most patriot organizations are closed to the outside world and have a great sense of external threat.

Animal rights movements also have a weak structural make-up. Actions such as releasing animals from their cages can be carried out by a few people. The animal rights movement asserts that it is leaderless and against a hierarchical order, but it is difficult to verify this claim. In the United Kingdom, at least, some prominent figures seem to broadly direct the movement and, presumably, control a variety of activities. Well-established Internet networks offer instructions on propaganda initiatives or the organization of demonstrations and blockades, advertise future actions, describe the results and often glorify the participating 'warriors'. Although the groups raise money by selling merchandise and soliciting donations, it seems unlikely that they can accumulate significant sums.

A loner is an individual without formal connection to an organization or a person who works without instructions and logistical or financial support from an organization. Nevertheless, according to the FOA database such individuals are responsible for approximately 25 per cent of all incidents involving CB materials; arguably, they pose the greatest challenge to law enforcement officials. If a loner is caught, it is usually because someone has informed the authorities, the loner himself has talked too much or he was caught in the act.[21]

The interest in CB materials

Materially and structurally many cults are capable of undertaking CB programmes, although whether or not they do so will depend on their characteristics and goals. Aum Shinrikyo's failure to win seats in the Lower House of Japan's Parliament in 1990 fuelled its leader's apocalyptic visions, hate towards the government and paranoia. Shortly after the election failure the cult made its first attempts to manufacture biological agents. Aum Shinrikyo set up a complex of chemical factories and biological laboratories over a period of almost five years.[22] Its leader, Shoko Asahara, had long been fascinated by non-conventional weapons, and they played a central role

[21] In 1998 Larry Wayne Harris and an accomplice attempted to buy equipment to test anthrax (which later proved to be a harmless vaccine strain) for $20 million from a businessman who contacted the Federal Bureau of Investigation (FBI). Claiborne, W., 'Two men charged with possessing anthrax', *Washington Post*, 20 Feb. 1998, URL <http://www.washingtonpost.com/wp-srv/digest/nat1.htm>. In 1995 Harris had ordered plague germs from the American Type Culture Collection (ATCC). However, when he called the ATCC because the shipment was delayed he revealed that he was unfamiliar with its procedures. The sales representative contacted the Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia, which in turn informed the FBI. Windrem, R., 'The man who talks too much', MSNBC, 20 Feb. 1998, URL <http://www.msnbc.som/news/145425.asp>.

In 1998, Valeriy Borzov manufactured mustard gas in his Moscow flat but was revealed by a person who knew that offers to sell the gas had been made to various mafia groups by Borzov. Kartsev, A., 'Rysk kemist tillverkade senapsgas i lägenheten', [Russian chemist manufactured mustard gas in his apartment], *Göteborgs-Posten*, 17 Sep. 1998 (in Swedish).

In 1998 Kathryn Schoonover was arrested outside a post office in Marina del Rey, Calif., when she was about to mail more than 100 envelopes containing sodium cyanide in plastic bags and brochures for nutritional and dietary supplements. Apparently, she did not attempt to conceal her activities in the post office. Hastings, D., 'Authorities seek answers on cyanide letter', *Boston Globe*, 25 Aug. 1998, URL <http://www.boston.com/dailynews/wirehtm…thorities_seek_answers_on_cyanide.shtm>.

[22] In addition to the 2 sarin attacks in Matsumoto (1994) and Tokyo (1995), the cult made several unsuccessful attempts to spray botulinum toxin and anthrax from the roofs of trucks and was apparently interested in other pathogens, such as the Ebola virus and Q fever. WuDunn, S., Miller, J. and Broad, W. J., 'How Japan germ terror alerted world', *New York Times*, 26 May 1998, pp. A1, A10.

in his predictions of approaching Armageddon. Ultimately, the cult did not use its chemical weapons in pursuit of its grand visions but to counter direct threats posed by law enforcement officials. Bhagwan Rajneesh, the leader of the Rajneesh cult, did not make apocalyptic statements, but anticipated defeat in an election important to the future of the cult apparently was deemed to justify extreme measures. The cult bought a relatively harmless organism, whose cultivation was not technically difficult, from a medical laboratory.[23] The attack was not planned far in advance as cultivation of the organism reportedly started in late summer 1984 and its dissemination took place in September.[24]

Although the patriot organizations have not yet used non-conventional weapons, there are many indications of a growing interest in such weapons. On several occasions poisons, toxins or infective agents (including cyanide, ricin and typhoid bacteria) have been found in the possession of right-wing extremists.[25] In some instances there have been plans to release the toxicants in the water reservoirs of large cities. If successful, the attacks would have indiscriminately affected the whole population, not just the designated enemies of these groups. Other reports detail attacks or planned attacks with toxic substances against specific targets such as politicians or other individuals, although such operations would be far easier to carry out with firearms (which most right-wing groups possess). So far, most of the patriot organizations that have either manufactured or purchased CB materials have limited themselves to agents that are relatively safe to handle without special precautions such as protective clothing. Most of the reported incidents have only involved plans to use CB agents.

The animal rights activists have acted similarly and have utilized CB materials such as cyanide, rat poison, oven cleaner and mercury. Generally, they have not used these agents against people.[26] Given their structure and limited financial assets, it is difficult to envisage how they could finance the purchase or manufacture of chemical or biological warfare agents. Furthermore, their members are mainly teenagers, who usually lack the knowledge and skill to set up and run a CBW production programme or to carry out a large-scale attack with CBW. There have been no cases of verified possession of chemical or biological warfare agents, but a threat with CBW or an allegation of use can terrorize individuals and negatively affect a targeted company.

Loners have experimented with biological and chemical warfare agents, which could cause large numbers of casualties if employed in sufficient amounts utilizing efficient dissemination technique. Some of the loners who have been involved in terrorist activities have had a university degree in microbiology or chemistry[27] and have experimented with potentially more dangerous agents. A loner can be a threat if he possesses the intellectual, technical and operational skills to select and disperse CB

[23] Carter (note 3), p. 204.

[24] Callister, S. and Zaitz, L. L., 'Sheela, once a roaring, snarling tigress, docile, tamed by court', *The Oregonian*, 23 July 1986.

[25] Campbell, J. K., *Weapons of Mass Destruction Terrorism* (Interpact Press: Seminole, Fla., 1997), pp. 113–15; and Purver (note 10), p. 37.

[26] One incident occurred on 11 Jan. 1999 when 4 animal rights activists threw a corrosive agent at a guard at the Swedish Institute for Infection and Disease Control (SMI) with the obvious intent of injuring him. He was not injured and no motive for the attack has been established. 'Djurrättsaktivister anhållna' [Animal rights activists arrested], *Svenska Dagbladet*, 12 Jan. 1999 (in Swedish).

[27] There are several examples of well-educated loners. Larry Wayne Harris was taking courses in advanced microbiology at Ohio State University. Harris, L. W., 'Bacteriological warfare: a major threat to North America. What you and your family can do defensively before and after. A civil defense manual', 1998, URL <http://norden1.com/~hawkins/civil.htm>. Schoonover claims that she has a background in chemistry. Hastings (note 21). Borzov studied chemistry at Moscow University. Kartsev (note 21).

materials. The likelihood of conducting a 'successful' large-scale release resulting in mass casualties is slim, but a smaller attack can be sufficiently difficult for authorities to handle. Most loners will probably continue to experiment with the less harmful CB materials that are described in underground literature and on the Internet.

CBW hoaxes are another type of terrorist threat. A series of such hoaxes were apparently inspired by the highly publicized 24 April 1997 incident in which a Petri dish supposedly containing anthrax and plague was delivered to the Washington headquarters of the Jewish organization B'nai B'rith.[28] In the latter part of 1998 and throughout 1999 various US organizations and authorities received letters and parcels containing anthrax threats. The fear of terrorist attacks with CB materials has taken on such enormous proportions in the USA that hoaxes are almost as potent a terrorist tool as actual use of the agents. Hoaxes are currently able to close down entire facilities or installations.[29]

IV. Sub-state proliferation: the process of acquiring CBW

In order to judge the likelihood of terrorist attacks with CBW it is necessary to have a clear understanding of the weapon acquisition process from the perspective of the demand side: the terrorist organization. Using the assimilation model, a heuristic device designed for studying CBW armament programmes in countries for which limited information is available on decision-making processes and the structure of armament programmes, it is possible to identify and assess the key parameters in a CBW programme set up by a terrorist organization.[30] There are three main sets of parameters to consider: the material base of the terrorist organization, the tension between norms and threats, and the group strategy and structure.

The material base of the terrorist organization

The material base of a terrorist organization is a key determinant of whether or not it will be able to develop and produce CBW domestically. The material base consists of the organization's physical base and its internal characteristics.

The physical base comprises elements that determine whether the organization will be able to acquire chemical and biological weapons. A terrorist organization has little

[28] United States Fire Administration, *Fire Department Response to Biological Threat at B'nai B'rith Headquarters, Washington, DC*, Report no. 114 of the major fires investigation project, Technical Report Series (United States Fire Administration: Emmitsburg, Md., Apr. 1997), p. 2.

[29] E.g., in Jan. 2000 some 20 letters alleged to contain anthrax were sent to abortion clinics across the USA, forcing them to close certain areas or be wholly evacuated. Associated Press (AP) via Yahoo News, 'Anthrax threat closes Ala. clinic', 3 Jan. 2000, URL <http://dailynews.yahoo.com/h/ap/20000103/us/clinic_threats_2.html>; Seewer, J., AP via Yahoo News, 'More threats to abortion clinics', 4 Jan. 2000, URL <http://dailynews.yahoo.com/h/ap/20000104/us/clinic_threats_4.html>; AP via Yahoo News, 'Anthrax threat closes Ohio clinic', 4 Jan. 2000, URL <http://dailynews.yahoo.com/h/ap/20000104/us/clinic_threats_3.html>; and Jones, T. F. *et al*., 'Mass psychogenic illness attributed to toxic exposure at a high school', *New England Journal of Medicine*, 13 Jan. 2000, pp. 96–100.

[30] Zanders, J. P., 'Tackling the demand side of chemical and biological weapon proliferation', ed. D. Schroeer, *Technology Transfer* (Ashgate Publishing: London, 1999), forthcoming. Regarding the adaptation of the assimilation model for the study of terrorist organizations, see Zanders, J. P., 'Assessing the risk of chemical and biological weapons proliferation to terrorists', *Nonproliferation Review*, vol. 6, no. 4 (fall 1999), pp. 17–34. The model is also explained with graphics in the Internet Educational Module on CBW Non-proliferation, created by the SIPRI CBW Project, the Centre for Peace and Security Studies of the Free University of Brussels and the International Relations and Security Network (ISN), Zurich, URL <http://cbw.sipri.se>.

influence over certain elements. For example, the organization's geographical location and the type of culture in which it is embedded will have a direct bearing on the nature of the organization and its appeal. Aum Shinrikyo enjoyed its greatest success in Japan, where alienated members of the intellectual stratum of society were receptive to mysticism, and in Russia, where many victims of the social disintegration following the collapse of the Soviet Union were similarly seeking solace in various kinds of mysticism.[31] In contrast, the cult was unsuccessful in Germany and the USA despite its efforts (the lack of a strong and charismatic regional leader may have been a contributing factor). Other important components of geographical location for Aum Shinrikyo included the overall level of scientific, technological and industrial development of the Japanese society, the tax exemptions granted to recognized religious organizations (which enabled Aum to amass its considerable assets) and the general hands-off attitude of the Japanese authorities towards religious organizations as a consequence of the religious persecutions before 1945. Some elements of the physical base (e.g., number of members, financial assets, property owned and infrastructure) can be altered by a terrorist organization through targeted policies with great investment of time and resources. Aum Shinrikyo constantly attempted to expand its membership and to extract the largest possible amount of wealth from its members, their families and its sympathizers. The transfer of property rights, including those of companies, was part of the initiation rites of new members of the cult.

The second component of the material base consists of the internal characteristics of the terrorist organization. The organization can relatively easily exploit, manipulate or develop certain of these characteristics to achieve its goals. Its culture may be based on social ideology, apocalyptic or millenarian visions, racial superiority, ethnic nationalism, religious fanaticism, and so on. In the quest to acquire CBW the level of education and training of the members, as well as the science and technology base that they are able to establish, become important factors. Aum Shinrikyo launched repeated recruitment drives to attract promising young scientists and people with needed skills from Japan's leading institutes. These individuals were able to set up the programmes and build the necessary installations. However, in the CBW programmes the reliance on relatively unskilled cult members for the operation and maintenance of the installations contributed to many leaks and accidents. Internal secrecy and dedication to the cause of Aum Shinrikyo in the selection of members to work on the CBW programmes were negative factors, as was Aum Shinrikyo's limited functional specialization. For example, the people in charge of developing the agents were also responsible for developing the dissemination devices. They also executed the attacks, and their lack of experience in operational planning contributed to many mistakes and failures. In an organization the accumulated finances and skills must be transformed into significant levels of economic and industrial development. Success depends on how the organization as a whole is able to optimize its (always limited) resources and prioritize their allocation to meet its goals.

Norms and threats

Norms influence the willingness of the terrorist organization to pursue CBW. However, they form a complex aspect of social interaction and often do not manifest them-

[31] References to Aum Shinrikyo in this section are based on the analysis by Kaplan, D. E. and Marshall, A., *The Cult at the End of the World: The Incredible Story of Aum* (Arrow Books: London, 1996).

selves in an absolute form. The application of a norm hinges on the recognition of the other party as an equal partner. However, for political entities based on religion this may be problematic as authority and sovereignty are derived directly from God. The rules, norms and values which apply to members of the faith do not apply to non-members. Historical analysis reveals that regulations such as the prohibition of the use of poisoned weapons governed the conduct of belligerents of the same faith, but the use of such weapons was permitted against infidels.[32] As evidenced by Nazi Germany and the Japanese biological weapon (BW) experiments in World War II, sentiments of racial and cultural superiority can affect the formulation and application of norms. Several of the terrorist organizations profiled here display similar traits.

This has a double implication for terrorist organizations. First, the norms maintained by the group may differ significantly from those of the broader society. Internal or external constraints that could raise the threshold for acquiring CBW may therefore be non-existent, and the success of the armament dynamic may depend entirely on factors in the material base. Second, because of their convictions the group members may differentiate themselves from the rest of society to such an extent that the elimination of non-members—even on a large scale—can be easily justified. This world view may remove any moral objection against CBW use.

The strength of norms is also directly linked to the nature of the threat. This raises the question of whether an existential threat to a terrorist organization (e.g., a threat which is gradually building and which the group feels it cannot manage) contributes to the erosion of the group's norms. As noted above, the Rajneesh cult and Aum Shinrikyo resorted to the indiscriminate use of biological and chemical agents in response to what they perceived to be an existential threat.

Group strategy and structure

If the leadership of a terrorist organization decides to initiate a CBW armament programmes it must make decisions regarding the allocation of its resources. These decisions, and the nature of the programme, will depend on the organization's goals and the way it is structured. A loosely structured, amorphous group with little central guidance or an organization structured in small cells for maximum security (e.g., patriot organizations, animal rights groups and loners) will find it harder to set up a CBW armament programme than a vertically structured, highly integrated and ideologically uniform group, such as Aum Shinrikyo or the Rajneesh cult. On the other hand, any organization will be constrained by its material base and will have to import many of the components and technologies necessary for a CBW armament programme. For a terrorist organization this can be a formidable challenge. A state actor enjoys freedom from prosecution, can buy technologies abroad and hire foreign

[32] E.g., in his work published in the late Middle Ages, *Von allerlei Kriegsgewehr und Geschütz* [On types of gun and cannon], Wulff von Senftenberg expressed reservations about his own proposals for 'poisonous fumes' if used against Christians, but had fewer misgivings regarding use against the 'godless Turks' or other infidels. Meyer, J., *Der Gaskampf und die chemischen Kampfstoffe* [Gas warfare and chemical warfare agents] (Verlag S. Hirzel: Leipzig, 1925), p. 277; and Jones, D. P., 'The role of chemists in research on war gases in the United States during World War I', PhD diss., University of Wisconsin, 1969, p. 40. International norms and laws emerged in the Westphalian state system because the sovereign territorial states recognized each other as equal systemic units that could enforce an international agreement within the territory of their jurisdiction. E.g., the first known international agreement on the prohibition of the use of poison weapons was concluded in Strasbourg between France and the German Empire in 1675, 27 years after the Peace of Westphalia. Officers were to exemplarily punish the person who possessed or used such implements. Lewin (note 6), p. 563.

specialists. In contrast, a terrorist organization must work in secrecy because of the threat that law enforcement officials may raid its facilities. This makes it impossible for the organization to hire an outside specialist or technician for a limited time to solve a particular problem. Instead the organization must recruit and convince such an individual of the justness of its cause. The degree of dependency on external skills and technologies is also a function of the complexity of the weapon system which the leaders of the group have decided to acquire.

The influence of the various parameters can be illustrated by comparing the activities of the Aum Shinrikyo and the Rajneesh cults. The Rajneesh cult was responding to a rapidly evolving crisis that threatened its continued existence in Oregon. The cult therefore had no time to develop its material base. Because its goal was limited in scope and time (i.e., influencing the outcome of local elections) it could opt for an incapacitating rather than a lethal agent, thereby decreasing the technical demands on the laboratory. The choice of a salmonella strain also simplified the dissemination as a liquid solution could be poured on food in public places. In addition, this reduced the need for functional specialization in the cult. The straightforward goal–instrument relationship also meant that as soon as the cult realized that it would not attain the desired outcome it terminated its programme.

Aum Shinrikyo's plans were more ambitious: it sought to destabilize Japan and to eventually take over all governmental functions. To this end, the cult pursued a broad set of instruments, including conventional weapons, an earthquake machine, a laser gun and a nuclear device as well as CBW. While many accounts of Aum Shinrikyo's activities have focused narrowly on the CBW programmes, the important point is that the cult actively sought a broad range of weaponry. This had two major implications.

First, the element of priority resource allocation by the cult leadership became an important element of the CBW armament dynamic. The cult spread its huge financial assets and other resources over several weapon programmes as it tried to become self-sufficient in every area. Each programme placed increasing demands on manpower, the ability of the offices outside Japan to purchase the required technologies, and so on. Had the cult concentrated its resources on CBW it might have achieved greater success in terms of creating a viable biological weapon or larger production batches of higher-quality chemical warfare agents. Ultimately, the cult had some success in a few of its weapon programmes. Second, there was no rationale for the CBW programmes without the other weapon programmes. Chemical and biological weapons could conceivably have played a role in destabilizing Japan, but they would have been insufficient to establish the cult's own form of governance. A large-scale release of chemical or biological warfare agents in isolation would have been met by a massive response from the law enforcement authorities (as happened after the Tokyo underground attack), possibly leading to the demise of the organization. In other words, it was impossible in practice for Aum Shinrikyo to concentrate its resources on CBW alone. Because of its grand strategy the leadership had to spread its large, but limited, resources over various programmes. Together, the various constraints and conflicting imperatives led to a reduction of the quality and quantity of the chemical agents and to failure with respect to the biological agents. In summary, the factors that contributed to the establishment of the CBW programmes were also responsible for Aum Shinrikyo's limited success.

V. Assessing the consequences of the release of CBW

The dissemination patterns for chemical and biological warfare agents in a terrorist attack differ in many respects from those in military operations. Utilizing FOA models for the dispersion of the chemical and biological warfare agents used, two realistic scenarios have been developed.[33]

The first scenario assumes that, at a shopping centre, a cult like Aum Shinrikyo has disseminated a type and quantity of anthrax similar to that which was accidentally released from a military microbiology facility in Sverdlovsk in 1979.[34] The scenario demonstrates that, given realistic conditions, several hundred people concentrated in a relatively narrow area would be infected but not necessarily killed. This contrasts with the many predictions that such use would result in mass casualties over large areas.

The second scenario is modelled on the 1994 Matsumoto attack by Aum Shinrikyo, but some parameters have been optimized (e.g., the quality of the sarin and the single point of release). Nonetheless, the casualty patterns observed at Matsumoto and Tokyo—few fatalities, a high proportion of other casualties and a significant number of exposed individuals who displayed no physiological symptoms—may, in fact, be typical of a terrorist release of sarin.

The scenario of a terrorist attack with a biological warfare agent

The dissemination of biological warfare agents into the air can cause numerous casualties even far from the release point. However, virulent strains of the relevant microorganisms would need to be used, and technical skills and equipment for culturing and storing the organisms as well as the appropriate technology to release the agent efficiently would also be required. In order for the aerosol particles to be able to reach the non-ciliated alveolar region in the lungs, the particle size has to be less then 10 μm and preferably around 5 μm.[35] In theory, terrorists can cause massive casualties with rather limited means. However, in practice, they may experience great difficulty in acquiring and growing virulent strains of the pathogens because of a lack of technical skills and equipment. Aum Shinrikyo, for instance, sprayed botulinum toxin over Tokyo several times in 1990 and conducted similar activities with anthrax spores in 1993 without any known effects. Japanese authorities later disclosed that the cult had used a relatively harmless anthrax vaccine strain and that the aerosolizer was not sufficiently efficient.

The following scenario assumes that a terrorist organization comparable to Aum Shinrikyo has overcome any technical hurdles and is able to aerosolize an amount of respirable anthrax spores comparable to that accidentally released in Sverdlovsk. In the scenario, the 4 billion respirable anthrax spores are released over a 15-minute interval from a road 15 metres above street level. The south-westerly wind has a

[33] In order not to provide potential terrorists with precise predictions, the scenarios utilize published data about past events. Certain modelling parameters have been wholly or partially excluded. The results nevertheless present a true picture of the potential consequences of the release of chemical or biological warfare agents.

[34] In that incident in the former Soviet Union an estimated 4 billion respirable spores became airborne and approximately 65 people died. Meselson, M. *et al*., 'The Sverdlovsk anthrax outbreak of 1979', *Science*, vol. 266 (Nov. 1994).

[35] The aerosol particles may consist of different amounts of spores: the more spores, the larger the aerosol particle.

speed of approximately 4.5 metres per second at a height of 10 metres. The target is a large shopping mall in central Tokyo.

Even with relatively advanced spray equipment the diameter of most of the released aerosol particles would be larger than 10 μm. It is therefore reasonable to assume that about 5 per cent of the spores released by a terrorist group would be of respirable size. In order to generate 4 billion respirable spores, a total of approximately 80 billion respirable spores would have to be released. Such an amount can easily be suspended in a few litres of solution. With optimal distribution and inhalation this number could infect approximately 4–5 million people (the infective dose ID_{50} is assumed to be 8000–10 000 inhaled spores).[36] However, the estimate is of limited value since only a small fraction of the released spores would reach people because of the dispersion in the atmosphere. An even smaller fraction of the amount would be respirable.

The dispersion, inhalation and deposition patterns have been calculated using a stochastic particle dispersion model.[37] In figures 9A.1–9A.3 the course of the dispersion of the calculated aerosol cloud is shown at 2, 6 and 18 minutes after the release of the anthrax spores. The figures illustrate typical dispersion patterns and show relative concentrations (the darker the shading, the higher the concentration). The irregularities (i.e., the isolated pockets) are patterns that change rapidly during the passage of the aerosol cloud.

It is likely that individuals would spend more time than the 15 minutes of the agent release in the shopping mall, and as many as 20 000–30 000 persons could be exposed to the cloud of spores. Figure 9A.4 shows the dose (i.e., the number of spores that a person standing still at one point during the entire passage of the aerosol cloud would receive and retain in the lungs). The respiration rate was set at 25 litres per minute, a typical value for moderate physical exercise. Although most people would not remain in the same place for 15 minutes, figure 9A.4 nonetheless depicts a conceivable result of the release. In their study of the anthrax release at Sverdlovsk, Meselson and his co-authors suggest a dose–response relation for inhalation of anthrax spores based on an LD_{50} value of 8000 and a geometric standard deviation of 27.[38] For anthrax it is possible to assume that an infective dose (ID) can be substituted for the lethal dose (LD). Using this relation, a rough estimate of the probability of infection at the different doses can be calculated (table 9A.1).[39] The curve of the estimated dose–response relation is illustrated in figure 9A.4.

[36] ID_{50} represents the number of spores which, if inhaled, yields a 50% risk of infection.

[37] Schönfeldt, F., *A Langevin Equation Dispersion Model for the Stably Stratified Planetary Boundary Layer*, FOA-report FOA-R--97-00523-862--SE (Swedish Defence Research Establishment: Umeå, Sweden, 1997). In a particle dispersion model, a certain amount of mass is represented by a tracer 'particle'. A large number of particles are released and move in the wind and turbulence fields. By collecting the particles in boxes estimates of the concentration can be made. E.g., 10 particles/m^3 equal 100 mg/m^3 if each particle represents 10 mg. In the current scenario each particle stands for a certain number of micro-organisms.

[38] Meselson *et al*. (note 34). LD_{50} represents the number of spores which, if inhaled, yields a 50% risk of death.

[39] This estimate is based on a small amount of data from experiments on monkeys.

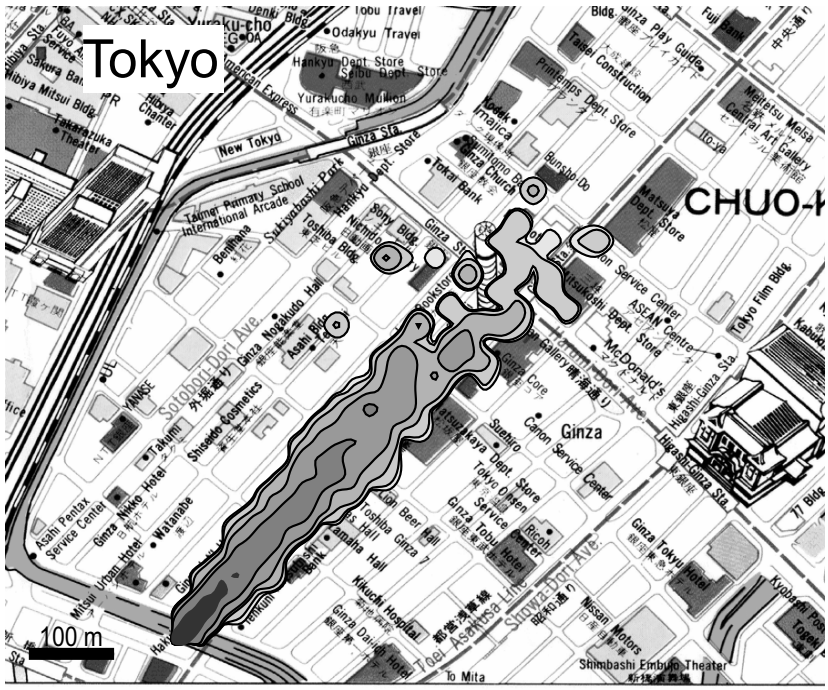

Figure 9A.1. Relative concentration pattern 2 minutes after release
Source: Swedish Defence Research Laboratory (FOA), Umeå, Sweden.

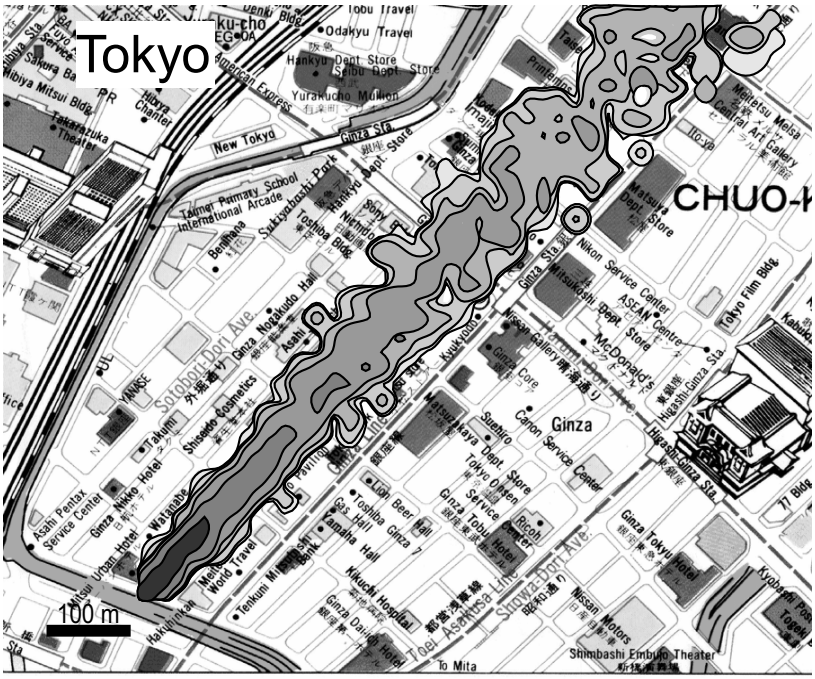

Figure 9A.2. Relative concentration pattern 6 minutes after release
Source: Swedish Defence Research Laboratory (FOA), Umeå, Sweden.

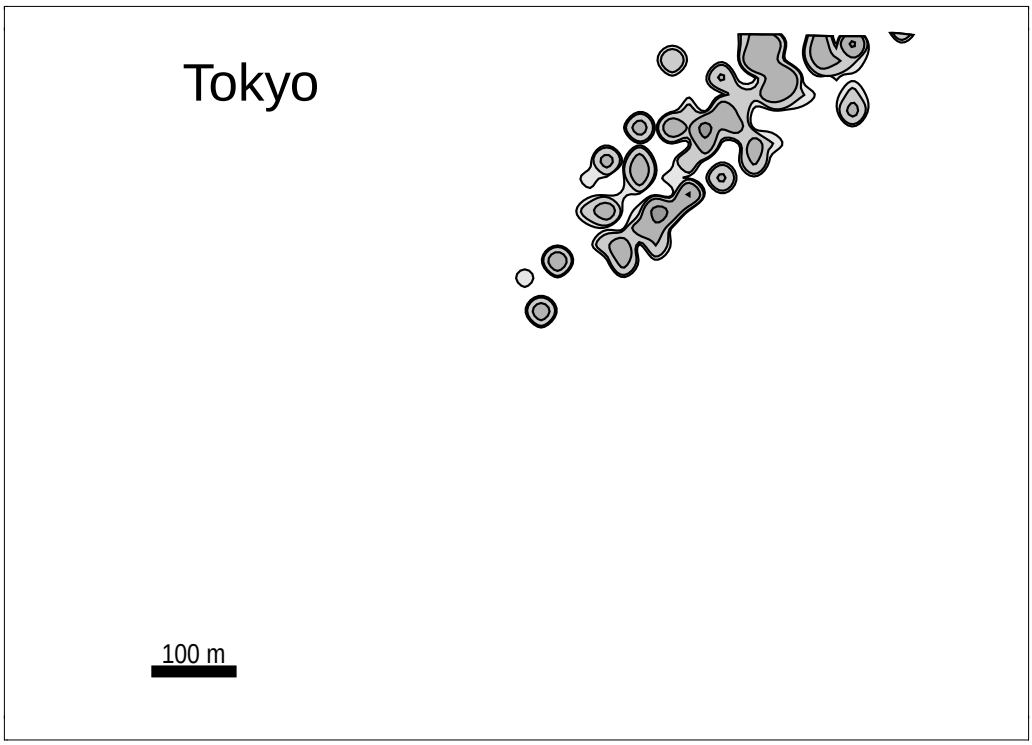

Figure 9A.3. Relative concentration pattern 18 minutes after start and 3 minutes after end of release

Source Swedish Defence Research Laboratory (FOA), Umeå, Sweden.

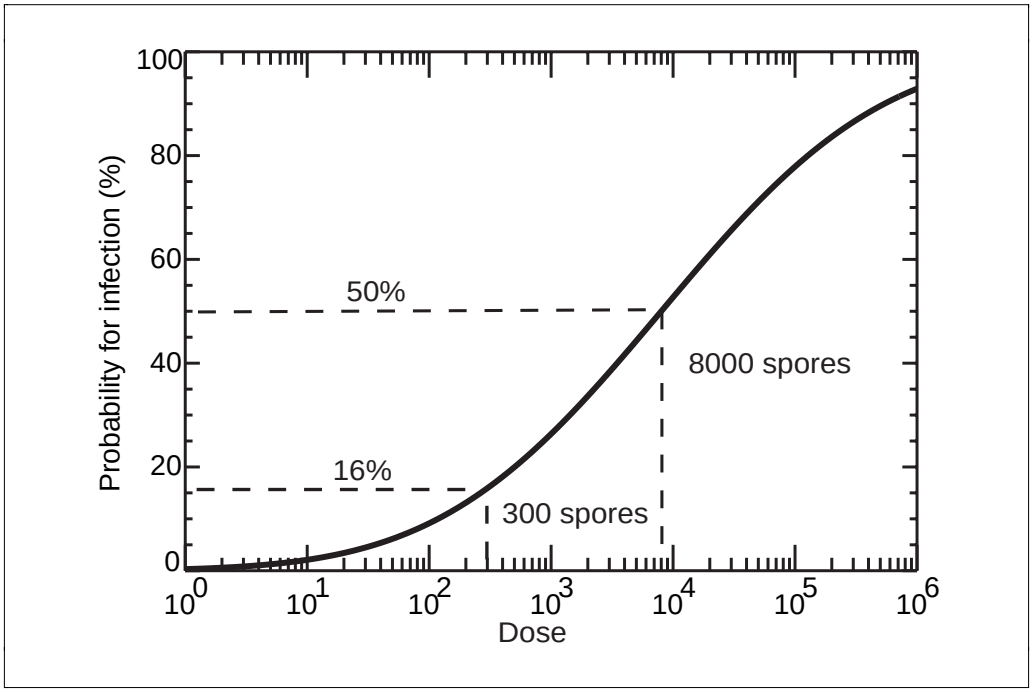

Figure 9A.4. Dose–response relationship for anthrax

Source Swedish Defence Research Laboratory (FOA), Umeå, Sweden.

Without medical treatment most of the infected people would die. However, if treatment with wide spectrum antibiotics were started within 24 hours after the first symptoms appeared this would decrease the number of fatalities considerably. If, following a warning, the authorities were prepared to treat the approximately 30 000 people in the scenario with antibiotics within a few days after their exposure (incubation time for anthrax is 1–7 days) the consequences would be limited. If there were no warning, however, it would take too long to make a correct diagnosis and begin massive prophylactic treatment. Effective medical treatment of the people with symptoms would nevertheless save many lives.

The consequences of an anthrax release at, for example, a large sporting event, where there would be a greater concentration of people, can be estimated by applying the pattern of the spread of contamination illustrated in figure 9A.5. If 30 000 spectators were seated in an area that was 150 metres long (a density of approximately three people/square metre), roughly 1500 people would be infected. Anthrax is not very infectious (i.e., only those exposed to the agent cloud would be infected). Dissemination of a more contagious biological warfare agent could, however, significantly increase the burden on the medical services. A biological warfare agent in dry powder form might be easier to disseminate, but there would be substantial technical problems and a significant risk of infection during preparation of the agent.

The scenario of a terrorist attack with a chemical warfare agent

Terrorists operating in secrecy cannot manufacture or transport large amounts of toxic agents into populated areas. For the 1995 attack in the Tokyo underground Aum Shinrikyo manufactured 6–7 litres of 30 per cent pure sarin (1 litre of solution weighed approximately 1 kilogram), which were transferred to 11 nylon-polyethylene bags. The bags were placed on the floor of five railway carriages on different trains and punctured with the sharpened tips of umbrellas.[40] Most injuries were caused by inhalation of the toxic vapour, but some may also have been the consequence of direct skin contamination from the sarin that was spilled on the floor. The low purity of the sarin solution reduced evaporation significantly (compared to pure sarin). For the Matsumoto attack in 1994 the cult manufactured 5–10 litres of purer sarin.[41] In that attack evaporation was accelerated because the agent was dropped on to an electric heater and released outdoors. However, the process may also partially have decomposed the agent into less toxic compounds. In both attacks the amount of pure sarin that was actually airborne was less than the liquid amount.

Evaporation is a slow process that is further influenced by the surface area of the liquid, agent purity, temperature and air turbulence.[42] Sarin is a liquid that evaporates

[40] Tu, A. T., 'Overview of sarin terrorist incidents in Japan in 1994 and 1995', *Proceedings of the Sixth International Symposium on Protection Against Chemical and Biological Warfare Agents*, Stockholm, Sweden, 10–15 May 1998 (Swedish Defence Research Establishment: Umeå, Sweden, May 1998), pp. 13–18.

[41] For a detailed description of the Matsumoto attack, see Kaplan and Marshall (note 31), chapters 19 and 20; and Croddy, E., 'Urban terrorism . . . chemical warfare in Japan', *Jane's Intelligence Review*, vol. 7, no. 11 (Nov. 1995), pp. 520–23. Additional details are from documents, notes and press reports stored in the Harvard Sussex Information Bank on CB warfare, armament and arms limitation at SPRU (Science and Technology Policy Research), University of Sussex, Brighton, UK.

[42] Karlsson, E. *et al.*, 'Consequences of release of the nerve agent sarin in restricted spaces: some calculations in order to illustrate the terrorist attack in the Tokyo underground', *Supplement to the Proceedings of the Fifth International Symposium on Protection Against Chemical and Biological*

at a rate similar to that of water. The total evaporation time for sarin spilled indoors is estimated to be several hours. This low evaporation rate can produce a high agent concentration because the limited volume of the room prevents the agent from mixing with larger volumes of clean air. Normally, ventilation is also too low for rapid dilution. Outdoors a much larger amount of agent is needed because of the dispersive effects of wind and air turbulence. If there is little wind and low turbulence, high agent concentration can be achieved outdoors. The effect indoors of an outdoor release depends on the ventilation and on the amount of adsorption by indoor surfaces. A low level of ventilation will reduce the effect, and increased ventilation after the agent has dissipated outdoors will also reduce the effect indoors.

The following simulation is based on the outdoor sarin attack in Matsumoto. In that attack the Aum Shinrikyo members vaporized the sarin by dropping it on an electric heater in the back of a lorry. The resulting toxic cloud dispersed over a densely populated residential area at night. An estimated 3 kg of pure sarin were airborne over a 25-minute period. However, the attack did not proceed as planned because the person in charge overslept, and the release point had to be changed at the last moment because the judges who were the target of the attack had already left the courthouse. The sarin, while purer than that used in Tokyo in March 1995, had too high a proportion of isopropyl alcohol, giving it a cobalt blue colour. Furthermore, the heat generated by the heater created a white hydrogen chloride or hydrogen fluoride mist inside and around the lorry. Fear of discovery led to hasty abandonment of the operation, and the lorry left the site with the valves for releasing the sarin still open, which caused further casualties.

In order to assess the potential of a terrorist attack with vaporized sarin, the simulation uses the setting and conditions of the Matsumoto attack, but assumes a single point of release and the use of pure sarin. As in the actual attack, the wind direction shifts from west to south-south-east and back during the period of release and the subsequent formation of the sarin vapour. The wind speed is low and varies between 1.8 and 0.5 metres per second.

In the simulation the continuous release forms a narrow plume that moves with the wind (figure 9A.6). The low wind speed and air turbulence at night produce low horizontal dispersion and contribute to formation of the narrow plume. The concentration of sarin is highest close to the release point, but at greater distances the plume becomes wider and the concentration lower. However, because the direction of the wind varies over time (which is normal at low wind speeds), the agent is swept over a wider area than that of the narrow plume itself. Consequently, the sarin cloud strikes certain objects that are some distance downwind for only a limited time while some objects may be missed completely. The vertical dispersion is also low, resulting in lower agent concentration on the higher floors of the buildings. The indoor concentration is lower than the outside concentration, but the agent remains inside the rooms for a period that is longer than that of the passage of the cloud. Buildings with open windows acquire a high indoor concentration that relatively quickly fades away after the cloud passes.

Warfare Agents, Stockholm, Sweden, 11–16 June 1995 (Swedish Defence Research Establishment, Department of NBC Defence: Umeå, Sweden, 1995), pp. 173–180.

The effect on people depends on agent concentration, respiration, transfer rate from the lungs to the blood, and exposure time. The concept 'acquired dose' (AD) is used to model casualties as a result of exposure to a toxic agent. The AD is defined as:

$$AD = [(\text{concentration}) \times (\text{respiratory rate}) \times (\text{transfer factor})]^n \times (\text{time})$$

where $n = 1.65$ for sarin, the transfer factor is 0.5, and the respiratory rate is 15 litres/min for people at rest.

Figure 9A.7 indicates the effect of an AD of 800, which would be obtained in a room 75 metres from the point of release after 50 minutes. The outcome of such a dose is that 12 per cent of those exposed would die, 22 per cent would suffer severe injuries, and 25 per cent would sustain light injuries. The remaining 41 per cent would not display any symptoms. This wide range of responses was observed in the Matsumoto attack. Individuals who had all been in the same room during the attack arrived at hospital in varying conditions: some were unconscious while others exhibited minor symptoms. However, some of those who did not complain of any symptoms nonetheless had a tremendous decrease in their acetylcholinesterase level.[43]

It is difficult to compare the release patterns and effects of such terrorist use of a chemical warfare agent with those of similar military use. The amounts of highly pure agent delivered by the military may range from tens of kilograms to several tonnes per hour depending on the mission and the target size. Bombs, artillery shells or missiles may be used to disseminate the agent over an area of the order of one square kilometre. The large amounts of agent and the dissemination method produce an immediate high concentration. There are two effects of such a release. First, a primary cloud, which may have an immediate high agent concentration, is formed and drifts away on the wind. A substantial part of the agent will consist of droplets that are deposited in the immediate vicinity of the target. Second, evaporation from the ground produces a secondary cloud that, depending on the type of agent and the weather conditions, may persist for many days.

The effects of the release by terrorists of a chemical warfare agent will vary depending on the circumstances. As a consequence of the probable method of release, there will be only a single cloud of agent and its vertical dispersion will be limited (unless it is released from an elevated point). If people are outside or indoors with the windows open when the sarin cloud passes, the severity of the injuries and the number of fatalities will increase. However, those outdoors may escape the vapour, which would reduce its effect. Because of low vertical dispersion the people on the lower floors of a building are normally at greater risk than those on the higher floors. A larger volume of agent or a more efficient method of dissemination would also increase the number of casualties. If the agent were less pure the evaporation rate would be reduced as would the amount of airborne agent. Some first-generation chemical warfare agents such as phosgene and chlorine are far more volatile than nerve agents and would dissipate more quickly. Although less toxic than nerve agents, such agents can cause severe casualties, especially if released indoors. Hydrogen cyanide and industrial chemicals like sulphur dioxide and ammonia have similar properties. A terrorist could obtain and use such chemicals in or near a populated area.

[43] Acetylcholinesterase is an enzyme found in some nerve endings that controls the functioning of the neurotransmitter acetylcholine. Nerve agents reduce the levels of acetylcholinesterase, so that the transmission of nerve impulses via the acetylcholine becomes uncontrolled, leading to the malfunctioning of many bodily organs and ultimately resulting in death.

Most chemical warfare agents act more rapidly than biological warfare agents, and prompt identification of the agent and immediate medical treatment is required to prevent severe poisoning. The treatment will vary from agent to agent.[44] If the antidote to a nerve agent is injected shortly after exposure to it the effect of the nerve agent will be considerably reduced. Detoxification of hydrogen cyanide can be accelerated by immediate treatment with antidotes that bind cyanide ions in the blood. Exposure to phosgene, chlorine, sulphur dioxide and ammonia may cause pulmonary oedema (i.e., abnormal accumulation of liquid in the lung tissues), and treatment with oxygen together with substances to widen the bronchi and cortisone is required.

As is the case with a BW attack, prompt identification of the agent, the availability of antidotes (in the case of nerve agents) and quick medical treatment may considerably reduce the consequences of exposure.

VI. Conclusions

This appendix focuses on chemical and biological weapons because they represent a new qualitative element of the terrorist threat. Toxicants and pathogens have often been used in assassinations and sabotage in the past. Currently, a large number of people may have access to the knowledge and technologies required to manipulate these agents, which can increase the quantitative dimension of the threat, but the use of these agents generally will not cause mass casualties. In contrast, chemical and biological warfare agents are indiscriminate by nature; theoretically, some military-grade agents can produce large numbers of fatalities and casualties. Their insidiousness makes them ideal instruments of terror and chaos. The processes for manufacturing and disseminating the most lethal and complex CB warfare agents in sufficient quantities to obtain such effects are more complex than those for other chemical and biological materials. Despite large investments, Aum Shinrikyo's CBW programme experienced considerable problems. In addition, such a programme is dependent on external sources of supply, and the programme must be conducted in secrecy because of its illegality. This considerably complicates the acquisition of such weaponry.

The likelihood of the recurrence of events like the 1994 and 1995 releases of sarin in Japan must be judged on the basis of realistic, testable parameters. This appendix utilizes a multidisciplinary approach to profile the new terrorist organizations and analyse the prerequisites for large-scale CBW programmes. Only vertically organized, highly integrated and ideologically uniform groups (such as a religious cult) are able to carry out large-scale CBW production in secrecy. The material base (number of members, financial assets, property owned and infrastructure) on which a terrorist group can draw plays a critical role. Variations in the composition of a group have a direct impact on its ability to sustain a CBW programme. This reduces the number of potential CBW terrorists. Aum Shinrikyo's material base was substantial, and few other terrorist organizations will be able to match it. The cult's difficulties and ultimate failure are therefore significant in the risk assessment of terrorism with chemical and biological weapons.

Technical hurdles affected the range and quality of the warfare agents that Aum Shinrikyo was able to develop. Military-grade warfare agents are therefore unlikely to constitute the primary threat from such a group. The sarin attacks in Japan demonstrated that a terrorist CBW attack may result in few fatalities while numerous victims

[44] *Chemical Weapons* (note 9), pp. 29–30, 38, 47.

will probably suffer short or low-level exposure to the chemical or biological warfare agents. The simulations in this appendix suggest that even if agents of a high quality are employed the casualty patterns observed at Matsumoto and Tokyo may be typical.

If the material base of a terrorist group is restricted it may only be able to produce a limited quantity of high-quality chemical or biological warfare agents. Loosely structured and cell-based terrorist groups or loners can manufacture small quantities of such agents. While this increases the possibility of the use of these agents in terrorist attacks, small quantities are unlikely to cause mass casualties, although high-quality agents would be effective for targeting individuals or small groups. Such discriminate use of warfare agents does not differ fundamentally from the more 'traditional' use of chemical or biological materials. In recent decades various terrorist organizations and individuals have possessed extremely toxic substances, but until recently this did not affect the risk assessment of terrorism.

First-generation chemical warfare agents such as phosgene or hydrogen cyanide are not difficult to produce in large quantities, and various terrorist organizations could manufacture them. Because of their chemical properties they are less lethal than nerve agents and are therefore unlikely to produce large numbers of casualties. Some persistent first-generation warfare agents could be employed to interrupt critical services rather than to cause bodily harm. Other types of agent, such as animal or plant pathogens, would be better suited for economic terrorism: and could cause widespread damage to the targeted society without necessarily killing or injuring individuals.

Governments face a multitude of CB terrorism threats, but the most catastrophic scenarios involving mass casualties, though possible, are not likely to occur. (Catastrophic scenarios involving non-conventional weapons, which feature in many policy debates, are often made plausible by insistence on the existence of a threat posed by state-sponsored terrorism.) Nevertheless, because of the potential consequences for the targeted society of a terrorist attack with CBW, governments must be prepared for such an attack. The key issue is thus to devise and execute balanced policies. Overreaction can lead to country-wide anxiety and paranoia. In such an atmosphere, hoaxes may become as efficient—especially in terms of economic terrorism—as actual attacks with CBW.