Appendix G
Weapons of Mass Destruction

"The future may see a time when such a [nuclear] weapon may be constructed in secret and used suddenly and effectively with devastating power by a willful nation or group against an unsuspecting nation or group of much greater size and material power."

- US Secretary of War Henry Stimson to Harry Truman 25 April 1945

Nuclear, Biological and Chemical Weapons

The threat of terrorists using weapons of mass destruction appears to be rising, especially since the attack on the World Trade Center on September 11, 2001. As noted by the State Department in the 2001 terrorism report, this demonstrated the capability of terrorists to plan, organize, and execute attacks to produce mass casualties.[204] In an unclassified report to Congress, the CIA stated that several of the 30 designated foreign terrorist organizations have expressed interest in WMD. Additionally, Usama bin Laden and groups aligned with him have shown interest in conducting unconventional attacks and they make public statements about unconventional weapons.[205] In fact, Usama bin Laden has professed the acquisition of WMD to be a religious duty and he has threatened to use them.[206]

Terrorist groups that acquire NBC weapons pose significant dangers to foreign interests they oppose. Terrorists armed with these weapons can gain leverage for their demands because of the weapons' nature. They are the ultimate terror weapons, since the actual or threat of use of NBC weapons is real and very feasible. Terrorists obtain these weapons for a variety of motives. Such groups might threaten the use of these weapons as "saber rattlers" to raise the ante in response to foreign political or military actions or to achieve a specific objective. Likewise, some groups simply want to employ them to create large numbers of casualties, both military and civilian, and capitalize on the effects of these events.

A real-world example of the threat has been voiced by the al Qaeda organization. In an interview with ABC News in May 1998, Usama bin Laden stated, "We do not have to differentiate between military or civilian. As far as we are concerned, they are all targets, and this is what the fatwa says."[207]Additionally, al Qaeda spokesman Suleiman abu Ghaith has stated: "We have the right to kill four million Americans – two million of them children – and to exile twice as many and injure and cripple hundreds of thousands. We have the right to fight them by chemical and biological weapons, so they catch the fatal and unusual diseases that Muslims have caught due to their (US) chemical and biological weapons."[208]

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[204] Department of State, *Patterns of Global Terrorism 2001* (Washington, D.C., May 2002), 66.
[205] Director of Central Intelligence, DCI Weapons Intelligence, Nonproliferation, and Arms Control Center, *Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, 1 January Through 30 June 2001* (Washington, D.C., January 2002), 8-9.
[206] Department of State, *Patterns of Global Terrorism 2001* (Washington, D.C., May 2002), 66.
[207] Ben N. Venzke and Aimee Ibrahim, *al Qaeda Tactic/Target Brief*, Version 1.5 (Alexandria, VA: IntelCenter, 2002), 8.
[208] Ibid., 10.

These statements by al Qaeda should leave no doubt in your mind that terrorists are committed to using weapons of mass destruction if they can acquire them.

This raises the question concerning where terrorists would acquire weapons of mass destruction. With the poor economy of Russia, they do not have the money to provide adequate security for the vast amount of WMD they possessed during the cold war. There is a concern that the scientists and soldiers, who once were the elite of the Soviet Union and are now underpaid, will sell these weapons to terrorists. Additionally, there is the concern that some of the unemployed scientists from the former Soviet Union will be willing to sell their knowledge and services to other countries, such as Iran, Iraq, and Libya, who are known state sponsors of terrorism. However, the former Soviet Union is not the only source. There are many other sources available, to include the United States. Chemical plants, biological labs, food irradiation plants, medical x-ray labs, and nuclear reactors and waste repositories are all possible sources for terrorists to acquire material to make WMDs.

Weapons of Mass Destruction Categories

> "Acquiring weapons for the defense of Muslims is a religious duty. If I have indeed acquired these weapons (WMD), then I thank God for enabling me to do so. And if I seek to acquire these weapons, I am carrying out a duty. It would be a sin for Muslims not to try to possess the weapons that would prevent the infidels from inflicting harm on Muslims."
>
> - Usama Bin Laden interview with *Time Magazine*, December 23, 1998

Weapons of mass destruction are normally categorized into 3 categories: nuclear, biological, and chemical.

Nuclear

For the present, the use of a fully developed nuclear weapon is the least likely terrorist scenario because most groups do not have the financial and technical resources to acquire nuclear weapons. The most likely scenario dealing with nuclear material is sabotage or a siege-hostage situation at a nuclear facility.[209] They could; however, gather materials to make radiological dispersion devices (aka "dirty bomb"). These weapons are constructed with conventional explosives, which are used to scatter radioactive debris, such as spent fuel rods. This eliminates the problem of obtaining fissile material and the complexity of developing an actual nuclear device.

Although these type weapons are unlikely to cause mass casualties, they would present a significant radiation contamination effect on the target.[210] Radiation casualties would be low initially, but would increase over time. However, just the fact that a "nuclear" type weapon was employed would have a significant psychological impact on the populace where it is detonated. From the terrorists' viewpoint, though, one down side of these weapons is that they also pose a significant health risk to those building and employing them.

Some groups may have state sponsors that possess or can obtain nuclear weapons, but the CIA has no credible reporting at this time on terrorists successfully acquiring nuclear

[209] *Encyclopedia of World Terrorism*, 1997 ed., s.v. "Nuclear."
[210] Steve Bowman, *Weapons of Mass Destruction: The Terrorist Threat* (Washington, D.C.: Congressional Research Service Report for Congress, 7 March 2002), 4; available from http://www.fas.org/irp/crs/RL31332.pdf; Internet; accessed 23 December 2002.

weapons or sufficient material to make them.[211] However, since the collapse of the Soviet Union in 1989, there has been a growth in nuclear trafficking. It's believed that three shipments of Plutonium 239 intercepted by the German police in 1994 came from Russia.[212] Since 1991, Russian authorities say there have been 23 attempts to steal fissile material, some of which have been successful. In fact, intelligence officials believe enough nuclear material has left Russia to make a bomb.[213] Table G-1 reflects the quantities of material required to build a crude atomic bomb.[214] As demonstrated in the al Qaeda statements earlier, when and if a terrorist group does obtain a nuclear weapon, there should be no doubt that they will use it.

Type Fissile Material	*Required for a Weapon*
Plutonium (Pu)	7 kg
Plutonium oxide (PuO2)	10 kg
Metallic uranium (U-235)	25 kg
Highly enriched uranium oxide (UO2)	35 kg
Intermediate enriched uranium oxide (UO2)	200 kg

Table G-1: Fissile Material

Biological

Biological weapons consist of pathogenic microbes, toxins, and bioregulator compounds. Depending on the specific type, these weapons can incapacitate or kill people and animals; and destroy plants, food supplies, or materiel. The type of targets being attacked determines the choice of agents and dissemination systems.

Biological warfare agents are virtually undetectable while they are in transit and evidence of a biological attack may not show up for days after the actual release has occurred. These agents are easier and cheaper to produce than either chemical or nuclear weapons, and the technology is readily available on the Internet. In fact, any nation with a modestly sophisticated pharmaceutical industry is capable of producing these type agents.[215] Biological agents are also very lethal. Whereas about 1800 pounds of sarin is required to inflict a large number of casualties over a square mile area, only a quarter ounce of anthrax spores is required to achieve the same effect.[216]

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[211] Director of Central Intelligence, DCI Weapons Intelligence, Nonproliferation, and Arms Control Center, *Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, 1 January Through 30 June 2001* (Washington, D.C., January 2002), 9.
[212] *Encyclopedia of World Terrorism*, 1997 ed., s.v. "Nuclear."
[213] Lewis M. Simons, "Weapons of Mass Destruction: An Ominous New Chapter Opens on the Twentieth Century's Ugliest Legacy," *National Geographic* 202, no. 5 (November 2002): 16.
[214] *Weapons of Mass Destruction* (New York: United Nations Office on Drugs and Crime, December 2002), 6; available from http://www.undcp.org/odccp/terrorism_weapons_mass_destruction_page006.html; Internet; accessed 19 December 2002.
[215] Canadian Security Intelligence Service, "Report 2000/05 Biological Weapons Proliferation," *Perspectives* (9 June 2000): 2; available from http://www.csis-scrs.gc.ca/eng/miscdocs/200005_e.html; Internet; accessed 6 February 2003.
[216] *Encyclopedia of World Terrorism*, 1997 ed., s.v. "Biological."

The Fall 2001 anthrax attacks in the United States following the World Trade Center and Pentagon bombings show that terrorists will use biological weapons. Although the attacks were originally suspected to be linked to al Qaeda or Iraq, there is no evidence that a known terrorist organization was involved. Current views indicate that the attacks were probably domestically initiated or that a lone terrorist with previous access to weapon quality anthrax conducted them.[217] Although the outcome of these attacks resulted in few casualties, the attacks did show the psychological and economic disruption such attacks could cause. Washington, D.C. and other East Coast cities were in a panic dealing with these attacks. Additionally, the numerous hoaxes using talcum powder showed the psychological and economic impact of the potential use of these type weapons.

Although the anthrax attacks from 2001 are more recognizable events, biological attacks in the United States are not new. Another example of biological terrorism was the food tampering attack in Dalles, Oregon in 1984. Followers of the Bagwan Shree Rajneessh cult sprayed salmonella on salad bars in several restaurants, causing over 700 people to become ill.[218]

Biological warfare agents include three basic categories: pathogens, toxins, and bioregulators. Table G-2 lists some examples of each.

Pathogens	*Toxins*	*Bioregulators*
Anthrax	Mycotoxins	Neurotransmitters
Cholera	Venoms	Hormones
Plague	Shell fish	Enzymes
Smallpox	Botulinum	
Tularemia	Ricin	
Influenza		
Fevers		

Table G-2: Examples of Biological Warfare Agents

Some of the characteristics of biological weapons are shown below[219]:

Agent	*Contagious*	*Mortality if Untreated*	*Incubation Period (Days)*	*Illness Duration (Days)*
Anthrax	No	90-100%	1-7	3-5
Plague	Yes	100%	1-6	Fatal within 6
Tularemia	No	30-40%	1-14	14 or more

[217] Steve Bowman, *Weapons of Mass Destruction: The Terrorist Threat* (Washington, D.C.: Congressional Research Service Report for Congress, 7 March 2002), 3; available from http://www.fas.org/irp/crs/RL31332.pdf; Internet; accessed 23 December 2002.

[218] Department of Justice, Federal Bureau of Investigation, Counterterrorism Threat Assessment and Warning Unit, Counterterrorism Division, *Terrorism in the United States 1999*, Report 0308, (Washington, D.C., n.d.), 39.

[219] Lewis M. Simons, "Weapons of Mass Destruction: An Ominous New Chapter Opens on the Twentieth Century's Ugliest Legacy," *National Geographic* 202, no. 5 (November 2002): 22-23.

Smallpox	Yes	30%	7-17	10-28
Botulinum	No	60-100%	1-5	Days to weeks
Ricin	No	Variable	18-24 hours	Days

Table G-3: Characteristics of Biological Weapons

Pathogens cause diseases such as anthrax, cholera, plague, smallpox, tularemia, or various types of fever. These weapons would be used against targets such as food supplies, port facilities, and population centers. Of particular concern is the threat of contagious diseases, such as smallpox. Since it has an incubation period that can last over 2 weeks without any symptoms, the release of smallpox could easily infect a large number of people in a short period of time.

Living organisms, such as snakes, spiders, sea creatures, and plants, produce toxins. Toxins are faster acting and more stable than live pathogens. Most toxins are easily produced through genetic engineering.

Bioregulators are chemical compounds that are essential for the normal psychological and physiological functions. A wide variety of bioregulators are normally present in the human body in extremely minute concentrations. These compounds can produce a wide range of harmful effects if introduced into the body at higher than normal concentrations or if they have been altered. Psychological effects could include exaggerated fear and pain. In addition, bioregulators can cause severe physiological effects such as rapid unconsciousness, and, depending on such factors as dose and route of administration, they could also be lethal. Unlike pathogens that take hours or days to act, bioregulators could act in only minutes.

Another way to categorize biological warfare agents is by their effects. The four categories and effects of biological agents are shown in Table G-4.

Agent Type	*Agent Effects*
Antipersonnel	Disease or death causing microorganisms and toxins.
Antiplant	Living micro-organisms that cause disease or death
Antianimal	Agents that can be used to incapacitate or destroy domestic animals through disease. Used to limit wool, hide, or fur production.
Antimaterial	Agents used to deteriorate critical materiel needed for the war effort such as leather, canvas, fuels, or electronics.

Table G-4: Effects of Biological Agents

As shown in Table G-4, there is a threat of agro-terrorism, which affects plants and animals. The outbreaks of foot-and-mouth disease and mad cow disease in Europe are recent examples of the economic impact of such diseases. Additionally, this type terrorism allows a terrorist group to inflict significant economic and social disruption without the stigma of inflicting large numbers of human casualties.[220] Based on statements from al Qaeda that they intend to target key sectors of the U.S. economy, agro-terrorism is a likely threat.

[220]Steve Bowman, *Weapons of Mass Destruction: The Terrorist Threat* (Washington, D.C.: Congressional Research Service Report for Congress, 7 March 2002), 6; available from http://www.fas.org/irp/crs/RL31332.pdf; Internet; accessed 23 December 2002.

Chemical

Chemical weapons contain substances intended to kill or incapacitate personnel and to deny use of areas, materiel, or facilities. These agents can be both lethal and non-lethal, and can be either persistent or non-persistent. As with biological weapons, terrorists have already exhibited the capability to use chemical weapons. This was demonstrated in 1978 when a group of Palestinians injected oranges with cyanide to damage Israel's citrus exports.[221] Additionally, in 1995 the Japanese cult, Aum Shinrikyo, released sarin gas in the Tokyo subway network killing 12 people and injuring 5,500.[222] This attack, however, shows the unpredictable nature of chemical weapons and associated dissemination problems. Although the Japanese cult was able to produce sarin and release it in a closed environment, there was a problem with dissemination. Consequently, the attack resulted in a very small number of fatalities even though agents like sarin nerve gas require infinitesimal amounts to kill a human being.

The attacks on September 11, 2001 raised the chemical industry's awareness of possible terrorist sabotage of facilities that store toxic industrial chemicals. These type attacks could provide the mass casualty effects of a chemical weapons attack, yet would not present the terrorist group with the problem of developing or acquiring chemical agents. This scenario occurred in Bhopal, India in 1984 when a disgruntled pesticide plant employee is believed to have released 40 metric tons of methyl isocyonate into the atmosphere. The resulting casualties were 2,000 killed and 100,000 injured.[223]

Chemical agents are categorized by the effects they have on the target organism. Lethal agents include nerve, blood, blister, and choking agents. Nonlethal agents include incapacitants and irritants. Table G-5 lists characteristic effects of various chemical agents.

Agent	*Lethal*	*Symbol/Name*	*Symptoms in Man*	*Effects on Man*	*Rate of Action*
Nerve	Yes	G Series GB/Sarin GD/Soman (VR 55)	Difficult breathing, sweating, drooling, nausea, vomiting convulsions, and dim or blurred vision.	At low concentrations, incapacitates; kills if inhaled or absorbed through the skin.	Very rapid by inhalation; slower through skin (5-10 minutes).

[221] *Encyclopedia of World Terrorism*, 1997 ed., s.v. "Chemical."
[222] Walter Laqueur, *The New Terrorism: Fanaticism and the Arms of Mass Destruction* (Oxford: Oxford University Press, 1999), 54.
[223] Steve Bowman, *Weapons of Mass Destruction: The Terrorist Threat* (Washington, D.C.: Congressional Research Service Report for Congress, 7 March 2002), 7; available from http://www.fas.org/irp/crs/RL31332.pdf; Internet; accessed 23 December 2002.

	Yes	V Agent	Same as above.	Incapacitates; kills if skin is not rapidly decontaminated	Delayed through skin; more rapid through eyes.
Blood	Yes	AC/Hydrogen cyanide	Rapid breathing, convulsions, coma, and death.	Incapacitates; kills if high concentration is inhaled.	Rapid
Blister	Yes	HD/Mustard HN/Nitrogen Mustard L/Lewisite HL/Mustard and Lewisite CX/Phosgene Oxime	Mustard, nitrogen mustard: no early symptoms. Lewisite and mustard: searing eyes and stinging skin. Phosgene oxime: powerful irritation of eyes, nose, and skin.	Blisters skin and respiratory tract; can cause temporary blindness. Some agents sting and form wheals on skin.	Blister delayed hours to days; eye effects more rapid.
Choking	Yes	CG/Phosgene DP/Diphosgene	Eye and throat irritation, fatigue, tears, coughing, chest tightness, nausea, vomiting.	Damages the lungs.	Delayed, variable.
Incapa-citant	No	BZ	Slowing of mental and physical activity, disorientation and sleep.	Temporarily incapacitates.	30-60 minutes.
Irritant	No	DA/Diphenylchloroarsine DM/Adamsite CN/Chloroacetophenone CS/O-Chlorobenzylidene-malononitrile PS/Chloropicrin	Causes tears, irritates skin and respiratory tract.	Incapacitates, non-lethal.	Very rapid.

Table G-5: Effects of Example Chemical Agents.

Nerve agents are fast-acting chemical agents. Practically odorless and colorless, they attack the body's nervous system causing convulsions and eventually death. Nerve agents are further classified as either G- or V-agents. At low concentrations, the GB series incapacitates; it kills if inhaled or absorbed through the skin. The rate of action is very rapid if inhaled, but slower if absorbed through the skin. The V-agents are quicker acting and more persistent than the G-agents.

Blood agents are absorbed by breathing and block the oxygen transferal mechanisms in the body, leading to death by suffocation. A common blood agent is hydrogen cyanide. It kills quickly and dissipates rapidly.

Blister agents, such as mustard (H) or lewisite (L), and combinations of the two compounds, can disable or kill. These type agents burn the skin and produce large water blisters. They also cause damage to the eyes, blood cells, and lungs. These agents are especially lethal when inhaled.

Choking agents, such as phosgene and diphosgene, attack the respiratory system and make the membranes swell so the lungs fill with fluid, which can be fatal. As with blood agents, poisoning from choking agents comes through inhalation, since both types of agents are nonpersistent. Signs and symptoms of toxicity may be delayed up to 24 hours.

Incapacitants include psychochemical agents and paralyzants. These agents can disrupt a victim's mental and physical capabilities. The victim may not lose consciousness, and the effects usually wear off without leaving permanent physical injuries.

Irritants, also known as riot-control agents, cause a strong burning sensation in the eyes, mouth, skin, and respiratory tract. The effects of these agents, the best known being tear gas (CS), are also temporary. Victims recover completely without having any serious aftereffects.

Chemical agents are also classified according to their persistency. Persistency is the length of time an agent remains effective on the battlefield or other target area after dissemination. The two basic classifications are persistent or nonpersistent.

Persistent nerve agents, such as V-agents, thickened G-agents, and the blister agent mustard, can retain their disabling or lethal characteristics for days to weeks (depending on environmental conditions). Persistent agents produce either immediate or delayed casualties. Immediate casualties occur when an individual inhales a chemical vapor. Delayed casualties occur when the chemical agent is absorbed through the skin, thus demonstrating the need for protective equipment.

Non-persistent agents generally last a shorter period of time, depending on the weather conditions. For example, the nerve agent sarin (GB) forms clouds that dissipate within minutes after dissemination. However, some liquid GB could remain for periods of time varying from hours to days, depending on the weather conditions and method of delivery.

Delivery

It is possible to disseminate NBC weapons and agents in a number of ways. Groups execute any or all of these delivery means as required to achieve the desired effects on the target.

Nuclear

The size of most nuclear weapons makes them hard to clandestinely transport. The most likely means of transporting them would be via commercial shipping, such as trucks, vehicles, and boats.[224] Backpacks and "suitcases" can be covertly used to deliver small nuclear weapons or dangerous radiological dispersion devices. Of the two, the latter is the most likely to be seen in the near-term.

Biological

The objective of biological weapon delivery is to expose humans to an agent in the form of a suspended cloud of very fine agent particles. Airborne particles are the most effective because, once inhaled, particles of this size tend to lodge deep in the lungs close to vulnerable body tissues and the bloodstream. Dissemination through aerosols, either as droplets from liquid or by particles from powders, is by far the most efficient method. This method does create a challenge, though, since aerosol disseminators need to be properly designed for the agent used, and proper meteorological conditions must exist to conduct the attack.[225]

Terrorist groups or civilian sympathizers deliver biological weapons by unconventional dissemination means. These include commercially available or specially designed sprayers or other forms of aerosol generators mounted in automobiles, trucks, or boats. Backpack and "suitcase" devices also can be used to effectively disseminate biological agent aerosols. Devices resembling insecticide spray cans can be used to introduce an agent into heating, ventilating, and air conditioning systems. Drinking water can be contaminated by means of high-pressure agent injectors attached to plumbing system components. Another way to disseminate infectious agents is by the use of insects, rodents, or other arthropod vectors. Methods of dissemination are varied and limited only by the perpetrators' imagination.

Chemical

The real difficulty using chemical weapons is not the manufacturing, but the dissemination. Vapors are affected by the direction of the wind as well as temperature. Additionally, there are biological activities that diminish the toxicity of the agent, therefore, the amount of chemical needed in the open air or in water to have its intended effect is much larger than what is successful in the laboratory.[226] Numerous means to include mortars and bombs can be used to deliver chemical warfare agents. Chemical munitions are fitted with different burst capabilities, according to the agent properties and the intended effect. For example, a chemical munitions fitted with a long burst fuse releases the agent as a vapor or fine aerosol.

[224] Ibid., 4.
[225] Ibid., 5.
[226] Walter Laqueur, *The New Terrorism: Fanaticism and the Arms of Mass Destruction* (Oxford: Oxford University Press, 1999), 60.

This creates an immediate inhalation hazard with some of the fragmentation effect of conventional munitions. Theoretically, terrorists could obtain these munitions, modify them and emplace them by hand. Other delivery means could be by vehicle, backpack, canisters or sprayers, similar to those used for biological agents.

Accessibility

> **"Our enemies have openly declared that they are seeking weapons of mass destruction, and evidence indicates that they are doing so with determination."**
>
> **- President Bush, The National Security Strategy of the United State of America, 17 September 2002**

As stated earlier in this appendix, the poor security in the former Soviet Union for their weapons of mass destruction provides a possible resource for terrorists to acquire these weapons. Additionally, radioactive materials or waste can be easily purchased legally, or on the black market. They can be obtained from governmental or civilian research and medical facilities such as power plants, construction sites, laboratories, or hospitals, or from military facilities concerned with the storage, production, and weaponization of these materials.

Biological agents are naturally occurring and relatively easy to obtain as compared to nuclear material. In addition to the above sources, they can be easily obtained from universities or medical schools. Chemical agents and their precursors can be obtained from civilian agriculture sites, textile, plastic, or civilian chemical production facilities, or the above mentioned military research and military facilities. Terrorist access to these weapons can also be through a state sponsor or, given the increasing sophistication of terrorist groups, manufactured in laboratories they have established and financed.

Production

Biological weapons are extremely potent and the most rudimentary program will likely have lethal agents that have been a threat for some time. Botulism and anthrax are high-probability candidates that are difficult to reckon with. In addition, the revolution in biotechnology may produce other agents that are even more toxic and resilient.

Chemical and biological agents can be produced in small laboratories with little or no signature to identify the facility or their production. Normal biological warfare research facilities resemble completely legitimate bio-technical and medical research facilities. The same production facilities that can produce biological warfare agents may also produce wine and beer, dried milk, food and agricultural products. It is therefore difficult to distinguish legitimate production plants from illicit ones.

The basic knowledge needed to produce an effective NBC terrorist weapon can be found in college and medical school textbooks, advanced engineering books, magazines and periodicals, and on the Internet. With minimal training, individuals can produce NBC weapons in a relatively short period of time in any home, school, or university laboratory, medical production or research facility, or commercial production facility. Minimal special equipment is needed to produce biological or chemical weapons, and it can be easily purchased on the open market. These weapons can be produced at a relatively low cost, as

compared to other types of weaponry. Some precursor agents for biological and chemical production are dual use, therefore they are not illegal to acquire or posses and are not expensive to purchase. Some can be easily stolen from production facilities. Widespread effects of these weapons can be obtained from small-scale production lots, reducing the total production costs to achieve the desired effects.

Toxic Industrial Chemicals

There is a near-universal availability of large quantities of highly toxic stored materials. Exposure to some industrial chemicals can have a lethal or debilitating effect on humans, which, in combination with their ready availability, their proximity to urban areas, their low cost, and the low security associated with storage facilities, makes them an attractive option for terrorist use as weapons of opportunity or of mass destruction.

The most important factors to consider when assessing the potential for adverse human health impacts from a chemical release are acute toxicity, physical properties (volatility, reactivity, flammability), and likelihood that large quantities will be available for exploitation. Foremost among these factors is acute toxicity; thus, the highest concern for human health is associated with a subgroup of industrial chemicals known as toxic industrial chemicals (TICs). TICs are commercial chemical substances with acute toxicity that are produced in large quantities for industrial purposes.

Table G-6 lists high- and moderate-risk TICs based on acute toxicity by inhalation, worldwide availability (number of producers and number of continents on which the substance is available), and physical state (gas, liquid, or solid) at standard temperature and pressure. In addition, the current definition of TICs does not include all chemicals with high toxicity and availability. Specifically, chemicals with low volatility are not included. These low-vapor-pressure chemicals include some of the most highly toxic chemicals widely available, including most pesticides.

High Risk	*Moderate Risk*	
Ammonia	Acetone cyanohydrin	Methyl chloroformate
Arsine	Acrolein	Methyl chlorosilane
Boron trichloride	Acrylonitarile	Methyl hydrazine
Boron trifluoride	Allyl alcohol	Methyl isocyanate
Carbon disulfide	Allyl amine	Methyl mercaptan
Chlorine	Allyl chlorocarbonate	n-Butyl isocyanate
Diborane	Boron tribromide	Nitrogen dioxide
Ethylene oxide	Carbon monoxide	Phosphine
Fluorine	Carbonyl sulfide	Phosphorus oxychloride
Formaldehyde	Chloroacetone	Phosphorus pentafluoride
Hydrogen bromide	Chloroacetonitrile	Selenium hexafluoride
Hydrogen chloride	Chlorosulfonic acid	Silicon tetrafluoride
Hydrogen cyanide	Crotonaldehyde	Stibine
Hydrogen fluoride	Diketene	Sulfur trioxide

Hydrogen sulfide	1,2-Dimethyl hydrazine	Sulfuryl chloride
Nitric acid, fuming	Dimethyl sulfate	Tellurium hexafluoride
Phosgene	Ethylene dibromide	Tert-Octyl mercaptan
Phosphorus trichloride	Hydrogen selenide	Titanium tetrachloride
Sulfur dioxide	Iron pentacarbonyl	Trichloroacetyl chloride
Sulfuric acid	Methanesulfonyl chloride	Trifluoroacetyl chloride
Tungsten hexafluoride	Methyl bromide	

Table G-6: High- and Moderate-Risk Toxic Industrial Chemicals