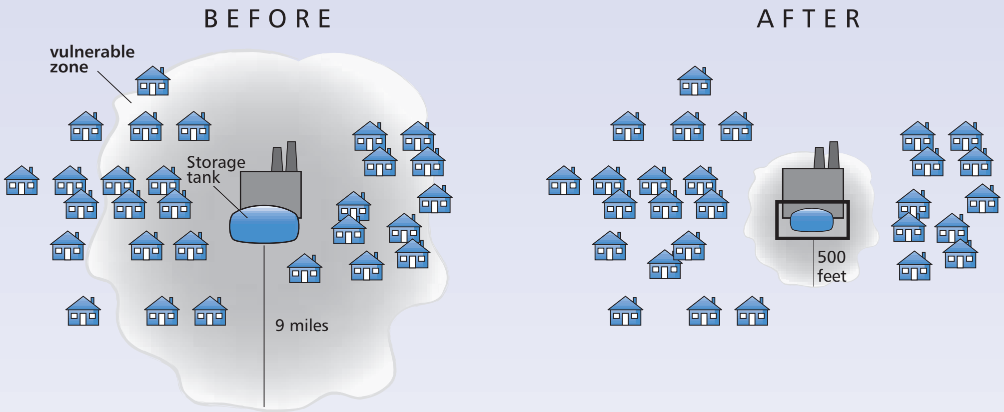
A PUBLICATION OF THE
SAFE HOMETOWNS INITIATIVE

THE SAFE HOMETOWNS GUIDE

HOW TO DO A COMMUNITY REASSESSMENT OF CHEMICAL SITE SAFETY AND SECURITY AFTER SEPTEMBER 11, 2001



Many lives in the community are at risk from accidental or intentional chemical releases.

Using safer materials, reducing storage volumes, adding barriers, and relocating nearest neighbors eliminates major community vulnerability.

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A CHECKLIST FOR REASSESSING CHEMICAL SITE SAFETY AND SECURITY

This checklist lays out steps for community reassessments of the safety and security of sites where chemicals are stored, used or produced. It provides a framework for inquiry and action by local emergency responders, local emergency planning committees, public health officials, businesses, workers, and concerned local residents to reduce and eliminate the dangers to communities from these facilities. Page references refer to sections in this guide that discuss this point

APPENDICES

INTRODUCTION

This is a guide for local health and safety officers, elected officials, emergency responders, local emergency planning committees, businesses, workers and concerned citizens to reassess community safety and security regarding the storage, use, production and transport of extremely hazardous chemicals. Throughout the US economy, thousands of facilities use and ship high volumes of these chemicals, threatening populous communities near to facilities and transit routes where chemical releases can happen.

Most chemical incidents to date have involved accidental releases of chemicals to the environment. The terrorist attacks of September 11, 2001 made apparent that chemical sites around the US could also be targets of terrorists wishing to intentionally harm people and property. While hiring more security guards at these sites may safeguard against some threats, the truth is that these facilities are often so vulnerable that only sharply reducing or eliminating the presence of extremely hazardous substances can truly protect against intentional assaults.

The Blue Plains Sewage Treatment Plant in Washington, DC - located across the Potomac River from the Pentagon - was one of the first places after the September attacks to recognize and act in response to this threat. The facility began a rapid reassessment of its continued storage and use of liquid chlorine. The facility housed 10 rail cars of toxic chemicals, and the rupture of even one of those cars could have killed thousands within minutes. Over the course of eight weeks, authorities quietly removed up to 900 tons of liquid chlorine and sulfur dioxide, moving tanker cars at night under guard as they raced to secure one of the Washington region's biggest toxic chemical stockpiles. While the conversion to safer materials had been planned to occur over a three year period, the sense of urgency resulting from the terrorist attacks yielded a shift to safer materials over just ten weeks.

Our Safety and Security Is Built Upon the Public's Right to Know

This guide is built upon the assumption that we will continue to live in an open society, and that we will work to fight hazards and eliminate vulnerabilities within that context. It details the needs for responsible uses of information available to the public under existing Right to Know laws, and additional information disclosures and institutional arrangements needed to reduce chemical hazards at vulnerable sites.

"Routine" accidents at chemical sites were already a pervasive problem long before the new concerns. Thousands of accidental releases of hazardous materials to the environment have occurred at facilities where extremely hazardous substances are used, stored and produced. Hundreds are injured or killed each year. There is a real danger, in many locations, of a chemical catastrophe that could lead to the deaths of hundreds or thousands in a single incident. In 1984 in Bhopal, India, a single chemical release at a Union Carbide factory killed more than 3,000 people in a single night. The US has not yet experienced a Bhopal-scale chemical incident, but the potential exists at many sites for an tragedy of this magnitude, whether triggered by accidental or intentional releases of chemicals.

The premise of this guide is that local citizens, businesses and officials, working together, can often reduce or eliminate large scale chemical hazards. In the following pages, we suggest some steps to follow to reduce chemical vulnerabilities in your hometown.

BLUE PLAINS TREATMENT PLANT MOVES TO SAFER MATERIALS

"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, said this week. "We decided it was unacceptable to keep this material here any longer."

Chlorine and sulfur dioxide are so volatile that the rupture of a full 90-ton tanker could spread a lethal cloud, which could kill people within 10 miles, Johnson said. From Blue Plains, such a swath could cover downtown Washington, Anacostia, Reagan National Airport and Alexandria. The District's plant operators said they have been convinced that the *previously dismissed risk of a catastrophic chemical release had become a pressing concern*.

James E. Ivey, president of the plant workers' union, said, "You understand that if they had hit those tankers, we'd be talking about more than 6,000 people killed in this area."

Carol D. Leonnig and Spencer S. Hsu, "Fearing Attack, Blue Plains Ceases Toxic Chemical Use," *Washington Post*, November 10, 2001, page A01.

EXECUTIVE SUMMARY

As a result of the attacks of September 11, 2001, communities with facilities storing large volumes of extremely hazardous materials have begun to take a hard look at their safety and security. This guide is intended to aid local officials and concerned citizens in that reassessment.

Terrorist Threat Prompts Reassessments

Months before September 2001, Mohammad Atta, the alleged ringleader of the attacks reportedly had been flying over and scoping out chemical storage tanks. According to a witness in Tennessee, Atta had a peculiar and aggressive curiosity about a group of chemical storage tanks he had seen from the air.

It is not known exactly why Atta was taking such an interest. But it is not idle speculation to be concerned that he may have been looking for targets that could inflict maximum harm on local populations. The federal Agency for Toxic Substances and Disease Registry (ATSDR) reported in 1999 that there have been several incidents in other countries in which terrorists targeted industrial chemical storage or manufacturing facilities as "improvised explosives, incendiaries, or poisons." Routine storage and production of chemicals can, in short, be converted by terrorists into sites of mass destruction.

The ATSDR examined two key chemical communities - the Kanahwa Valley in West Virginia and Las Vegas, Nevada, concluding that chemical industry security ranged from fair to poor. 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 in the report regarding potential vulnerabilities of children, patients and health care facilities located near to these facilities.

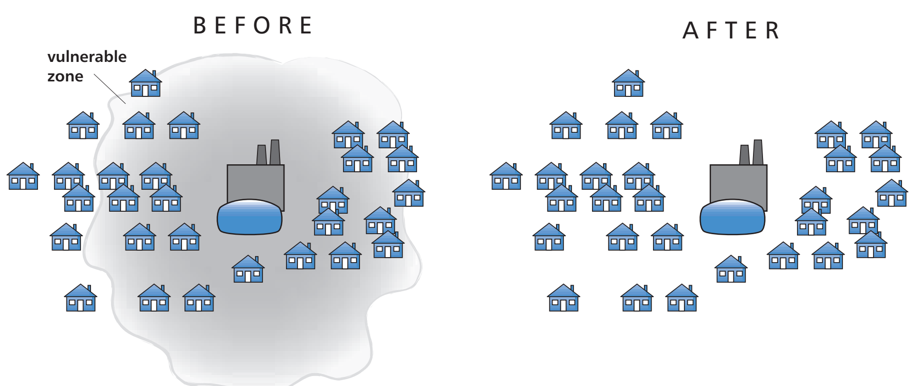
A public reassessment to protect our safety is urgently needed. We know from experience with the airline industry that leaving such issues to the private sector alone does not ensure public safety and security.

Safer Substitutes are the Best Solution

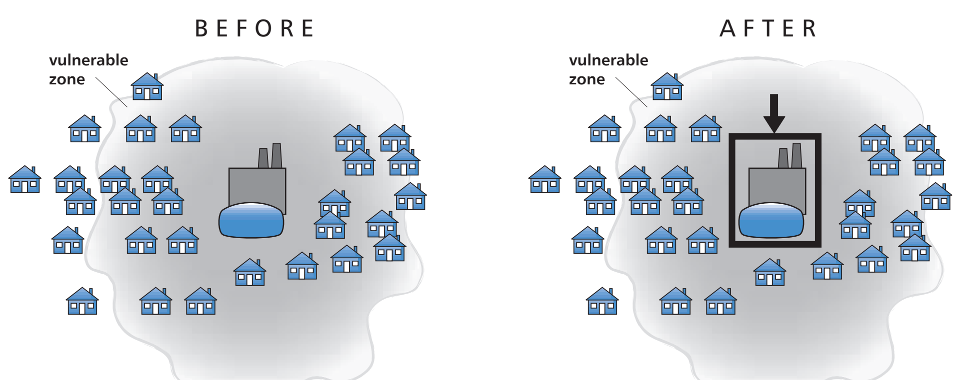
In the face of potential terrorism, it has become necessary to consider the vulnerability of chemical sites to someone intentionally overriding all the existing safety measures, and causing a chemical catastrophe, through assaults on storage tanks by aircraft, vehicles, rocket launchers or other currently unanticipated methods. In the face of such assaults, conventional accident prevention measures are not necessarily going to be able to protect surrounding communities.

The Blue Plains Sewage Treatment Plant in Washington, DC –located across the Potomac River from the Pentagon –was one of the first places after the September terrorist attacks to take urgent action to reduce chemical hazards. With ten railroad cars loaded with liquid chlorine onsite, the intentional rupture of even one of those cars could have killed thousands in the nation's capital within minutes. Under the cover of darkness, facility workers quietly removed the tank cars, and the facility shifted to safer materials. While the facility had plans to convert to safer materials over a three year period, the changeover took just ten weeks with the new urgency posed by terrorism. The switch also raises a fundamental question which every community now should ask: why are local facilities stockpiling chemicals of mass destruction if safer alternatives are readily available?

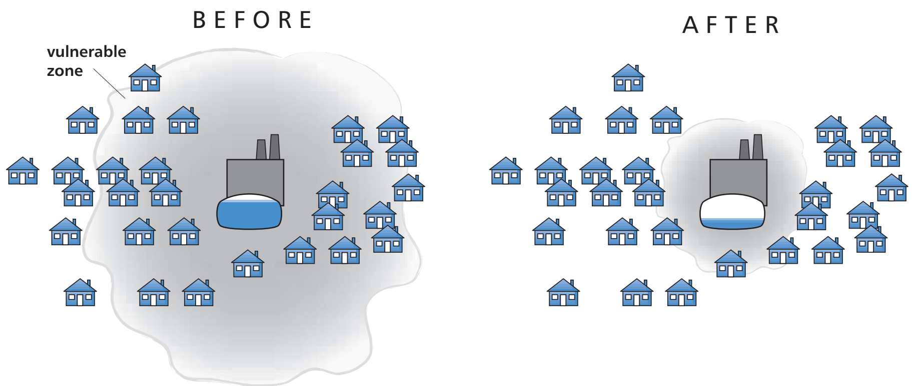
Eliminating Vulnerability By Substituting Safer Materials



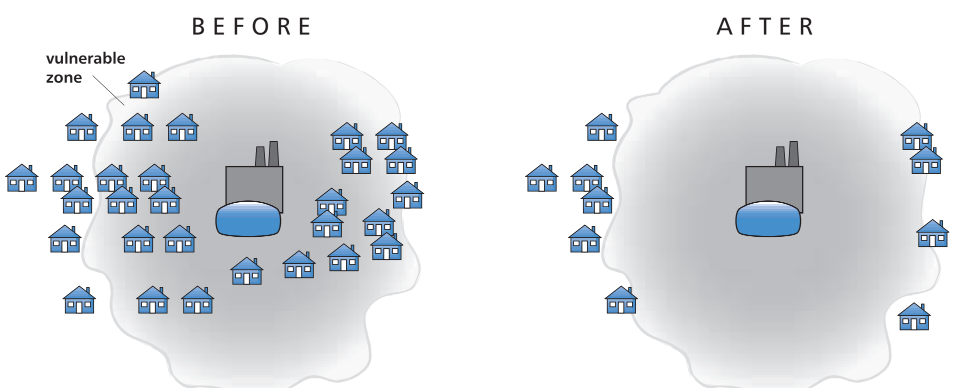
Enhancing Security Through Barriers To Site Access



Reducing Vulnerability By Curtailing High Volume Storage



Reducing Vulnerability By Expanding Buffer Zones



Continued Threat of Catastrophic Accidents

While terrorism has brought immediacy to this issue, chemical accidents are already a pervasive problem plaguing America's hometowns. Between 25,000 - 50,000 accidental releases of hazardous materials occur every year, injuring thousands and killing a hundred or more at refineries, chemical plants, water utilities and other industries. In 1984 in Bhopal, India, a chemical cloud released at a Union Carbide factory killed more than 3,000 people in a single night. The potential exists in many communities in the US for an incident of this magnitude, triggered either by accidental or intentional releases of chemicals.

Inherent Safety First

Past efforts have often over-emphasized emergency planning (e.g. notification and evacuation of local residents) and add-on safeguards to attempt to capture emissions once a release is underway (e.g., stronger containers, trenches around storage tanks). These measures may be ineffectual against a terrorist assault, especially as compared with opportunities for eliminating the hazards. "Inherent safety" measures, such as safer materials or minimizing storage volumes at local sites, are the most effective means of protection and may be readily available for many situations. Communities should give priority to inherent safety strategies whenever possible.

This guide will walk you through a process of identifying and reducing the major hazards in your community.

ACTION STEPS

Establish a Reassessment Group
Identify local officials, concerned citizens, workers and their representatives, school and health officials, and others to conduct a reassessment of chemical vulnerabilities.

Inventory Local Vulnerabilities

- Use information available under national Right to Know and chemical accident preparedness laws to prepare an inventory of local facility hazards. Where possible, also identify materials likely to be in transit through the community.

- Review worst case scenarios generated by companies as part of risk management planning, which indicate how many people could be harmed in an incident, and over how wide an area. When these were originally generated, industries asserted that the worst case dangers were highly unlikely; in the face of potential terrorist assaults, this can no longer be taken for granted.

Prioritize Facilities
Using the information gathered, identify priority sites for hazard reassessment and reduction.

Assess Opportunities to Eliminate Hazards
Evaluate opportunities at the priority facilities for inherent safety:

- A process of reviewing inherent safety and hazard reduction options can involve developing a large list of potential options, and then refining and assessing the list to find the solutions that are most cost-effective and most beneficial.
- Safer materials are available for many processes.
- Where safer materials are not available, many industries have devised strategies for reducing the volumes of materials stored on a site.

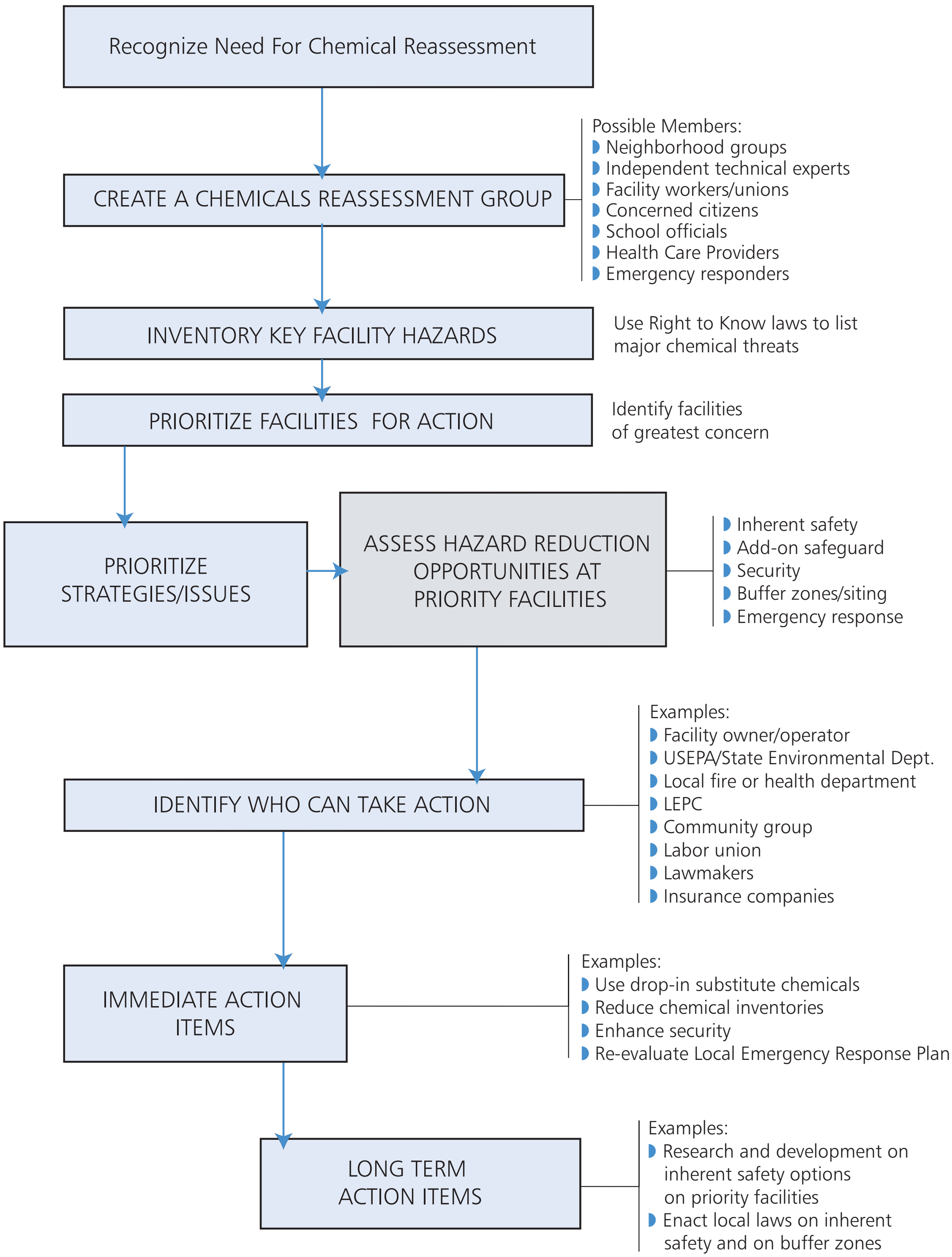
Assess Add-On Safeguards for Remaining Hazards
Where moving to inherent safety is not feasible, at least in the near term, other measures should also be examined:

- Facility siting issues and buffer zones.
- Add-on Safety Devices and Strategies.
- Site Security.

Review Emergency Response Plans and Systems.
Many communities lack properly trained and equipped emergency responders to cope with potential incidents. Systems for alerting potentially affected people, and for protective measures such as evacuation, were prepared prior to the current post-911 era and are in need of reassessment. Improving inherent safety at local sites can reduce these needs.

Assess Costs and Trade-Offs
Regardless of whether inherent safety measures or other add-on safeguards are applied, it is necessary for facility owners, workers and the community to consider trade-offs that may be involved —product quality, worker health and safety, and environmental pollution. For example, the Blue Plains facility's shift to sodium hypochlorite improved community safety against a sudden chlorine release, but closer review could have led to recognition that the alternative raised continued environmental pollution concerns. Alternatives which could have eliminated both the safety hazard and the pollution are available, and have been applied at other sites. Economic trade-offs and miti-

COMMUNITY REASSESSMENT OF CHEMICAL VULNERABILITIES



gating measures are also part of this evaluation. For instance, if any jobs will be cut as a result of new safeguards, will there be fair economic and educational transitions of affected workers to equivalent jobs?

Identify Who Can Take Action

Various individuals and organizations can play a role in hazard reduction efforts:

- Facility owners and operators can cooperate with reassessment processes and implement the best hazard reduction opportunities. They can open their existing hazard reduction efforts to public scrutiny, and work with local citizens and officials to put reassessment and implementation on a rapid timetable.
- Federal, state and local regulators have extensive enforcement and regulatory authority to order hazard reduction. They have a new responsibility to act in light of reassessments of hazard reduction needs.
- Concerned citizens and community groups have often stepped into the breach where government regulators have failed to act. Directing pressure toward site owners, as well as regulatory officials, has often resulted in effective action and commitments to improve hazard reduction.
- Labor unions have special rights to review and negotiate improvements in hazard reduction. As representatives of workers on the front line of facility changes, unions have the ability to bring close attention to hazardous practices by company managers.
- Local Emergency Planning Committees (LEPC's) were created by Congress in the 1980's to cover every hometown in America. Only a few of these committees have taken an active role in promoting hazard reduction. As voluntary bodies created by federal law for planning responses such as evacuations and sheltering, most LEPC members believe they do not have the time, resources or expertise to encourage hazard reduction.
- Insurance companies can play a unique role in hazard reduction. Insurers have the capacity to provide financial incentives to site owners to reduce hazards. Insurers can reduce or elevate premiums contingent on hazard reassessment and reduction.
- Lawmakers can enact new laws to bring public policies up to date with current understanding of hazards. Where existing institutions and officials are inadequate, new laws can promote hazard reduction. Important legislative precedents include:
    - The New Jersey Toxic Catastrophe Prevention Act, and ordinances in New York City and Contra Costa County, California, require certain industries to engage in state of the art reviews of inherent safety opportunities.
    - The Silicon Valley Toxic Gas Ordinance which prompted electronics companies to reduce both the volume and toxicity of gases used in the San Jose, California area.
    - The Massachusetts Toxics Use Reduction Act, which requires companies to evaluate opportunities for reducing the use of toxic chemicals.

Ultimately, effective public policies and enforcement will be necessary to curtail chemical vulnerabilities. Just as reliance on voluntary measures proved inadequate to prevent airlines from cutting corners in passenger screening and airplane design, it is unrealistic to expect facilities storing and using chemicals to redesign operations and facilities on their own. Government and concerned citizens will need to play a proactive role in providing the incentives, education and enforcement to encourage effective hazard reduction by facility owners and operators.

FORM A COMMUNITY REASSESSMENT GROUP

Who will reassess chemical site hazards in your community? In each locale, the situation will be different. Who cares about and understands this issue where you live? We wrote this guide on the assumption that a group of individuals will come together to conduct a reassessment of chemical hazards and the need to reduce them. In some hometowns, this effort may be led by the fire chief. In others, the chairman of the health board may drive the process. In many instances, we expect that civic groups will initiate the process, and persuade school board members, hospital officials, local emergency responders, facility owners and operators and local elected officials to join together in a reassessment of chemical vulnerabilities and opportunities for eliminating or reducing them.

Later in this guide, we discuss in more depth some of the people and institutions with the power or responsibility to reduce chemical hazards. For now, we will assume that you have brought together at least an initial group to begin this work, and that your group is ready to take a hard look at the chemical vulnerabilities that may confront your community.

CONDUCT AN INVENTORY OF CHEMICAL SITE HAZARDS USING COMMUNITY RIGHT TO KNOW LAWS

A) Where are the chemical production and storage sites in our community?

In order to assess the vulnerabilities posed to the community by each chemical storage, usage or production facility, concerned citizens and officials can use information available under existing Right to Know and chemical accident preparedness laws to prepare a local inventory.

The Right to Know laws are the essential tool of local citizens and government officials in gathering the baseline of information needed concerning local facilities. The **1986 Emergency Planning and Community Right to Know Act**, required facilities to report to federal, state and local officials regarding the amounts of hazardous chemicals at their sites. These facility reports are known as **annual chemical inventories**. The law also created **Local Emergency Planning Committees** (LEPC's) to develop emergency response plans in the event of releases of chemicals indicated by the facilities' inventories. As a result of this process, LEPC's were required to generate plans that include an inventory of facilities utilizing significant quantities of extremely hazardous materials in their area, transportation routes likely to be used by those facilities, and other facilities (e.g. hospitals, schools, or natural gas facilities) that are subject to added risk due to their proximity to the facilities.[1] Therefore, the first stage of reassessment may include initially looking at what the LEPC has done so far to assess community vulnerabilities.

Local emergency response planners should have already compiled a list of vulnerable facilities and transportation issues. Examining their work is a good first step to developing an inventory.

However, not every LEPC has complied with this requirement, and even if the emergency plan was prepared, it may not give you sufficient information to identify the largest vulnerabilities. The next place for the community reassessment process to turn is individual facilities' annual chemical inventory forms, which should be available at the LEPC, the local fire department, or the State Emergency Response Commission (SERC).

The basic annual inventory reports are known as "Tier One" reports, and provide aggregate information, by chemical category, about the amount and location of hazardous chemicals stored at the facility. This information is only listed according to types of chemicals, for example corrosive materials, rather than the specific chemical names. Some 860,000 facilities across the U.S. are required to submit this information to local emergency planning committees, state emergency response commissions, and local fire departments.

The EPCRA inventories cover many thousands of chemicals.

More detailed information on the amount of 600 specific chemicals stored on-site is available through the Toxic Release Inventory, an EPA-maintained database that discloses toxic emissions as well as toxics stored at about 23,000 facilities across the US.

Still more detailed information can be requested from the facility under EPCRA by the LEPC, SERC or fire department. When requested, the facility must provide more detailed "Tier Two" information, detailing individual chemicals rather than categories. This more detailed information may also be available to concerned citizens upon written request to the LEPC or SERC. Local citizens can ask any of those entities to obtain this information on their behalf, though it is discretionary for the officials to do so.

By reviewing chemical inventories, you can at

TABLE 1

EXAMPLE OF EPCRA CHEMICAL INVENTORY DATA ON AMOUNTS OF EXTREMELY HAZARDOUS SUBSTANCES STORED AT A FACILITY

How identical substances are described in either Tier 1 or Tier 2 data

TIER OF DATA	HOW CHEMICALS ARE DESCRIBED	QUANTITY
Tier One Data	Corrosive compounds	3,000,000 lbs.
Tier Two Data	Hydrochloric acid	300,000 lbs.
	Sulfuric acid	2,000,000 lbs.
	Chlorine	700,000 lbs.

TABLE 2

POINTS OF VULNERABILITY

Industry Sectors Reporting the Most Processes Containing Extremely Hazardous Substances

	NUMBER OF PROCESSES INVOLVING EXTREMELY HAZARDOUS SUBSTANCES REPORTED IN THE US:
Farm supplies wholesalers	4409
Water supply and irrigation	2059
Sewage treatment	1646
Petroleum refineries	1609
Basic organic chemical manufacturers	655
Chemical and allied products wholesalers	607
Refrigerated warehousing and storage facilities	549
Natural gas liquid extraction	533
Plastics material and resin manufacturing	418
All other basic inorganic chemical manufacturing	358

Data generated under EPA's Risk Management Planning program indicate that the largest number of processes containing extremely hazardous substances in the US occur in a few sectors. RMP data exclude gasoline.

TABLE 3

EXAMPLES OF INFORMATION SOURCES REGARDING LOCAL FACILITIES FOR CHEMICAL SECURITY AND SAFETY

TYPE OF INFORMATION	NAME OF SOURCE	LOCATION
Contacting our local emergency planning committee	National LEPC list	http://www.epa.gov/ceppo/lepclist.htm
Hazards of specific local facilities: worst case scenarios and accident history over five years	RMP database, on internet	http://www.rtknet.org/rtkdata.html
Assessing School and hospital vulnerability, determining whether site is within toxic chemical vulnerability zones	EPA's Vulnerable Zone Indicator System	www.epa.gov/ceppo/vzis.htm type in address to ascertain whether vulnerable
Summary data on categories of extremely hazardous chemicals stored at site	"Tier One Data" under EPCRA	Local emergency planning committee, fire department or state emergency response commission
Detailed data on amounts of each extremely hazardous chemical stored at site	"Tier Two Data" under EPCRA	Local emergency planning committee, state emergency response commissionor fire department (requires separate request)
For each facility, a description of worst case scenarios, offsite consequences, andprevention and response plans	Risk Management Plan Summary	www.epa.gov/ceppo/readingroom.htm Possibly also through Local Emergency Planning Committee
Analysis of process hazards and internal strategies such as training, add-on technologies, etc.	EPA and OSHA requirements for detailed analysis by the facility	Held by company onsite - accessible to employees and unions, LEPCs
Changes in process design and capacities	OSHA Management of Change info	Held by company onsite - accessible to employees and unions, LEPCs
Annual toxic pollution emissions report and amounts of certain substances stored onsite	Toxic Release Inventory database	www.scorecard.org and www.rtknet.org
Hazards and precautions related to specific chemicals	Material Safety Data Sheets	Povided by facilities to LEPC and fire departments
Map of our community showing hospitals, schools, pollution emitters, waste sites	EPA's Enviromapper website	http://maps.epa.gov/ enviromapper/
Past chemical spills and accidents	Chemical Spill Reports	www.nrc.uscg.mil/foia.htm and www.rtknet.org

a minimum generate a list of local facilities of concern. You may need to come back later and fill in information gaps - e.g. specific chemical identities rather than just the large categories. When you have enough information to identify priority facilities, you should move on to the next step, identifying transportation issues of concern.

B) What are the dangers of hazardous materials being transported through our community?

Materials in transit present special concerns and vulnerabilities. Even a terrorist organization could set up a new trucking company in the U.S. or Canada, and obtain operating authority in the U.S. for an 18-month period without any federal or state safety review or security check simply by paying a fee. After obtaining a hazardous materials endorsement for a commercial drivers license by passing a written exam, drivers can legally drive semi-trailers carrying up to 80,000 pounds of hazardous materials on nearly all roads and through all cities in the U.S.[2]

> After obtaining a hazardous materials endorsement for a commercial driver's license by passing a written exam, drivers can legally drive semi-trailers carrying up to 80,000 pounds of hazardous materials on nearly all roads and through all cities in the U.S. Little has been done to prevent these licenses from falling into the wrong hands.

Finding out exactly what materials are in transit in your community can also be a vexing problem. Materials that are in transit have been exempted from government "right to know" requirements. As a result, emergency responders, emergency planners and concerned citizens typically lack the information needed to plan for, and prevent, accidents or terror attack incidents involving transportation. The Environmental Protection Agency's guide "Chemicals in Your Community" suggests a combination of legwork and guesswork to anticipate and cope with these chemicals in transit:

> Chemicals transported through your community by rail, barge, or truck **are not reported to EPA.** You may assume that any of the chemicals you find at facilities in your locality are moving through your community via railroad lines or major highways. But, chemicals also may be transported through your community on the way to some other location. Some [Local Emergency Planning Committees] have surveyed traffic on major roads and rail lines to determine which chemicals are being transported and who is transporting them. Most vehicles that carry hazardous materials must be marked with placards that identify the hazard class and give a number that identifies the specific chemical.[3]

Despite the lack of effective information resources on these hazards, according to a recent report done for the Department of Transportation (DOT) by the Argonne National Laboratory on transportation hazards, "the potential exists for very serious accidents involving large numbers of injuries and fatalities, especially for TIH [toxic-by-inhalation] materials." The report notes that six toxic-by-inhalation (TIH) chemicals account for over 90% of total TIH transportation-related risk.[4] See box page 2-5. The Argonne report estimates that there are 100,000 shipments a year of highly toxic chemicals such as chlorine.

Local emergency planners in some communities have conducted the best analysis that they could, based on available information, of the hazards of transportation and transportation-related storage in their areas. Reassessment efforts should begin by examining the extent to which the emergency planning process has effectively addressed this issue. Special attention should be given to the extent to which the assessment addresses issues associated with transport such as:

- **Storage of the materials in unguarded areas.** Many facilities store tank cars full of extremely hazardous materials in side yards (sometimes called "leased sidings"), often in close proximity to residential neighborhoods. The graffiti commonly found on rail cars attests to how poor security is for rail cars. Sometimes the storage areas are a mile or more from the facility that uses the materials - so that these sites are not readily apparent in assessing the facility. A reassessment must make detailed inquiry into storage locales to identify the range of vulnerabilities.

TOXICS IN TRANSIT

TOXIC BY INHALATION

- ammonia
- chlorine
- sulfur dioxide
- hydrogen fluoride
- fuming nitric acid
- fuming sulfuric acid

FLAMMABLE/EXPLOSIVE

- liquefied petroleum gas
- gasoline
- explosives

Source: Argonne National Laboratories

- **Potential for chain reactions** among, for instance, tank cars on a rail line.

- **Movement through urbanized, highly populated areas.** This issue has been largely unregulated by the Department of Transportation. Local governments can prohibit transport of hazardous materials through some congested areas, but few have done so.

C) What are the vulnerabilities posed to the community by facilities and transportation?

Risk Management Plan (RMP) summaries identify some key vulnerabilities and prevention efforts.

The 1990 Clean Air Act established risk management planning, making the issues of chemical risks more graphic for the community. That law required facilities to prepare maps of the zone which could be impacted in the event of a worst case scenario chemical release, regardless of whether it is caused by terrorism or by an accident. The law also created an obligation, known as a "General Duty", for companies to prevent catastrophic chemical incidents. Documents summarizing facilities' plans for emergency notification and for community response, based on potential scenarios for incidents at facilities, were prepared by facility owners and operators and submitted to the Environmental Protection Agency (EPA). Portions of these documents are available on the internet - see reference in Table 3. In addition, more detailed renditions of these documents are available through regional Environmental Protection Agency reading rooms and through local emergency planning committees. However, the LEPC's have no formal role or requirement in disseminating this information. The more detailed documents - available by direct inquiry to the agencies, rather than on the internet - include maps showing the vulnerable zones in relation to a worst-case and more likely case scenario associated with each facility.

The **worst case scenario** is typically based upon what would happen if there were a release of all of the chemicals from the largest storage unit at a facility, and all active containment and protection systems were to fail in worst-case weather conditions. The more likely scenario, also known as the **planning scenario**, is based on an assumption that various protective systems (e.g. secondary containment systems, shut-off valves, etc.) inside of the facility function as intended in the event of an incident. These release incidents are utilized to draw a map estimating the range within which human health and safety may be threatened by an incident. The **offsite consequence analysis** indicates how many people may be within range of serious harm in the event of an incident. The **toxic release endpoint** indicates the range within which people could be hurt or killed. Across the US, in facility plans the average (median) toxic release endpoint from a facility is 1.6 miles, and the average (median) number of potentially affected people is 1500 people. A given facility may, however, affect substantially more or less than this. For instance, some facilities have endpoints affecting up to twenty five miles away, with potential to affect hundreds of thousands of people.

> The worst case scenarios generated by companies as part of risk management planning have new significance. In the past, many companies asserted that the scenarios were unlikely; but in the face of potential terrorist assaults, the improbability of those scenarios can no longer be taken for granted.

RMP summaries which include a description of worst case scenarios and potential offsite consequences, are available online through http://www.rtknet.org/rtkdata.html. Local access to this data is also available. As of August 4, 2000, LEPCs and related local government agencies such as fire, police and planning departments are authorized to provide citizens with *read-only* access to Offsite Consequence Analysis information (if they have it) for facilities within the LEPC area where residents live or work, and for any other facilities that have vulnerable zones that extend into those LEPC areas. You can find contact information for an LEPC on the Web at http://www.epa.gov/ceppo/lepclist.htm or http://www.rtk.net/lepc/ or by calling your local fire department or the EPA's RCRA, Superfund & EPCRA Hotline at (800) 424-9346. EPA and the Department of Justice have

THE SEPTEMBER 11 TERRORISTS MAY HAVE BEEN SCOPING OUT CHEMICAL SITES

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. Why he wanted to know, we can only speculate, but there is ample reason to believe that he may have had in mind attacks on chemical facilities as weapons of mass destruction. After all, the approach, which the terrorists ultimately chose on September 11, used our own day to day technologies ~~jet~~ aircraft ~~ag~~ainst us as weapons of mass destruction. Atta's inquiry regarding the chemical plants stands as a warning to our communities that these chemical storage sites, pervasive in their presence, represent a point of vulnerability.

Danny Whitener, a 48-year-old junk car dealer who was alone tending his plane when the strangers arrived, is convinced one of the men was Mohamed Atta, whom authorities believe was the 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.

.Whitener said he spoke to the man he later recognized as Atta for about 15 minutes. That man was the pilot; the accompanying passenger never spoke and neither man used any airport facilities, he said.

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."

Whitener said he repeated, "They are all empty."

Joel Engelhardt , "Hijacking Suspect Cased Targets, Experts Say Mohamad Atta Called A 'Little Bomb Walking Around'," *Palm Beach Post*, October 28, 2001, pg. 17A.

also established ten regional reading rooms for access to the RMP information. For details, see www.epa.gov/ceppo/readingroom.htm.

Using this data, concerned citizens are able to make inquiries of facilities as to their efforts to reduce the hazards, especially the size of the vulnerable area at risk from the facility. Current law provides that companies must file updates of these offsite consequence analyses whenever the company makes a change that doubles or halves the "footprint" (vulnerable area) or at minimum every five years.

EPA has exempted certain facilities from this risk management planning reporting system. Most important are facilities containing only explosives or gasoline, and ammonia held by farmers. Special attention may be merited to assess vulnerabilities relative to such facilities.

D) How have the events of September 11, 2001 changed our community's understanding of the vulnerabilities and the needs for hazard reduction?

The terrorist acts of September 11, 2001, have given new urgency to reassessing and reducing facility hazards. People intent on causing mass injuries and property damage could override all the safety measures put in place at chemical sites to prevent releases. The potential for an assault on chemical sites by aircraft, vehicles, rocket launchers or high-powered rifles cannot be ignored. Many conventional accident prevention measures may not work; safer materials and lower storage volumes are examples of measures that would work, because they would eliminate rather than simply defend against the vulnerability of facilities.

The worst case scenarios generated by companies as part of risk management planning have also taken on new significance. When those scenarios were generated, many companies made a point of persuading local communities that the scenarios were unlikely; but in the face of potential terrorist assaults, the improbability of those scenarios can no longer be taken for granted.

E) Which are the priority facilities that pose the greatest danger to our community?

By this point you have compiled an inventory of sites and identified the facilities with highest volumes of extremely hazardous substances. You have reviewed vulnerability information including the proximity of the facility to local populations and the number of people in the vulnerable zone. Now you need to identify priority facilities. You may wish to also take account of an array of other information. For instance:

- Are there other factors that make this facility especially vulnerable to terrorism?
- Are there known alternatives to the extremely hazardous substances used at the facility that make this a likely place for reducing vulnerabilities? See alternatives Table in Appendix for examples.
- Does the accident record of the facility compound the sense of a need for hazard reduction? For instance, what is the facility's record of accidents as indicated in the risk management plan's five year accident reports, or accidents reported to the National Response Center? What is the facility's record of near misses? Are there certain units in the facility that have been prone to accidents or near misses? Have there been complaints by employees or local citizens filed with federal, state, or local agencies?
- Have the facility's hazard reduction measures already been thoroughly reviewed by third-party experts with local citizen oversight?

> In setting priorities for hazard reduction, you may want to consider the vulnerabilities of facilities to accidents as well as criminal assaults.

An essential issue worthy of consideration is the potential for accidents at facilities as well as of intentional/criminal actions. An enormous number of accidents occur in the US each year. By one measure, facilities in the United States report more than 25,000 fires, spills, or explosions involving hazardous chemicals to the National Response Center. This is a broad, but incomplete, federal record of mishaps involving oil or chemicals.[5] At least 1,000 of these events each year involve deaths, injuries, or evacuations. When one combines data from additional federal sources, analysts at the Texas A&M University concluded that in 1998 there were over 100 deaths, nearly 5,000 injuries, and when including small spills, almost 50,000 incidents related to ordinary industrial use of chemicals in the United States.[6]

How can the national databases inform your priorities? One way is by focusing you on some problem industries and chemicals. Data submitted to the U.S. Environmental Protection Agency as part of Risk Management Plans (RMP's) under the Clean Air Act demonstrate that certain types of industries and types of chemicals are most prevalent and cause the most chemical accidents. See Tables 4 and 5. For instance, ammonia and chlorine together account for about half of all facilities in the US storing high volumes of extremely hazardous substances reported under risk management

TABLE 4

ACCIDENTS REPORTED BY INDUSTRY SECTOR, IN THE RISK MANAGEMENT PLANS DATABASE

(RMP*Info) for the period 1994-1999

NAICS Description	NAICS Code	Number of Accidents
Petroleum Refineries	32411	192
Water Supply and Irrigation Systems	22131	116
Sewage Treatment Facilities	22132	110
All Other Basic Inorganic Chemical Manufacturing	325188	89
All Other Basic Organic Chemical Manufacturing	325199	89
Other Chemical and Allied Products Wholesalers	42269	87
Farm Supplies Wholesalers	42291	85
Alkalies and Chlorine Manufacturing	325181	80
Nitrogenous Fertilizer Manufacturing	325311	68
Poultry Processing	311615	67
Petrochemical Manufacturing	32511	55
Pulp Mills	32211	54
Refrigerated Warehousing and Storage Facilities	49312	50
Animal (except Poultry) Slaughtering	311611	47
Natural Gas Liquid Extraction	211112	34
Plastics Material and Resin Manufacturing	325211	34
Frozen Fruit, Juice, and Vegetable Manufacturing	311411	32
Meat Processed from Carcasses	311612	31
Paper (except Newsprint) Mills	322121	25
Industrial Gas Manufacturing	32512	24
Other Basic Organic Chemical Manufacturing	32519	24
Other Basic Inorganic Chemical Manufacturing	32518	22
Pesticide and Other Agricultural Chemical Manufacturing	32532	22
Ice Cream and Frozen Dessert Manufacturing	31152	19

Table includes most frequently occurring National Industrial Classification System (NAICS) Sector Codes

TABLE 5

ACCIDENTS REPORTED BY CHEMICAL INVOLVED IN THE ACCIDENT FROM 1994-1999

Chemical Name	Number of Accidents
Ammonia (anhydrous)	656
Chlorine	518
Hydrogen Fluoride	101
Flammable Mixture	99
Chlorine Dioxide	55
Propane	54
Sulfur Dioxide	48
Ammonia (concentration 20% or greater)	43
Hydrogen chloride (anhydrous)	32
Hydrogen	32
Methane	30
Butane	26
Ethylene oxide	19
Hydrogen Sulfide	19
Formaldehyde	17
Isobutane	17
Pentane	17
Titanium tetrachloride	15
Phosgene	12
Nitric Acid (conc 80% or greater)	12
Ethane	12
Oleum	11
Ethylene	11
Vinyl chloride	11
Trichlorosilane	11
Methyl chloride	10

*Extremely hazardous substances most frequently involved in accidents according to the Risk Management Plans database for 1994-1999. Note that database excludes gasoline and explosives. Source: Belke, James C., *Chemical accident risks in U.S. industry - A preliminary analysis of accident risk data from U.S. hazardous chemical facilities*, United States Environmental Protection Agency Chemical Emergency Preparedness and Prevention Office, September 25, 2000.

planning; they also account for the most releases reported in the RMP's.

F) What are our priority strategies for hazard reduction?

Once priority chemical sites are identified, a range of choices typically exist to reduce the hazard of the facilities. These include:

- **Clean Production:** Designing production processes and products to maximize the use of clean safe materials, renewable energy, and closed loop, efficient process systems. This eliminates or dramatically reduces harm to environment and public health.

- **Inherent Safety:** Eliminating or dramatically reducing the worst toxic release or explosion that can happen at a site through adopting safer materials, lower volumes of toxic materials stored on site, or other design factors.

- **Buffer Zones:** Expanding the space between the facility and potentially affected populations.

- **Add-on/Capture Technologies:** Improving equipment to capture and prevent any release from reaching the environment.

- **Site Security:** Preventing access to facilities and their infrastructure by those with potential to intentionally cause releases.

- **Emergency Response Plans:** Improving plans for warning local residents in the event of a release, and for evacuation or sheltering against exposures. The reassessment group should commit to giving top priority to the most effective strategies whenever possible.

From the standpoint of preventing terrorism as well as protecting the local environment, these activities can be listed as a hierarchy. At the top of the hierarchy, clean production and inherent safety methods are less prone to failure than the methods at the bottom of the list. These measures can have the greatest benefit for the environment as well as for public safety. Even from the standpoint of cost and the array of benefits to all concerned, inherent safety and clean production can also prevail as the clear winners. Companies that have invested primarily in add-on approaches often presume that it is too expensive to employ clean production methods or inherent safety. Yet the costs of changing are often fully recovered through savings in reduced costs of maintenance, regulatory compliance, insurance and other hidden costs such as lower costs of materials. Many companies have produced long-term financial gains by evaluating and applying safer materials.

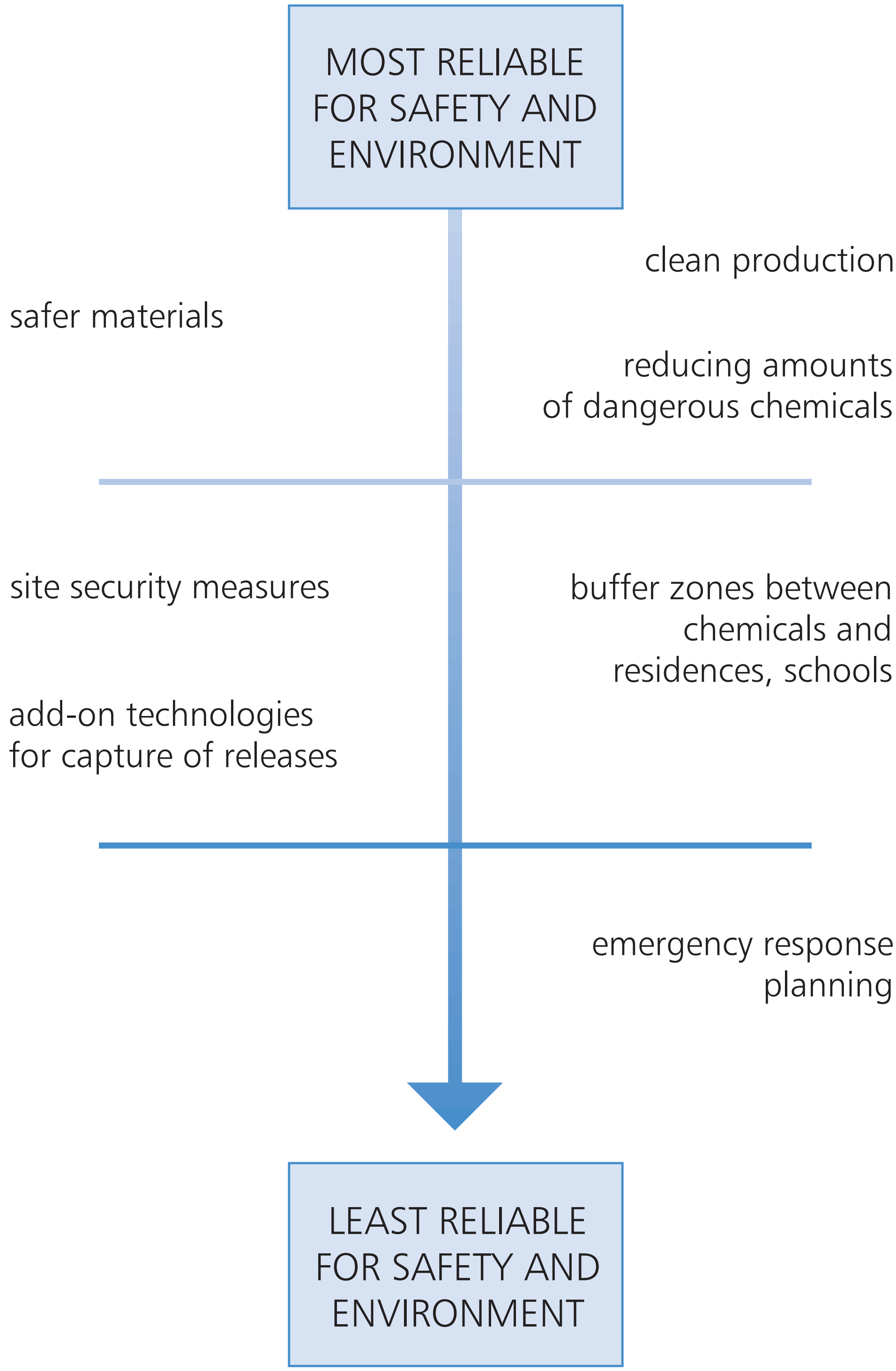
Traditionally, more emphasis has been placed on measures toward the bottom of the chart. But as demonstrated later in this guide, expenditures in this area may be the least effective in improving the real safety or security of the community. Before embarking on the process of reassessing local facilities, your reassessment group should consider your priorities for hazard reduction. We recommend that you adopt the hierarchy shown above, placing the greatest emphasis on opportunities for improving inherent safety.

However, you also need to apply this analysis to your local circumstances. In a community with hundreds of hazardous facilities and a volunteer fire department ill-equipped to respond to chemical incidents, you may need a two-track strategy, which both seeks inherent safety opportunities while simultaneously improving equipment, training and other funding for emergency responders. Reassessment of inherent safety options at facilities may need to proceed on a parallel track with a reassessment of emergency response capabilities.

Notes

1. 42 USC 11003 (c)(1); EPCRA section 303 (c)(1).
2. Testimony of Joan Claybrook, Advocates for Highway and Auto Safety and Public Citizen, before the Senate Subcommittee on Surface Transportation and Merchant Marine, Senate Committee on Commerce, Science, and Transportation, October 10, 2001.
3. USEPA, Chemicals in Your Community, (1999), page 17.
4. D.F. Brown, W.E. Dunn, and A.J. Policastro, A National Risk Assessment for Selected Hazardous Materials Transportation, Argonne National Laboratory,December, 2000, research sponsored by the US DOT, Research & Special Programs Adminisration, Office of Hazardous Materials Technology.
5. 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 initial and subject to verification and change (www.nrc.uscg.mil/foia.htm).
6. 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.

A HIERARCHY OF HAZARD REDUCTION RESPONSES



EVALUATE OPPORTUNITIES FOR REDESIGN TO ELIMINATE VULNERABILITIES AT PRIORITY SITES

By this point in the reassessment process, you have formed a chemical reassessment group and inventoried local facilities. You have identified some of the key facilities to be reassessed. Now the reassessment process moves to ensure more detailed reassessments of hazards, and hazard reduction opportunities, at each of the priority facilities.

A) Have the choices of materials and processes used at the site increased hazards?

Sometimes also referred to as "primary prevention," **inherent safety** relies on the development and deployment of technologies **that prevent the possibility of a chemical accident**. By comparison, "secondary prevention" reduces the probability of a chemical accident, and..emergency responses seek to reduce the seriousness of injuries, property damage, and environmental damage resulting from chemical accidents.[1]

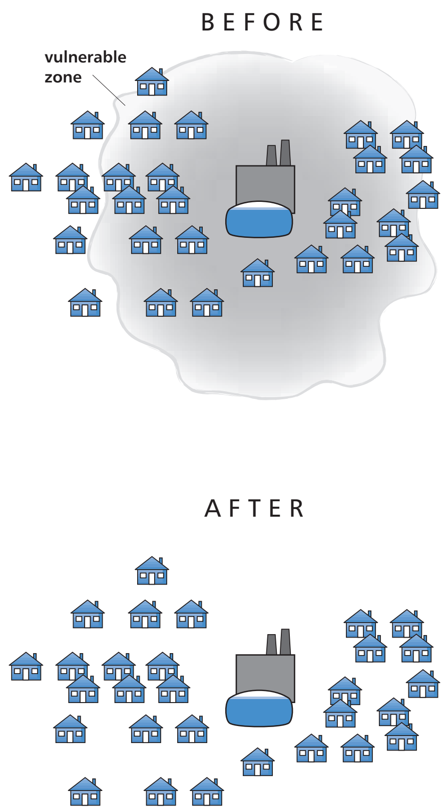
If a facility is vulnerable because it *has been unnecessarily designed to store high volumes of extremely dangerous chemicals*, and then it suffers a release due to an accidental explosion or an intentional assault by terrorists, there are really at least two "causes" to the incident—one, an initiating event, and secondly, the dangerous manner in which the facility is designed. Creating safer communities requires addressing both potential "causes" of incidents ~~bo~~th potential triggers, and the root causes that create the vulnerabilities.

Many companies, after accidents occur, blame the incidents on human error or operator error. If a forklift is driven into an ammonia-loaded refrigeration unit, setting off a massive ammonia leak, the incident could be blamed on negligence by the forklift operator, or perhaps on the lack of adequate training of the operator.

One paper by EPA would suggest, looking at the same incident, that the cause may be the *lack of a barrier to prevent a forklift from hitting the unit*. By this view, the owner and designer of the facility needed to take into account the fact that human error is inevitable; basic plant layout should prevent a release incident from so easily being triggered by a straying forklift.

Another perspective on the same matter might say that the cause is the lack of adequate analysis of accident risks (Process Hazard Analysis) by the management of the company - a failure to adequately assess and prevent the things that could go wrong.

Finally, taken from an inherent safety perspective, one might say that even if a barrier is erected, incidents may happen in unforesee-



Eliminating Vulnerability By Substituting Safer Materials

Evaluate: has the facility considered all costs and risks to community in deciding feasibility of substitutions?

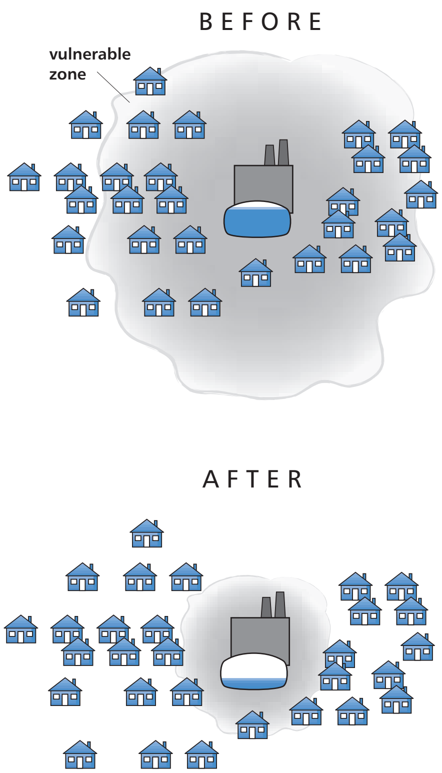
For instance, did the facility take account of local health impacts of chronic pollution? Local policing costs associated with having potential terrorist targets?

Some Inherently Safe Technologies Sit on Shelf

Few chemical companies have set measurable goals and timelines to reduce inherent hazards. A 1999 survey of 175 chemical industry facilities found only one facility with a measurable goal and timeline for eliminating or reducing the size of its vulnerability zone for a worst-case accident.[1] In a separate 1999 survey of nearly 200 major chemical companies, only three had developed measurable goals and timelines to reduce worst-case vulnerability zones.[2]

To cite one example, about half of US oil refineries use large volumes of hydrogen fluoride (HF). The substance, if released in an incident, could pose a danger of a ground-hugging toxic gas cloud similar to the cloud that killed 3,000 people quickly in the Bhopal, India disaster. This hazard can be eliminated by switching to safer forms of catalysts. But there is no government mandate to undertake the needed expenditures, and little or no implementation at HF-using refineries.[3]

1. U.S. Public Interest Research Group and Working Group on Community Right-to-Know, *At Risk and In the Dark: Will Companies in Our Communities Reduce Their Chemical Disaster Zones?*, June 1999.
2. Environmental Defense, National Environmental Trust, OMB Watch, Sierra Club, Unison Institute, U.S. Public Interest Research Group, and Working Group on Community Right-to-Know, *Hazard Reduction Challenge*, June 1999.
3. Lapkin, Milton and Sanford Lewis, Boosting the First Line of Defense: Moving Toward Safer Materials in Refinery Alkylation. A Technical Report , Good Neighbor Project (1993)



Reducing Vulnerability By Curtailing High Volume Storage

Evaluate: has the facility considered all costs and risks to community in deciding feasibility of these reductions?

For instance, did the facility take account of local health impacts of chronic pollution? Local policing costs associated with having high impact targets?

able ways as long as there is a high volume of ammonia in use in the unit. In particular, if there is a high volume of ammonia in use it is difficult to **eliminate** the hazards of intentional sabotage or failures of the various safety measures. Such a perspective would seek to go further to minimize the amount of ammonia that could be released into the environment in the event of a breach - perhaps by minimizing the amount of ammonia that is present in the system, or using an alternative cooling material, or using ammonia in a safer form.

In reassessing chemical release prevention at facilities, a range of actions and analyses is usually needed. What is most often overlooked, however, is the opportunity to apply inherent safety measures. It often takes a significant external demand or sudden changes in conditions to ensure that assessment and implementation of inherent safety measures occurs.

Inherent safety looks for ways to make the basic process, or its components, less dangerous so that even if security or safety systems fail, **the worst that can happen will not be a large scale catastrophe**. Major inherent safety design strategies[2] include:

- **Minimize:** Use smaller quantities of hazardous material and less energy.
- **Substitute:** Replace with a less hazardous substance.
- **Moderate:** Use less hazardous conditions or a less hazardous form of a material.
- **Simplify:** Eliminate unnecessary complexity to make operating errors less likely.

A well-designed facility, by its layout, limits the possibility that equipment will be damaged and, by its process design, limits the quantity of chemical that could be released. Facility and process design (including chemicals used) determine the need for safety equipment, site security, buffer zones, and mitigation planning. Eliminating or attenuating to the extent practicable any hazardous characteristic during facility or process design is generally preferable to simply adding on safety equipment or security measures.

USEPA *Site Security Guide, 2000*.

- Design systems that are **forgiving of errors**.

In addition to advancing the safety of workers and the public, inherent safety also reduces liability, and can save on safety-related costs such as maintenance and repairs. It may even eliminate coverage of a facility by regulations such as Risk Management Planning (CAA 112r), thereby saving regulatory compliance costs.

The inherent safety approach can be applied to retrofit a process as a whole, or incrementally, by making inherent safety changes at potential failure points in the existing system.

B) Have the range of inherent safety options been assessed or reassessed?

Ensure that an evaluation is conducted to identify the range of opportunities for applying inherently safer technologies at the facility, including evaluation of costs, benefits and trade-offs of the leading options. Typically, an assessment of this kind is conducted most intensively by technical consultants working with the facility's own personnel. External involvement, advice or oversight by external stakeholders such as the community reassessment group, local concerned citizens, emergency responders, and others may occur intermittently throughout the process.

INHERENT SAFETY IS NOT JUST FOR NEW FACILITIES: EXISTING CHEMICAL SITES CAN BE REDESIGNED TO ELIMINATE VULNERABILITIES

- Rohm and Haas converted one of its processing systems from batch to continuous, resulting in the replacement of its 3,000 gallon batch reactor by a 50 gallon continuous reactor.
- Hoffman-LaRoche had been storing 12,000 to 15,000 gallons of liquid ammonia in a refrigerated tank. Levels were reduced to 2,000 gallons.
- Dow substituted aqueous ammonia at atmospheric pressure for pressurized anhydrous ammonia to reduce the effects of volatility in the event of a spill. Dow also reduced by 95% its 100,000 pound inventory of phosgene at one of its plants in La Porte, Texas by operating the facility on an adjusted-time system--having the satellite units run continuously off the feed unit.
- PPG Industries recently developed carbonyldiimidazole, a benign phosgene substitute that can be used in the synthesis of some of their pharmaceutical products.
- DuPont had been making a crop-protection insecticide at its plant in LaPorte, Texas using methyl isocynate (MIC) purchased from Union Carbide. This is the substance which caused the Bhopal chemical disaster, blamed for 3,000 immediate deaths and another 13,000 in the subsequent years. In the aftermath of Bhopal, DuPont found a way to avoid keeping 40,000 to 50,000 pounds of MIC in storage. Though it produces MIC as an intermediate, the firm immediately consumes it in a closed-loop process. The result is a maximum of two pounds of MIC on-premises at any one time.

From Ashford, Nicholas, et. al., *The Encouragement of Technological Change for Preventing Chemical Accidents: Moving Firms from Secondary Prevention and Mitigation to Primary Prevention*, A Report to the U. S. Environmental Protection Agency, Center for Technology, Policy and Industrial Development at MIT, Cambridge, MA, July 1993.

The group of people who will engage in a rigorous process of technology assessment should at a minimum include facility staff with knowledge of processes, materials, hazards and costs, and external technical advisors (engineers, chemists, etc.) with expertise in inherent safety assessments relevant to the facility. This team will typically need to:

- Identify priority activities within the facility
- Identify why the activity is hazardous.
- Brainstorm a wide array of alternative methods, materials, processes which would be inherently safer.
- Winnow down the list of options to identify those showing the most promise.
- Conduct a more detailed feasibility assessment of those options.
- Assess costs and benefits of the feasible options.
- Assess other benefits or issues associated with feasible options, such as environmental or community impacts.
- Select feasible options for implementation.
- Set a timetable for implementation.
- Implementation.

> Ensure that a range of options for improving inherent safety at a facility have been evaluated, weighing the costs and benefits of each of the options.

Analysis of inherent safety opportunities merits a separate review from other issues such as contingency planning or site security. The issue of inherent safety analysis should not be buried in these other studies, but should be linked to the studies so that cost and other considerations can be compared across strategies.

To reinforce public credibility, inherent safety studies can be conducted or evaluated by third-party experts, selected and trusted by members of the community in addition to the facility owner or operator. Community reassessment teams should expect, at a minimum, to engage in periodic meetings with the assessment team, to receive detailed reports of progress, to ensure a thorough process is being followed, and to ensure that adequate consideration is given to relevant options, costs, and other tradeoffs. See the chart regarding facility specific assessments. Starred boxes represent points in the process where a community reassessment group may want to ensure its oversight and involvement.

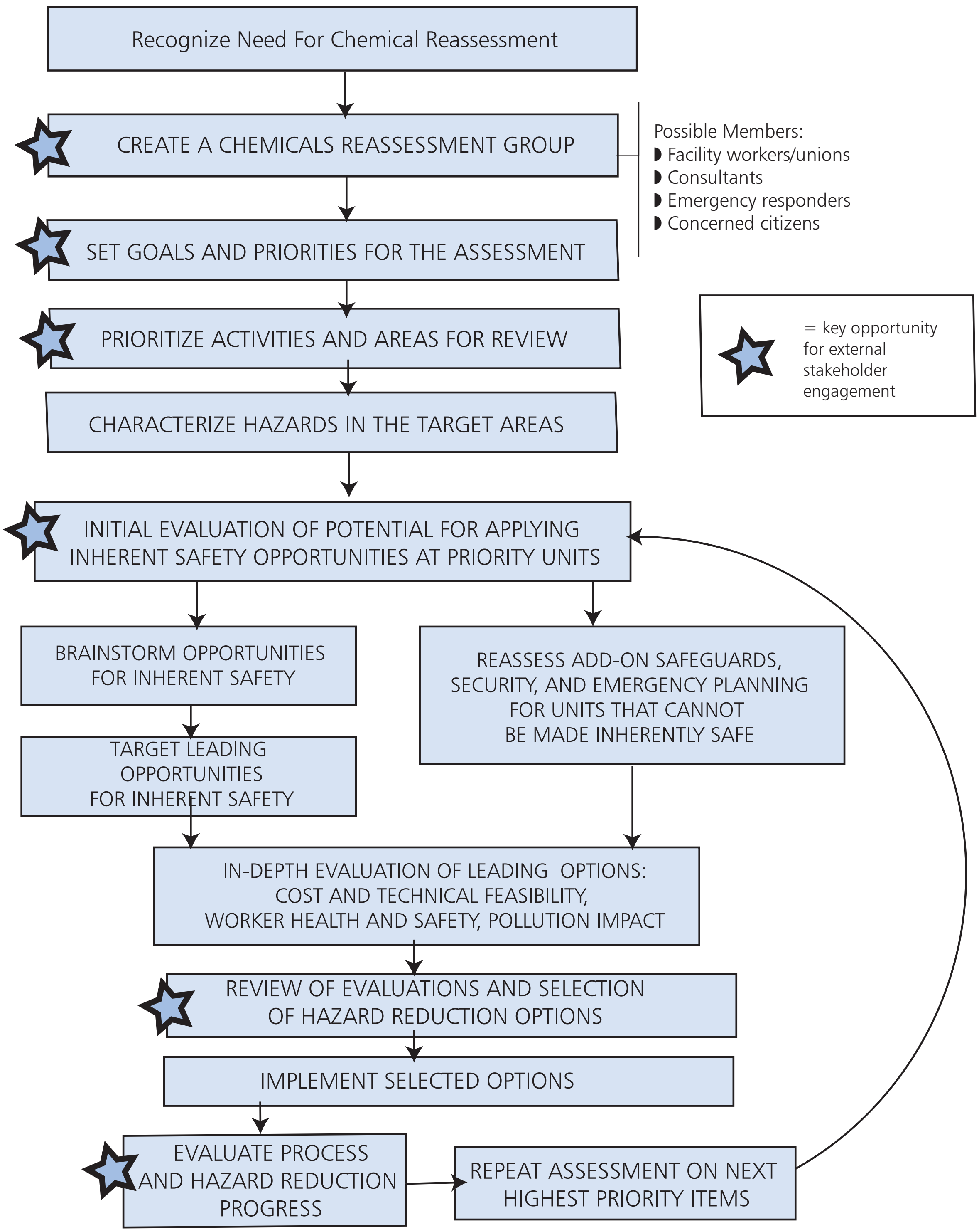
LIQUID CHLORINE IN DECLINE AT WATER/WASTEWATER FACILITIES

Citing the September 11th attacks, Washington, DC main sewage treatment facility, Blue Plains, accelerated by one year their program to substitute the use of chlorine due to their vulnerability to terrorists.

Public policies adopted in New Jersey, through the Toxic Catastrophe Prevention Act (TCPA), have led to a dramatic reduction in the amount of hazardous chlorine stored at water treatment facilities. Many of the facilities have shifted to less dangerous materials -- sodium hypochlorite. In the fall of 1988 New Jersey had 575 TCPA regulated water treatment sites with the then 500-pound threshold quantity or greater of chlorine. By April 1991, 375 water treatment facilities had lowered the quantity of chlorine on hand to less than the TCPA threshold quantity; also, approximately 100 other water treatment facilities ceased the use of liquid chlorine altogether, leaving a total in the water treatment group of 100 in April 1991.

Source of New Jersey data: Correspondence with Reginald Baldini, NJ Department of Environmental Protection, November, 2001.

PROCESS FOR REASSESSING HAZARDS AT AN INDIVIDUAL FACILITY



C) Have the costs, benefits and tradeoffs of safety measures been evaluated?

According to the chemical industry's own analysis,[3] in many instances companies can discover a reason to apply inherent safety based on cost savings resulting from simpler design, smaller equipment, and reduced materials consumption. But in other cases, the costs of investing in inherent safety are only justified after consideration of an accident that has already occurred, or the potential costs and risks to the operator and society if such an accident does occur.

Some analysts indicate that the principal economic benefit of inherent safety to the firm is generally likely to be reliability of production—less time troubleshooting and repairing, lower maintenance and operational costs, and less downtime for production.[4] But this widely applicable incentive has not yet translated to a general shift to inherent safety. The failure of firms to study the available options and thereby identify potential savings is a key obstacle. This can be overcome by educational programs, and by legal requirements or orders to facilities to analyze available options.

Whether inherent safety measures are being applied, or other types of safety measures discussed later in this guide, a range of costs, benefits and tradeoffs need to be considered. For example, if a potential new process is inherently safer but it undermines product quality or poses other health and safety hazards to workers, this may hinder the switch.

From a business management standpoint, the user of the chemicals will likely ask questions such as the following:

- Are there chemicals which can be substituted (dropped in) to our production process to substitute for the substances in question?
- Can the production process be redesigned either to eliminate the need for the extremely hazardous substance, or the need for the product to be stored in large quantities?
- Are there short term and long term measures to make our activities inherently safer?
- If there is no drop-in substitute, can the end product be redesigned to eliminate the need for the extremely hazardous materials?
- What are the costs, and potential savings, associated with the toxic materials (regulatory, disposal, insurance) and with conversion to a process that is less toxic or hazardous?
- Will product quality be satisfactory?
- Will costs of production be altered?
- Will the change affect our markets positively or negatively?
- Are there other reasons driving the need for redesign, which make overall process or product redesign for safety and pollution prevention a timely issue?
- If storage volumes are being reduced, how will lower stockpiles of materials affect production if there is a disruption of shipping? Is there a backup strategy for sustaining production outputs, or can we manage the risks associated with this issue?
- Do changing federal, state or local regulatory requirements increase the cost of use of toxics or of emissions controls?
- How do newfound concerns about facility security affect the balance of costs for redesign? Can redesign, modernization and upgrading be a more productive form of expenditure than adding guards and redundant security systems?

From the standpoint of other stakeholders, such as workers and the community other factors are important, such as:

Workforce

- What added risks are imposed on workers?
- How do the changes affect employees' responsibilities or eliminate jobs?
- If jobs will be eliminated, will there be programs to ensure smooth and just transitions of affected workers - including education/retraining and income maintenance leading to an equivalent position in the future?

Community

- What are the costs of security guards, extra policing, and so forth to the community now that there is a heightened state of alert regarding the facility?
- What other costs (e.g. hospital and fire department preparedness) are imposed on the community by continued utilization of high volumes of hazardous materials?
- How much will any given change reduce the size of the plant's vulnerability zone?

Environmental and Worker Health and Safety Tradeoffs

Special attention is needed to environmental and occupational health and safety tradeoffs. In the best cases, reducing safety hazards will also reduce risks to workers and prevent ongoing pollution of the community. The application of inherent safety measures that eliminate the use of toxic substances without adding other hazards or emissions exemplify this.

> Ensure that hazard reduction measures truly advance the well-being of the community, the workforce, the site owner and the environment.

But, in other instances, for a variety of reasons, firms may consider changes that reduce the threat of accidents but increase other risks to workers and communities, such as through chronic exposure to low levels of toxics in the workplace or pollution emissions. It is important to guard against such changes, principally by asking questions before the change. Ask questions like these:

- What effect will new safety or security measures have on worker and community risk from ongoing pollution?
- Will chemical hazard reduction at the facility increase hazards on the roads and rails-or is the planned change truly "inherently safer" all around?
- Have the costs and effects of chronic emissions and waste disposal been integrated to the plan?
- What kinds of potential harmful health effects are suspected regarding substitute chemicals, even if there is some scientific uncertainty about how severe the effects will be?
- Are there other options that would increase safety and reduce pollution without shifting any risks to new areas?

By asking basic questions, people can help make sure that firms consider and air the answers.

When a facility is designed in a manner that is not inherently safe, there is also potential for add-on pollution controls to actually trigger safety hazards. For instance, one facility installed carbon filters to capture flammable emissions. But the carbon filters themselves burst into flames, causing a fire at the facility.

The emerging trend at wastewater treatment plants—shifting away from liquid chlorine to reduce community vulnerabilities to a sudden release incident—is a good example to illustrate how bringing environmental concerns into the decisionmaking process may change the outcome. Some of these facilities have shifted to sodium hypochlorite (bleach) for waste treatment, while others have shifted to ultraviolet light treatments. While either approach eliminates the gas cloud hazard posed by the liquid chlorine, from the standpoint of the environment the two solutions are not equal. Serious environmental concerns remain in environmental dispersion of chlorine, as occurs with sodium hypochlorite. Trihalomethanes (THMs) form during water purification when chlorine reacts with natural and synthetic organic chemicals in the water. Research by the Centers for Disease Control and the New Jersey Department of Health identified potential associations between high

THM levels in drinking water and low birth weights and birth defects.[5]

Continued use of chlorine in sodium hypochlorite also results in the generation of dioxins. Dioxin is the name given to a group of highly toxic chemicals that result from certain reactions with chlorine. Dioxin is produced during incineration, paper production, metal smelting and petroleum refining, and the manufacture of chlorinated chemicals including pesticides, herbicides and polyvinyl chloride plastic. A draft EPA dioxin reassessment, published in 2001, indicates that, even at very low levels of exposure, dioxin is linked to cancer, infertility, immune system damage and learning disabilities. More than 90 percent of dioxin exposure comes through the food we eat, especially fish, meat and dairy products.

The International Joint Commission - a US - Canada Commission created by an international treaty, has called for ending the use of chlorine in manufacturing processes:

> "We know that when chlorine is used as a feedstock in a manufacturing process, one cannot necessarily predict or control which chlorinated organics will result, and in what quantity. Accordingly, the Commission concludes that the use of chlorine and its compounds should be avoided in the manufacturing process."

So, even though it currently remains legally permissible to discharge chlorine, a growing body of opinion suggests that it is not environmentally advisable to do so. Thus, in addressing vulnerabilities of wastewater facilities from chlorine usage, the environmental concerns argue for switching to UV treatment systems—which do not use any chlorine—rather than sodium hypochlorite used by some operations, such as Blue Plains. While sodium hypochlorite eliminates the hazards of a sudden chlorine release, it does not eliminate the larger issues posed by the chlorine production cycle.

Worker health and safety tradeoffs can be affected positively or negatively by changes intended to improve a site's chemical safety or security. Eliminating toxic substances generally makes the workplace safer. By contrast, moving storage tanks away from the vulnerable peripheries of a facility to prevent terrorism can move them closer to where people work,

Toulouse, France Chemical Plant Explosion Changes World Views

A chemical explosion at a fertilizer plant of Atofina, in Toulouse, France, killed at least 30 persons including 10 employees at this site, 11 contract workers, one worker at an adjacent chemical plant, and the rest, people outside the plant. The explosion created a 15 meter deep crater, damaged 3000 homes, and 80 schools. It also shattered half the window glass in the city of one million people. 650 people were hospitalized. The financial cost is estimated at up to $850 million.

Soon after, there was speculation that the incident may have been a result of an intentional terrorist act. However, investigators have since stated that an accident, not an intentional action, was the most likely cause.

In response to the incident, the Mayor of Toulouse, Phillipe Douste-Blazy, called for the immediate shutdown and removal of all chemical production from the city, as well as a national debate on industrial risks. He noted that 10 million people live close to chemical plants in France.

As a result of the incident, the French government launched a national debate on chemical safety, involving 26 regional discussions to culminate in national policy recommendations. The French government has called on industry to reinforce safety at all sites. Short-term recommendations and measures include reducing operating inventories, strengthening monitoring plans and evaluating investments necessary for industrial protection. The European Community has also been pressed to act.

> **TWO WAYS OF MEASURING INHERENT SAFETY OF A CHEMICAL PROCESS**
>
> - Area affected by potential incidents.
> - Impact of a potential incident measured in casualties, property and environmental damage, etc.

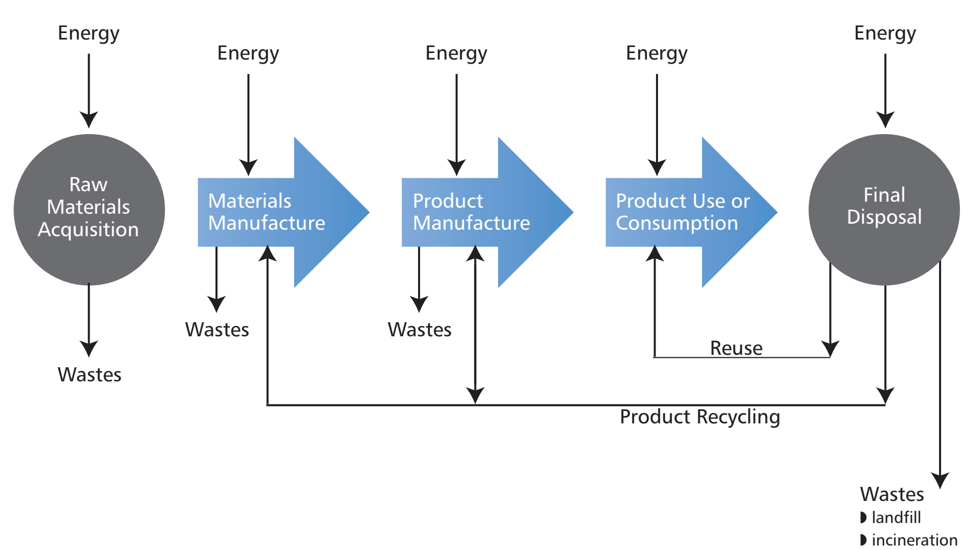
and therefore place them at greater risk from exposures or accidents.

Measures that eliminate toxic materials can often both eliminate chronic pollution issues as well as potential for catastrophic releases. A "clean production" inquiry may go the furthest in evaluating changes at a site -- asking not only about the safety of the facility, but also about the toxicity of products and wastes, and the consumption of energy throughout the production and consumption lifecycle. See chart below.

Notes

1. "The Feasibility of Encouraging Inherently Safer Production in Industrial Firms," in a Special Issue on Safety and Design, Safety Science, E. Fadier Guest Editor, in press.
2. There is an extensive literature of inherent safety, much of it developing in recent year. See for instance: "The Feasibility of Encouraging Inherently Safer Production in Industrial Firms," Zwetsloot G.I.J.M. and N. Askounes Ashford, in a Special Issue on Safety and Design, Safety Science, E. Fadier Guest Editor, in press; "Encouraging Inherently Safer Production in European Firms: A Report from the Field" N.A. Ashford and G. Zwetsloot, Journal of Hazardous Materials, Special Issue on Risk Assessment and Environmental Decision Making, A. Amendola and D. Wilkinson (eds.), 1999, pp 123-144; "Industrial Safety: The Neglected Issue in Industrial Ecology" in the Special Issue on Industrial Ecology, Ashford, N. A. Journal of Cleaner Production, 1997. 5(1/2), pp 115-121 (available at http://www.elsevier.com/locate/jclepro); The Encouragement of Technological Change for Preventing Chemical Accidents: Moving Firms from Secondary Prevention and Mitigation to Primary Prevention, N.A.Ashford et al., A Report to the U. S. Environmental Protection Agency, Center for Technology, Policy and Industrial Development at MIT, Cambridge, MA, July 1993; Trevor Kletz, Process Plants: A Handbook for Inherently Safer Design, 1998; Trevor Kletz, Plant Design for Safety:A User-friendly Approach, 1991; R.E. Bollinger, et al, Inherently Safer Chemical Processes: A Life Cycle Approach, Center for Chemical Process Safety, 1996; Health and Safety Executive (of the United Kingdom), Technology Division, Designing and operating safe chemical reaction processes (www.hse.gov.uk)..
3. Batelle Laboratories, Responsible Care Powerpoint presentation on Inherent Safety, 1998.
4. "Encouraging Inherently Safer Production in European Firms: A Report from the Field" N.A. Ashford and G. Zwetsloot, Journal of Hazardous Materials, Special Issue on Risk Assessment and Environmental Decision Making, A. Amendola and D. Wilkinson (eds.), 1999, pp 123-144.
5. Massachusetts Toxics Use Reduction Institute, Massachusetts Chemical Fact Sheet: Chlorine.

The Product Life Cycle



Thorpe, Beverly, *Citizen's Guide to Clean Production*, Produced for the Clean Production Network, University of Massachusetts Lowell, 1999.

Clean Production Action

IF VULNERABILITIES REMAIN, REASSESS BACK-UP SAFETY AND SECURITY FACTORS

Although there are many circumstances in which inherent safety options may be quickly applied, in other situations, major vulnerabilities will remain for the near or long term.
It may be necessary to also reassess back-up safety and security factors which, despite their shortcomings, could be vital to minimizing the damage caused by potential chemical releases. These factors include buffer zones and siting issues, add-on technologies and safety practices, facility and infrastructure security issues, and emergency response planning.

BUFFER ZONES/ SITING ISSUES

Aside from the volume and type of extremely hazardous materials stored on-site, the *location* of a facility may be the most significant determinant of the degree to which the facility poses potential for large-scale human casualties.

Good practices separate hazardous industrial chemicals from populated areas *before* there is a conflict, through set-back requirements, zoning, etc. Unfortunately, there are not adequate reference standards for land use planners.

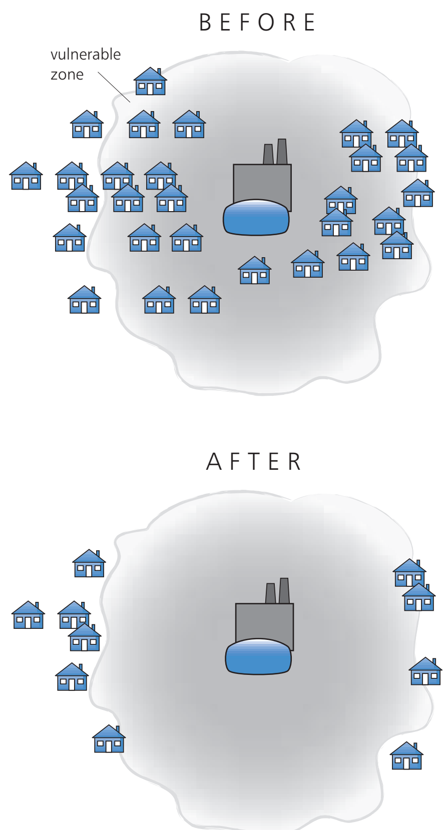
Determining the severity of a potential chemical disaster at a particular facility is a matter of ascertaining the amount of materials that could be released, the speed with which they would travel under adverse wind conditions, and the population that could be exposed if safety systems fail. This last factor, numbers of people at risk, is determined largely by the location of the facility away from or proximate to populous areas and the number of workers on-site. In addition, proximity to sensitive facilities, such as schools, day care centers or hospitals determines the degree to which particularly vulnerable individuals such as children or the infirm may be in the zone of potential exposure.

Are there adequate buffers between vulnerable populations and chemical facilities?

In many areas, chemical facilities have been constructed in areas that were relatively remote from local populations, only to witness the later development of housing and urbanization encroaching on the facilities over time. This reportedly happened both in Bhopal, India and Toulouse, France - in each instance, the facility was more remote from populations when it was built than at the time that disaster struck.

In the aftermath of the Toulouse France chemical catastrophe of September 21, 2001 the Mayor of Toulouse declared that all chemical industries should be moved out of this urbanized area.

Relocation of chemical facilities or surrounding homes due to poor siting/development



Reducing Vulnerability by Expanding Buffer Zones and Relocating Facilities or Neighbors

Evaluate: costs of relocation compared with volume reduction changes.

For instance, if the facility cannot eliminate high volume storage, is it less expensive to move near neighbors away from the facility? Workers in the facility remain at risk.

decisions has been achieved in some communities. For instance, at the Lewcott chemical plant in Worcester, Massachusetts, evaluation by local citizens and their experts concluded that the facility stored high volumes of very flammable materials in close proximity to a densely packed residential neighborhood. The neighbors and the company reached a "Good Neighbor Agreement" in which the company agreed on a two year timeline to relocate its operations to another site, also owned by the company, that was further away from residential populations.

In this case the company was able to move certain operations to another site. More relocations of facilities or neighbors are in order. Neighbors of some U.S. facilities have been particularly concerned after September 11 with threats of terrorism. Prior to September, neighbors of the Shell refinery in Norco, Louisiana had already been asking the company to pay for their relocation away from the facility. They believe that chronic emissions and frequent upsets at the facility are harming their health. Recent terror incidents highlight the potential for catastrophe for the African-American neighborhood near the facility.

Moving residences or factories after the conflict between uses becomes apparent is highly disruptive. Buffer requirements should be widely established through zoning or other legal mechanisms to anticipate this issue before construction happens.

Are there safety concerns related to relocating storage and other systems within local facilities?

In some instances, the new need to address terrorism can conflict with other facility safety considerations. The repositioning of storage tanks and other vulnerable equipment within a facility can affect both overall safety and anti-terrorist security. In current responses to the terrorist threat, facility managers may make dangerous tradeoffs between security and safety. According to "Site Security Guidelines For The U.S. Chemical Industry," published by the American Chemistry Council (the chemical producers' trade association):

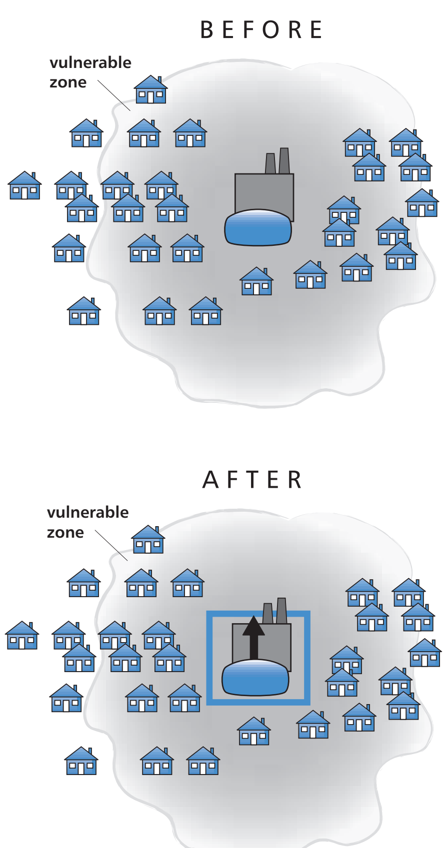
> .any site redesigns should be done with security in mind. For example, plants should generally be laid out so that the most vulnerable or important locations are hardest for adversaries to reach.

By contrast, many facilities have been laid out to prevent the potential for chain reactions among storage tanks. Tanks with large volumes of hazardous materials are placed at the periphery of the facility so that if one explodes, it does not in turn ignite others. Therefore, shifting design considerations to address the security concerns could mean bringing those tanks closer together and thereby increasing the potential for catastrophic chain reactions. Also, locating storage units closer to the center of the facility may place them closer to more employees of the facility and to critical control systems.

Management of change requirements within the OSHA process safety management rule are intended to surface these issues for employees when plants rearrange their operations. Therefore workers who could be at increased risk from such changes, and their representatives, should be alert for opportunities to address these issues, ensuring that redesign is consistent with worker safety as well as security. Local communities should also insist on engagement on such changes, including the establishment of mechanisms of notification.

'ADD-ON" SAFETY DEVICES AND PRACTICES

In contrast to "inherent" safety measures which eliminate vulnerabilities associated with hazardous chemical uses, there are a wide array of other issues at facilities that fall under the general category of add-on prevention



Enhancing Safety Through Add-On Barriers to Discharge

Evaluate: limits to effectiveness of add-on barriers.

For instance, in the Bhopal disaster, barrier systems failed. What would happen if the barriers fail at this site?

Examples: trenches or water curtains

(sometimes referred to secondary prevention.) While primary prevention/inherent safety eliminates or dramatically minimizes the danger of an accident or assault, secondary prevention can reduce the likelihood or severity of something going wrong. It may focus, for instance, on the structural integrity of production vessels and piping, neutralizing escaped gases and liquids, and the installation of shut-off devices. Unlike primary prevention, however, secondary prevention can be overridden or can fail to work as intended.

Despite its weaknesses, there may be a need for extensive analysis of add-on measures at a facility if inherent safety cannot be applied to eliminate facility hazards. The following are some of the components of add-on prevention that may need to be reassessed.

- **Process Hazard Analyses (PHA's)** are detailed analytical processes to anticipate potential spills or emergencies, and design strategies for prevention. These processes are required for many facilities by EPA and OSHA rules. In a complex facility such as a refinery, it is often difficult to anticipate all that can go wrong; the PHA attempts to do this. Many PHA's have lacked adequate attention to inherent safety, but the detailed information in PHA's is a good starting point to identify where investigation of inherent safety options may be appropriate. PHA documents are held on the site of a facility, and can be inspected by EPA or OSHA. Others with rights to review these documents include members of the workforce, and Local Emergency Planning Committees. In some instances, local concerned citizens have also arranged for review of those documents, with help from independent experts.

In investigations of accidents, many experts point to the lack of adequate analysis by the management to head off foreseeable dangers. For instance, after an explosion during maintenance of the Tosco Refinery in Martinez, California killed four workers, the federal Chemical Safety Board investigation concluded that the "root causes" of the accident were the lack of effective processes for assessing maintenance operations and correcting unsafe practices indicated by "near miss" accidents.

- **Training measures** attempt to ensure that employees and contractors working at a facility do not make dangerous mistakes that could trigger an accident. Training may need reassessment, especially security related training, in light of the terrorist attacks of September 11, 2001.

- **Maintenance** activities can involve checking or cleaning critical functions of facilities, which, if allowed to fall into disrepair, can lead to releases. At many larger facilities such as refineries, waste incinerators and chemical plants, there are frequently small accidents, referred to as "upsets," which pollute neighborhoods and harm the health of neighbors. Unfortunately, many state environmental agencies have come to accept, and not penalize, these periodic incidents caused by various maintenance and upkeep related events such as failure of pollution controls, or startup or shutdown of equipment. Many of these upsets are actually a result of the need to vent-off the build up of explosive materials, in order to prevent a catastrophic explosion. These fugitive emissions and the related "upset clauses" in air pollution permits are often abused by refineries in particular, in order to bypass pollution controls. A study conducted in December of 2000 by chemist Wilma Subra showed that neighborhoods in Beaumont/Port Arthur, Texas were exposed to accidental upsets an average of five times a week. While in some instances, inherent safety measures might eliminate the need to engage in venting, in other instances, the upsets can be eliminated by replacing other equipment or engaging in better maintenance that anticipates and heads off releases. According to Subra, industry's records show that 75 percent of the refinery upsets would have been avoided if up-to-date pollution control technology and new valves had been installed.

- **Management of change** ensures that when site owners change technology or operating practices, they carefully consider the ways that the changes can lead to catastrophic accidents. The kinds of changes that can lead to chemical accidents are diverse; indeed, the EPA has

EXPERT ASSISTANCE IN REVIEW OF TECHNICAL ISSUES

Due to the complex technical issues that may be involved in hazard assessment, community residents and officials seeking to assess hazards at local facilities often draw upon independent third party experts. These have included individuals from consulting firms, public interest groups, and retired professionals. Funding to hire these experts has come from diverse sources - from public revenues, foundation grants, settlements of a company's legal violations, fee systems, and special agreements between companies and local entities.

Lois Epstein, an engineer, has assisted community organizations in assessing chemical hazards. For instance, she worked with residents near Chicago (in the community of Blue Island) who were granted access to process hazard analysis (PHA) documents generated by the Clark Oil Refinery as part of the Clean Air Act risk management process.

Epstein says that "review by technical analysts working with public interest groups of PHAs or relevant portions of PHAs as part of hazard assessments enables the public to:

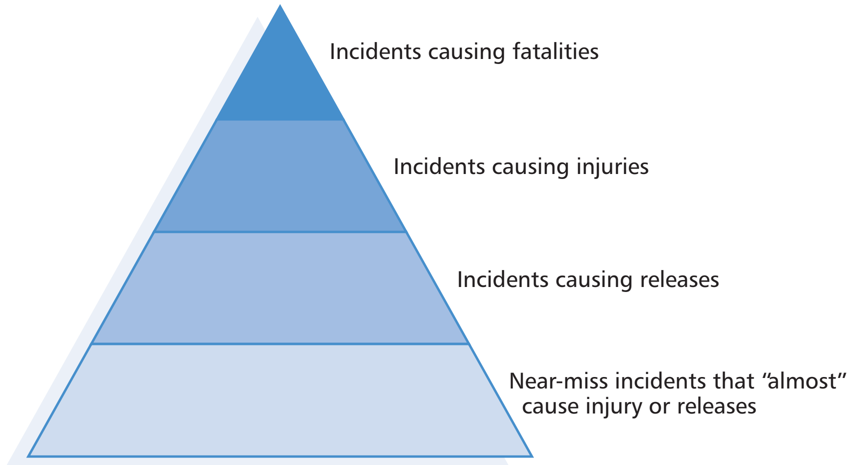
- provide informed input to companies on processes of greatest concern so companies can incorporate that input into their PHA 'action item' implementation plan,
- monitor whether PHA 'action items' are being addressed in a reasonable timeframe, and,
- understand better facility-specific tradeoffs if certain PHA 'action items' are addressed before others."

Such expert-assisted community assessments of a company's detailed safety assessments can lead to a better understanding of opportunities for for hazard reduction. It can also help to elevate the dialogue between concerned residents and company officials.

noted that in a number of instances, the installation of needed pollution control equipment ~~to~~ curtail chronic pollution ~~led~~ to chemical accidents due to the failure to take account of the way these changes could otherwise affect processes.

- **Near-miss tracking and response.** The processes by which a company tracks and reacts to potential *warning signs* of a chemical disaster are also a kind of a secondary prevention measure. Many companies experience a number of near accidents ("near-misses") before a catastrophic accident occurs and causes injury or a release to the environment; having a strong system in place to track these incidents and to make changes to head off disaster is crucial.

- **Containment systems** seek to prevent toxic materials from reaching the environment when a potential release has been triggered. Examples include double walling of vessels, the installation of dikes to capture materials on the ground and "water curtains" that spray water to halt the passage of a gaseous release. Any of these measures may help to slow the passage of materials from a punctured tank or process into the surrounding community.



Adapted from: M. Sam Mannan, Michela Gentile, and T. Michael O'Connor, Chemical Incident Data Mining and Application to Chemical Safety Analysis, Mary Kay O'Connor Process Safety Center, Chemical Engineering Department Texas A&M University System, 2001 and Squire, Richard H., "Zero Period Process ~~-~~A Description Of a Process to Zero Injuries," Process Safety Progress, Vol. 20, No. 1, March 2001, pp. 33-44.

For every accident that causes a fatality or injury, facilities experience hundreds of near-misses which are warning signs against more serious events.[1]

Add-On Systems Prone to Fail

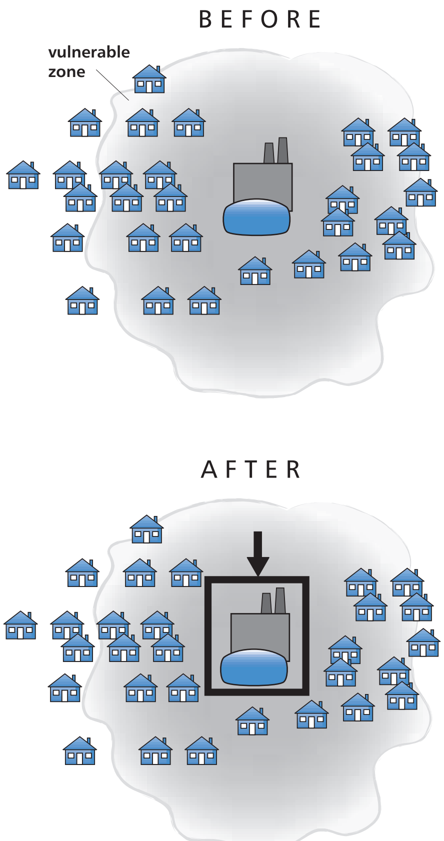
Unlike changes in inherent safety, add-on measures are prone to failure or even being sabotaged by determined terrorists. For instance, in the Bhopal chemical disaster, at a Union Carbide facility in Bhopal, India in which 3,000 people died quickly from a chemical release, the company alleged that a saboteur, such as a disgruntled employee, triggered the accident. Yet, regardless of whether the controversial sabotage claim was true, the management had also undermined the add-on safety equipment. For instance, to save on electric bills, the management had turned off a refrigeration unit intended to keep dangerous chemicals close to zero degrees centigrade to slow or prevent reactions. The management had failed to replace the caustic soda in the scrubber which was designed to neutralize any escaping gas. The flare tower meant to burn off any gases from the scrubber was in disrepair. Just as in Bhopal, in many other incidents chemicals have reached local communities because containment systems have failed.

Reassessing safety at chemical storage sites may require review of these secondary, add-on measures. However, given their tendency to fail, priority should be given to inherent safety. Secondary prevention is necessary to address residual hazards after adopting inherent safety whenever possible. Add-on safeguards may also be needed in an intervening period while awaiting the results of longer term assessments of inherent safety options for some units.

SITE SECURITY

There is a need to prevent unauthorized access to facilities presenting dangers to local communities. There have been a number of incidents and assessments indicating that security at facilities is not currently consistent with the hazards presented by facilities. For instance:

- Snooping reporters have had access to facilities without being stopped by security. In 1999, a reporter roamed about inside Washington, DC's Blue Plains sewage treatment facility, which at that time stored tons of chlorine and sulfur dioxide, without being stopped or asked for identification.[2] Similarly, a CBS TV news team ~~-in~~cluding a camerman and two reporters ~~-w~~alked onto the site of a



Enhancing Security Through Barriers to Access

Evaluate: limits to effectiveness of barriers.

For instance, can the barriers used at a facility prevent a hijacked jet or long distance rifle or projectile from piercing storage tanks?

New Jersey chemical plant in November 2001 without security stopping them.[3]

- The environmental organization, Greenpeace, reports that its activists entered a Dow Chemical facility in Plaquemine, Louisiana undetected: that there were no guards at the perimeter, no security cameras, no alarms, and the door was unlocked. Greenpeace published photographs showing the inside of an unoccupied building that controls big pumps that dump 500 million gallons of industrial wastewater into the Mississippi River each day).[4]

- The Pacific Northwest National Laboratory found inadequate security at several Department of Energy military facilities that store hazardous chemicals.[5]

The potential for terrorists to turn local chemical storage and production sites into weapons of mass destruction has become a widely acknowledged concern. For instance, the federal Agency for Toxic Substances and Disease Registry (ATSDR) published a study in 1999 evaluating chemical industry vulnerability to terrorism. It reported that there have been several incidents in other countries in which terrorists targeted industrial chemical storage or manufacturing facilities as "improvised explosives, incendiaries, or poisons."[6]

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-as a result of complacency and lack of awareness of the fact that almost half the targets of terrorists are businesses and industries:

- Chemical plant security managers were very pessimistic about their ability to deter terrorist attacks by employees, yet their companies had failed to conduct simple background checks for key employees such as chemical operators.

- 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 etc.

> Given the potential for high tech assaults by aircraft or high-powered rifles, only moving to inherent may truly protect vulnerable communities from high volume chemical sites. Where inherent safety measures may require extended study, or otherwise prove infeasible, increased security may be needed in the meantime.

The American Chemistry Council (the chemical industry's trade association) has asserted that the two communities selected in study are not necessarily representative of the entire chemical industry, and that scenarios chosen were not representative of the likely incidents from terror attacks.[7] Be that as it may, the ATSDR report demonstrates the need for a serious reassessment of the design and security of chemical storage and production facilities everywhere. It demonstrates that any assertions of the existence of adequate security and safety by industry should not be relied upon without thorough evaluation by government and affected communities.

The ATSDR report concluded that industrial chemicals provide terrorists with effective, readily accessible materials to develop improvised explosives, incendiaries, and poisons. It sounded an alarm ~~lo~~ng *before* the September terror attacks ~~fo~~r vigorous efforts to ensure that these potential threats are taken seriously, identified, and prevented.

The basic goal of security is preventing individuals from having access to sites or potential targets without clearance by plant management. In addition to fences and other barriers, many companies utilize a combination of security lighting, guards at fixed posts and in mobile patrols, and security clearance badges to limit access to the facility. Unfortunately, there may be little that such security measures can do to fend off some potential security threats to chemical sites and their neighbors. For instance, a report by the Violence Policy Center, indicates that Al Qaeda and Osama Bin Laden have acquired at least 25 high powered 50 caliber rifles, capable of piercing storage tanks from as far as 1000 feet away from a facility.[8] The Violence Policy Center states that it believes the rifles would be suited to turning chemical or other industrial facilities into bombs, with the potential for mass casualties. Similarly, they noted the potential for explosive attacks on bulk fuel carriers or storage depots, including the risk of chain-reacting explosions spreading damage from tank-to-tank to reach catastrophic levels.

Given the potential for high tech assaults by aircraft or high powered rifles, only moving to inherent safety, as described earlier in this guide, may truly protect against such long distance assaults on chemical sites. However, the pages which follow describe some of the various strategies which a facility's management may need to deploy to bolster security.

Security of facilities and environment

- Provide Security Lighting that delivers protective illumination in all weather, including secure automatic auxiliary systems and power sources (such as generators or batteries), underground circuits, and redundant wiring.
- Install Intrusion Detection Systems and Alarms that protect operations by detecting motion, heat, smoke, sound, or pressure at the facility perimeter, in critical areas (such as computer centers and extremely hazardous substance areas), and at all potential access points (such as doors, windows, floors, roof hatches and skylights, gates, manholes, drains and discharge outfalls, adjoining buildings, and air vents).
- Consider Closed Circuit TV that maximizes intrusion-monitoring capabilities.
- Install Access Controls that address personal identification and clearance, key control, parcel inspection, metal detection, visitor logs, escorts for outside service vendors, remote locks, and lock change schedules (including upon changes in employees).
- Consider Grounds Maintenance and Landscaping procedures that keep extremely hazardous substance zones and sightlines free from obstructions, such as double fences with vegetation-free medians.
- Establish Guard Force Requirements that ensure sufficient and well-prepared staffing, with accurate and updated written duties and standards for supervision, training, and performance evaluation.
- Construct Physical Barriers that prevent unauthorized access by persons and vehicles (including air and watercraft) through building design, well-maintained and monitored fences, walls, truck barriers, locks, window bars, safety glass, etc., including compartmental barriers around areas where extremely hazardous substances are stored.
- Install Projectile Shields that protect extremely hazardous substance tanks and vessels from airborne and propelled explosive devices and projectiles (as well as from blast fragments).

Product Transportation

- Revise Product Transportation to reduce hazards through delivery route planning (avoiding tunnels, downtown areas, and sensitive populations), random timing, alternate routes, driver training, security escorts, equipment maintenance, secure valves, compatible cargoes, and appropriate volume packaging.

Computer and Utility Systems

- Review Computer Security and Consider Cyber Barriers that block persons outside a facility from electronically manipulating computers that control critical valves, pressures, temperatures, facility access, and other safety systems (using cyber "firewalls," encryption, and electronic pass keys with changing codes).
- Consider Physical Computer Security safeguards for critical computer systems via fire/water/blast safe construction, access controls, dedicated security officers, safe distances from extremely hazardous substance hazards, secure air vents safe from extremely hazardous substance gas leaks, fully-compatible backup computers and expertise, backup electricity and communications, and automatic shutdown capabilities.
- Install Failsafe Computer Backup Systems that independently monitor critical security and safety systems and take over to prevent catastrophic failure.
- Install Secure Backup Utilities to ensure continuous safety and emergency response capabilities upon loss of electricity, telephones, water, sewers, or cyber systems, including redundant wiring (on-site and incoming), secure electrical panels, and backup generators.

Controls On Processes For Quick Shutdown

- Establish Safe Shutdown Procedures that enable operators to shut down facilities in emergencies; they must be clearly documented, simple, and robust enough to function in urgent situations, including clear procedures, exercises, and authority.

Staff relations, training and protection

- Establish and Maintain a Labor Dialogue that ensures that workers and their representatives are involved in security problem solving.
- Consider Blast and Fire Safe Control Rooms and Safe Rooms to protect workers and visitors from explosions and fires that originate from criminal activity or plant design, and con-

tain breathing devices, first aid supplies, and secure independent external communications.

- Provide for Certified Training that prepares and certifies security and other staff on safety, fire protection, weapons, bomb threats, hostage situations, arson, access controls, security devices, first aid, self defense, case reports and records, communications, human relations, and special training on extremely hazardous substance dangers and response.
- Establish Testing and Maintenance Schedules that ensure the evaluation of security equipment and systems, including periodic fire and emergency drills, and daily review of grounds, fences and barriers, utilities, backup systems (such as lighting and computers), fire and intrusion detection systems, alarms, sprinklers, and other security elements.
- Inspect Emergency Exits and ensure that workers can quickly vacate buildings and grounds through clearly marked and maintained exits. Self-contained alarms and warning signs prevent non-emergency use.
- Appoint On-site Response Teams to shut down or reestablish power or water, contact outside assistance (police, fire, medical, bomb squad), provide first aid, direct evacuations, and operate and troubleshoot backup computer systems.

Internal and external auditing procedures

- Establish Materials Accounting Procedures that make evident any theft of extremely hazardous substance chemicals, facilitate site safety and prevention planning, and help managers to keep unwanted substances out of a facility (the hazardous materials pharmacy concept).
- Establish Theft Prevention Guidelines that provide for tracking and safely storing extremely hazardous substances to prevent theft and to address legal liability for harm associated with inadequate theft and fraud prevention.
- Audit Internal Security to periodically assess security systems and safer alternatives.
- Provide for Certified Third-Party Audits that regularly review security systems, risk management plan issues and inherent safety opportunities.

Administrative and managerial controls

- Establish Policy Statements that commit facilities to determine if chemical hazards can be readily reduced or eliminated before analyzing risks and potential consequences of these hazards, and help engage senior managers and full corporate resources in design for safety and security.
- Establish Financial Analysis Standards that ensure that prevention investments receive comprehensive treatment during the capital budgeting process, including costs of extremely hazardous substance operations that were avoided through specific projects (such as heightened security, liability, regulatory compliance, add-on safety equipment, and remedial cleanups).
- Establish Line Item Security Budgeting to inform senior managers about security costs for extremely hazardous substance operations in existing and proposed projects.
- Establish Security Records Systems that document security deficiencies, malfunctions, case reports, and corrective actions in a written retrievable format sufficient to support planning, budgeting, and maintenance schedules.
- Establish Administrative Controls that ensure that facilities operate within design capacity, and eliminate or reduce chemical hazards through mandatory review of: proposed process changes; extremely hazardous substance purchases; order frequency and volume; and chemical uses.

These safety and security elements are derived from, among other sources: Lawrence J. Fennelly, Handbook of Loss Prevention and Crime Prevention, Second Edition, 1989; and Russell L. Bintliff, The Complete Manual of Corporate and Industrial Security, 1992. Elements related to inherent safety are derived from, among other sources: Trevor Kletz, Process Plants: A Handbook for Inherently Safer Design, 1998. Adapted from list prepared by Cuyahoga County (Cleveland, Ohio) Local Emergency Planning Committee.

EMERGENCY RESPONSE PLANS

Since the 1980s, most of our nation's response to the threat of catastrophic chemical releases has been through local emergency preparedness planning, a process that anticipates and describes what should be done during and after a chemical release. Emergency preparedness plans developed by Local Emergency Planning Committees address the mechanisms by which chemical sites experiencing accidents or terrorism would alert local residents, schools, hospitals, and others, and tell them what to do and where to go to best enhance their chances for safely surviving the incident.

While emergency planning can help to reduce the number of people who are injured or killed during a release, by its nature it does not *prevent* the releases from happening. The focus in law and public discourse on emergency planning creates a sense of inevitability of chemical incidents, even though many of them could be prevented with more focused hazard reduction efforts.

USEPA Region VI describes the tasks a Local Emergency Planning Committee (LEPC) needs to go through in developing an emergency response plan as follows:

- Identify facilities and transportation routes of extremely hazardous substances and other chemicals
- Identify additional facilities which could be subjected to additional risk due to their proximity to facilities subject to the requirements mentioned above, such as hospitals, nursing homes, schools, prisons, or others
- Describe emergency response procedures for handling chemical releases at a facility, both on-site and off-site. These procedures should be followed by facility owners and operators, local emergency responders and medical personnel responding to the incident.
- Designate a community emergency coordinator and facility coordinator(s) to implement the plan.
- Develop reliable, effective, and timely notification procedures for facility emergency coordinators to convey information to community emergency coordinators and to the public, that a release has occurred.
- Describe methods for determining the occurrence of a release and the probable affected area and population.
- Describe community and industry equipment available for response operations, and identify the persons responsible for the equipment.
- Define training programs for emergency response personnel, and the schedules of training for emergency response and medical personnel.
- Present methods and schedules for exercising emergency response plans to emergency responders, emergency medical personnel, fire service, and law enforcement agencies.

The plan thus developed shall be reviewed at least once a year, or more often as circumstances within the community or facilities changes.

PUBLIC EDUCATION NEEDED

A survey conducted by the Center for Process Safety at Texas A&M University found that between 50 and 67 percent of people living with a one mile radius of facilities covered by risk management plans were unaware of the existence of the facility.

These activities are dramatically affected, and are made more important, as a result of the events of September 11, 2001. Here are some of the questions that should be addressed:

New roles of worst case scenarios in the emergency plan

The prior work to assess the risks of chemical accidents has involved the use of the planning case ("more likely case") rather than worst case as the pivotal scenario for planning of emergency responses. But given the occurrences of September 11, added attention and planning should be given to the potential for a worst case incident. The plans developed for evacuation, sheltering etc. must be evaluated with reference to worst case scenarios, not just the scenarios that site owners had previously designated as "likely."

In addition, the facilities' own worst case scenarios may need to be revisited and upgraded, since they can be based on releases from a single vessel, rather than the potential for criminal activities to cause releases from multiple vessels at once.

Equipping local emergency responders

In the event of an accidental or intentional chemical release, the health and safety of various groups of individuals is placed in jeopardy. Often when chemical incidents happen, a number of workers inside the facility, in close proximity to the explosion or chemical release, are immediate victims of the incident.

Given the difficulties in alerting and protecting local populations, are there safer materials or lower volume options which could truly get the local population out of harm's way?

Next, emergency responders such as firefighters show up at the facility and are confronted with chemical dangers that they may or may not know how to handle. They may or may not know where the chemicals are in the facility, whether there are other materials nearby in danger of subsequent release, what types of measures should be taken for personal protection and to curtail the incident. Even if they have the information needed, they may or may not have the equipment needed to safely eliminate the dangers. Often the emergency responders are themselves the next to succumb to the release, with resulting loss of life and short and long term damage to their health.

For instance, in the course of fighting a release emergency responders may make physical contact with materials. There are many chemicals which can cause adverse effects on unprotected skin ranging from contact dermatitis to permeation of the skin and systemic toxic effects. In addition, some chemicals (mostly solids) can present a contamination problem where inadvertent ingestion (e.g., lead) could occur or entry to the airstream (e.g., asbestos) could lead to inhalation. Chemical protective clothing (CPC), comprising gloves, boots, suits and other related components, can prevent direct skin contact and contamination. CPC can also prevent physical injury to the unprotected skin from thermal hazards such as from rapidly evaporating liquefied gases freezing the skin (e.g., liquefied petroleum gas).[9]

An assessment of emergency preparedness in the community should ensure that those emergency responders are ready to address the issues that may arise within their jurisdiction, with minimum threat to health and safety.

Some states and areas are better equipped than others. For example, some areas, recognizing the inadequacy of local resources for emergency responses to hazardous materials have created regional response teams. Fire Captain John Malool of Bergen County, New Jersey, says that he is part of a nine town response team which is trained and equipped to handle hazmat events anticipated within those towns. He suggests questions such as the following:

- Is there a separate hazmat team, or a group of fire department personnel, with adequate training to respond to the types of materials at local facilities?
- Do our local emergency responders have the equipment needed to deal with the kinds of incidents which could occur at local facilities?
- Do the responders have supplies of chemical protective equipment including gas masks and other clothing?

- What are decontamination plans for exposed populations, such as showering systems and tents?

- Are there grant programs developed in the aftermath of September 11, 2001 by state and federal governments to fund protective equipment and training? Can a portion of these funds also be applied for prevention?

- Who will respond to an incident that is beyond the capacity of local responders? How long will it take them to arrive on the scene?

Alerting the local population
Options for alerting the local population may include a loudspeaker system, a buzzer alert, door to door alerts, and phone calls. One of the more effective systems for alert of the population is a dial-up system that quickly and automatically calls each home in the area and notifies them of the need to shelter or evacuate.

Some Potential Weaknesses in Emergency Response

The Federal Emergency Management Agency (FEMA) operates the Comprehensive HAZMAT Emergency Response Capability Assessment Program (CHER-CAP), working with Federal, State, Tribal, local and industry partners. CHER-CAP is delivered through Local/Tribal Emergency Planning Committees and is designed to assist communities in improving their capability to respond to major HAZMAT incidents, both intentional and accidental. A key CHER-CAP component is a full field mass casualty exercise involving the range of people and institutions that would need to move into action on local chemical emergencies, even local hospitals. Dennis Atwood, the Acting Chief of FEMA's Hazardous Materials Preparedness Branch, summarizes major issues learned from CHER-CAP exercises as follows:

1) Hospitals lacked adequate patient decontamination capabilities and viable emergency management/incident command plans. A recently revised standard of the Joint Commission on Accreditation of Healthcare Organizations, EC 1.4, requires hospitals to develop such emergency response plans, so this issue should improve over time.

2) It sometimes took the responders too long to make initial contact with victims of the incidents. Sometimes hazmat teams and emergency medical services took as long as an hour and a half to be in contact with and administer care to victims.

3) The rapid intervention teams, whose job it is to stand by to rescue any responders who may get in trouble or become overwhelmed, were themselves too quickly enlisted for general response - so that they were unavailable for protection of the first responders.

4) There was inadequate sharing of information regarding crime scenes among the emergency responders, which could make it more difficult to prevent additional acts by criminal perpetrators that are still at large, and which also may impede the preservationof evidence at the crime scene.

5) There was inadequate early action to contain the potential for environmental contamination such as preventing runoff from the site.

For more information see www.fema.gov/pte/cher_cap_info.htm

Shelter in place or evacuation?
Local emergency response plans need to evaluate the potential actions of people who may be exposed to a toxic release from a facility. Options generally include sheltering in place, or evacuating.

Once a release has occurred, some harm to public health may be inevitable. Under some circumstances, sheltering in place may lead to the least damage to health. The National Institute for Chemical Studies stated that:

> Some early studies of sheltering effectiveness calculated that, for a typical dwelling and a plume lasting 10 minutes, the dose indoors would be about one-tenth of the outside dose. For other types of dwellings and releases, the indoor dose could be as little as one percent of that received outdoors.[10]

However, sheltering is a strategy with many shortcomings. For instance, if a release goes on longer than anticipated, the dosage of the sheltered population may reach harmful levels. The viability of shelter in place as a response strategy is also dependent on the types of materials released, and the degree to which the buildings in which people will be sheltered will keep out the vapors. Especially where people live in older buildings, shelter in place can fail to prevent serious harm to the public's health. For instance, in a sulfuric acid release at General Chemical in Richmond, California, this approach resulted in about 2400 people seeking care at local hospitals, primarily for respiratory and eye injuries.

By contrast, the viability of **evacuation plans** will largely depend on the capacity of local roadways to handle the flow of people out of the community. Attention is also needed for evacuation of vulnerable populations - from day care centers, schools, hospitals, and nursing homes.

In many instances, communities will also want to establish a secure shelter into which the community can evacuate in an incident.

The location of Evacuation Shelters to be used for hazardous materials emergencies should be identified in the Plan by a list and/or a map. The decision making process for which shelter (s) to open should exclude any location that could become encompassed by a hazardous atmosphere. Also, the Plan should designate a "Transportation Coordinator" and a "Sheltering Coordinator," points that are probably already addressed in the Community's overall Emergency Operations Plan.

The need for a shelter location to be out of reach of potential emissions is a critical point. This has been learned the hard way in some communities where the evacuees have had to be re-evacuated after the first evacuation shelter proved to be in the path of emissions as they moved further from the site.

Vulnerable Populations
Special attention is needed for identifying the impact and preparedness of schools, hospitals, day care centers and nursing homes. The

Example of a Shelter In Place Alert

"Attention! There has been a spill of carbon bisulfide in the Orange Avenue and Box Street neighborhood. Although our air monitoring still indicates that the levels are safe, the concentrations in the air may be highly irritating at this time - do not linger outside an enclosed building in this area. You are instructed to stay inside your home or business at this time, unless you are leaving the area. Since carbon bisulfide is heavier than air you may wish to avoid the lower floors of your building. You may also wish to temporarily leave the area - if you do so, avoid the intersection of Box and Orange where the spill has occurred. Stay tuned to WLAD (800 AM) for further information."

-From National Institute For Chemical Studies people in these facilities may be ill equipped to evacuate in a timely manner. Hospitals and other healthcare institutions should consult the guidelines of the Joint Commission on Accreditation of Healthcare Organizations which provide requirements for emergency preparedness. (JCAHO standards EC1.4 and 2.9.1).

Also consider the ability of hospitals to handle victims of a catastrophic incident. How many patients can be handled by the relevant personnel of the hospital (e.g. burn unit, acute respiratory care, etc.) how many would need to be referred elsewhere? Where would the excess patients be referred?

Even with the best possible emergency response plans in place, there will often be areas nearest to the plant where residents may be expected to suffer harmful exposures even if the plan is implemented perfectly. These people live too close to the facility to receive ***warnings*** to shelter or evacuate before a major release will reach them. Offsite consequence analyses for storage and transport facilities should be required to explicitly detail these areas. This area can be calculated by delineation of the amount of time it might take, in adverse wind conditions, for a release to reach those areas, and the amount of time it will realistically take for decisions to be made and notice to be provided.

Reconsidering inherent safety in view of shortcomings of emergency responses

After going through emergency response plans and understanding their shortcomings, revisit the question of inherent safety. Effective emergency response plans may minimize the number of casualties and injuries from an incident, but the truth is that extensive injuries may occur even with a plan that is as strong as it can be. By contrast, moving to safer materials or curtailing volumes of materials stored at a site can simplify the emergency planning process and ***ensure*** that few injuries will occur even in a worst case incident.

The Cuyahoga County, (Cleveland, Ohio) Local Emergency Planning Committee Policy Committee has been considering a draft resolution which states that because effective evacuation of the potentially exposed population is highly problematic in their urbanized area, and because the effectiveness of shelter-in-place is not well established, local facilities are *encouraged to review opportunities for hazard reduction and to upgrade their prevention measures.*

Given the difficulties in alerting and protecting local populations, are there safer materials or lower volume options which could truly get the local population out of harm's way?

> 'Even when you have a good emergency response plan and have well-trained emergency responders with all of the equipment they need, if there are people just on other side of the fenceline, they will be vulnerable.... There is no time for emergency responders to get to the scene and no time for people to take protective action, even with a good emergency response plan in place."
>
> Stuart Greenberg
> Cuyahoga County LEPC

Notes

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IDENTIFY WHO CAN ADVANCE OR ENFORCE HAZARD REDUCTION

- Facility owners and operators
- Federal, state and local regulators
- Community action organizations
- Local fire departments
- Labor unions and community labor coalitions
- Local Emergency Planning Committees (LEPC's)
- Insurance companies
- State and local lawmakers

In the following segments, we discuss opportunities for various individuals, officials and entities to take action to advance the cause of hazard reduction. In practice, it may be necessary to recruit some of these players in establishing and pursuing the reassessment process. While we focus on how these actors may promote implementation of hazard reduction, as we noted earlier, you may have already engaged many of them in the reassessment process as well as in the process of implementation of hazard reduction measures.

Facility owners and operators

The first responsibility for hazard reduction clearly rests with facility owners and operators. Facility owners and operators have a general duty under the Clean Air Act, section 112 (r) to "design and maintain a safe facility taking such steps aras are necessary to prevent releases, and to minimize the consequences of accidental releases which do occur." This should be understand as including the duty to redesign facilities to ensure inherent safety, given the relative ineffectiveness of other measures in preventing community vulnerabilities.

Facility owners and operators have a General Duty under two federal laws to reduce chemical hazards to the public, workers, and the environment, including safe facility design. State liability laws also impose such a duty. But often a lack of awareness of hazards, or of safer alternatives, impedes a shift to much safer options.

How can facility owners and operators be induced to act? Sometimes all that is needed to prompt companies to engage in better hazard management is for hazards and alternatives to be brought to light by suppliers, government, or neighbors.

For instance, the OSHA requirement for companies to provide workers with material safety data sheets indicating product hazards caused many companies to reassess chemicals. A survey published in 1992 by the General Accounting Office of employers covered by the OSHA Hazard Communication Standard found that 30 percent of employers were replacing hazardous chemical used in work places with less hazardous ones because of information they received on the Material Safety Data Sheets (MSDS's). Notably, a third of employers also said that they had not replaced substances because they did not know whether or not a replacement existed for the substances in question.[1]

Industries have typically made gestures toward in a limited amount of hazard reduction on a voluntary basis. For instance, after September 11, 2001, chemical industry trade associations published voluntary site security guidelines.[2] These guidelines these lack binding standards or timelines, or even measurable hazard reduction goals. While compliance with the guidelines was made a precondition of membership in the American Chemistry Council,[3] the requirements are vague and ignore many crucial issues.

Most significantly, the industry's guidelines do not focus on reassessing inherent safety, but instead on security measures to keep out criminally-minded intruders. They do not weigh the resultant security costs against the costs of safer design.

They also have other significant gaps in logic and coverage. They seem to assume that add-on safeguards will not be disabled (e.g., by an airplane crash). They do not address head-on the added security risks posed by contract workers. They do not apply margins of safety. They do not include accounting methods to help identify theft. They do not address internet sales and needed knowledge and clearance of customers.

Communities concerned with security and safety in the face of chemical vulnerabilities will need to ensure that local facilities go beyond the industry's guidelines to ensure effective solutions. Concerned citizens and officials who conduct local reassessments can hold forums on the availability of safer substitutes, engage in ongoing facility assessments and dialogues, and utilize regulatory programs and enforcement as needed to ensure effective hazard reduction.

Ultimately, effective public policies and enforcement will be necessary to curtail chemical vulnerabilities. Just as voluntary security measures in the air industry proved inadequate to prevent cutting of corners in airport screening and airline design, it may be unrealistic to expect facilities storing and using chemicals to redesign operations and facilities to reflect the new understanding of vulnerabilities. Various agencies and officials will need to play a role in providing incentives, education and enforcement to encourage effective hazard reduction by facility owners and operators.

Federal, state and local regulators

As noted above, under the Federal Clean Air Act Amendments of 1990, chemical facility owners and operators were given a General Duty of Hazard Reduction. Businesses which produce, process, handle, or store extremely hazardous substances were given a "General Duty" to design safe facilities and prevent releases.[4] Where a facility is failing to comply with this duty, the EPA is authorized to bring enforcement action. Unfortunately, the EPA has failed to do very much enforcement of this duty, and to our knowledge, has never enforced it to require facilities to apply inherent safety measures. Local citizens who observe apparent violations of this obligation may wish to ask the EPA to take enforcement action. OSHA also has its own General Duty clause, and can bring enforcement actions regarding failure of a site owner to deploy known safety options to eliminate recognized hazards.

In many states, state-level environmental agencies have been similarly empowered by state law to prevent releases of toxic materials to the environment.

A few states passed laws in the aftermath of Bhopal with a more extensive focus on extremely hazardous substances. Most notable is the **New Jersey Toxic Catastrophe Prevention Act**, which requires industry to engage in risk management planning and to engage in "state of the art" reviews which include assessment of inherent safety; it authorizes the New Jersey Department of Environmental Protection to order the owner and operator of the facility to prepare and implement a risk reduction plan for extraordinarily hazardous substances. Such an order identifies the risks which must, within the limits of practicality and feasibility, be abated and a reasonable timetable be set for implementation of the plan.

The **Massachusetts Toxic Use Reduction Act (TURA)** TURA mandates that manufacturers evaluate opportunities to reduce the use of toxic chemicals. This Act was the first of its kind in the United States and has spearheaded a new approach to reducing environmental harms. As a result of the Act, Massachusetts' companies have:

- Reduced 190 toxic chemicals by 40%.
- Cut toxic waste in half.
- Reduced toxic chemical emissions by 83%.
- Saved companies $15 million while using less toxic materials.

A **Contra Costa County** Industrial Safety Ordinance (section 450-8.016(D)(3)) requires major facilities to study, select and implement inherently safer systems to eliminate process safety hazards to the greatest extent feasible. If a facility operator concludes that inherent safety is not feasible, the basis for this conclusion must be documented, to demonstrate to the County's satisfaction that the financial impacts would be so severe as to render the changes impractical.

In **New York City** the city's environmental department administers a law requiring regulated companies to undertake Technology Options Analysis to identify inherently safer alternatives. The law states, "A responsible party shall make the following considerations...an examination of alternative substances and equipment to reduce the use of extremely hazardous substances or regulated toxic substances, and a timetable for implementing alternatives that are technically and economically feasible."

In many communities, the **public health department or Board of Health** is the agency with the broadest interest in, and willingness to act, to protect against hazards like those presented by chemical storage sites. Check with your local health officials to ascertain their potential involvement.

Local fire departments

Local fire departments engage in an array of fire prevention activities, and are typically also the "first responders" in the event of a hazardous materials incident, regardless of whether there is a fire involved.

Fire officials can engage in both education and enforcement activities. As educators, they often conduct preventive-focused training programs, and can work with local businesses to alert them to the existence of safer alternatives and low-volume storage approaches. Fire officials also conduct inspections for compliance with fire codes, and issue flammable storage licenses, which can, in some instances, be withheld until safer alternative designs are in place.

> Existing state and local laws require regulated companies to examine alternative substances and equipment to reduce the use of extremely hazardous substances or regulated toxic substances and to establish a timetable for implementing alternatives that are technically and economically feasible.

Some communities have amended their fire codes with specific reference to prevention. For instance, in the Silicon Valley of California, a Toxic Gas Ordinance (TGO) was enacted in Palo Alto. This ordinance requires the best practicable controls to ensure safe storage, use and handling of toxic gases. These controls can include secondary containment, automatic shut off, seismic protection, fail-safe-to-close valves, monitoring and alarm systems, and treatment systems should a release occur. Facilities using toxic gases are required to have adequate training programs for all staff handling the gases, emergency response plans, as well as annual testing and maintenance programs for the monitoring and treatment systems. The 1990 TGO requirements complement requirements for storage of other hazardous materials that have been in effect since the 1983 development and adoption of the Model Hazardous Materials Storage Ordinance. Most of the requirements in both of these ordinances have since been incorporated into Article 80 of the Uniform Fire Code (UFC) and so are applicable where ever the UFC is used.

Labor unions and community labor coalitions

Labor unions and workers inside of facilities can promote preventive approaches and clean production. Tools available to the unions include OSHA process safety rules, unions' collective bargaining power, and the detailed working knowledge available to members of the workforce.

One source of information that can be accessible to workers is produced by companies under Occupational Safety and Health Administration (OSHA) rules. The OSHA Process Safety Management (PSM) standard for Highly Hazardous Chemicals (HHC'S), 29 CFR 1910.119, is intended to prevent or minimize the consequences of a catastrophic release of toxic, reactive, flammable or explosive HHC's from a process.

It requires companies to compile written **Process Safety Information (PSI)** including hazard information on HHC's, technologies and equipment, and a written plan of action regarding employee participation. Some of the information developed includes process hazard analyses, training plans, operating procedures, mechanical integrity and incident investigation.

> Facility workers have special knowledge, rights, and opportunities to reduce facility hazards. They also have even more at stake in chemical safety than the general public, because their jobs place them in closest proximity to the hazards.

The work site employer must establish and implement written procedures to manage changes in technologies and processes at the facility, except "replacements in kind" to facilities that effect a covered process. The standard requires the work site employer and contract employers to inform and train their affected employees on the changes prior to start-up. Employers are required to engage in periodic audits. Information that can be made available to workers under this regulation also includes a record of accidents and near misses, data which can help to target areas that should be a priority for immediate hazard reduction measures.

The effect of these requirements is that employees have a right of access to significantly more information than members of the public surrounding facilities. Employees and their unions are granted access to the full array of information required to be developed by their companies under the rule. As a result, employees and their unions are in a position to help communities to evaluate hazards, and to encourage companies to implement hazard reduction measures.

OSHA's process safety regulations mention, but do not require, inherent safety. OSHA acknowledges that:

> [S]maller businesses which may have limited resources available...might consider alternative avenues of decreasing the risks associated with highly hazardous chemicals at their workplaces. One method which might be considered is the reduction of inventory of the highly hazardous chemical.[5]

Collective bargaining powers of unions can be utilized to press companies toward clean production. For instance, the Sheldahl collective bargaining agreement in Northfield, Minnesota, was the result of a union and community campaign. Among the commitments of the firm's management embodied in the agreement are requirements to develop means of eliminating the use of methylene chloride by making research and development into the alternatives a top capital spending priority. Specific emissions reduction deadlines were also specified in the agreement, as were labor-management update meetings, in which the union was specifically allowed to bring in community groups.

Alliances can be formed between neighbors of facilities, and workers inside of those facilities. Both have a common interest in reducing the vulnerability of the facility in the event of a terrorist attack, as well as in an array of other issues of safety and toxic exposure. A number of such neighbor-labor alliances have formulated a joint platform and sought negotiations with a plant's management on a Good Neighbor Agreement to address the concerns. See discussion of citizen activism, below.

Civic organizations

In the absence of laws and policies to mandate effective preventive action by corporations and government, many community civic groups have exerted pressure to persuade government and industry to act.

Some citizens groups have worked to pass new local laws, or persuade government regulators to use their powers to ensure hazard reduction at particular facilities. Others have organized accountability campaigns focused on particular companies. These efforts have involved persuading companies to allow citizens and their experts to evaluate facilities, and in some cases, entering legally binding agreements (**Good Neighbor Agreements**) with the companies to take specific actions to rectify community concerns.

For example, Dynasill in Berlin, New Jersey, produces glass for high tech applications, including laser and aerospace uses. In May 1988, upon a simple request of neighbors, the small firm's manager and owner cooperated with the citizens' request to conduct their own inspection of Dynasill. They brought along with them Richard Youngstrom, an industrial hygienist for the National Toxics Campaign and a local of the International Electrical Workers Union. While it became apparent that the company had not caused any fishkills, at least recently, a number of concerns were identified. A report prepared by Youngstrom after the tour included a number of recommendations for improving the facility's chemical safety. For instance, the report recommended that the company complete its diking around storage tanks containing silicon tetrachloride which, when exposed to water, can create heat and hydrochloric acid. It recommended installing shower and eye wash stations. It also suggested training employees to be a company fire brigade.

Within one month of receiving the inspection report, the company implemented all of the recommendations that the group had made.
Another example is the Good Neighbor Agreement reached in 1992, in Manchester, Texas by the statewide organization, Texans United, local citizens groups and Rhone Poulenc. Rhone Poulenc agreed to pay for a detailed environmental audit conducted by experts and a panel of community groups and workforce representatives. The agreement stipulates that the citizens and experts will have continuing access to the company and its plant for evaluation and negotiation on diverse concerns. Among the other features of the agreement are:

- A broad audit by an independent, third party expert which includes review of regulatory compliance, safety training, accident prevention, emergency response, waste analysis, information systems, monitoring programs, and waste minimization practices.
- Public disclosure of company documents including hazard assessment and risk analysis, lists of accidents/upsets/near-misses/corrective actions, and waste minimization and reduction plans.
- Rhone Poulenc will "negotiate in good faith" on implementation of the audit recommendations.
- Citizens are entitled to accompany the auditor and conduct other inspections by appointment.
- The agreement is integrated to the facility's water pollution permit.

> Civic organizations can play the pivotal role in promoting hazard reduction. They can persuade company and government officials to invest the resources in studying and implementing safer alternatives.

Potential Post-September 11 Good Neighbor Agreement Terms
In the context of current concerns about chemical storage sites, some of the potential demands for such agreements include:

- Development and disclosure of analyses of technology options to improve the inherent safety of facilities through materials substitution, redesign to eliminate high volume storage, etc.;

- Disclosure to the reassessment group of other documents needed to assess identified issues of concern at a facility;

- The right to inspect or "audit" facilities to evaluate inherent vulnerability and security issues;

- Technical assistance monies for community organizations;

- Specific types of facility equipment changes.

In addition, these issues may be addressed in combination with other issues:

- Health care and health monitoring related to a past release;

- Installing a water supply for a polluted community;

- Assurances of compliance with labor laws, or with other labor-related conditions;

- Evaluation or changes in the level of staffing of safety-critical operations or maintenance in a plant, the level of training of these personnel, or ending the practice of contracting out of these jobs;

- Whistleblower protection.

Review of Detailed Documentation of Hazard Reduction Issues
Part of these community accountability processes can involve companies sharing, or subjecting to third party review, the more detailed documentation of safety issues that they maintain in-house. For instance, facilities have been required by the Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA) regulations to prepare many detailed documents assessing potential accidents. Most of these documents are held on-site at the facilities, and are not shared with government or affected stakeholders unless specifically requested. Local Emergency Planning Committees are legally entitled to access these documents if they are needed in order for the committee to engage in its planning activities. However, the committees seldom request this information from facilities. In addition, these documents are available to members of the workforce, who have rights to many of these documents as a result of OSHA process safety management rules.

Sometimes the more detailed documents have also been made available to plant neighbors and their experts as a result of community dialogue and negotiation. In a more extensive effort, government, community members and site owners will also share information such as:

- the evaluation of technical options to eliminate the use of the extremely hazardous substances in question, or to reduce volumes stored and transported;

- site security issues of concern to facility neighbors;

- the site owner's legally binding commitments and timelines to implement needed hazard reduction measures;

- graphic indications of the potential **reduction of the vulnerability zones** as a result of the company's planned hazard reduction activities.

Local emergency planning committees (LEPC'S)

Local Emergency Planning Committees (LEPC's) are local bodies created by the 1986 Emergency Planning and Community Right to Know Act to conduct planning for chemical accident preparedness in every community throughout the US. By design of the law, the LEPC's have placed most of their emphasis on contingency plans for what to do AFTER a chemical accident happens –public alerts, putting out fires, evacuation and sheltering of local people, etc. As this guide has indicated, this singular focus to the exclusion of prevention measures may unnecessarily jeopardize the safety of many communities. Even the most effective plans cannot ensure against widespread injuries and fatalities in the event of serious chemical incidents.

A few LEPC's have gone beyond emergency planning, to integrate efforts geared toward prevention of chemical dangers. They have found that they can have a significant role to play in prevention efforts:

- **Bringing technical assistance to bear to promote hazard reduction.** LEPCs can bring local independent experts to the community to conduct trainings on hazard reduction. They can facilitate community meetings and conferences. They can help to identify experts to conduct third party reviews of the adequacy of safety and security of particular facilities. They may also be a conduit for funding of those experts, either through access to grant monies, or development of public policy mechanisms such as fee-based systems to pay for the needed expert support.

- **Increasing information acquisition.** An LEPC has broad authority under section 303(d)(3) of the Emergency Planning and Community Right to Know Act to request information from facilities as needed in the course of emergency planning. Section 303(d) of EPCRA says that, upon the request from a local emergency planning committee, the owner or operator of any facility subject to the emergency planning provisions of the Act must promptly provide information to the committee "necessary for developing and implementing the emergency plan."[6] The U.S. EPA, the state emergency response commission can assist the LEPC's in enforcing this far-reaching requirement – which can be used to address disclosure of detailed documentation of hazard reduction issues.

- **Requesting facility managers to meet with the LEPC to review vulnerabilities and hazard reduction measures.** Many LEPCs have requested meetings with specific facilities' managers to review facilities' chemical storage and potential offsite consequences. Unfortunately, these discussions have seldom involved in depth review of prevention opportunities.

- **Serving as watchdogs and combining efforts with regulatory officials.** Local emergency planning committees can be the eyes and ears of regulatory officials and enforcement officers. They can help to identify instances where additional prevention measures are needed and can seek support of regulators in enforcing such changes.

The LEPC which arguably has engaged in the most prevention-focused activities is the one covering Cuyahoga County (Cleveland, Ohio). The County LEPC covers 59 political subdivisions including the City of Cleveland, and includes over 260 facilities that report storing extremely hazardous chemicals. The LEPC has sought to encourage hazard reduction by annually surveying facilities to determine what reductions in extremely hazardous substances they have achieved, and providing public recognition of these companies through an environmental awards program.

> Most Local Emergency Planning Committees believe they do not have the time, resources or expertise to encourage hazard reduction.
>
> 2001 Study by
> National Institute for Chemical Studies

The LEPC used the risk management planning process to enhance receptivity for inherent safety measures. It was able to encourage companies to reduce their "footprint" ~~the~~ area around the facility that could suffer deaths and injuries in an accident—before the plans were published. A key element of the Cleveland strategy, according to Stuart Greenberg, LEPC member, was an all day seminar of the LEPC prior to publication of companies' risk management plans, laying out strategies on inherent safety. The meeting featured various speakers covering the principles of hazard reduction, case studies of inherent safety designs and retrofits, and the relationship between inherent safety and pollution prevention.

Greenberg said that the LEPC made the most headway in promoting inherent safety by being honest in explaining the limitations of emergency response: "even when you have a good emergency response plan and have well-trained emergency responders with all of the equipment they need, if there are people just on other side of the fenceline, they will be vulnerable. When you look at how fast a gas cloud is likely to move toward those first 'receptors', and consider the decision process involved in issuing an alert, those neighbors can often be expected to be hit by the cloud before the warning is even issued. There is no time for emergency responders to get to the scene and no time for people to take protective action, even with a good emergency response plan in place."[7]

The following examples identified by the National Institute for Chemical Studies[8] reinforce the notion that preventive action may be possible at LEPC's, even though the majority of these bodies have generally not focused on prevention.

Fayette County, Georgia
The Fayette County LEPC, the oldest LEPC in the state,[9] is located 25 miles south of Atlanta in a low population density area with predominately high tech industries. A 1995 hazard analysis showed the greatest chemical hazard is chlorine used for treatment in local water treatment plants and local industrial facilities. The LEPC worked with state officials and local chlorine users. Several reduced or eliminated chlorine treatment.

Washtenaw County, Michigan
This LEPC is located in Ann Arbor, Michigan and includes approximately 65 facilities, primarily wastewater treatment plants and facilities related to the automobile industry. The LEPC has worked in conjunction with county officials to conduct regular inspections of facilities, in conjunction with the county Environmental Services Division. The inspections address pollution prevention as well as emergency planning.

Johnson County, Kansas
Although Johnson County, which is part of the Kansas City metropolitan area, is not a major chemical producing area, its LEPC has developed a proactive approach toward hazard reduction at wastewater treatment plants and other facilities. Working with the LEPC, six area wastewater treatment plants found they could easily switch from chlorine treatment to ultraviolet treatment, thus eliminating a potential major hazard.

Springfield, Massachusetts
The Springfield LEPC, which covers over 200 facilities, seeks to promote hazard reduction through facility inspections and training. The LEPC participates on an inspection team that includes police, fire, health department and LEPC representation. The LEPC also conducts a general chemical safety course, with a focus on toxic use reduction, for local industries and emergency responders, and has worked with local schools to identify and dispose of unneeded chemicals.

Most Other LEPC's Have Not Yet Adopted a Prevention Focus

These are exceptional examples of LEPC's activities on prevention. By contrast a recent study by the National Institute for Chemical Studies of 32 "active" Local Emergency Planning Committees found that most of the LEPCs believe they "do not have the time, resources or expertise to encourage hazard reduction." The expectations for LEPC's should be even worse than this, since that survey was of "active" LEPCs, and 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."[10] Among many additional barriers, LEPCs lack the authority and mandate for hazard reduction; can be hampered by dependent relations with industry; have no formal role in implementing Risk Management Planning; and can become discouraged by a perceived unwillingness of government and industry to act. Most lack needed funding.

LEPC's with the will to act can be an important vehicle for promoting prevention. But there are many other officials who may have more enforcement authority and resources.

Insurance companies

Insurance companies have a vested interest in ensuring that insured facilities which store or use large volumes of hazardous chemicals minimize the hazards associated with those practices. The insurers hire loss prevention experts and risk assessors who visit insured or potentially insured facilities, to identify risks as well as hazard reduction opportunities. Premium levels may be higher or lower for many businesses according to the chemical risks on the site.

Where significant hazards are identified at a facility, insurers might be drawn into the conversation regarding facility hazards and the availability of alternatives, so as to become a powerful ally for encouraging hazard reduction measures.

The state of Massachusetts, through its Office of Technical Assistance of the Executive Office of Environmental Affairs, has been encouraging insurers to provide incentives to companies who effectively reduce their use of toxic substances.[11] Companies that are already required by state law to evaluate alternatives for reducing the use of toxics will be encouraged by insurers to action implement the safer alternatives that they identify. Participating insurance providers will offer incentives to those qualified policyholders that demonstrate "superior environmental management practices." The determination of what these practices entail is at the discretion of each individual environmental insurance provider. The type and character of incentives offered through this program will vary by insurance company. The incentives may include:

- lower deductibles;
- enhanced lines of coverage;
- reductions in insurance policy pricing premiums;
- other favorable underwriting terms.

Though this is promising, the insurers' role is far from a complete incentive structure for hazard reduction. For instance, large facilities and municipal water systems are often self-insured. Also, new contractual or legislated exemptions regarding insurance coverage or liability related to terrorism may undermine insurers' motivations or incentives.

State and local lawmakers

State and local lawmakers can serve as leaders in hazard assessment efforts, increasing the visibility of issues in need of resolution. Where responses or policies remain inadequate, the lawmakers can all enact new laws to ensure consideration of inherent safety or clean production methods. See discussion, above, regarding federal, state and local regulators, for examples of some of the legislative precedents. Local law can mandate assessment of inherent safety options as well as other security and safety measures when implementing inherent safety does not prove feasible, or does not eliminate accident or security issues at local chemical sites.

Notes

1. General Accounting Office, Occupational Safety and Health: Employers' Experience In Complying With The Hazard Communication Standard, May 1992 GAO/HRD-92-63-BR.
2. American Chemistry Council, Chlorine Institute Inc., and Synthetic Organic Chemical Manufacturers Association, Site Security Guidelines for the U.S. Chemical Industry, October 2001.
3. American Chemistry Council, Press Release, January 30, 2002.
4. Clean Air Act, section 112(r)(1).
5. 57 Fed. Reg. No. 36 p. 6411.
6. 42 USC sec. 11003.
7. For additional information see the website, www.ehw.org, and click on chemical accidents.
8. National Institute for Chemical Studies, Local Emergency Planning Committees and Risk Management Plans: Encouraging Hazard Reduction, Charleston, West Virginia, June, 2001.
9. Georgia originally had just one statewide LEPC.
10. George Washington University, Department of Public Administration, Nationwide LEPC Survey, 1994.
11. http://www.state.ma.us/ota/support/incentivesprog.htm

6

COMMUNITY-WIDE RESPONSE STRATEGIES: IDENTIFY SHORT TERM AND LONG TERM ACTIONS FOR HAZARD REDUCTION

Examining the hazard reduction opportunities at particular facilities inevitably leads back to larger issues of public policy—local, statewide and even national policies. Ultimately, effective public policies and enforcement at every level of government will be necessary to curtail chemical vulnerabilities. Just as reliance on voluntary measures proved inadequate to prevent airlines from cutting corners in passenger screening and airplane design, it is unrealistic to expect facilities storing and using chemicals to redesign operations and facilities on their own. Government and concerned citizens will need to play a proactive role in providing the incentives, education and enforcement to encourage effective study and implementation of hazard reduction measures by facility owners and operators.

In your work at the community level, you need to realize that the hazards posed by chemical sites have developed over many years. It may take many years to bring the risks down to an appropriate level in your hometown. Concerned citizens and officials should develop a plan with short and long term elements. As suggested by this guide, on the following pages we set forth examples of the measures that communities can take.

SAFE HOMETOWNS ACTION LIST

SHORT TERM

- Examine maps and data for local facilities, to identify specific locations vulnerable to chemical accidents and terrorist attacks.
- Identify priority facilities for immediate action.
- Identify which local officials (Board of Health, Fire Department, LEPC) will promote hazard reduction for facilities in the community.
- Ensure the commitment of those officials to follow the checklist of this guide (see table of contents), and the recommended hierarchy of hazard reduction options.
- Maintain and defend public rights to know about facility hazards; expand public rights to know regarding inherent safety assessment- i.e. the right to know what is being done to fix the problem and when it will be done.
- Establish a process for implementing a hazard reduction reassessment.
- In view of the tragedy of September 11, 2001, assess and apply immediate options for inherent safety at priority facilities, such as "drop in" chemical substitutes or inventory reductions at chemical storage sites.
- Conduct local educational forums to discuss opportunities for enhancing inherent safety at local industries, and establishing longer term processes to explore and apply the safer alternatives.
- Implement immediate measures by facilities to bolster site security, staff training, etc. While this may not preclude a successful attack by a determined terrorist, this baseline of community protection is clearly a necessity, at least until safer design options can be assessed and implemented.
- Secure fair transitions of any workers whose jobs may be changed or eliminated as a result of new safeguards, including immediate full income and education support for displaced workers.
- Immediately evaluate practices at all facilities storing large amounts of hazardous materials of hiring contractors for maintenance and construction. Prevent the use of transient contractors who are not well screened and/or trained.
- Facilities should avoid relocation of storage units where security is enhanced while safety is undermined (e.g. increasing workforce hazards or chain reaction risks by concentrating materials at center of facilities).
- End transport of high hazard cargos through urban and populous areas. Utilize enforcement of environmental impact and haz-mat transport laws to bar transport of materials such as liquefied natural gas and phosgene in populous areas. Expand public and government rights to know regarding materials transportation.
- End the practice of keeping tank cars full of extremely hazardous materials in unguarded areas.

SAFE HOMETOWNS ACTION LIST

Long Term

- Engage in an in-depth process of assessment of inherent safety options for priority facilities, including research and development, third party audits, review of the array of options available, and implementation of the best options.
- Create an ongoing reassessment of security, secondary prevention, land use and buffering issues.
- Require chemical storage and transporter organizations to pay the costs of added community policing associated with their operations.
- Expand the use of third party experts for review of opportunities for facilities to improve inherent safety and site security.
- Reassess emergency planning. Offsite consequence analyses for storage and transport facilities should be required to explicitly detail the distance of locations in which people may be expected to be harmfully exposed to a release from the facility *prior to receiving timely warnings* allowing sheltering or evacuation. This area should be calculated by delineation of the amount of time it might take, in adverse wind conditions, for a release to reach those areas, and the amount of time it may take for decisions to be triggered to provide notice.
- Establish local policies for notification to the public regarding design changes planned at facilities that may affect the inherent vulnerability of the community.

APPENDIX A: ALPHABETICAL ORDER LIST OF EXTREMELY HAZARDOUS SUBSTANCES

(SECTION 302 OF EPCRA)

For links to chemical profiles and Emergency Treatment and First Aid Guides, visit
http://www.epa.gov/swercepp/ehs/ehsalpha.html

CAS Number	Name	Threshold Planning Quantity (TPQ)	Reportable Quantity for Release Incidents (RQ)
75865	Acetone cyanohydrin	1,000	10
1752303	Acetone thiosemicarbazide	1,000/10,000	1,000
107028	Acrolein	500	1
79061	Acrylamide	1,000/10,000	5,000
107131	Acrylonitrile	10,000	100
814686	Acrylyl chloride	100	100
111693	Adiponitrile	1,000	1,000
116063	Aldicarb	100/10,000	1
309002	Aldrin	500/10,000	1
107186	Allyl alcohol	1,000	100
107119	Allylamine	500	500
20859738	Aluminum phosphide	500	100
54626	Aminopterin	500/10,000	500
3734972	Amiton oxalate	100/10,000	100
78535	Amiton	500	500
7664417	Ammonia	500	100
300629	Amphetamine	1,000	1,000
62533	Aniline	1,000	5,000
88051	Aniline, 2,4,6-trimethyl-	500	500
7783702	Antimony pentafluoride	500	500
1397940	Antimycin A	1,000/10,000	1,000
86884	Antu	500/10,000	100
1303282	Arsenic pentoxide	100/10,000	1
1327533	Arsenous oxide	100/10,000	1
7784341	Arsenous trichloride	500	1
7784421	Arsine	100	100
2642719	Azinphos-ethyl	100/10,000	100
86500	Azinphos-methyl	10/10,000	1
98873	Benzal chloride	500	5,000
98168	Benzenamine, 3-(trifluoromethyl)-	500	500
100141	Benzene, 1-(chloromethyl)-4-nitro-	500/10,000	500
98055	Benzenearsonic acid	10/10,000	10
3615212	Benzimidazole, 4,5-dichloro-2-(trifluoromethyl)-	500/10,000	500
98077	Benzotrichloride	100	10
100447	Benzyl chloride	500	100
140294	Benzyl cyanide	500	500
57578	beta-Propiolactone	500	10

CAS Number	Name	TPQ	RQ
15271417	Bicyclo[2.2.1]heptane-2-carbonitrile,		
	5-chloro-6-((((methylamino)carbonyl)oxy)imino)-,		
	(1-alpha,2-beta,4-alpha,5-alpha,6E))-	500/10,000	500
534076	Bis(chloromethyl) ketone	10/10,000	10
4044659	Bitoscanate	500/10,000	500
353424	Boron trifluoride compound with methyl ether (1:1)	1,000	1,000
10294345	Boron trichloride	500	500
7637072	Boron trifluoride	500	500
28772567	Bromadiolone	100/10,000	100
7726956	Bromine	500	500
2223930	Cadmium stearate	1,000/10,000	1,000
1306190	Cadmium oxide	100/10,000	100
7778441	Calcium arsenate	500/10,000	1
8001352	Camphechlor	500/10,000	1
56257	Cantharidin	100/10,000	100
51832	Carbachol chloride	500/10,000	500
26419738	Carbamic acid, methyl-, O-(((2,4-dimethyl-1,		
	3-dithiolan-2-yl)methylene)amino)-	100/10,000	1
1563662	Carbofuran	10/10,000	10
75150	Carbon disulfide	10,000	100
786196	Carbophenothion	500	500
57749	Chlordane	1,000	1
470906	Chlorfenvinfos	500	500
7782505	Chlorine	100	10
24934916	Chlormephos	500	500
999815	Chlormequat chloride	100/10,000	100
79118	Chloroacetic acid	100/10,000	100
107073	Chloroethanol	500	500
627112	Chloroethyl chloroformate	1,000	1,000
67663	Chloroform	10,000	10
107302	Chloromethyl methyl ether	100	10
542881	Chloromethyl ether	100	10
3691358	Chlorophacinone	100/10,000	100
1982474	Chloroxuron	500/10,000	500
21923239	Chlorthiophos	500	500
10025737	Chromic chloride	1/10,000	1
10210681	Cobalt carbonyl	10/10,000	10
62207765	Cobalt, ((2,2'-(1,2-ethanediylbis(nitrilomethylidyne))		
	bis(6-fluorophenylato))(2-)-N,N',O,O')-	100/10,000	100
64868	Colchicine	10/10,000	10
56724	Coumaphos	100/10,000	10
5836293	Coumatetralyl	500/10,000	500
535897	Crimidine	100/10,000	100
4170303	Crotonaldehyde	1,000	100
123739	Crotonaldehyde, (E)-	1,000	100
506683	Cyanogen bromide	500/10,000	1,000
506785	Cyanogen iodide	1,000/10,000	1,000
2636262	Cyanophos	1,000	1,000
675149	Cyanuric fluoride	100	100
66819	Cycloheximide	100/10,000	100
108918	Cyclohexylamine	10,000	10,000
17702419	Decaborane(14)	500/10,000	500
8065483	Demeton	500	500
919868	Demeton-S-methyl	500	500
10311849	Dialifor	100/10,000	100
19287457	Diborane	100	100
111444	Dichloroethyl ether	10,000	10
149746	Dichloromethylphenylsilane	1,000	1,000
62737	Dichlorvos	1,000	10
141662	Dicrotophos	100	100
1464535	Diepoxybutane	500	10
814493	Diethyl chlorophosphate	500	500
71636	Digitoxin	100/10,000	100
2238075	Diglycidyl ether	1,000	1,000
20830755	Digoxin	10/10,000	10
115264	Dimefox	500	500
60515	Dimethoate	500/10,000	10
2524030	Dimethyl phosphorochloridothioate	500	500

CAS Number	Name	TPQ	RQ
77781	Dimethyl sulfate	500	100
99989	Dimethyl-p-phenylenediamine	10/10,000	10
75785	Dimethyldichlorosilane	500	500
57147	Dimethylhydrazine	1,000	10
644644	Dimetilan	500/10,000	1
534521	Dinitrocresol	10/10,000	10
88857	Dinoseb	100/10,000	1,000
1420071	Dinoterb	500/10,000	500
78342	Dioxathion	500	500
82666	Diphacinone	10/10,000	10
152169	Diphosphoramide, octamethyl-	100	100
298044	Disulfoton	500	1
514738	Dithiazanine iodide	500/10,000	500
541537	Dithiobiuret	100/10,000	100
316427	Emetine, dihydrochloride	1/10,000	1
115297	Endosulfan	10/10,000	1
2778043	Endothion	500/10,000	500
72208	Endrin	500/10,000	1
106898	Epichlorohydrin	1,000	100
2104645	EPN	100/10,000	100
50146	Ergocalciferol	1,000/10,000	1,000
379793	Ergotamine tartrate	500/10,000	500
1622328	Ethanesulfonyl chloride, 2-chloro-	500	500
10140871	Ethanol, 1,2-dichloro-, acetate	1,000	1,000
563122	Ethion	1,000	10
13194484	Ethoprophos	1,000	1,000
538078	Ethylbis(2-chloroethyl)amine	500	500
371620	Ethylene fluorohydrin	10	10
75218	Ethylene oxide	1,000	10
107153	Ethylenediamine	10,000	5,000
151564	Ethyleneimine	500	1
542905	Ethylthiocyanate	10,000	10,000
22224926	Fenamiphos	10/10,000	10
115902	Fensulfothion	500	500
4301502	Fluenetil	100/10,000	100
7782414	Fluorine	500	10
640197	Fluoroacetamide	100/10,000	100
144490	Fluoroacetic acid	10/10,000	10
359068	Fluoroacetyl chloride	10	10
51218	Fluorouracil	500/10,000	500
944229	Fonofos	500	500
107164	Formaldehyde cyanohydrin	1,000	1,000
50000	Formaldehyde	500	100
23422539	Formetanate hydrochloride	500/10,000	1
2540821	Formothion	100	100
17702577	Formparanate	100/10,000	1
21548323	Fosthietan	500	500
3878191	Fuberidazole	100/10,000	100
110009	Furan	500	100
13450903	Gallium trichloride	500/10,000	500
77474	Hexachlorocyclopentadiene	100	10
4835114	Hexamethylenediamine, N,N'-dibutyl-	500	500
302012	Hydrazine	1,000	1
74908	Hydrocyanic acid	100	10
7647010	Hydrogen chloride (gas only)	500	5,000
7783075	Hydrogen selenide	10	10
7664393	Hydrogen fluoride	100	100
7722841	Hydrogen peroxide (Conc.> 52%)	1,000	1,000
7783064	Hydrogen sulfide	500	100
123319	Hydroquinone	500/10,000	100
13463406	Iron, pentacarbonyl-	100	100
297789	Isobenzan	100/10,000	100
78820	Isobutyronitrile	1,000	1,000
102363	Isocyanic acid, 3,4-dichlorophenyl ester	500/10,000	500
465736	Isodrin	100/10,000	1
55914	Isofluorphate	100	100
4098719	Isophorone diisocyanate	100	100
108236	Isopropyl chloroformate	1,000	1,000

CAS Number	Name	TPQ	RQ
119380	Isopropylmethylpyrazolyl dimethylcarbamate	500	1
78977	Lactonitrile	1,000	1,000
21609905	Leptophos	500/10,000	500
541253	Lewisite	10	10
58899	Lindane	1,000/10,000	1
7580678	Lithium hydride	100	100
109773	Malononitrile	500/10,000	1,000
12108133	Manganese, tricarbonyl methylcyclopentadienyl	100	100
51752	Mechlorethamine	10	10
950107	Mephosfolan	500	500
1600277	Mercuric acetate	500/10,000	500
21908532	Mercuric oxide	500/10,000	500
7487947	Mercuric chloride	500/10,000	500
10476956	Methacrolein diacetate	1,000	1,000
760930	Methacrylic anhydride	500	500
126987	Methacrylonitrile	500	1,000
920467	Methacryloyl chloride	100	100
30674807	Methacryloyloxyethyl isocyanate	100	100
10265926	Methamidophos	100/10,000	100
558258	Methanesulfonyl fluoride	1,000	1,000
950378	Methidathion	500/10,000	500
2032657	Methiocarb	500/10,000	10
16752775	Methomyl	500/10,000	100
151382	Methoxyethylmercuric acetate	500/10,000	500
78944	Methyl vinyl ketone	10	10
60344	Methyl hydrazine	500	10
556649	Methyl thiocyanate	10,000	10,000
556616	Methyl isothiocyanate	500	500
79221	Methyl chloroformate	500	1,000
3735237	Methyl phenkapton	500	500
74931	Methyl mercaptan	500	100
80637	Methyl 2-chloroacrylate	500	500
676971	Methyl phosphonic dichloride	100	100
74839	Methyl bromide	1,000	1,000
624839	Methyl isocyanate	500	10
502396	Methylmercuric dicyanamide	500/10,000	500
75796	Methyltrichlorosilane	500	500
1129415	Metolcarb	100/10,000	1
7786347	Mevinphos	500	10
315184	Mexacarbate	500/10,000	1,000
50077	Mitomycin C	500/10,000	10
6923224	Monocrotophos	10/10,000	10
2763964	Muscimol	500/10,000	1,000
505602	Mustard gas	500	500
13463393	Nickel carbonyl	1	10
65305	Nicotine sulfate	100/10,000	100
54115	Nicotine	100	100
7697372	Nitric acid	1,000	1,000
10102439	Nitric oxide	100	10
98953	Nitrobenzene	10,000	1,000
1122607	Nitrocyclohexane	500	500
10102440	Nitrogen dioxide	100	10
62759	Nitrosodimethylamine	1,000	10
991424	Norbormide	100/10,000	100
95487	o-Cresol	1,000/10,000	100
NONE	Organorhodium Complex (PMN-82-147)	10/10,000	10
630604	Ouabain	100/10,000	100
23135220	Oxamyl	100/10,000	1
78717	Oxetane, 3,3-bis(chloromethyl)-	500	500
2497076	Oxydisulfoton	500	500
10028156	Ozone	100	100
2074502	Paraquat methosulfate	10/10,000	10
1910425	Paraquat dichloride	10/10,000	10
56382	Parathion	100	10
298000	Parathion-methyl	100/10,000	100
12002038	Paris green	500/10,000	1
19624227	Pentaborane	500	500
2570265	Pentadecylamine	100/10,000	100

CAS Number	Name	TPQ	RQ
79210	Peracetic acid	500	500
594423	Perchloromethyl mercaptan	500	100
108952	Phenol	500/10,000	1,000
64006	Phenol, 3-(1-methylethyl)-, methylcarbamate	500/10,000	1
4418660	Phenol, 2,2'-thiobis[4-chloro-6-methyl-	100/10,000	100
58366	Phenoxarsine, 10,10'-oxydi-	500/10,000	500
696286	Phenyl dichloroarsine	500	1
59881	Phenylhydrazine hydrochloride	1,000/10,000	1,000
62384	Phenylmercury acetate	500/10,000	100
2097190	Phenylsilatrane	100/10,000	100
103855	Phenylthiourea	100/10,000	100
298022	Phorate	10	10
4104147	Phosacetim	100/10,000	100
947024	Phosfolan	100/10,000	100
75445	Phosgene	10	10
732116	Phosmet	10/10,000	10
13171216	Phosphamidon	100	100
7803512	Phosphine	500	100
2703131	Phosphonothioic acid, methyl-,		
	O-ethyl O-(4-(methylthio)phenyl) ester	500	500
50782699	Phosphonothioic acid, methyl-,		
	S-(2-(bis(1-methylethyl)amino)ethyl) O-ethyl ester	100	100
2665307	Phosphonothioic acid, methyl-,		
	O-(4-nitrophenyl) O-phenyl ester	500	500
3254635	Phosphoric acid, dimethyl 4-(methylthio) phenyl ester	500	500
2587908	Phosphorothioic acid,		
	O,O-dimethyl-5-(2-(methylthio)ethyl)ester	500	500
10025873	Phosphorus oxychloride	500	1,000
10026138	Phosphorus pentachloride	500	500
7719122	Phosphorus trichloride	1,000	1,000
7723140	Phosphorus	100	1
57476	Physostigmine	100/10,000	1
57647	Physostigmine, salicylate (1:1)	100/10,000	1
124878	Picrotoxin	500/10,000	500
110894	Piperidine	1,000	1,000
23505411	Pirimifos-ethyl	1,000	1,000
151508	Potassium cyanide	100	10
10124502	Potassium arsenite	500/10,000	1
506616	Potassium silver cyanide	500	1
2631370	Promecarb	500/10,000	1
106967	Propargyl bromide	10	10
107120	Propionitrile	500	10
542767	Propionitrile, 3-chloro-	1,000	1,000
70699	Propiophenone, 4'-amino	100/10,000	100
109615	Propyl chloroformate	500	500
75569	Propylene oxide	10,000	100
75558	Propyleneimine	10,000	1
2275185	Prothoate	100/10,000	100
129000	Pyrene	1,000/10,000	5,000
504245	Pyridine, 4-amino-	500/10,000	1,000
140761	Pyridine, 2-methyl-5-vinyl-	500	500
1124330	Pyridine, 4-nitro-, 1-oxide	500/10,000	500
53558251	Pyriminil	100/10,000	100
14167181	Salcomine	500/10,000	500
107448	Sarin	10	10
7783008	Selenious acid	1,000/10,000	10
7791233	Selenium oxychloride	500	500
563417	Semicarbazide hydrochloride	1,000/10,000	1,000
3037727	Silane, (4-aminobutyl)diethoxymethyl-	1,000	1,000
13410010	Sodium selenate	100/10,000	100
7784465	Sodium arsenite	500/10,000	1
62748	Sodium fluoroacetate	10/10,000	10
124652	Sodium cacodylate	100/10,000	100
143339	Sodium cyanide (Na(CN))	100	10
7631892	Sodium arsenate	1,000/10,000	1
10102188	Sodium selenite	100/10,000	100
26628228	Sodium azide (Na(N3))	500	1,000
10102202	Sodium tellurite	500/10,000	500

CAS Number	Name	TPQ	RQ
900958	Stannane, acetoxytriphenyl-	500/10,000	500
57249	Strychnine	100/10,000	10
60413	Strychnine, sulfate	100/10,000	10
3689245	Sulfotep	500	100
3569571	Sulfoxide, 3-chloropropyl octyl	500	500
7446119	Sulfur trioxide	100	100
7446095	Sulfur dioxide	500	500
7783600	Sulfur tetrafluoride	100	100
7664939	Sulfuric acid	1,000	1,000
77816	Tabun	10	10
7783804	Tellurium hexafluoride	100	100
107493	Tepp	100	10
13071799	Terbufos	100	100
78002	Tetraethyl lead	100	10
597648	Tetraethyltin	100	100
75741	Tetramethyllead	100	100
509148	Tetranitromethane	500	10
10031591	Thallium sulfate	100/10,000	100
2757188	Thallous malonate	100/10,000	100
6533739	Thallous carbonate	100/10,000	100
7791120	Thallous chloride	100/10,000	100
7446186	Thallous sulfate	100/10,000	100
2231574	Thiocarbazide	1,000/10,000	1,000
39196184	Thiofanox	100/10,000	100
297972	Thionazin	500	100
108985	Thiophenol	500	100
79196	Thiosemicarbazide	100/10,000	100
5344821	Thiourea, (2-chlorophenyl)-	100/10,000	100
614788	Thiourea, (2-methylphenyl)-	500/10,000	500
7550450	Titanium tetrachloride	100	1,000
91087	Toluene-2,6-diisocyanate	100	100
584849	Toluene-2,4-diisocyanate	500	100
110576	trans-1,4-Dichlorobutene	500	500
1031476	Triamiphos	500/10,000	500
24017478	Triazofos	500	500
1558254	Trichloro(chloromethyl)silane	100	100
27137855	Trichloro(dichlorophenyl)silane	500	500
76028	Trichloroacetyl chloride	500	500
115219	Trichloroethylsilane	500	500
327980	Trichloronate	500	500
98135	Trichlorophenylsilane	500	500
998301	Triethoxysilane	500	500
75774	Trimethylchlorosilane	1,000	1,000
824113	Trimethylolpropane phosphite	100/10,000	100
1066451	Trimethyltin chloride	500/10,000	500
639587	Triphenyltin chloride	500/10,000	500
555771	Tris(2-chloroethyl)amine	100	100
2001958	Valinomycin	1,000/10,000	1,000
1314621	Vanadium pentoxide	100/10,000	1,000
108054	Vinyl acetate monomer	1,000	5,000
129066	Warfarin sodium	100/10,000	100
81812	Warfarin	500/10,000	100
28347139	Xylylene dichloride	100/10,000	100
1314847	Zinc phosphide	500	100
58270089	Zinc,dichloro(4,4-dimethyl-5((((methylamino) carbonyl)oxy)imino)pentanenitrile)-, (T-4)-	100/10,000	100

APPENDIX B: EXAMPLES OF EXTREMELY HAZARDOUS SUBSTANCES AND SAFER ALTERNATIVES

The following sections give some examples of extremely hazardous chemicals that are common in the U.S. economy and potential alternatives. This is not an exhaustive description of the many uses that these substances are used for, but rather is intended to demonstrate the breadth of use and some of the potential alternatives. Also, it should be understood that applying alternatives to a particular facility and use requires assessment of technical and cost factors, other safety and environmental concerns, and legal issues.

ARSINE GAS

USES:
Arsine gas is widely used in the production of microchips for electronics products.

EFFECTS:
An extremely toxic gas that destroys red blood cells and can cause widespread organ injury and death. Inhalation of arsine can cause impairment of kidney function, damage to the liver and heart, electroencephalogram abnormality, hemolytic anemia, and death due to kidney or heart failure.

SAFER ALTERNATIVES:
While arsine gas is a necessary ingredient in the production of certain microchips, it is not necessary to store large volumes of arsine gas in order to produce the final products. Instead, under scrutiny of local government, microelectronics producers in the Silicon Valley have applied technologies to produce arsine gas at the point of use, to be consumed immediately in production processes, leaving very little in storage, and eliminating the potential for a catastrophic scale of release.

CHLORINE

USES:
Production of chlorinated organics, including PVC and other hazardous chemicals like perchloroethylene, and trichloroethylene, accounted for 76% of national chlorine consumption in 1995. (The production of polyvinyl chloride accounts for about 35% of national chlorine consumption.) Use in water and wastewater treatment systems accounts for 2-4%. Use in bleaching of paper in pulp and paper mills is another common usage. In etching processes, manufacturers use chlorine gas to regenerate spent etchant (ferric chloride and cupric chloride). Chlorine was used as a chemical warfare agent during World War I.

EFFECTS:
In high concentrations chlorine can act as an asphyxiant and cause respiratory distress, chest pain, loss of breath (leading to death), vomiting, filling of the lungs with fluid (pulmonary edema), and pneumonia. Chlorine products also result in the generation of dioxin, one of

the most toxic and carcinogenic compounds. There is substantial evidence of effects of dioxin on the impaired development of children's immune, reproductive, and nervous systems, in particular cognitive and learning abilities. Dioxins are unintended by-products of many chemical and combustion processes which involve chlorine, reaching the environment from industrial air emissions, wastewater discharges, disposal activities, and from burning material that contains chlorine.

SAFER ALTERNATIVES:
Many wastewater and water treatment plants have been switching to safer alternatives. Water and sewer treatment facilities are moving away from elemental chlorine and substituting sodium hypochlorite (bleach). This largely eliminates gas cloud hazards because bleach does not vaporize as quickly or easily as liquid or gaseous chlorine, but it does not eliminate dioxin and other environmental concerns regarding chlorine production and discharges. Ultraviolet light is another substitute suited to wastewater facilities which does not pose the same environmental concerns. Hydrogen peroxide and ozone can be substituted for chlorine in etchant regeneration, but they are not as effective in regenerating the solution, create more waste and have other hazards associated with their use.

There are many possible substitutes for polyvinyl chloride, which is the largest single use of chlorine. For instance, instead of using PVC, many end users are switching to polypropylene or polyolefins —plastics which do not use chlorine. Dow-Cargill placed a new $300 million plant on line in November 2001 in Blair, Nebraska that will make plastics out of sugar.

An international treaty on persistent organic pollutants (POPs) has recommended working toward the elimination of dioxins and the products that lead to their generation. Signatory nations are called on to reduce total releases "with the goal of their continuing minimization and, where feasible, ultimate elimination." The treaty urges the use of substitute or modified materials, products and processes to prevent the formation and release of dioxins.

HYDROGEN FLUORIDE (HYDROFLUORIC ACID)

USES:
Hydrogen Fluoride (HF) is used in an array of industries and uses. It is used and stored in large quantities at roughly half of all oil refineries to generate alkylates, which permit allow vehicles to have better gas milage per gallon. HF is also used in metal surface treatments. The electronics industry uses high purity, 49% hydrofluoric acid solution, to etch silicon. HF is also used to produce uranium.

EFFECTS:
Hydrogen Fluoride has a special capacity to form a self-regenerating toxic cloud that can remain at deadly densities despite the movement of the cloud over long stretches of land. Even slight contact with the chemical can cause severe skin and deep tissue burns, which may occur hours after contact and may not be felt immediately; severely burn the eyes, causing blindness; irritate the nose, throat, and lungs, causing coughing and/or shortness of breath; or cause the build up of fluid in the lungs (edema). Many workers who have been accidentally exposed to HF have died gruesome and painful deaths.

SAFER ALTERNATIVES:
HF in refinery alkylation is technologically unnecessary; safer processes and materials can fill the same purpose. Since the early 1990's alternative technologies have been available for refineries, known as solid acid and fixed bed catalyst technologies, which eliminate the risk of a large scale catastrophic incident from HF. These solid acid catalyst alternatives are inherently safer than traditional HF methods, due to their sharply reduced volatility. Unfortunately, the refining industry has not widely implemented these safer technologies due to the lack of government regulations mandating their adoption. The other half of refineries engaged in alkylation use sulfuric acid, which is also dangerous, though not as hazardous in the movement and concentration of its vapors.

A variety of acids can be used to accomplish metal surface treatments, such as nitric and sulfuric acids. Texas Instruments has implemented a new metal spraying technique for coating ceramic parts that decreased the need for hydrofluoric acid etching of the ceramic parts prior to metal application.

METHYL ISOCYANATE (MIC)

USES:
Used as an intermediate chemical in production of certain pesticides.

EFFECTS:
A wide array of damage to the lungs, brain, kidneys, muscles as well as gastrointestinal, reproductive, immunological and other systems. Bronchial asthma, chronic obstructive airways disease, recurrent chest infections, and fibrosis of the lungs are the principal effects of exposure-induced lung injury.

On December 3, 1984, Union Carbide Corporation's pesticide factory leaked poisonous gases into the city of Bhopal, India. In one night over three thousand residents were killed and hundreds of thousands of others were injured, many of them permanently. The prevalence of pulmonary tuberculosis among the survivors has been found to be more than three times that of the national average; survivors also have increased early-age cataracts and damaged immune systems.

SAFER ALTERNATIVES:
After the Bhopal disaster, many companies found that they could make the same pesticide products without continuing to store large quantities of methyl isocyanate. Some companies began making their products using different chemical pathways that eliminated the need to use of methyl isocyanate DuPont found a way to avoid keeping 40,000 to 50,000 pounds of MIC that it previously had in storage. Though it produces MIC as an intermediate, the firm immediately consumes it in a closed-loop process. The result is a maximum of two pounds of MIC on-premises at any one time.

AMMONIA

USES: Eighty percent of ammonia is used in agricultural operations, much of it as fertilizer. Ammonia is also used in high pressure refrigeration and in cleaning.

EFFECTS:
Effects of inhalation of ammonia range from irritation to severe respiratory injuries, with possible fatality at higher concentrations. Ammonia is
corrosive and exposure will result in a chemical-type burn. It readily migrates to moist areas of the body such as eyes, nose, throat, and moist skin areas. Exposure to liquid ammonia will also result in frostbite since its temperature at atmospheric pressure is –28ºF.

In a 1986 incident in a packing plant slaughterhouse, a refrigeration line ruptured, releasing ammonia. Eight workers were critically injured, suffering respiratory burns from ammonia inhalation, and 17 others were less severely hurt. A freight train crash near the North Dakota town of Minot on January 18, 2002 leaked a cloud of anhydrous ammonia gas that killed one person, injured dozens more and paralyzed part of the town.

SAFER ALTERNATIVES:
Responding to complaints from residents and political leaders, American Electric Power abandoned a plan for large scale liquid ammonia storage to clean the exhaust of its massive Gavin plant in southeastern Ohio. Instead of installing six 60,000-gallon tanks to hold toxic anhydrous ammonia at the plant, the company announced that it would use urea, a dry nitrogen fertilizer that will be converted into ammonia shortly before it is injected into the exhaust. The urea can be more stable in storage, provided it does not come into contact with other substances that it reacts with.

EXTREMELY HAZARDOUS SUBSTANCE	NDUSTRY SECTOR	PROCESS	EXISTING ALTERNATIVES	ALTERNATIVES UNDER DEVELOPMENT
Ammonia		industrial refrigeration	water	
Chlorine	Electronics	etching	Hydrogen Peroxide and Ozone	
	Many	Water Purification	Sodium Hypochlorite Ultraviolet Light Ozone	
	pulp and paper	pulp bleaching	Oxygen gas Ozone Hydrogen peroxide	
	Polyvinyl chloride (PVC)	Plastics production	Polypropylene Polyolefins Sugar-based plastics	
Chlorine Dioxide	pulp and paper	pulp bleaching	Oxygen gas Ozone Hydrogen peroxide	
Ethylene Oxide	Health care	Sterilization	Steam/Autoclave Dry heat Microwave Gamma-Cobalt 60 E-beam Mixed chemical plasma device using peracetic acid Hydrogen peroxide plasma Ozone Vapor phase hydrogen peroxide	

EXTREMELY HAZARDOUS SUBSTANCE	NDUSTRY SECTOR	PROCESS	EXISTING ALTERNATIVES	ALTERNATIVES UNDER DEVELOPMENT
Formaldehyde	construction-plywood, varnishes, laminated and foam insulation	phenolic resins	enzymatic water-based polymerization process (based on horseradish peroxidase and soy peroxidase) pyrolysis(rapid heating in the absence of oxygen) of biomass	
	Electronics	printed wiring boards	Carbon technology graphite tech. organic-palladium tech. tin-palladium tech. non-formaldehyde electroless copper(sodium hypophosphate reducing agent) tech. conductive polymer tech	
	Garment industry	wrinkle resistance		glyoxyl resins butaneteracarboxylic acid sodium hypophosphite polymeric carboxylic acid/citric acid
Hydrogen Chloride	pharmaceutical	neutralizing agent for ph control	other acids or bases	
	food		other acids or bases	

EXTREMELY HAZARDOUS SUBSTANCE	NDUSTRY SECTOR	PROCESS	EXISTING ALTERNATIVES	ALTERNATIVES UNDER DEVELOPMENT
Hydrogen Fluoride	metals and electronics	etching,pickling and cleaning metals		nitric acid hydrochloric acid phosphoric acid alkaline solution plasma etching
	petroleum production	alkylation	Solid acid catalyst	
Phosgene	polycarbonate plastics production	intermediary	diphenylcarbonate	
	polyurethane production	intermediary	carbon monoxide carbon dioxide	
	pesticide production	intermediary	carbon monoxide carbon dioxide	

APPENDIX C: GLOSSARY

Ambient - Any unconfined portion of the atmosphere; open air; outside surrounding air.

American Chemical Council - The chemical industry's trade association

Agency on Toxic Substances and Disease Registry (ATSDR) - Federal agency that conducts public health and safety studies.

Bhopal - A city in India which, in 1984, suffered the worst chemical accident in history, with a gas cloud from a Union Carbide plant that killed 3,000 people overnight and severely injuring 200,000.

Blue Plains - The name of a sewage treatment plant in Washington, DC which switched from liquid chlorine to sodium hypochlorite for wastewater treatment in October 2001.

Buffer Zones - The amount of land set aside between chemical storage, use or production facilities and surrounding land uses.

Capture Technologies - Equipment added to chemical facilities to impede a release of chemicals from reaching the external environment.

Clean Air Act Amendments of 1990 - Amendments enacted by Congress to the nation's key air pollution law, which added requirements for prevention of chemical catastrophes through risk management planning and a facility owner or operator's general duty to prevent chemical accidents.

Clean Production - Industrial design strategies which seek to minimize the damage of an industrial process on environment throughout the production lifecycle, including materials extraction and disposal, as well as waste and energy consumption issues at the production facility.

Community Labor Coalitions - Alliances of chemical facility workers, unions, local residents, and other organizations representing members of the community or the public interest.

Contingency Plan - A document setting out an organized, planned, and coordinated course of action to be followed in case of fire, explosion, or other accident that releases toxic chemicals, hazardous waste, or radioactive materials that threaten human health or the environment.

CPC - Chemical Protective Clothing

Department of Transportation - The federal agency responsible for policies and procedures governing the transport of materials, including hazardous wastes.

DOT - Department of Transportation

EHS - Extremely Hazardous Substance

Emergency and Hazardous Chemical Inventory - An annual report by facilities having one or more extremely hazardous substances or hazardous chemicals above certain weight limits, as specified in Section 311 and 312 of EPCRA.

Emergency Preparedness Coordinator - The local government official designated to be notified immediately of chemical emergencies (e.g., spills, chemical releases, explosions, or fires) under EPCRA.

Emergency Responders - Firefighters, police, health care workers and hazmat teams that respond to chemical incidents.

Emergency Response Plans - The plans prepared by emergency responders and LEPC's prescribing how various individuals and institutions will take action in the event of a future chemical accident or other emergency in the community.

End -of -Pipe pollution control technologies - Equipment added to facilities to capture waste or pollutants generated by processes within the operation of the facility. The opposite of end-of-pipe control technologies is pollution prevention or source reduction, which seek to change processes to avoid the creation of the wastes in the first place.

EPA - Environmental Protection Agency

EPCRA - Emergency Planning and Community Right to Know Act Also know as SARA Titile III, this law is intended to improve local community access to information about chemical hazards and to improve state and local emergency response capabilities. Some features of EPCRA include community Right-to-Know provisions and the TRI reporting requirement. See Also:CERCLA, SARA, LEPC, MSDS, SERC, TRI

EPCRA - The Emergency Planning and Community Right-To-Know Act of 1986, which is the third part of the Superfund Amendments and Reauthorization Act of 1986, also known as SARA Title III

Extremely Hazardous Substances - Any of 406 chemicals identified by EPA as toxic, and listed under SARA Title III. The list is subject to periodic revision.

Facility Emergency Coordinator - Representative of a facility covered by environmental law (e.g., a chemical plant) who participates in the emergency reporting process with the Local Emergency Planning Committee (LEPC)

FEMA - Federal Emergency Management Agency

Firewall - A protective element in software or hardware to prevented unwanted intrusions to computers via internet or networks.

Footprint - The vulnerable area indicated by a map, showing how large an area is vulnerable to injury from to chemical releases.

General Duty Clause - Provisions of law requiring measures to prevent known hazards.

Good Neighbor Agreement - A binding agreement negotiated between community organizations and site owners, sometimes including others, detailing the owners' commitments to environmental or safety improvements and other issues of concern to the community.

Hazard Communication Standard - An OSHA regulation that requires chemical manufacturers, suppliers, and importers to assess the hazards of the chemicals they make, supply, or import, and to inform employers, customers, and workers of these hazards through a Material Safety Data Sheet.

Hazardous Chemical - EPA's designation for any hazardous material that requires a Material Safety Data Sheet. Such substances are capable of producing adverse physical effects (fire, explosion, etc.) or adverse health effects (cancer, dermatitis, etc.)

Hazardous Chemicals - Any chemical as defined by SARA Title III Section 311.(e), which reads: "Substances as defined within the meaning of 29 CFR 1910.1200(c), except that the term does not include the following: (1) Any food, food additive, color additive, drug or cosmetic regulated by the FDA; (2) Any substance present as a solid in any manufactured item to the extent that exposure to the substance does not occur under normal circumstances; (3) Any substance to the extent that it is used for personal, family or household purposes or is present in the same form and concentration as a product packaged for distribution and use by the general public; (4) Any substance to the extent that is is used on a research laboratory or a hospital or other medical facility under the direct supervision of a technically qualified individual; (5) Any substance to the extent that it is used in routine agricultural operations or is a fertilizer held for sale by a retailer to the ultimate consumer."

Hazmat - Hazardous Material

HMTA - Hazardous Materials Transportation Act The HMTA provides for the safe transportation of hazardous materials. Regulations developed from the HMTA cover shipment preparation and labeling, handling, routing, emergency and security planning, incident notifications, and liability insurance. See Also:DOT, RCRA

Incident Command System (ICS) - An organizational scheme wherein one person, normally the Fire Chief, takes charge of an integrated, comprehensive emergency response. This commander is backed by an Emergency Operations Center which provides support, resources, communications, and advice.

Inherent Safety - Elements in the design or redesign of a facility which eliminate the potential for catastrophic chemical releases or incidents.

LEPC - Local Emergency Planning Committee. In Bucks County, the Bucks County Local Emergency Planning Committee.

LNG - Liquefied natural gas

Local Emergency Planning Committee (LEPC) - The body appointed by the State Emergency Response Commission (SERC), as required by EPCRA, which develops comprehensive emergency plans for Local Emergency Planning Districts, collects MSDS forms and chemical release reports, and provides this information to the public. Each county and some large city governments participate in an LEPC.

LPG - Liquefied petroleum gas.

Management of Change - OSHA requirements for regulated facilities to anticipate changes in technologies or operations, and to assess and prepare for the safety of the changes before they are undertaken.

Material Safety Data Sheet (MSDS) - Printed material concerning a hazardous chemical, or Extremely Hazardous Substance, including its physical properties, hazards to personnel, fire and explosion potential, safe handling recommendations, health effects, fire fighting techniques, reactivity, and proper disposal. Originally established for employee safety by OSHA.

MCL - Maximum contaminant level. The maximum level of contamination allowed under EPA standards.

MIC - Methyl isocyanate, the chemical involved in the 1984 Bhopal chemical disaster in which 3,000 people were killed in a single night.

National Response Center (NRC) - The primary communications center operated by the U.S. Coast Guard to receive reports of major chemical and oil spills and other hazardous substances into the environment. The NRC immediately relays reports to a predesignated federal On-Scene Coordinator.

National Response Team (NRT) - Representatives from 15 federal agencies with interests and expertise in various aspects of emergency response to pollution incidents. EPA serves as chair and the U.S. Coast Guard serves as vice-chair. The NRT is primarily a national planning, policy, and coordinating body and does not respond directly to incidents. The NRT provides policy guidance prior to an incident and assistance as requested by a federal On-Scene Coordinator via a Regional Response Team during an incident. NRT assistance usually takes the form of technical advice, access to additional resources or equipment, or coordination with other RRTs.

National Strike Force (NSF) - Operated by the U.S. Coast Guard, the NSF is composed of three strategically located teams (Atlantic, Pacific, and Gulf coasts) who back up the federal On-Scene Coordinator. These teams are extensively trained and equipped to respond to major oil spills and chemical releases. These capabilities are especially suited to incidents in a marine environment but also include site assessment, safety, action plan development, and documentation for both inland and coastal zone incidents. The NSF Coordination Center is at Elizabeth City, NC.

Offsite Consequence Analysis - An analysis in a facility's risk management plan, and risk management plan summary, that indicates how many people are placed in danger of injury or death in the event of a chemical release incident at the facility.

On-Scene Coordinator (OSC) - The federal official responsible for the coordination of a hazardous materials response action, as specified in individual Regional Contingency Plans. OSCs are predesignated by EPA for inland areas and by the U.S. Coast Guard for coastal areas. The OSC coordinates all federal containment, removal, and disposal efforts and resources during a pollution incident. The OSC is the point of contact for the coordination of federal efforts with those of the local response community. The OSC has access to extensive federal resources, including the National Strike Force, the Environmental Response Team, and Scientific Support Coordinators. The OSC can be a source of valuable support and information to the community.

Occupational Safety and Health Administration (OSHA) - Agency within the U.S. Department of Labor that is responsible for the implementation of the Occupational Safety and Health Act. Process Hazard Analysis (PHA) The analysis of a facility's hazards conducted by the facility or its consultants as required by EPA regulations on risk management planning.

Planning Case Scenario - The potential situation of a chemical release upon which a company builds its risk management plan under EPA rules. See also worse case scenario.

Primary Prevention - Front-end solutions to issues of facility hazards, which involve designing the process so that it eliminates vulnerabilities. Also known as inherent safety.

Process Safety Management (PSM) - The OSHA PSM rule requires employers subject to the rule to engage in various activities to prevent or minimize the consequences of catastrophic releases of toxic, reactive, flammable and explosive chemicals.

Right-To-Know - The public's rights to information regarding chemical sites, established under various laws.

Resource Conservation and Recovery Act (RCRA) - The federal law on hazardous and solid waste management.

Right-To-Know Act - 1986 Emergency Planning and Community Right-To-Know Act

RMP - Risk Management Planning. Planning that is required under the Air Toxics regulations of the Clean Air Act. Risk Management Plans—due by June 21, 1999 ~~are~~ intended to detect and prevent or minimize accidental airborne release of a set of "extremely hazardous substances" and to provide a prompt emergency response to any such release.

SARA Title III - The third part of the Superfund Amendments and Reauthorization Act of 1986, also known as EPCRA.

Secondary Prevention Measures - Hazard reduction measures that accept the existence of a design hazard and seek to reduce the consequences of a potential accident by adding on technologies (e.g. measures to capture releases) and operational practices (e.g. security guards). Opposite of inherent safety or primary prevention.

SERC - State Emergency Response Commission. One of the public agencies that must be notified under the term of EPCRA regarding the presence of certain hazardous substances on a facility property. The LEPC must also be notified if there is a release of a hazardous substance into the environment See Also:EPCRA, LEPC

Shelter in Place - An emergency response strategy in which people living or working near a facility where a chemical incident occurs, in which they are advised to stay indoors and to seal off ventilation against external air sources.

Technology Options Analysis - Analysis of opportunities for enhancing the inherent safety of a facility.

Threshold Planning Quantity (TPQ) - The amount of an extremely hazardous substance present at a facility above which the facility's owner/operator must give emergency planning notification to the LEPC and PEMC.

Tier 1 - The categorical reporting of chemicals stored on the site of a facility under annual chemical inventory reporting. Required to automatically be filed with state and local officials under federal law.

Tier 2 - The detailed item by item reporting of chemicals stored on the site of a facility under annual chemical inventory reporting which are only required to be filed with state and local officials if requested by state or local officials.

Toxic-by-Inhalation (**TIH**) - Materials which present the danger of forming a toxic cloud which can cause injury or death.

Toxic Cloud - An airborne mass of gases, vapors, fumes, or aerosols of toxic materials.

Toxic Release Inventory (**TRI**) - A database of annual toxic releases from certain manufacturers compiled from EPCRA Section 313 reports. Manufacturers must report annually to EPA and the states the amounts of almost 350 toxic chemicals and 22 chemical categories that they release directly to air, water, or land, inject underground, or transfer to off-site facilities. EPA compiles these reports and makes the information available to the public under the "Community Right-to-Know" portion of the law.

Toxic Substance - A chemical or mixture that can cause illness, death, disease, or birth defects. The quantities and exposures necessary to cause these effects can vary widely. Many toxic substances are pollutants and contaminants in the environment.

TRI - Toxic Release Inventory. An an annual inventory that must be reported to EPA and the state of releases of listed "toxic chemicals" and transfers of toxic chemicals that exceed specified threshold amounts. This submittal must also include information about the environmental media where releases take place. See Also: EPCRA

TRI - Toxic Chemical Release Inventory. A federal program described in SARA Title III that requires certain facilities to report releases and transfers of toxic chemicals to the U.S. EPA

U.S. EPA - United States Environmental Protection Agency. The U.S. government agency responsible for developing and administering environmental regulations.

Uniform Fire Code - The nationally developed code of fire prevention which has been adopted by many communities through local regulations or ordinances.

Vulnerability Zone - The area mapped by a facility in risk management planning which reflects the area in which people could suffer injury or death as a result of a chemical incident.

Water Curtain - A technology which sprays water to block the passage of toxic gases from a facility that is experiencing a chemical release.

Worst Case Scenario - The worst chemical release that can happen at a facility, based on EPA's guidelines for calculating this in risk management plans. This scenario involves the release of all of the contents of the largest tank holding extremely hazardous materials at a site.

AUTHOR PROFILE

SANFORD J. LEWIS is an environmental attorney with 20 years of experience in environmental law and policy. He has worked on behalf of state and local government, civic organizations, investors, environmental organizations, and trade unions. He is an internationally known expert on pollution prevention and chemical safety through negotiated "Good Neighbor Agreements" between facilities and their neighbors. He has been an instructor in environmental law and pollution prevention in graduate programs at Tufts University and U.C.L.A. He is the author of the *Good Neighbor Handbook: A Community-based Strategy for Sustainable Industry* (Apex Press, 1992). Lewis is a graduate of the University of Michigan Law School (J.D. '83) and holds a B.S. in Environmental Science and Urban Communications from Cook College, Rutgers University.

The Safe Hometowns Initiative

is a group of organizations and individuals sharing an urgent concern regarding the threat to public safety posed by the use and storage of extremely hazardous chemicals in thousands of American communities. The initiative encourages government and industry to protect American communities from the risk of a catastrophic chemical release, whether accidental or an act of terrorism, by putting prevention *first*. This means giving top priority to applying *inherently safer technologies,* such as using safer chemicals and reducing chemical quantities.

For a list of endorsers of the initiative, visit

www.safehometowns.org

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