Protecting Our Hometowns

Preventing Chemical Terrorism in America

A Guide for Policymakers and Advocates

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Table of Contents

Executive Summary

The events of September 11th, 2001 have triggered a national re-examination of the security of airlines, drinking water supplies, nuclear plants, and other areas. Policy-makers and industry have to date inadequately addressed one threat to our communities: the use and storage of highly hazardous chemicals.

Across America, thousands of industrial facilities use and store hazardous chemicals in quantities that put large numbers of Americans at risk of serious injury or death in the event of a chemical release. **One hundred twenty-five (125) facilities each put at least 1 million people at risk; 700 facilities each put at least 100,000 people at risk; and 3,000 facilities each put at least 10,000 people at risk.** The threat of terrorism has brought new scrutiny to the potential for terrorists to deliberately trigger accidents that until recently the chemical industry characterized as unlikely worst-case scenarios. Such an act could have even more severe consequences than the thousands of accidental releases that occur each year as a result of ongoing use of hazardous chemicals.

Frederick L. Webber, president of the American Chemistry Council, has said "No one needed to convince us that we could be – and indeed would be – a target at some future date….If they're looking for the big bang, obviously you don't have to go far in your imagination to think about what the possibilities are." The Agency for Toxic Substances and Disease Registry said in 1999 that industrial chemicals provide terrorists with "…effective and readily accessible materials to develop improvised explosives, incendiaries and poisons."

Fortunately, there are well-established measures for reducing hazards at facilities – and making communities safer. An industrial facility could take a range of actions in response to the threat of terrorism, from switching to inherently safer systems (using safer chemicals or using chemical in safer quantities or processes) to adding on secondary safety systems (emergency valves, containment dikes) to adding physical security at the site.

But the threat of terrorism requires eliminating or reducing hazards through the use of inherently safer technologies wherever feasible. **Reducing the amount of hazardous chemicals on site or switching to a safer chemical or process can reduce or eliminate the possibility of a chemical release.** If terrorists continue to use airplanes or truck bombs, add-on security measures such as safety guards and physical barriers cannot prevent a chemical release. Similarly, secondary prevention or mitigation measures, such as safety valves, would be decidedly inadequate in the event of an attack like those seen on September 11th.

Inherent safety is an opportunity for policymakers to *remove* a terrorist threat in many cases. This is an option that is not available for all terrorist risks. Airline passengers have to rely on increased security to make flying safer. For American industry, however, many chemicals have readily available safer alternatives, and many facilities could re-design processes to be inherently safer. The use of chlorine to treat drinking water is one of the best examples. Chlorine gas is one of the chemicals most prone to a catastrophic release; the contents of a 90-ton rail tank car could drift for miles if released, threatening injuries and death. However, safer options are available, and policymakers can encourage and require industries to use them. A state program in New Jersey has enabled hundreds of drinking water facilities to stop using chlorine. In the months following September 11th, the Blue Plains water treatment facility in Washington, DC, switched from the use of dangerous chlorine gas to safer sodium hypochlorite. As a result, no longer can a terrorist trigger a chemical release that could send a deadly chlorine gas cloud across the nation's capital.

This paper documents, for policymakers, advocates, and the general public, the terrorist threat posed by chemical use in communities and opportunities to make communities inherently safer.

Policymakers should encourage and require companies to reduce chemical hazards by implementing the following:

1) Require all companies manufacturing, storing, or using hazardous chemicals in quantities of concern to conduct an assessment of technology options to evaluate hazards and opportunities to reduce or eliminate each of them. Companies should be required to explain regulators why they chose not to implement safer options; regulators should narrowly limit the acceptable reasons for allowing a risk to remain.

2) Mandate specific inherently safer technologies where they provide clear alternatives to existing hazards. A good example is the use of chlorine in treating water, which should be phased out on the most rapid timeline possible. Policymakers should mandate inherently safer technologies for the highest-hazard facilities first, such as for the 125 facilities that each put at least 1 million people at risk.

3) Re-evaluate current regulatory programs for chemical risks to take into account the potential for terrorism. Because even facilities with small quantities of chemicals may be a terrorist target, policymakers should re-consider the threshold quantities of chemicals that currently trigger regulation at a specific facility and lower them where appropriate. Policymakers also should consider whether any industries or chemicals not currently covered by regulatory programs should be added.

4) Require strict accident prevention, accident mitigation, and site security measures to minimize the chance of a successful terrorist attack wherever chemical hazards cannot be eliminated. It is important that industries using high-hazard chemicals pay for these programs to internalize the cost of the hazard.

5) Maintain and improve public access to information about chemical hazards in communities and potential impacts of chemical releases.

Policymakers at the state and federal levels can and should enact these policy solutions. In addition, the Office of Homeland Security and state security agencies should adopt an inherent safety mandate in all their work with facilities that manufacture, use, store, or otherwise handle hazardous chemicals.

Part One:

The Threat of Chemical Terrorism

In the aftermath of the tragic events of September 11th, repeated threat warnings from the Federal Bureau of Investigation have made it clear that predicting where the next terrorist target could be and what the next terrorist attack might look like is difficult. Government officials and policymaker have therefore focused on securing as many potential targets as possible – increasing security at airports, water supplies, and nuclear facilities. These efforts have focused on targets where a significant hazard could affect large numbers of people.

Facilities located in high-population areas that use and store hazardous chemicals are attractive targets for terrorists. Frederick L. Webber, President of the American Chemistry Council, told the *Washington Post*: "No one needed to convince us that we could be – and indeed would be – a target at some future date….If they're looking for the big bang, obviously you don't have to go far in your imagination to think about what the possibilities are."[1]

While some attention has focused on the potential for terrorists to use chemicals to build chemical weapons, national security experts have asserted that the enormous complexity of creating a chemical weapon makes such a scenario less likely than an intentionally triggered chemical release from an industrial facility. Industrial facilities provide relatively easy access to chemicals at locations from which a significant chemical release could harm large numbers of people. Amy Smithson, director of the Chemical and Biological Weapons Non-Proliferation Project at the Henry L. Stimson Center, testified in a House of Representatives committee hearing:

> Although assembling from scratch an unconventional weapons capability that could cause mass casualties is not that elementary, there are tangible routes whereby terrorists could inflict considerable harm with chemical and biological substances. One shortcut involves foul play with industrial chemicals….Logic dictates that if the same result [mass casualties from a chemical release] can be achieved through a less arduous route, terrorists intent on causing mass casualties with chemicals would probably engineer the intentional release of industrial chemicals rather than wrestle with the complexities of making large quantities of the classic chemical warfare agents.[2]

Mohammed Atta, believed to have been the ringleader of the September 11 terrorists, had conversations with a junk car dealer in Tennessee in which he expressed an extraordinary and persistent interest in a chemical storage facility and surrounding rail tank cars (see box). Another individual suspected to have been an associate of the terrorists also had acquired a license to haul hazardous materials in Michigan.

Danny Whitener, a 48-year-old junk car dealer was alone tending his plane when several strangers arrived. He is convinced that one of the men was Mohammed Atta, the alleged ringleader of the September 11 suicide hijackings.

When photos of the hijackers were released, "I knew it was him," Whitener said. "I will never forget that face of his." Whitener said the man told him he had flown from the Atlanta area and asked about a nearby chemical plant. Uneasy about the conversation, Whitener reported it to the airport manager, who joked that the men might be terrorists.

According to Whitener the man asked: "So tell me about this factory I just flew over," referring to a former copper processing plant nearby, with dozens of round steel tanks and flanked by towering smokestacks. At the time, hundreds of rail tanker cars were parked near the plant, Whitener said.

The plant's owner, Intertrade Holdings, had recently stopped storing sulfuric acid and other hazardous chemicals in the tanks in preparation for closing the plant's acid manufacturing operation.

"He was just persistent about the chemical company," Whitener said. "I told him the tanks were empty. He came back and said 'Don't tell me that. What about all the ... tanker cars?' This guy was just arrogant."[3]

[1] Eric Pianin. "Toxic Chemicals' Security Worries Officials," *Washington Post*, November 12, 2001.
[2] Testimony of Amy E. Smithson, Director, Chemical and Biological Weapons Nonproliferation Project, Henry L. Stimson Center, before the House of Representatives Committee on Transportation and Infrastructure Subcommittee on Water Resources and the Environment, November 8, 2001.
[3] Joel Engelhardt , "Hijacking Suspect Cased Targets, Experts Say Mohammed Atta Called A 'Little Bomb Walking Around'," *Palm Beach Post*, October 28, 2001.

Weak Security at Chemical Facilities

The Agency for Toxic Substances and Disease Registry (ATSDR) published a study in 1999 evaluating chemical industry vulnerability to terrorism. It reported that industrial chemicals provide terrorists with "effective and readily accessible materials to develop improvised explosives, incendiaries and poisons."[4]

The ATSDR study of chemical site security examined two key chemical communities—the Kanahwa Valley in West Virginia and Las Vegas, Nevada. The study found the industry ill-prepared to fend off terrorist attacks. It concluded that industry security was fair to poor:

- Chemical plant security managers were pessimistic about their ability to deter terrorist attacks by employees, yet their companies had failed to conduct simple background checks for key position such as chemical operator.
- None of the corporate security staff had been trained to identify common chemicals at the facilities that could be used as improvised explosives and incendiary devices, although most were aware of chemicals that pose significant fire, explosion and poison hazards.
- Security around chemical transportation assets ranged from poor to nonexistent.
- Rail cars containing cyanide compounds, flammable liquid pesticides, liquefied petroleum gas, chlorine, and butadiene were parked alongside residential areas without adequate security safeguards.
- Serious concerns were raised about potential vulnerabilities of sensitive subpopulations such as children, patients, and health care facilities.[5]

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– Agency for Toxic Substances and Disease Registry

The ATSDR report concluded that industrial chemicals provide terrorists with effective, readily accessible materials to develop improvised explosives, incendiaries, and poisons.

Industry Responses to the Terrorist Threat

While there are several examples of industrial facilities acting preventively to reduce chemical stockpiles, most industry efforts to date have focused on site security measures that are unlikely to stop terrorists armed with airplanes and truck bombs. One of the best examples of a preventive response came at the Blue Plains sewage treatment plant, located in Blue Plains, Maryland, and serving Washington, DC.

The facility is situated across the Potomac River from the Pentagon, and before September 11th it housed multiple rail cars of chlorine and sulfur dioxide. Chlorine and sulfur dioxide are so volatile that the rupture of one full 90-ton tanker could spread a lethal cloud capable of killing people within 10 miles. From Blue Plains, such a swath could cover downtown Washington, DC, Anacostia, Reagan National Airport, and Alexandria.[6]

Over the course of eight weeks after September 11th, authorities quietly removed up to 900 tons of liquid chlorine and sulfur dioxide, moving tanker cars at night under guard. "We had our own little Manhattan Project over here," Jerry N. Johnson, general manager of the D.C. Water and Sewer Authority, which runs the plant, told the *Washington Post*. "We decided it was unacceptable to keep this material here any longer."[7]

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[4] Pianin 2001 *Ibid*.
[5] Agency for Toxic Substances and Disease Registry. "Industrial Chemicals and Terrorism: Human Health Threat Analysis, Mitigation and Prevention," 1999.
[6] Carol D. Leonnig and Spencer S. Hsu, Fearing Attack, Blue Plains Ceases Toxic Chemical Use, *Washington Post*, Saturday, November 10, 2001, Page A01.
[7] Leonnig and Hsu 2001 *Ibid*.

While the conversion to safer materials had been planned to occur over a three year period, the urgency of the terrorist attacks pushed the District to act in a matter of weeks. The District's plant operators said they became convinced that the previously dismissed risk of a catastrophic chemical release (recognized since 1982[8]) had become a pressing concern.

Unfortunately, the Blue Plains water treatment facility has emerged as an exception among facilities using hazardous chemicals.

The American Chemistry Council, the chemical industry's primary lobbying organization, has issued site security guidelines for its member companies and even gone as far as making membership in the Council contingent on application of the guidelines. However, the guidelines focus only on site security and fail to provide guidance on reducing hazards. The use of airplanes on September 11th and the use of truck bombs in previous attacks show that terrorists need not penetrate a site's perimeter to cause destruction, and security alone is inadequate to prevent a terrorist attack. By contrast, reducing chemical hazards at their source, as the operators of Blue Plains have done, mitigates or eliminates the possibility that a terrorist could trigger a chemical release.

An even less protective response has been the effort by some in industry and government to limit public access to information on chemical hazards. Arguing that such information could provide a "roadmap" for terrorists, federal agencies have removed information about chemicals used and stored in communities from the Internet; some in industry have demanded that all public access be denied. Such information should be used to protect public safety, not seen as a threat to it.

Chemical Targets in American Communities

Sites where a terrorist could trigger a chemical release are numerous and widespread. Approximately 15,000 facilities in the U.S. have submitted Risk Management Plans (RMPs) to the U.S. EPA as required under the 1990 Clean Air Act Amendments. The Risk Management Program is EPA's primary chemical accident prevention program. Nearly 5,000 of these facilities have a maximum quantity of at least 100,000 pounds of a chemical considered extremely hazardous on site – more than the amount released in the Bhopal, India, disaster that killed thousands and left hundreds of thousands injured. At least 100 facilities each store more than 30 million pounds of an extremely hazardous substance. The potential for a catastrophic chemical release is widely distributed: every U.S. state except Vermont has at least one facility storing more than 100,000 pounds of an extremely hazardous substance.[9]

In a Risk Management Plan, each facility is required to describe a worst-case chemical accident scenario and the vulnerability zone for such an accident. The vulnerability zone is the area in which injuries, death, environmental damage, or property damage could occur in the event of a chemical spill, release, or explosion. A preliminary analysis of these worst-case scenarios by EPA staff shows that the extent of potential harm a community could face is quite significant, both in the geographic area and the population that could be affected (see Table, next page).

[8] Radian Corporation, *Air Dispersion Model Assessment of Impacts From a Chlorine Spill at the Blue Plains Wastewater Treatment Plant (Final Report),* December 15, 1982.

[9] Jeremiah Baumann and Paul Orum, U.S. PIRG Education Fund and Working Group on Community Right-to-Know. "Accidents Waiting to Happen: Hazardous Chemicals in the U.S. Fifteen Years After Bhopal." December 1999.

Facilities Using Industrial Chemicals and the Numbers of Americans At Risk in a Worst-Case Scenario[10]	
Population At Risk	**Approx. Number of Facilities**
1,000 or more	8,000
10,000 or more	3,000
100,000 or more	700
1,000,000	125

As the table shows, 125 facilities each put at least 1 million people at risk; 8,000 facilities each put at least 1,000 people at risk. (These numbers represent the total number of people inside each facility's vulnerability zone; not all necessarily would be injured by a single chemical release.) The median number of people inside a facility's worst-case vulnerability zone is 1,500 people. In addition to the risks faced by the general population, workers at every facility and the emergency workers who would respond to an incident are the most likely to be injured or killed in a chemical release.

Certain Chemicals and Industries Account for a High Percentage of the Risk
Facilities have submitted Risk Management Plans (RMPs) for 70 toxic and 57 flammable substances or mixtures; however, only a handful of chemicals account for a high percentage of the risk. Four chemicals appear in approximately 70% of RMP processes[*]– ammonia, chlorine, flammable mixtures, and industrial uses of propane (see Appendix A).

Similarly, a handful of industrial sectors present the majority of the risk. Farm supplies wholesalers, water supply and irrigation, sewage treatment, and petroleum refineries together comprise more than 60% of the RMP processes reported (see Appendix B). The four chemicals that appear most frequently in RMPs (ammonia, chlorine, flammable mixtures, and propane) are among the chemicals most commonly associated with the four industries that account for the majority of reported RMP processes.[11]

Certain Communities Face Greater Risk
The public cannot identify the specific facilities that put the most Americans at risk – for example, the 125 facilities whose vulnerability zones include at least 1 million people – because Congress passed a law in 1999 that strictly limits public access to the Risk Management Program database of worst-case chemical scenarios. Worst-case scenario data would provide the best tool to determine the facilities, communities, and states where the most Americans are at risk. Unfortunately, the passage of the 1999 law means that the preliminary analysis of worst-case scenario data (cited in this report) is the only summary of worst-case scenario data available.

However, the storage data in the RMP database provide a rough indicator of how chemical release risk is distributed geographically. Appendix C shows the number of facilities in each state storing more than 100,000 pounds of an extremely hazardous substance. The risk is distributed widely – every state (and the District of Columbia) except Vermont has at least one facility storing more than 100,000 pounds of an RMP-covered substance. But the risk is also concentrated. The six states with the most facilities storing more than 100,000 pounds of a hazardous chemical – Illinois, Iowa, Kansas, Nebraska, Texas, and Minnesota – contain more than half the facilities that are above this threshold.

However, this examination of storage data does not take into account the population potentially affected by a chemical release. Farm states top this list because farmers commonly store ammonia in extremely high quantities for use as fertilizer; however, since rural areas tend to have

[10] James Belke, U.S. Environmental Protection Agency. "Chemical accident risks in U.S. industry – A preliminary analysis of accident risk data from U.S. hazardous facilities," September 25, 2000.
[*]The basic reporting unit for the RMP program is called a "process," defined as "any system of interconnected or co-located vessels and pipes which contain, in total, more than a threshold amount of at least one regulated substance" (Belke 2000). Many facilities contain more than one process.
[11] Belke 2000 *Ibid*.

lower population densities, fewer people are at risk in the event of a chemical release. To determine the geographic distribution of risk among areas with higher population densities, we examine the states with the highest number of facilities storing more than 100,000 pounds of a hazardous chemical other than ammonia.

Here again, the risk is distributed widely (see Appendix C), with every state (and the District of Columbia) except for Vermont and Alaska containing at least one facility that stores more than 100,000 pounds of a hazardous chemical other than ammonia. And again, the risk is also concentrated, with the top nine states – Texas, California, Louisiana, Ohio, Illinois, Pennsylvania, South Carolina, Georgia, and New Jersey – containing more than half the facilities that store more than 100,000 pounds. Because many of these states tend to have higher population densities than rural states where ammonia prevails, these states may be more likely terrorist targets.

The Real-Life Impact of Chemical Releases

Unfortunately, accidental chemical releases are a common occurrence in the United States. Examining the ongoing impacts of these accidental chemical releases demonstrates the potential impact of an act of chemical terrorism. Each year, companies in the United States report more than 25,000 fires, spills, or explosions involving hazardous chemicals to the National Response Center, a broad but incomplete federal record of mishaps involving oil or chemicals.[12] At least 1,000 of these events each year involve deaths, injuries, or evacuations. Combined data from additional federal sources suggest that there were more than 100 deaths in 1998, nearly 5,000 injuries, and when including small spills, almost 50,000 incidents related to ordinary industrial use of chemicals in the United States.[13] Serious incidents often cost jobs, and uncounted people suffer long-term consequences from exposure to the dangerous chemicals. One estimate suggests costs of about $5 billion for major U.S. chemical accidents each year.[14]

Calvert City, KY—On January 29, 2002, a fire at Westlake Monomers resulted in the release of approximately 5,000 pounds each of chlorine and vinyl chloride, highly toxic materials used at the plant to manufacture polyvinyl chloride (PVC) pipe. A toxic cloud spread across nearby communities, where residents first noticed the smell of the toxic gas. Residents and firefighters reported dogs, horses, and other farm animals exhibiting symptoms of sluggishness, diarrhea, and vomiting and that some small birds and dogs died. At least 50 people were evacuated and eight were treated for dizziness, sore throats, and burning skin.[15]

Minot, ND—On January 18, 2002, a train derailed and seven tank cars ruptured, releasing anhydrous ammonia. A white toxic cloud drifted over a neighborhood and lingered for about five hours. Three dozen residents were evacuated from their homes for at least a week, one man died from the chemical exposure, and approximately 1,300 people were treated for symptoms ranging from mild irritation of the eyes, nose, and throat to difficulty breathing to severe chemical burns.

Pleasant Hill, Missouri—On February 28, 2000, someone deliberately opened a valve at a chemical plant causing a leak of 200 gallons of anhydrous ammonia and a poisonous cloud that forced more than 250 people to be evacuated.[16]

Allentown, PA—On February 19, 1999, a deadly blast at Concept Sciences, which was manufacturing hydroxylamine, leveled the plant and seriously damaged several buildings off-site,

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[12] National Response Center. The NRC is the central federal agency to which chemical companies and transporters report oil and chemical spills. Reports to the NRC cover incidents small and large. Reports are preliminary and subject to verification and change (www.nrc.uscg.mil/foia.htm).

[13] Sam Mannan, Michela Gentile, and Mike O'Connor, "Chemical Incident Data Mining and Application to Chemical Safety Trend Analysis," Mary Kay O'Connor Chemical Process Safety Center, Texas A&M University, 2001.

[14] Larry Collins, Carmen D'Angelo, Craig Mattheissen, and Michael Perron, "Estimating Chemical Accident Costs in the United States: A New Analytical Approach."

[15] U.S. Chemical Safety & Hazard Investigation Board. Chemical Incident Reports Center (www.csb.gov/circ).

[16] "Dozens Flee Deliberate Poison Cloud," *Reuters*, 28 February 2000

including a nearby day care center. Five people were killed in the blast, and several others seriously injured.

Williamsport, PA—On January 4, 1996, a thick cloud of chlorine gas blanketed the city of Williamsport, sending 26 people to the hospital. Victims suffered headaches, eye irritation, and breathing problems. The cloud formed as a result of a chlorine leak from a railroad tanker at the Lonza Chemical Plant.

Rodeo, CA—August 22 - September 6, 1994. A 16-day release of 125 tons of a caustic catalyst including heavy metals and organics sickened and injured 1,500 people living near the Unocal plant. Victims experienced vomiting, headaches, memory loss, brain damage, and other cognitive disorders. Some residents remained sick for well over a year after the Unocal accident.

Richmond, CA—On July 26, 1993, a three hour leak of oleum (pure sulfuric acid) from an overheated railroad tank car at the General Chemical Corp. sent approximately 24,000 people to the hospital from having inhaled acid mist. The highly concentrated acid vapors, which were not captured by safety systems, formed a toxic plume and drifted about 15 miles from the site.

Superior, WI—A June 30, 1992 rail tank car accident caused the release of more than 20,000 gallons of benzene and other hazardous materials into the Nemadji River on the Minnesota-Wisconsin border, 17 miles from Lake Superior. More than 40,000 people were evacuated as the result of a 20 mile long cloud that engulfed the Duluth/Superior metropolitan area. Significant numbers of fish and wildlife, including beaver, mink, rabbits, and numerous species of birds, died as a result of the accident.

West Helena, AR—On May 8, 1997, an explosion and fire in a building containing 200,000 pounds of pesticides killed three firefighters and injured 16 people. The pesticides, combustion by-products, and even chemicals created by the firefighting activities formed a highly toxic cloud, forcing the regional hospital to be evacuated, along with residents in a 3-mile radius.

Part 2:

Reducing Chemical Hazards to Make Communities Safer

The actions of American industry – and American regulatory policy – have historically focused on preparing for or managing chemical risks rather than preventing them. The continuing legacy of chemical accidents in the United States is evidence that this strategy has failed to protect public safety. The events of September 11th make plain the need for preventive action. Safety valves may mitigate the effects of an accidental release, and employee training may reduce the chances of an accident, but neither can protect public safety if a terrorist parks a truck bomb at a chemical plant. Designed to protect only against accidental releases, many accident mitigation technologies could be foiled by a deliberate saboteur.

Reducing or eliminating chemical hazards offers the best strategy to fully protect American communities from terrorist attacks involving industrial chemicals. Hazard reduction means making a chemical process *inherently* safer by eliminating the use of highly toxic, volatile, or flammable chemicals or using chemicals in safer quantities or conditions. The concept of inherent safety leads to a hierarchy to guide decisions on the use and management of chemicals:

> **First**, reduce or eliminate the *possibility* of a chemical release by choosing inherently safer materials and technologies.
> **Second**, reduce the *probability* of a chemical release through secondary prevention measures such as safety valves and double-walled vessels. In preventing terrorism, increasing site security is an additional secondary prevention measure (although inadequate in the context of modern terrorist tactics).
> **Third**, reduce the *potential severity* of the impacts of a chemical release through mitigation measures (containment dikes, sprinkler systems) or emergency response plans.[17]

Again, the first option – inherent safety – provides the best response to the threat of chemical releases caused by acts of terrorism. Add-on security and mitigation measures could make minor contributions toward preventing an act of terrorism, but traditional tools of terrorists – truck bombs, suicide bombers, and now airplanes – would likely render such measures nearly useless. Site security measures could prevent a terrorist from entering the grounds of a facility, but in the embassy bombings in Africa, the trucks containing bombs were parked near, not inside, facility grounds; increased security would have been of little help.

A fourth option exists – establishing buffer zones to keep populations outside vulnerability zones. However, establishing buffer zones, either by relocating a facility or paying to relocate entire neighborhoods or communities (some vulnerability zones extend 25 miles), is both disruptive and expensive unless undertaken through proper planning *before* communities are built near chemical plants (or vice versa). Inherent safety, in contrast, can be an economically sound investment. A recent study of four firms, two in Greece and two in the Netherlands, found some two dozen inherently safer production options that had pay back times of less than two years.[18]

[17] Adapted from N.A. Ashford, Gobbel, J. V., Lachman, J., Matthiesen, M., Minzner, A., and R.F. Stone, *The Encouragement of Technological Change for Preventing Chemical Accidents: Moving Firms from Secondary Prevention and Mitigation to Primary Prevention*. Cambridge, Massachusetts: Center for Technology, Policy, and Industrial Development, Massachusetts Institute of Technology, Boston, 1993.

[18] N.A. Ashford and Gerard I.J.M. Zwetsloot, "The Feasibility of Encouraging Inherently Safer Production in Industrial Firms," to be published in *Safety Science*. Nicholas A. Ashford is professor at Massachusetts of Institute of Technology; Gerald Zwetsloot is professor at Erasmus University Rotterdam, the Netherlands.

Hazard Reduction in Practice

Many examples illustrate the range of what facilities can do to be inherently safer:

- In Washington, DC, the city's large Blue Plains Sewage Plant is switching from volatile chlorine gas to less volatile sodium hypochlorite bleach, which has far less potential for airborne off-site impact.[19]
- In New Jersey, hundreds of water treatment plants have stopped using or reduced their use of chlorine gas to below threshold levels as a result of the state's Toxic Catastrophe Prevention Act – from 575 such water treatment facilities in 1988 to just 22 in 2001.[20]
- In Cheshire, Ohio, American Electric Power selected a urea-based pollution control system rather than one involving large-scale storage of ammonia that would have endangered the surrounding community.[21]
- In Cuyahoga County, Ohio, ALCOA reduced its potential off-site impact by working with local emergency planners and ending on-site storage of hydrofluoric acid and nitric acid.[22]
- A recent study of Local Emergency Planning Committees identified successful examples of hazard reduction in eight communities, involving ammonia, chlorine, toluene diisocyanate, and cyanide.[23]

In order to apply the concept of inherent safety to the thousands of unique chemical facilities in the U.S., firms should assess chemicals, processes, or practices that could make their facilities inherently safer. A study by Nicholas Ashford *et al* of the Massachusetts Institute of Technology for the U.S. EPA recommends that toxic chemical producers and users be required to undertake a technology options analysis[24], a concerted effort to identify inherently safer alternative technologies. A technology options analysis provides an opportunity for facilities to adopt inherently safer technologies with acceptable cost and appropriate performance characteristics and to explain why any technically feasible options were not selected. Facilities and government agencies should make information contained in technology options analyses available to the public (while protecting legitimate confidential business information) in order to disseminate information on innovative technologies and to inform residents of safety measures in their communities.

Toxics use reduction planning has shown that assess-and-disclose programs, like a required technology options analysis, can significantly reduce chemical use and therefore chemical hazards. In Massachusetts, firms are required to assess and disclose the chemicals used by their facilities – the amounts brought on site, shipped in product, released to the environment, generated as waste, etc. In addition, firms complete toxics use reduction plans. Between 1990 and 1999, Massachusetts firms reduced their overall use of toxic chemicals by 41%, the waste generated by 57%, and their environmental releases by 87%. Meanwhile, production rose 52% at the same facilities, which saved a total of $15 million by reducing their chemical use.[25]

The Right to Know as a Safety Tool

It is important to note the role that ensuring a community's right-to-know about chemicals used, stored and released has already played in protecting public safety from toxic hazards. Public disclosure of hazards has been critical to the success of the Toxics Release Inventory and the Massachusetts program described above. Similarly, New Jersey's Toxic Catastrophe Prevention

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[19] Eric Pianin. "Toxic Chemicals' Security Worries Officials," *Washington Post*, November 12, 2001.
[20] New Jersey Department of Environmental Protection, communication between Reggie Baldini and Paul Orum, Working Group on Community Right-to-Know. September 19, 2001.
[21] American Electric Power, press release, December 18, 2000.
[22] Communication between Stuart Greenberg, member, Cuyahoga County (Ohio) Local Emergency Planning Committee, and Paul Orum, Working Group on Community Right-to-Know, 1998.
[23] National Institute for Chemical Studies (Charleston, W.V.), "Local Emergency Planning Committees and Risk Management Plans: Encouraging Hazard Reduction," prepared for U.S. EPA, Chemical Emergency Preparedness and Prevention Office (#CX 824095), June 2001.
[24] Ashford et. al. 1993 *Ibid.*
[25] Toxics Use Reduction Institute, Lowell, MA. See http://www.turi.org/turadata/Success/ResultsToDate.html.

Act, which has contributed to hundreds of drinking water facilities ceasing the use of chlorine gas, is complemented by the Pollution Prevention Act, which requires companies to assess and report chemical use.

Public access to information about chemical use and releases, and communities' involvement in reducing chemical hazards, should not be limited in the effort to prevent chemical terrorism. While officials must make certain that terrorists do not obtain technical information not available elsewhere, the chemical industry has a responsibility to inform the public of chemical hazards and potential harm from a chemical release.

Existing Policies Are Inadequate to Protect Against Terrorism

The Emergency Planning and Community Right-to-Know Act

After the 1984 Union Carbide chemical disaster in Bhopal, India, which killed more than 3,000 people, grassroots pressure to address the potential for chemical releases grew quickly. Congress responded in 1986 by passing the Emergency Planning and Community Right to Know Act (EPCRA). This established a network of Local Emergency Planning Committees and required facilities to disclose and make publicly available a baseline of important information on chemical risks. Among the information facilities were required to report was information on the amount of extremely hazardous materials stored at particular facilities (EPCRA sections 312 and 312, also called Tier I and Tier II information).

The information collection and dissemination portions of EPCRA were significant; for the first time the public had, by right of law, access to information on chemical storage in communities, as well as information on routine releases of toxic substances. The Toxics Release Inventory, created under EPCRA, annually discloses thousands of facilities' toxic releases. This disclosure has contributed to a nearly 50% decline in reported releases.

Nevertheless, EPCRA primarily addressed the need to *prepare for and respond to* chemical releases, rather than the need to prevent them. The Local Emergency Planning Commissions (LEPCs), while an important potential point of communication between residents and facilities, lack an adequate legal mandate for prevention. A recent study of 32 "active" LEPCs found that "with a few exceptions, they do not believe they are positioned to effectively encourage facilities to reduce chemical hazards." Most of these LEPCs believe they "do not have the time, resources or expertise to encourage hazard reduction."[26]

Those surveyed were "active" LEPCs. An earlier national survey found that 21 percent of LEPCs were "inactive," 39 percent were "quasi-active," 16 percent were "compliant," and 24 percent were "proactive."[27] Among many additional barriers, LEPCs lack the authority and mandate for hazard reduction; can be hampered by dependent relations with industry; and can become discouraged by a perceived unwillingness of government and industry to act. Many also lack funding. According to one report, "many LEPCs exist only on paper, and many others exist, but have not succeeded in meeting even their basic responsibilities.[28]

The Clean Air Act and the Risk Management Program

In 1990, Congress took further action, partially in response to an explosion at a Phillips chemical facility in Texas that killed 23 workers. While stopping short of requiring standards for industry performance on safety, the 1990 amendments to the Clean Air Act, in section 112(r), established a general duty of industries to ensure the safety of their facilities. Businesses which produce, process, handle, or store extremely hazardous substances have, under the Clean Air Act's section 112(r)(1), a general duty "to identify hazards which may result from such releases, using appropriate hazard assessment techniques, to design and maintain a safe facility taking such

[26] National Institute for Chemical Studies (Charleston, W.V.), "Local Emergency Planning Committees and Risk Management Plans: Encouraging Hazard Reduction," prepared for U.S. EPA, Chemical Emergency Preparedness and Prevention Office (#CX 824095), June 2001.
[27] George Washington University, Department of Public Administration, *Nationwide LEPC Survey*, 1994.
[28] Resources for the Future, *The Future of Local Emergency Planning Committees*, 1993.

steps as are necessary to prevent releases, and to minimize the consequences of accidental releases which do occur."

The Clean Air Act also required covered firms to prepare risk management plans to guide the process of implementing the general duty. The risk management plans include three basic elements:

- A **hazard assessment** covers release scenarios, worst-case off-site consequences, and a five-year accident history;
- A **prevention program** requires management of basic procedural areas (such as training, maintenance, pre-startup reviews, and safety audits); and
- An **emergency response program** includes response plans, drills, and coordination with local emergency planners.

The general duty clause of Section 112(r) was a significant step toward preventing chemical releases, because it includes the *prevention* of chemical releases (not just the mitigation of their impacts) in industry's duty to operate safely. However, the implementation of the law failed to take this opportunity to move industry toward true prevention. The implementing regulations establish no standards for industries to adopt specific safety measures. Instead, they require companies to study and inventory existing measures and the risks presented and to comply with voluntary standards adopted by industry trade associations.

Even the inventorying of existing measures focuses on mitigating the impacts of a release rather than preventing the release. EPA failed to require that facilities conduct a technology options analysis or other means of even evaluating chemical or process changes that could reduce or eliminate the possibility of a catastrophic release.

Thus, the Clean Air Act and its Risk Management Planning program primarily address the *management* of chemical risks, but still not their *prevention*. The RMP program, if fully implemented as EPA originally planned, could have reduced hazards through its right-to-know components. EPA intended to compile the worst-case scenario estimates of off-site impacts of chemical releases in a national database and make it available to the public. This facility-specific hazard disclosure could have led to hazard reductions as the Toxics Release Inventory has. However, this public safety tool was never realized; in 1999 Congress forbade the release of worst-case scenarios in any form that could allow their posting on the Internet.

An additional significant shortcoming of both EPCRA and the Clean Air Act's Risk Management Program, as they pertain to the risk of terrorism, is that these laws (and the ensuing regulations) were written and passed with no concern for potential terrorist attacks on American chemical facilities. These laws only pertain to certain chemicals and industries, and within those industries, only to facilities using quantities of chemicals above certain thresholds.

However, smaller quantities of chemicals, which may be of less concern because easier management makes an accident less likely, can be hazardous if a terrorist is deliberately intending to cause harm. There could be additional chemicals and industry sectors that would be attractive targets for chemical terrorism, such as relatively smaller facilities located in denser urban areas, even if the risk of accidents has previously been considered low. For example, releasing the contents of a single one-ton cylinder of chlorine gas could result in toxic concentrations nearly two miles off-site, but one ton of chlorine falls below the thresholds that trigger risk management planning.

Some local and state laws go beyond federal law and take a preventive approach to reducing hazards. New York City and Contra Costa County (in California) have adopted laws that require facilities in their jurisdiction to consider and adopt inherently safer technologies, and Contra Costa County requires facilities to document "meaningfully" why any safer technologies were not adopted.

New Jersey's Toxic Catastrophe Prevention Act (TCPA) includes consideration of alternative technologies in its implementing regulations. In addition, the TCPA levies fees on facilities using hazardous chemicals. This program has contributed to a dramatic reduction of hazards. As noted above, in 1988, 575 water treatment facilities were using threshold quantities of chlorine gas; by late 2001, only 22 remained.[29]

Policy Solutions to Make Communities Safer

The possibility that terrorists could turn American industry into weapons that threaten Americans' safety provides policy-makers with a clear imperative to revise existing policy immediately in order to encourage, even require, preventive action to eliminate the possibility of lethal chemical releases.

The most effective means of protecting American communities from the consequence of an act of chemical terrorism is to encourage and mandate hazard reduction actions that make use of inherently safer technologies wherever feasible. This could be achieved through a range of policy strategies and avenues that are available for legislators and regulators at the state and federal levels.

The vast complexity of the U.S. chemical industry makes it difficult to develop one-size-fits-all regulations, but there are several ways that policymakers at all levels of government can mandate the use of inherently safer technologies wherever feasible while affording the flexibility to encourage innovation and allow facilities to adapt available technologies to their sites' needs.

Policies Options to Reduce Chemical Hazards

Policymakers must first determine which policies would best ensure that industries reduce hazards by applying inherently safer technologies wherever possible. One strategy for achieving this is to target specific combinations of industries and chemicals. Policymakers could create groupings of industries and chemicals and require specific technological changes for those groups. Chlorine and hydrogen fluoride provide opportunities for this kind of requirement. Policymakers could, for example, mandate that water treatment facilities cease using chlorine and switch to safer chemicals. There are numerous alternatives to the use of chlorine for water treatment that would provide reduced or eliminated potential for off-site consequences of a release. Similarly, policymakers could restrict refineries' use of hydrogen fluoride, which is extremely toxic and easily forms a toxic cloud (because its boiling point is only 62 degrees Fahrenheit).[30]

Another strategy, however, provides facilities with even more flexibility – the technology options analysis. Policymakers could require facilities, as part of the accident prevention planning already required, to evaluate inherently safer alternatives to current practices and adopt those alternatives wherever feasible.

Facilities should be required to explain why they chose not to change any process for which there is an inherently safer alternative; however, policymakers should narrowly limit the reasons a facility could choose not to apply inherent safety. These could include prohibitively high economic impacts (with a very high threshold for allowing cost to outweigh the elimination of risk to facility neighbors), the unavailability of reliable alternative technologies, or increased risk elsewhere in the production process as a result of a technology change (for example, if reducing on-site storage increases the frequency of non-secured transportation of the chemical or if risks to workers increase as a result of decreasing potential off-site impacts).

[29] New Jersey Department of Environmental Protection, communication between Reggie Baldini and Paul Orum, Working Group on Community Right-to-Know. September 19, 2001.
[30] Sanford Lewis, Good Neighbor Project, and Milton Lapkin, "Boosting the First Line of Defense: Moving Toward Safer Materials in Refinery Alkylation."

Reducing Hazards for Diverse Industries
The second question is how to regulate a group of industries that includes hundreds of thousands of facilities using hazardous chemicals in different capacities. The technology options analysis addresses this challenge well, because it allows flexibility. Policymakers should require this assessment of all facilities that use hazardous chemicals in quantities that could threaten the surrounding population.

Policymakers should additionally mandate the use of safer alternatives where clear alternatives exist, but should develop such regulations for facilities that pose the greatest threat first. The Risk Management Program's worst-case scenario component provides a starting point for addressing the highest-hazard facilities first. Policymakers could study and develop regulations first for the 125 facilities that each put more than one million people in at risk, then for the 700 facilities that each put more than one hundred thousand people at risk, and so on. Where significant hazards cannot be eliminated, policymakers should establish a strict and comprehensive site security program to minimize the likelihood of a terrorist attack.

Using existing regulatory programs as a starting point requires careful evaluation to ensure that all hazardous facilities are addressed. The RMP program was developed primarily to address accidental releases, not releases related to acts of terrorism.

Policymakers should examine chemicals, industrial sectors, and facilities not covered by existing programs and expand programs to cover them where appropriate. Within covered industrial sectors, only facilities using chemicals in quantities above certain thresholds are currently subject to risk management planning. However, as discussed, smaller quantities could be of greater concern when the potential for terrorist attacks is considered. Policymakers should consider, and adopt where appropriate, lowering chemical use thresholds to trigger chemical release prevention planning.

Changes to Existing Policy
The third question is how to modify existing policies and at what level of government. Congress and the state legislatures have the authority to compel each of the changes described here. State regulatory agencies' authority to establish a hazard reduction mandate that applies to all facilities and chemicals of concern varies from state to state. Federally, the U.S. EPA has authority to compel necessary changes under the Clean Air Act and authorities created by other laws.

The U.S. EPA and other policymakers should move forward with existing authority to initiate the process of implementing necessary changes. The threat of chemical terrorism is immediate, so a policy response also needs to be immediate. Since technology options analyses allow flexibility among industries and facilities, policymakers should immediately require technology options analyses by facilities already covered by regulatory programs and establish a date by which the results of such analyses must be submitted to EPA. In addition, EPA should re-evaluate current thresholds and covered industries and chemicals and promulgate regulations mandating inherent safety changes for specific groups of facilities, starting with the facilities that threaten the most people.

Because the threat of terrorism is immediate, policymakers also should adopt stopgap measures short of inherently safer technologies, including improved release mitigation technology and increased site security. These immediate requirements would not only partially protect safety in the short term but would contribute to safety in the longer term at facilities where inherently safer technologies are not available.

Additionally, in the short term, the site security requirements would provide a financial incentive for facilities to identify and apply safer technologies more rapidly than a statutorily required timeline might provide. The increased cost of security would create an incentive for facilities that are currently unable to identify safer choices to develop them over time.

Policymakers should require that industries that create a threat to neighboring communities pay the cost associated with increased security or safety technology. This concept follows from the well-established “polluter pays” principle and creates a disincentive to rely only on expensive add-on safety measures that fail to completely protect the public. Policymakers could create an additional financial incentive for inherent safety by levying fees on facilities that use hazardous chemicals that could become terrorist targets. These fees could be used to provide technical assistance for smaller firms to conduct technology options analyses and to conduct research into inherently safer technologies for chemicals and processes for which inherently safer choices are not currently available.

Policymakers should consider a final measure where inherent safety options are not used but where the potential off-site impacts remain too severe to rely on add-on release mitigation measures or physical security. In such situations, facilities should establish buffer zones and pay to relocate residences, hospitals, schools, or other vulnerable sites outside the vulnerability zones. These choices can most appropriately be made in the design phase for a new facility; locating a facility far enough from the nearest population reduces the hazard.

By swiftly implementing a comprehensive policy approach that reduces or eliminates the possibility of a chemical release, policymakers can protect American communities against chemical terrorism. This approach must be mandatory in requiring facilities to consider safer options and apply them where feasible. The goal must remain fixed on reducing hazards at their source rather than relying on site security and other measures to respond, rather than prevent, a chemical release.

Appendix A: Chemicals That Most Frequently Create Accident Risks

Four chemicals are present in nearly 70% of all processes reported to EPA's Risk Management Program.[31]

Chemical	Number of Processes	Percentage of Total
Ammonia (anhydrous)	8343	32.5
Chlorine	4682	18.3
Flammable Mixtures	2830	11
Propane (industrial use)	1707	6.7
Sulfur Dioxide	768	3
Ammonia (aqueous 20% or more concentration)	519	2
Butane	482	1.9
Formaldehyde	358	1.4
Isobutane	344	1.3
Hydrogen Fluoride	315	1.2
Pentane	272	1.1
Propylene	251	1
Methane	220	0.9
Hydrogen	205	0.8
Isopentane	201	0.8
All Others	4139	16.1

[31] Belke 2000 *Ibid*.

Appendix B: Industries That Have the Most High-Risk Processes in EPA's Risk Management Program

Four industries account for more than sixty percent of processes reported to EPA's Risk Management Program.[32]

Industry NAICS Code and Description	**Number of Processes**	**Percent of All RMP Processes**
42291 Farm Supplies Wholesalers	4,409	28.84
22131 Water Supply & Irrigation	2,059	13.47
22132 Sewage Treatment	1,646	10.77
32411 Petroleum Refineries	1,609	10.52
325199 All Other Basic Organic Chemical Manufacturing	655	4.28
42269 Other Chemical and Allies Products Wholesalers	607	3.97
49312 Refrigerated Warehousing and Storage Facilities	549	3.59
211112 Natural Gas Liquid Extraction	533	3.49
325211 Plastics Material and Resin Manufacturing	418	2.73
325188 All Other Basic Inorganic Chemical Manufacturing	358	2.34
49313 Farm Product Warehousing	345	2.26
32511 Petrochemical Manufacturing	321	2.10
454312 Liquefied Petroleum Gas Dealers	311	2.03
11511 Support Activities for Crop Production	302	1.98
311615 Poultry Processing	253	1.65
115112 Soil Preparation, Planting, and Cultivating	207	1.35
32512 Industrial Gas Manufacturing	205	1.34
325998 All Other Miscellaneous Chemical Product Manufacturing	193	1.26
325311 Nitrogenous Fertilizer Manufacturing	159	1.04
49311 General Warehousing and Storage Facilities	151	0.99
TOTAL	**15,290**	**100.00**

[32] Belke 2000 *Ibid*.

Appendix C: Number of Facilities in Each State Storing Significant Quantities of Hazardous Chemicals

Ammonia is stored in extremely high quantities in rural areas. However, because of low population density, these are presumably less likely terrorist targets. For that reason, the chart shows both the number of facilities storing *any* extremely hazardous chemical (defined in implementation of the Clean Air Act section 112(r)) in quantities above 100,000 pounds as well as facilities storing an extremely hazardous chemical *other than ammonia* in quantities above 100,000 pounds. The states are ranked by the number of facilities storing more than 100,000 pounds of a chemical other than ammonia.

	State	Number of facilities storing more than 100,000 pounds of any extremely hazardous substance.	Number of facilities storing more than 100,000 pounds of an extremely hazardous substance other than ammonia.
1	Texas	299	152
2	California	155	66
3	Louisiana	85	66
4	Ohio	171	56
5	Illinois	628	55
6	Pennsylvania	52	40
7	South Carolina	44	36
8	Georgia	56	32
9	New Jersey	36	31
10	Florida	59	30
11	Alabama	37	30
12	North Carolina	45	29
13	Tennessee	44	28
14	New York	40	28
15	Kentucky	84	26
16	Indiana	245	25
17	West Virginia	26	24
18	Michigan	67	23
19	Missouri	139	20
20	Arkansas	28	20
21	Washington	91	19
22	Mississippi	30	19
23	Oregon	34	18
24	Minnesota	290	17
25	Wisconsin	72	17
26	Virginia	27	17
27	Kansas	415	13
28	Iowa	524	11
29	Arizona	28	9
30	Maryland	19	9
31	Utah	15	8
32	Delaware	9	8
33	Massachusetts	8	8
34	Oklahoma	117	6
35	Nevada	8	6
36	Nebraska	366	5
37	North Dakota	227	5
38	Montana	42	5
39	Maine	6	5

	State	Number of facilities storing more than 100,000 pounds of any extremely hazardous substance.	Number of facilities storing more than 100,000 pounds of an extremely hazardous substance other than ammonia.
40	Connecticut	5	5
41	Colorado	67	4
42	New Mexico	8	4
43	Rhode Island	4	3
44	District of Columbia	3	3
45	Idaho	32	2
46	Wyoming	10	2
47	Hawaii	3	2
48	South Dakota	50	1
49	New Hampshire	2	1
50	Alaska	1	0
51	Vermont	0	0
	Total	**4,853**	**1,049**