Center for American Progress

AP PHOTO/LM OTERO

Chemical Security 101

What You Don't Have Can't Leak, or Be Blown Up by Terrorists

Paul Orum

November 2008

Center for American Progress

Chemical Security 101

What You Don't Have Can't Leak, or Be Blown Up by Terrorists

Paul Orum
Reece Rushing Project Manager

November 2008

Contents

Executive summary

Most of the nation's 101 most dangerous chemical facilities could become less attractive terrorist targets by converting to alternative chemicals or processes. Doing so would improve the safety and security of more than 80 million Americans living within range of a worst-case toxic gas release from one of these facilities, according to data compiled for this report. Millions more living near railroads and highways used for transporting hazardous chemicals would also be safer and more secure.

The Department of Homeland Security and numerous security experts have repeatedly warned that terrorists could use industrial chemicals as improvised weapons of mass destruction. Current chemical security efforts, however, are inadequate to protect workplaces and communities.

Indeed, temporary standards enacted two years ago (and set to expire in 2009) focus almost entirely on physical security measures, such as adding gates and guards. These measures, however worthy, cannot assure protection against a concerted attack, insider sabotage, or catastrophic release. Nor do they protect communities along chemical delivery routes. More than 90 percent of the 101 most dangerous facilities ship or receive their highest-hazard chemical by railcar or truck.

The only certain way to protect our communities is to remove the possibility of a toxic gas release by converting facilities to safer, more secure alternative technologies. This report identifies opportunities for conversions at the 101 most dangerous facilities, each of which threaten roughly 1 million people or more in surrounding areas. The chemicals most often posing the greatest danger at the top 101 facilities are chlorine—almost always in railcars—followed by hydrofluoric acid and sulfur chemicals.

Most of the top 101 facilities could convert to safer and more secure chemicals or processes already being used by similar facilities that do not endanger large numbers of people. In particular:

- Thirty bleach plants could remove danger to some 50 million Americans by generating chlorine on-site without rail shipment and bulk storage. This includes the Clorox Company in Los Angeles, which puts over 5.5 million people in danger.

- Fifteen water utilities could remove danger to 17 million people by converting from chlorine gas (and sometimes sulfur dioxide gas) to alternatives that include liquid bleach or ultraviolet light. This includes the Howard F. Curren wastewater plant in Tampa, Fla., which puts more than a million people in danger.

- Eight petroleum refineries could remove danger to 11 million Americans by substituting toxic hydrofluoric acid, used in refining crude oil, with sulfuric acid or emerging solid acid catalysts. This includes the ExxonMobil Corp. refinery in Chalmette, La., which puts over 1 million people in danger.

- A variety of safer, more secure alternatives are available to 21 facilities that receive chemicals by rail or truck for use in making such diverse products as oil additives, water treatment chemicals, and materials for bulletproof vests. This includes Stepan Company in Elwood, Ill., which puts 1.2 million people in danger in producing industrial and household cleaners with sulfur trioxide. Using on-site sulfur burning equipment would eliminate this danger.

In addition to the top 101, the report also identifies 202 additional high-hazard facilities that could make similar changes. Each of these facilities has some 100,000 people or more living within range of a worst-case toxic gas release (commonly called a "vulnerability zone"). Together these 303 facilities are found in 41 states and endanger a total of 110 million people.

Previous reports by the Center for American Progress show such conversions are possible. In fact, many chemical facilities have already switched to safer, more secure alternatives, and frequently they saved money doing so. While gates and guards always cost money, facilities that remove hazardous chemicals reduce their need for costly physical security. They also may reduce regulatory burdens, improve efficiency, upgrade production, and better protect workers.

Despite this opportunity, the federal government currently has no plan, program, or authority to spur removal of unnecessary catastrophic chemical hazards—or even to require chemical facilities to *examine* safer and more secure alternatives. To address these deficiencies, Congress should establish a comprehensive chemical security program rooted in identifying, developing, and leveraging the use of safer and more secure technologies. In particular, this program should:

- Require chemical facilities to assess and use feasible alternatives that reduce the potential harm of a terrorist attack
- Create financial incentives for facilities to convert by requiring liability insurance and targeting conversion funding to publicly owned facilities and first-adopters of innovative technologies
- Invest in collaborative research to identify safer, more secure alternatives

- Utilize the experience and knowledge of facility employees in security assessments, plans, and inspections
- Build the oversight capacity of government agencies and require administrative transparency to hold those agencies accountable
- Ensure equal enforcement of standards without special treatment for facilities in voluntary industry security programs
- Include all relevant industries, in particular currently exempted water utilities
- Respect the right of states to set more protective standards if federal actions won't protect communities

Safer and more secure technologies fix the root of the problem. What you don't have can't leak, or be blown up by terrorists.

Major findings

- Safer and more secure chemicals or processes could remove the worst chemical release scenario at most of the nation's 101 highest-hazard chemical facilities (See Appendix A on page 29 for the details)
- At least 90 percent of the 101 most dangerous facilities ship or receive their highest-hazard chemical in indefensible railroad tank cars or trucks
- More than 80 million Americans live within range of a catastrophic chemical release from at least one of the 101 most hazardous chemical facilities
- Solutions applicable to the top 101 facilities could improve safety and security at many other high-hazard facilities, including an additional 202 listed in this report (See Appendix B on page 35 for the details)

Background

Current temporary security standards are insufficient

Certain industrial chemicals, if released, have the potential to form a poison gas cloud that spreads over large areas, possibly over many miles. Those exposed to the gas may be severely injured or even killed. The Department of Homeland Security, for example, estimates that a major chlorine gas spill in an urban area could kill 17,500 people.[1] Because of this lethal potential, many federal agencies have warned about terrorism at chemical plants, as have chemical industry associations, labor unions, and other non-governmental organizations.[2]

The response from Congress, however, has been slow and incomplete. In October 2006, Congress enacted temporary Chemical Facility Anti-Terrorism Standards, or CFATS, which expire in October 2009. These standards lay important groundwork but leave fundamental challenges unresolved. The CFATS framework cannot ultimately lead to chemical security.

Under CFATS, the Department of Homeland Security sets performance standards that focus on physical site security and effectively end at the plant fence line. Yet 90 percent of the nation's 101 most dangerous chemical facilities ship or receive their most hazardous chemical by rail or truck. The CFATS do not require facilities to account for chemical hazards in transportation along supply or distribution chains. Spending a billion dollars—or a trillion—on plant-site security won't protect unguarded railcars and trucks that travel thousands of miles over railroads and highways. Indeed, rail workers report "a disturbing lack of security along the railroad tracks and in rail yards."[3]

The CFATS framework does not require facilities to assess safer and more secure alternatives. Rather, the focus on site security assumes a given chemical hazard is unavoidable—or a company prerogative. The CFATS actually prohibits the Department of Homeland Security from requiring facilities to consider cost-effective alternative technologies that could remove the threat of a catastrophic toxic gas release. Moreover, the standards fail to cover water utilities even though 15 are among the nation's 101 most dangerous facilities and could readily convert to alternatives.[4]

There has been legislation introduced every year since 1999 to require chemical facilities to assess safer and more secure alternatives (see box below describing recent legislation).[5] But the Bush administration, the chemical industry, and some congressional leaders have consistently opposed such measures, effectively stifling comprehensive chemical security legislation.

Replacement chemicals can substantially improve safety and security

It should not simply be assumed that a given chemical hazard is unavoidable. In many cases, chemical facilities may be able to convert to safer and more secure chemicals and processes. A previous report by the Center for American Progress identified 284 facilities in 47 states that have already made such conversions.[6] As a result, 38 million people no longer live under the threat of a major toxic gas cloud from these facilities.

Another report by the Center also identified 25 water utilities that eliminated railcar shipments of chlorine gas by converting to safer and more secure alternatives for water treatment.[7] These conversions removed the threat to 25 million Americans living in surrounding communities and millions more along rail delivery routes.

Adopting safer and more secure alternatives is the only *certain* way to prevent a catastrophic chemical release. Such measures remove the possibility of a release. By contrast, physical barriers may be destroyed by a truck bomb, evaded by insider sabotage, or otherwise defeated. Security may also be unreliable. Investigative journalists have found lax security at more than 100 chemical facilities across the country.[8]

Recent chemical security legislation

In 2006, Senator Joe Biden (D-DE) introduced S.2855/S.2920 to provide grants for water utilities that replace hazardous chlorine gas

In 2006, Senator Frank Lautenberg (D-NJ), Senator Barack Obama (D-IL), and others introduced S.2486 to require chemical facilities to thoroughly review and use safer and more secure alternatives where practicable

In 2006, the House Homeland Security Committee passed H.R.5695, a bipartisan compromise to assess and reduce, where feasible, the potential consequences of a terrorist attack. House leaders abandoned this bipartisan compromise in creating the temporary Chemical Facility Anti-Terrorism Standards, or CFATS, included in the Homeland Security Appropriations Act (Sec. 550). These standards make no structured effort to remove unnecessary chemical targets and expire in October 2009

In 2007, Congress modified the temporary CFATS program to protect the right of states to set protective standards

In March 2008, the House Homeland Security Committee, chaired by Representative Bennie Thompson (D-MS), passed the Chemical Facility Anti-Terrorism Act, H.R.5577, requiring chemical facilities to develop feasible alternative chemicals and processes that reduce the potential consequences of a terrorist attack. This bill has yet to be voted on by the full House.

For some facilities, there may be no safer, readily available substitute chemical or process. These facilities should maintain sufficient emergency mitigation systems, establish adequate buffer zone distances to surrounding populations, and act to minimize transportation risks. In particular, chemical suppliers should co-locate with chemical users where possible. At co-located facilities, chemical trucks or trains can be replaced by less hazardous local pipelines. Many facilities identified in this report represent dispersed supplier-user combinations and thus rely on roads or rails that travel through densely populated areas.

"If we make fewer toxic products, use milder manufacturing conditions, and produce less toxic waste, we reduce the opportunities for terrorists."

– National Research Council[9]

Converting to safer alternatives is affordable

The Department of Homeland Security estimates that chemical facilities will spend $1.5 billion each year on security measures under the current temporary CFATS regulations.[10] Facilities that are able to convert to safer alternatives, however, are able to avoid security costs associated with storing and transporting a high-hazard chemical.

If a facility does not have a chemical with catastrophic potential, it does not need to spend as much on guards, gates, and other security measures. Nor is such a facility subject to the requirements of the CFATS and other laws and regulations governing extremely hazardous chemicals. As a result, the facility may save money on regulatory compliance staff, permits and fees, inspections, emergency planning, and personal protective equipment for employees, among other savings.

The facility may also pay lower insurance premiums, and certainly faces lower liabilities for deaths, injuries, contamination, and property damage in the event of a major toxic gas release. High-hazard toxic gases account for just 0.3 percent of rail carloads, for example, but they carry enormous risks and potential liabilities.[11] One insurance study found that a major chlorine rail spill in an urban area could cause 10,200 fatalities and over $7 billion in damages.[12]

Indeed, converting to safer, more secure technologies may provide the most economical solution to chemical security. According to survey findings from the Center for American Progress, 76 of 226 facilities (34 percent) that recently adopted safer alternatives expected to save money as a result, and half did not anticipate any increase in costs.[13] Twenty large water utilities surveyed by the Center converted to safer disinfectants for no more than $1.50 per year per person served—or less than the cost of a bag of potato chips—and typically spent much less.[14]

Major findings

This report examines safer and more secure options at the 101 most dangerous U.S. chemical facilities, measured by the number of people in surrounding areas who live within range of a major toxic gas release. This list was developed from Risk Management Plans, or RMPs, reported by chemical facilities to the Environmental Protection Agency, as directed by the Clean Air Act. Approximately 13,600 chemical facilities currently submit an RMP.

Each RMP includes the company's assessment of potential consequences, including a worst-case scenario, of a major chemical release. This "off-site consequence analysis" is meant to help communities prevent and prepare for serious chemical spills and emergencies. The public, however, can only obtain access to this information at federal reading rooms that are subject to cumbersome access restrictions.[15]

Since RMPs include only one toxic chemical worst-case scenario, this report only investigates alternatives for each facility's most dangerous toxic chemical. This excludes other toxic chemicals used on-site—even if they also pose major emergency release hazards—as well as flammable chemicals, which typically endanger far fewer people.[16, 17]

The 101 highest-hazard facilities endanger millions of Americans

More than 80 million Americans in 30 states live within range of a catastrophic chemical release from at least one of the nation's 101 highest-hazard chemical facilities. The chemicals most commonly reported by these facilities as posing the greatest danger are chlorine gas (63 facilities), hydrofluoric acid (12 facilities), anhydrous sulfur dioxide (six facilities), and oleum or sulfur trioxide (four facilities). Just 14 chemicals comprise the worst-case scenarios at the top 101 facilities. The types of facilities that make up the 101 highest-hazard facilities include:

- Thirty rail-dependent bleach plants, which together threaten nearly 50 million Americans. Kuehne Chemical in South Kearny, N.J., for example, puts 12 million people in danger, and KIK Company in Denver puts 1.7 million people in danger.

- Fifteen water utilities that use chlorine gas or sulfur dioxide gas, which together threaten 17 million people. For example, Fiveash Water Treatment Plant in Fort Lauderdale, Fla., puts 1.5 million people in danger.

- Eight petroleum refineries that use hydrofluoric acid in turning crude oil into gasoline. These facilities threaten approximately 11 million Americans. For example, Marathon Petroleum in St. Paul Park, Minn., puts 2.2 million people in danger.

- Twenty-seven other chemical-user facilities that receive chemicals by rail or truck for use in making diverse products. Appleton Papers in West Carrollton, Ohio, for example, uses chlorine gas to bleach recycled paper, putting 1.2 million people in danger. Infineum USA in Linden, N.J., uses chlorine gas to produce oil additives, putting 4.2 million people in danger. And, Midland Resources in St. Louis, Mo., uses chlorine gas in producing water treatment chemicals, putting 1.2 million people in danger.

- Fourteen facilities that produce chemicals for distribution or further manufacturing. For example, PVS Chemical Solutions in Chicago, Ill., distributes sulfur dioxide, and Rhodia in Houston, Texas ships oleum, each putting more than 3 million people in danger nearby, plus millions more along rail or truck distribution routes.

- Five companies that solely assist in the distribution of hazardous chemicals (and do not manufacture or produce). The Olin Corporation Foote Yard in Niagara Falls, N.Y., for example, holds chlorine railcars awaiting shipment. Roughly 1 million people live within this facility's vulnerability zone.

- Two facilities that incinerate furan and other hazardous wastes. They are Clean Harbors in Deer Park, Texas, which endangers 2.4 million people, and Ross Incineration Services in Eaton Township, Ohio, which threatens 1.3 million people.

Appendix A lists each of the 101 most dangerous facilities. Appendix B lists 202 additional facilities that use similar preventable chemicals or processes, putting 30 million additional people unnecessarily in harm's way.

Rail and truck shipments magnify the hazard

Hazardous chemicals are delivered by rail and road in dangerous bulk shipments that travel through almost every major American city and town. Consider that:

- More than 90 percent of the 101 highest-hazard facilities ship or receive their most dangerous chemical in railcars or tanker trucks
- At least 80 percent of the 101 highest-hazard facilities ship or receive a toxic gas chemical (commonly called a Toxic Inhalation Hazard, or TIH) by rail

Facility-reported "vulnerability zones" only provide the number of people at risk from a catastrophic release that occurs at the facility. The facility does not provide estimates of people in danger along shipping or delivery routes. Nonetheless, it is clearly many millions based on the amount of TIH chemicals being transported and the locations of the top 101 facilities.

The Association of American Railroads is well aware of this threat and has supported efforts to find and use substitutes that get TIH chemicals off the rails.[18] The common use of railcars for on-site storage is also one reason many facilities have large vulnerability zones.[19]

Of the top 101 highest-hazard facilities, 11 ship their worst-case chemical to other facilities, 82 receive their worst-case chemical from other facilities, five solely distribute or hold chemicals without manufacturing, and three neither ship nor receive their worst-case chemical.

While this report primarily identifies changes that specific facilities can make, at least some distributors can remove major dangers by adjusting products or delivery. Two examples developed below are alternatives to bulk distribution of chlorine gas and anhydrous sulfur dioxide.

Safer and more secure alternatives are available

Safer and more secure chemicals or processes are available to most of the 101 highest-hazard chemical facilities identified in this report. Specifically, potential alternatives are available for:

- All 30 bleach plants
- All 15 water utilities
- All eight petroleum refineries
- Twenty-one of the 27 other chemical-user facilities
- Two of the five distribution-only facilities
- Both of the facilities that treat hazardous waste

This report does not identify complete alternatives for the 14 facilities that produce chemicals for distribution or further manufacturing. Alternatives, however, are plainly available for many of the end-uses to which these facilities distribute chemicals.

The alternative methods identified in this report are largely already used or under development at other facilities with similar products or processes. They typically involve using an alternate chemical or process, using the chemical in a less dangerous form (a less concentrated one, or aqueous instead of gaseous), or generating the chemical as needed on-site without storage. Other identified alternatives include co-locating chemical suppliers with users, improving inventory control, and minimizing bulk storage.

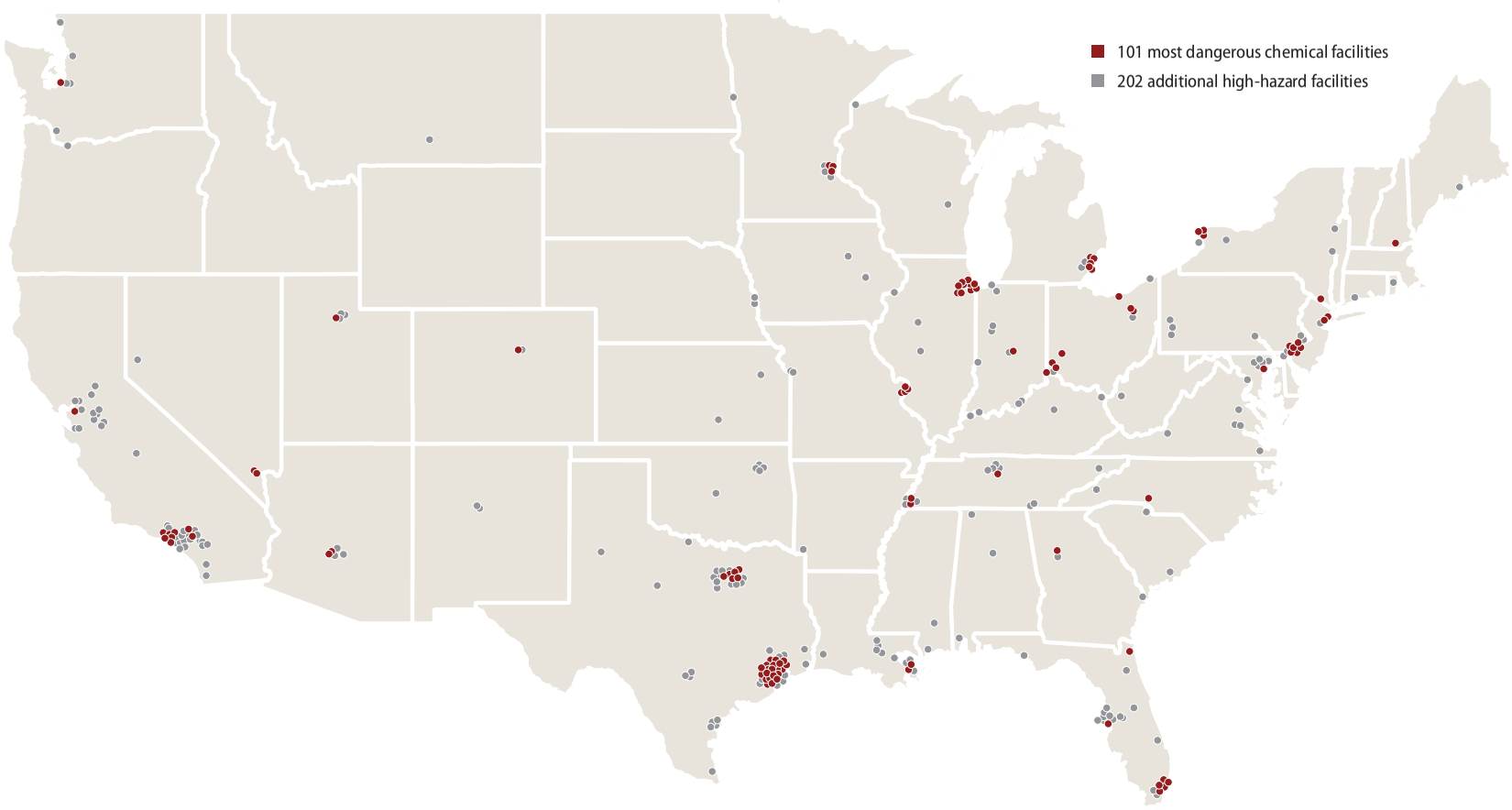
On page 12, this report examines the alternatives for each industry category represented in the top 101 facilities. Appendices A and B on pages 29 and 35, respectively, also list alternatives for individual facilities. The following are some of the opportunities discussed in this report:

- Bleach manufacturers can eliminate bulk chlorine gas by generating chlorine on-site as needed without storage
- Petroleum refineries can eliminate hydrofluoric acid alkylation by using less hazardous sulfuric acid or by developing solid acid catalysts
- Water utilities can eliminate bulk chlorine gas by using liquid bleach, ozone without storage, and ultraviolet light as appropriate
- Paper mills can eliminate bulk chlorine gas by using hydrogen peroxide, ozone, or chlorine dioxide without bulk storage
- Manufacturers of polyurethane foams can eliminate bulk ethylene oxide by substituting vegetable-based polyols
- Soap and detergent manufacturers can eliminate bulk oleum and sulfur trioxide by using sulfur burning equipment on-site
- Manufacturers of ferric chloride can eliminate bulk chlorine gas by processing scrap steel with less concentrated liquid hydrochloric acid (below 37 percent) and oxygen
- Titanium dioxide producers can eliminate bulk chlorine gas by generating chlorine on-site or using the sulfate process
- Secondary aluminum smelters can eliminate bulk chlorine gas by removing impurities with nitrogen gas injected with magnesium salts
- Power plants can eliminate bulk anhydrous ammonia gas by using cleaner combustion or by using aqueous ammonia or urea in pollution control equipment
- Wholesale chemical distributors can eliminate most bulk chlorine gas and sulfur dioxide gas by distributing alternatives such as liquid bleach and sodium bisulfite
- Pulp mills, food processors, and wastewater plants can eliminate bulk sulfur dioxide gas by, as appropriate, generating sulfur compounds on-site or purchasing sodium bisulfite, metabisulfite, hydrosulfite, or other alternatives
- Diverse manufacturers can eliminate bulk chlorine gas by generating chlorine on-site as needed, such as for fuel additives, water treatment chemicals, and aramid polymers used to make bulletproof vests

There is, of course, variability among industries as to the time, cost, and innovation needed to convert to these alternatives. Facilities that use chemicals may be able to change operations more readily than facilities that produce and distribute chemicals to others. These producer industries need solutions that satisfy user facilities and avoid transportation hazards. As users convert, however, there will be less demand to produce high-hazard chemicals and more demand to produce safer and more secure alternatives.

High-hazard chemical facilities endanger millions

This map shows the locations of the nation's 101 most dangerous chemical facilities. These facilities each threaten some one million or more Americans. An additional 202 chemical facilities are also shown. These facilities threaten some 100,000 or more people. Converting facilities to safer, more secure chemical alternatives would substantially reduce the threat of toxic terrorism.



Solutions for the 101 most dangerous chemical facilities

Most of the top 101 facilities could significantly improve security by switching to safer and more secure technologies already in use. These alternatives may carry dangers themselves, but they remove the risk of a catastrophic gas release that could kill or injure thousands of people.

More and better alternatives almost certainly exist than are identified in this report. But only a concerted national effort can bring to light the needed solutions across all industries. This report is a starting point—chemical security 101—that we hope will spur further development. Below is a breakdown of the 101 most dangerous chemical facilities by industry category. Safer and more secure alternatives are indicated for each category for which they are identified.

Bleach manufacturing

Thirty of the 101 highest-hazard facilities receive bulk chlorine shipments for producing liquid bleach (sodium hypochlorite). All of these facilities receive railcars of chlorine gas for use in bleach making, posing deadly hazards to communities. These manufacturers can instead produce bleach from salt and electricity on-site in a continuous "as-needed" process without ever storing chlorine gas.[20] By some estimates, converting U.S. bleach manufacturers to as-needed production could take one-third of chlorine gas railcars off the rails.[21] Converting just these 30 rail-dependent bleach manufacturers to produce bleach without storing chlorine gas would eliminate their toxic gas dangers to some 50 million people, plus more along rail delivery routes.

Of these 30 bleach-manufacturing facilities, at least half also repackage the chlorine gas into smaller containers, typically one-ton and 150-pound cylinders. A one-ton cylinder of chlorine gas is an order of magnitude less hazardous than a railcar, but still poses substantial hazards. Roughly 80 percent of one-ton and 150-pound chlorine gas cylinders shipped in the United States are used in water treatment (yet account for 4 percent or less of U.S. chlorine use). Chlorine gas, however, is not necessary for water treatment. Instead, other options are available, including liquid bleach, the most common alternative, as well as ozone and ultraviolet light. As water treatment customers convert off chlorine gas, distributors supply safer and more secure alternatives.

Examples from the Top 101 include:

- Hill Brothers Chemical, Phoenix, Ariz., 1.7 million people in danger
- Vertex Chemical, Dupo, Ill., 1 million people in danger
- JCI Jones Chemicals, Tacoma, Wash., 1.8 million people in danger
- Clorox Products, Forest Park, Ga., 1 million people in danger

Drinking water and wastewater treatment

Fifteen of the 101 highest-hazard facilities are water utilities. These 15 facilities together endanger some 17 million people. Eleven of these facilities treat drinking water using chlorine gas.[22] Chlorine disinfects water at the treatment plant and in water distribution pipes. These facilities can instead use alternate disinfectants to chlorine gas, including liquid bleach, ozone without storage, or ultraviolet light.

At least 160 large U.S. cities already use liquid bleach.[23] A previous CAP report also identified nearly 100 water plants that have converted off chlorine gas since 1999.[24] Several of the drinking water facilities in the top 101 use anhydrous ammonia gas in addition to chlorine gas. These facilities can switch from anhydrous to aqueous ammonia, which has far less potential to drift off site.

The other four water utilities are wastewater treatment plants that use both chlorine gas and sulfur dioxide gas. These water plants disinfect with chlorine gas and then remove residual chlorine with sulfur dioxide gas. Wastewater plants commonly replace chlorine gas with liquid bleach, and replace sulfur dioxide gas with sodium bisulfite, or avoid both by switching to ultraviolet light. Roughly two-thirds of large U.S. wastewater utilities already use a disinfectant other than chlorine gas or plan to stop using chlorine gas.[25]

Expert reviews convened by at least three government agencies identify chlorine gas in water treatment as a preventable security concern.[26] Some water utilities are converting off chlorine gas—pressed by requirements for chemical security, worker safety, risk management, hazard communication, emergency planning, and other obligations—but the pace of change is slow. Approximately 1,650 drinking water plants and 1,000 wastewater plants still report extremely hazardous substances, primarily chlorine gas, under the EPA's Risk Management Planning program.[27]

Examples from the top 101 include:

- Alexander Orr Water Treatment Plant, Miami, Fla., 1.6 million people in danger
- Bachman Water Treatment Plant, Dallas, Texas, 1.1 million people in danger
- Omohundro Water Treatment Plant, Nashville, Tenn., nearly 1 million people in danger
- Central Valley Water Reclamation, Salt Lake City, Utah, 1.3 million people in danger

Shifting to place-of-use chlorine production

For years, large industrial sites have produced most chlorine and used it on-site or shipped it to customers, primarily by rail. This model becomes obsolete, however, with distributed place-of-use production. Increasingly, efficient on-site units produce chlorine as needed at capacities tailored to specific uses, typically without storage. Driving this change are newer technologies, transportation costs, and security concerns. These on-site units use the same inputs—salt and electricity—and produce from 10 pounds to 100 tons or more per day for immediate use without the dangers of shipping and storing bulk chlorine gas.[28] In Europe, the amount of chlorine transported by rail and truck has been cut in half over the past decade by point-of-use production, supplier-customer relocations, and local pipelines.[29]

Petroleum refining

Eight of the 101 highest-hazard facilities are petroleum refineries that use concentrated hydrofluoric acid as an alkylation catalyst in turning crude oil into high-octane gasoline. These facilities together endanger some 11 million people. Many U.S. refineries use less hazardous sulfuric acid as an alkylation catalyst. Only about 50 of the 148 U.S. petroleum refineries use hydrofluoric acid.[30] Concentrated hydrofluoric acid is very toxic and corrosive. A major release can form a dangerous airborne plume that drifts miles downwind. A terrorist attempting to exploit hydrofluoric acid at a refinery, even if unsuccessful, could damage the facility, cost jobs, and disrupt fuel supplies.

By contrast, if spilled sulfuric acid tends to pool on the ground—a serious problem, but one that is easier to contain and prevent airborne exposure. Emerging solid acid alkylation processes also eliminate the danger of a catastrophic chemical release.[31] Some refineries may resort to less-volatile modified hydrofluoric acid, but it can still endanger people miles off-site.[32] At best, modified hydrofluoric acid is an interim step to fully remove the danger of a catastrophic chemical release.

Examples from the top 101 include:

- PDV Midwest Refining (Citgo), Lemont, Ill., 3.1 million people in danger
- Chalmette Refining (ExxonMobil), Chalmette, La., 1 million people in danger
- Marathon Petroleum, St. Paul Park, Minn., 2.2 million people in danger
- Sunoco Philadelphia Refinery, Philadelphia, Pa., 4.4 million people in danger

Pulp and paper manufacturing

One of the 101 highest-hazard facilities is a paper mill, Appleton Papers, in West Carrollton, Ohio, that uses chlorine gas to bleach recycled paper. This facility has a chlorine gas vulnerability area of 1.2 million people.

Historically, most pulp and paper mills used elemental chlorine gas, but few do so today. Alternatives are available that eliminate or reduce toxic gas hazards.[33] A few U.S. mills use totally chlorine-free bleaching, which employs an oxygen-based process with ozone or hydrogen peroxide. Many more U.S. mills use elemental chlorine free bleaching, which employs chlorine dioxide. However, like elemental chlorine gas, chlorine dioxide poses significant dangers of a toxic gas release to workers and communities.[34] These mills can nonetheless reduce the danger of a toxic gas release by using up chlorine dioxide with minimal accumulation or storage.

One paper mill, Shweitzer-Mauduit of Spotswood, N.J., recently converted its bleaching process from chlorine gas delivered by rail to chlorine dioxide generated as needed without bulk storage from a premix solution.[35] This change eliminated a chlorine gas vulnerability zone that included more than a million people. Because Shweitzer-Mauduit is a smaller mill, it can use a premix to generate chlorine dioxide without posing the danger of an off-site gas release. Larger mills usually have their own chemical facilities to produce chlorine dioxide, and can also reduce dangers by minimizing run-time storage.

Moving away from bulk distribution of sulfur dioxide

Anhydrous sulfur dioxide gas is often distributed through merchant wholesalers who receive shipments by rail for repackaging into smaller containers. This bulk distribution system poses unnecessary dangers. To avoid the safety and security hazards of sulfur dioxide gas, user companies increasingly generate sulfur chemicals on-site or purchase less hazardous forms. Industries primarily use sulfur dioxide to produce other chemicals (40 percent), bleach pulp and paper (20 percent), process food (16 percent), and treat wastewater (10 percent).[36] These major uses can be met without bulk transportation and storage of sulfur dioxide gas. Large industrial users frequently install sulfur-burning equipment and generate their own sulfur chemicals as needed.[37] Indeed, well over half of global sulfuric acid production comes from burning elemental sulfur at its place of use.[38] Smaller facilities purchase alternatives such as sodium hydrosulfite, bisulfite, or metabisulfite, depending on the application. These alternatives can be supplied by companies that never store or transport sulfur dioxide gas.[39]

Some mills may also use the toxic gas anhydrous sulfur dioxide. Sulfur dioxide gas may be brought on-site for use as a bleaching agent to remove residual hydrogen peroxide, or as a digesting agent to separate pulp from lignin. Such mills can instead use sulfur-burning equipment to generate sulfur compounds on-site, eliminating the dangers of transporting sulfur dioxide gas.

Chemical manufacturing: oleum and sulfur trioxide

Four of the 101 highest-hazard facilities ship or receive oleum or sulfur trioxide. Together these four facilities endanger more than 7 million people, plus additional millions along shipping routes.

Two of these facilities are Rhodia, in Houston, and DuPont, in North Bend, Ohio, which *produce* oleum (sulfur trioxide mixed with sulfuric acid) in regenerating spent sulfuric acid, primarily from petroleum refineries. Oleum and sulfur trioxide are optional co-products of this process when stored in bulk for use or sale. As major producers, there is no apparent single-facility alternative. Many consumer industries, however, avoid the dangers of transporting oleum or sulfur trioxide by producing sulfur compounds on-site or using alternate chemicals.

The other two facilities *receive* shipments of oleum or sulfur trioxide for further manufacturing. DuPont in Memphis receives bulk oleum shipments for use in manufacturing potassium monopersulfate, used primarily in swimming pool sanitation products. The Stepan Company in Elwood, Ill., brings in bulk shipments of sulfur trioxide to produce surfactants used in detergents, soaps, and cleaners.

These facilities could instead use on-site sulfur-burning equipment to remove the dangers of transportation and bulk storage. Case in point: Proctor and Gamble facilities in Pineville, La., and Cincinnati eliminated bulk delivery of oleum or sulfur trioxide by installing sulfur-burning equipment. The Stepan Company in fact uses such equipment at another of its locations.

Chemical distribution: sulfur dioxide gas

Three of the 101 highest-hazard facilities ship or receive anhydrous sulfur dioxide gas (other than water utilities). More than 9 million people live within range of a toxic gas release from just these three facilities, plus additional millions along transportation routes.

PVS Chemical Solutions in Chicago produces and distributes sulfur dioxide gas, sodium bisulfite, and other chemicals. JCI Jones Chemicals in Torrance, Calif., uses bulk shipments of sulfur dioxide gas in producing sodium bisulfite. And DXI Industries in Houston repackages sulfur dioxide gas from railcars to smaller cylinders for distribution.

The major distributed uses of sulfur dioxide gas can be met without bulk storage and transportation, generally by producing sulfur compounds at the point of use, or by substituting sodium hydrosulfite, bisulfite, metabisulfite, or other alternatives (see discussion of sulfur dioxide on page 15).

Fertilizer manufacturing

One of the 101 highest-hazard facilities manufactures ammonia fertilizers.[40] Agrifos Fertilizer in Pasadena, Texas, stores millions of pounds of anhydrous ammonia for use with phosphoric acid and sulfuric acid in manufacturing ammonium phosphate and ammonium thiosulfate fertilizers. More than 3 million people live within range of a worst-case ammonia gas release. As a major fertilizer producer, there is no apparent single-facility alternative; however, the facility may be able to reduce its vulnerable population by reducing ammonia gas storage.

Most commercially produced ammonia is used as fertilizer.[41] Manufacturing and distributing fertilizers commonly involves anhydrous ammonia gas. Shifting to alternative fertilizers would remove most of the distribution hazards of anhydrous ammonia. More widely used liquid nitrogen and dry urea fertilizers do not pose the emergency gas release hazards of anhydrous ammonia. Nor are they well suited for illegal methamphetamine production, a pervasive problem, or for the creation of improvised explosives. Evolving supply chain efficiency to more as-needed delivery could also help reduce anhydrous ammonia storage.

Railcar service or storage

Two of the 101 highest-hazard facilities solely support rail transportation. Rail transportation facilities only report RMP vulnerability zones when chemicals are stored or held rather than in transit. Yet railcars traverse wide-open infrastructure through every major American city, and cannot be protected.

The GATX Rail Tank Car Facility in Colton, Calif., repairs and maintains railcars, some of which may contain hazardous chemicals. This facility has more than 2 million people in its vulnerability zone in densely populated San Bernardino County. Since railcars are mobile, routine service and maintenance on the few that hold TIH chemicals can take place away from densely populated locations or when the railcars are empty. Over time, safer and more secure chemicals and processes can reduce and phase out transport of TIH chemicals.

The Olin Corporation Foote Yard in Niagara Falls, N.Y., is a facility-controlled holding yard for chlorine railcars awaiting shipment to customers. Almost a million people live within range of a chlorine gas release. As a major producer, there is no apparent single-facility alternative; however, distributed point-of-use production and alternative processes at downstream industries can remove the demand for such shipments.

Chemical shipping terminals

Two of the 101 highest-hazard facilities are terminals for ocean-going ships. Together these terminals endanger some 2.5 million people in the Houston area. These terminals store chemicals rather than manufacture or process them. The Houston Ammonia Terminal (Terra/PCS Nitrogen) receives some 350 million pounds of anhydrous ammonia gas each year, which it stores and distributes for agricultural fertilizer and industrial uses.

The Stolthaven Houston terminal holds some 14 million pounds of acrylonitrile in storage tanks for shipping or distribution. Domestic or export uses of acrylonitrile include synthetic rubber, resins, nylon, and acrylic fibers. As major shipping terminals, there is no apparent single-facility alternative apart from changes to the downstream uses of these materials.

Hazardous waste incinerators

Two of the 101 highest-hazard facilities receive and incinerate hazardous waste, including furan, which they both report as their most dangerous chemical. More than 3.7 million people live in the toxic gas vulnerability areas of these facilities (Clean Harbors in Deer Park, Texas, and Ross Incineration Services in Eaton Township, Ohio).

One clear response to this threat is to prevent pollution at the source, eliminating wastes that may otherwise be shipped to hazardous waste incinerators. Short of this, incinerator facilities can improve control of inventory to maintain extremely hazardous chemicals below amounts that pose significant reportable off-site toxic gas hazards. Other incineration facilities have already taken this step.[42]

Chemical manufacturing: ethylene oxide

Four of the 101 highest-hazard facilities produce or use ethylene oxide (oxirane) in chemical manufacturing, posing toxic gas release hazards to roughly 6 million people. Pelron in Lyons, Ill., uses ethylene oxide in producing polyols, used primarily in rigid or flexible polyurethane foams. This facility could convert from ethylene oxide. There are already a series of soy-based alternatives for producing polyols—including some made by Pelron.[43]

Akzo Nobel Surface Chemistry in Houston uses ethylene oxide in making surfactants (soaps and detergents for consumer and industrial use). Taminco in Riverview, Mich., uses ethylene oxide to produce alkanolamines that are used in diverse products such as paints, inks, fuel additives, and metal-working fluids. And Celanese in Pasadena, Texas, is a major producer of ethylene oxide for use in ethylene glycol and sale to other manufacturers. We did not identify specific alternatives for these uses of ethylene oxide.

Chemical manufacturing: ferric chloride

Three of the 101 highest-hazard facilities receive bulk shipments of chlorine gas for use in producing ferric chloride: Kemira Water Solutions in East Chicago, Ind.; PVS Technologies in Detroit; and Midland Resources in St. Louis. Just these three facilities pose toxic gas hazards to some 6.5 million people.

These facilities do not need to use chlorine gas. Instead, it is possible to produce ferrous chloride from liquid hydrochloric acid, at a concentration less than 37 percent, and scrap steel, oxidized with liquid hydrochloric acid and oxygen to ferric chloride. Below 37 percent concentration, hydrochloric acid does not readily form a toxic gas plume.

Other ferric chloride manufacturers reduce hazards by receiving chlorine through local pipelines rather than railcars.[44] Ferric chloride is primarily used to precipitate impurities during water and wastewater treatment; various competitive alternatives exist, such as aluminum sulfate.

Chemical manufacturing: titanium dioxide pigments

One of the 101 highest-hazard facilities, Millennium Chemicals Hawkins Point in Baltimore, uses chlorine gas in manufacturing titanium dioxide pigments. This process, known as the chloride process, also generates the hazardous intermediate chemical titanium tetrachloride. Some 1.4 million people live within range of a chlorine gas release from the Hawkins Point plant.

There are a couple of available safer and more secure alternatives. The facility could generate and use chlorine in a continuous process on-site without bulk storage. Or less hazardous still, the facility could rely only on sulfuric acid (sulfate process) rather than chlorine to extract titanium pigment from titanium ores. The sulfate process is a somewhat older process, yet some 70 percent of European production is by the sulfate process and 30 percent from chloride.[45]

In North America, Millennium Chemicals (Baltimore) and Kronos (Varennes, Canada) use both sulfate and chloride processes. Both processes produce waste (dioxin pollution from the chloride process is of particular concern) but only the chloride process poses the danger of a catastrophic gas release.

Chemical manufacturing: hydrofluoric acid

Four of the 101 highest-hazard facilities produce or use hydrofluoric acid (concentration 50 percent or greater) in chemical manufacturing. These facilities together pose toxic gas release dangers to approximately 8 million people.

One of these facilities, General Chemical in Pittsburgh, Calif., produces high purity electronic grade hydrofluoric acid (concentration 49 percent to 70 percent) for use by manufacturers of semiconductors and silicon wafers. Electronics manufacturers regularly use less concentrated hydrofluoric acid (less than 50 percent) in producing these products. Intel Corp., for example, does not use hydrofluoric acid above 50 percent for high-volume manufacturing. At concentrations below 50 percent, hydrofluoric acid does not have the same potential to form a dangerous toxic gas plume.

Of the three other facilities in this category, DuPont in La Porte, Texas, is a basic manufacturer of hydrofluoric acid for use in various industries; Honeywell in Claymont, Del., uses hydrofluoric acid in producing fluosulfonic acid; and Solvay Solexis' Thorofare Plant in West Deptford, N.J., uses hydrofluoric acid in producing vinylidene fluoride for diverse industrial applications. While we did not identify specific alternatives for these uses of hydrofluoric acid, less concentrated forms may replace some applications.

Chemical manufacturing: formaldehyde

Two of the 101 highest-hazard facilities use formaldehyde solution in chemical manufacturing. INVISTA in LaPorte, Texas, uses formaldehyde to produce intermediate chemicals—butanediol and tetrahydrofuran—that are used to make spandex fibers. INVISTA has more than 1.8 million people living in its vulnerability zone. Improving pipeline delivery and related storage could remove or reduce this danger. In addition, formaldehyde is not needed to produce these intermediates.

Indeed, they are more commonly made without formaldehyde.[46] Commercial processes for producing butanediol and tetrahydrofuran, which have diverse industrial uses, are evolving. Alternate methods also use hazardous substances and in some cases pose toxic gas dangers (allyl alcohol and propylene oxide). To enhance security, manufacturers should adopt those methods that avoid the use of bulk toxic inhalation hazard chemicals.

MacDermid in Ferndale, Mich., uses formaldehyde solution in making specialty chemicals, putting 1.5 million people in danger. While this paper does not identify a definitive alternative, this facility may be able to receive and store formaldehyde chilled as a gel or solid to remove or minimize the consequences of a release during transportation or use.

Chemical manufacturing: vinyl chloride

Two of the 101 highest-hazard facilities are the Oxy Vinyls VCM plants in Deer Park and La Porte, Texas, which use anhydrous hydrogen chloride in producing polyvinyl chloride (PVC). These facilities have more than 2.5 million people living within range of a worst-case chemical release.

Hydrogen chloride is a byproduct and feedstock in producing ethylene dichloride (from ethylene and chlorine), which is purified and processed to form vinyl chloride. PVC products consistently exhibit fire, health, security, and pollution hazards during manufacturing, use, or disposal. While PVC manufacturers may improve security by reducing chemical storage and transportation, catastrophic release hazards may not be removed short of conversion to substitute materials.[47] Two other top 101 facilities (counted in other industry categories) are related to PVC production; one provides chlorine and the other manufactures PVC additives.

Chemical manufacturing: chlorine producers

Four of the 101 highest-hazard facilities are major chlorine producers. Each has nearly a million or more people within range of a chlorine gas release, with millions more living alongside transportation routes. Pioneer Americas in Henderson, Nev., and Occidental Chemical and Olin Corp., both in Niagara Falls, N.Y., are merchant manufacturers of chlorine gas, caustic soda, and hydrochloric acid. The Oxy Vinyls Battleground Chlor-Alkali Plant, in La Porte, Texas, produces chlorine gas primarily for captive-use manufacturing of polyvinyl chloride at other sites.

As major producers, these facilities supply chlorine to diverse industries. As such, there is no single-facility "drop in" solution that would remove their large vulnerability zones. While alternatives to chlorine are available for almost all industrial uses, conversion would take time and costs would vary widely.[48] Yet even short of major long-term changes in chlorine industries, more limited changes can dramatically reduce the need to transport chlorine gas by rail and truck, arguably the point of greatest security vulnerability. These changes include co-locating suppliers and customers, modifying gaseous to aqueous chlorine, using local pipelines, increasing distributed place-of-use production without storage, and using feasible substitutes.

Chemical manufacturing: chlorine users

Ten of the 101 highest-hazard facilities receive chlorine gas by railcar for the manufacturing of various intermediate chemicals or products. These facilities include:

- Infineum in Linden, N.J., Afton Chemical in Sauget, Ill., and Ethyl in Houston, which produce oil and fuel additives
- AMVAC Chemical in Los Angeles and GB Biosciences in Houston, which make agricultural fungicides
- Dover Chemical in Hammond, Ind., which makes chlorinated paraffin
- Solutia in Sauget, Ill., which manufactures water treatment products
- Bayer MaterialScience in Baytown, Texas, which makes diverse industrial chemicals

- Rohm & Haas in Cincinnati, which produces PVC plastics additives
- DuPont in Deepwater, N.J., which produces phosgene for aramid polymers used in bulletproof vests

Together these facilities put more than 14 million people in harm's way of a toxic gas release. To remove their large vulnerability zones, these facilities can instead generate chlorine gas on-site as needed or with minimal storage, or co-locate with a chlorine producer by local pipeline. Bayer MaterialScience in fact does generate part of the chlorine it uses.

Chemical manufacturing: other materials

The remaining three of the 101 highest-hazard facilities produce or use other chemicals:

- Penn Specialty Chemicals (now Penn A Kem) in Memphis produces furan for sale or use in a variety of furan-based specialty chemicals
- PPG Industries in Barberton, Ohio, produces and uses phosgene in making chloroformate for optical monomers
- Arkema in Houston, Texas, produces and sells carbon disulfide as a byproduct of manufacturing hydrogen sulfide and mercaptans

We did not identify alternatives at these facilities.

Solutions for 202 additional high-hazard facilities

Appendix B on page 35 lists 202 additional facilities that can remove the possibility of a catastrophic chemical release through safer and more secure technologies. These 202 facilities endanger 30 million additional people beyond the 80 million endangered by the top 101 facilities. These facilities are listed because:

- They have 100,000 or more people living within range of a worst-case chemical release
- They have alternatives similar to the 101 highest-hazard facilities *or* alternatives to three commonly distributed gases—chlorine, sulfur dioxide, and ammonia

The industries described below do not appear in the top 101, but are included in the additional 202 because they use chlorine, sulfur dioxide, or anhydrous ammonia.

Secondary aluminum smelters

Five secondary aluminum smelters listed in Appendix B use chlorine gas in fluxing operations to remove impurities from molten aluminum. One of these, Custom Alloy Light Metals in Industry, Calif., falls just outside the 101 highest-hazard facilities (based on vulnerable population).

An alternative for secondary aluminum smelters is magnesium chloride salts injected with nitrogen gas. Kaiser Aluminum in Spokane, Wash., for example, converted off chlorine gas railcars using this alternative.

Food processors

Five food processors listed in Appendix B use anhydrous sulfur dioxide to inhibit microbes and oxidation. Four conduct wet corn milling and one manufactures sugar from beets. Food processors may also use sulfur dioxide gas in cherry brining, wine making, or other applications.

Food processors can instead generate sulfur chemicals on-site from sulfur burning equipment or can purchase alternatives such as sodium (or potassium) bisulfite or metabisulfite.

Cargill in Memphis, for example, switched from sulfur dioxide to sodium bisulfite for use in wet corn milling. The Minn-Dak Farmers Cooperative in Wahpeton, N.D., switched to generating sulfur chemicals on-site for use in beet-sugar processing.

Power plants

Thirteen power plants listed in Appendix B use anhydrous ammonia to control nitrogen oxides (NOx), a component of smog. Power plants may prevent NOx formation during combustion or use ammonia in air pollution control equipment. While some power plants use anhydrous ammonia gas, many use less hazardous aqueous ammonia or even solid urea.

Converting power plants from anhydrous to aqueous ammonia dramatically reduces the number of people in danger off-site.[49] Generating ammonia as needed from solid urea eliminates the danger of a major emergency toxic gas release. For example, six GWF Power Systems plants in California switched from anhydrous ammonia to aqueous.

Conclusion and recommendations

This report finds that most of the nation's 101 most dangerous chemical facilities could switch to safer, more secure chemicals or processes. Making these changes would significantly reduce or eliminate the threat to 80 million Americans living near these facilities and millions more living along train or truck delivery routes.

Current requirements and incentives, however, are generally inadequate to spur the adoption of safer and more secure alternatives. The temporary Chemical Facility Anti-Terrorism Standards, which expire in October 2009, do not require chemical facilities to assess and use alternatives that could remove the possibility of a catastrophic chemical release. These standards leave in place unnecessary and indefensible chemical hazards that could kill or injure thousands of people.

Incentives are needed for change. As long as chemical facilities do not internalize the full costs of security, the incentives to develop and use solutions will be deficient—no matter how great the safety and security benefits. Accordingly, the new Congress and the Obama administration should enact a comprehensive chemical security program that creates these incentives. Specifically, this program should:

- **Focus on removing unnecessary terrorist targets.** The program should direct dangerous chemical facilities to identify and develop safer, more secure chemicals and processes. Facilities should use these alternatives where cost effective, technically viable, and risk-reducing. In pushing for these conversions, the Department of Homeland Security should employ a tiered approach that gives highest priority to converting the facilities that present the greatest danger.

- **Create financial incentives for facilities to convert.** Dangerous chemical facilities should be required to carry sufficient liability insurance to cover a catastrophic chemical release. The cost of adequate insurance will create a market-based incentive for change that complements other regulations. In addition, government funding to implement safer, more secure alternatives should give priority to publicly owned facilities and first-users of innovative technologies, to help overcome the natural aversion of businesses to be the first to adopt substantial change. Federal funding should not subsidize inevitably insufficient physical security at facilities that could eliminate catastrophic chemical hazards but have no plan and timeline to do so.

- **Generate knowledge to fix the problem.** Requiring chemical facilities to identify safer and more secure alternatives in vulnerability assessments and security plans will generate awareness of alternatives, help overcome institutional inertia, and identify specific liabilities, savings, and opportunities. The program should also convene government agencies, the chemical industry, academic institutions, technology vendors, and independent experts for collaborative research to identify alternatives. In addition, DHS should develop security-assessment methodologies and auditing standards that help facilities assess the savings, costs, hazards, and technical feasibility of alternatives.

- **Utilize the experience and knowledge of workers.** Employees and their union representatives should be involved in assessing hazards, drafting plans, and participating in drills and inspections. Training and involving employees improves the outcome and validity of security activities. To promote effective collaboration, the program should protect whistleblowers from retaliation and limit background checks to security-relevant areas. Where third parties prepare assessments or plans, these parties should be qualified in process engineering to help companies identify and develop solutions that remove unnecessary chemical hazards.

- **Require government accountability.** The program should promote accountability by disclosing the status of facility assessments and plans, any fines or penalties levied, and other administrative activities. The program should not limit information that is already publicly available, readily observed, or easily discovered. Nor should it limit current obligations under other chemical safety laws. The Government Accountability Office should review and publicly report on program progress and the capacity of emergency response resources to address a worst-case chemical release.

- **Build oversight capacity.** The Department of Homeland Security, the EPA, and other agencies that have chemical security responsibilities must have the funding and capacity to work with facility operators, employees, state and local officials, and others in overseeing the program. In particular, each agency must have adequate engineering staff with expertise in intrinsically more secure design of chemical facilities.

- **Ensure equal enforcement.** Chemical companies should not receive special treatment just because they participate in voluntary industry security programs, as proposed in some recent bills before Congress. Voluntary industry programs lack oversight and are inherently unenforceable. The program must have enforceable requirements for preparing assessments and plans, involving employees, and conducting inspections, among other elements. Each facility should have to comply with each requirement regardless of participation in a voluntary industry program.

- **Include all relevant facilities and activities.** The program should cover all types of facilities that pose major chemical hazards, including drinking water and wastewater plants, which are currently exempt from chemical security standards. The program

should establish collaboration among government agencies to avoid regulatory redundancy, inconsistency, and gaps in supply chain analysis and oversight. Doing so will help address the spectrum of activities undertaken by chemical facilities—beyond security at the fence line—from manufacture and repackaging to transportation, storage and use.

- **Respect local control.** The program should not preempt effective state laws. The program should ensure the right of states to set more protective chemical security standards if federal actions are insufficient to protect communities.

Even prior to further action by Congress, chemical facilities and other federal agencies can take action to reduce chemical hazards. Specifically:

- The facilities listed in this report, and others that use highly hazardous processes, should make every effort to identify and use safer and more secure chemicals and processes. Where alternatives are available, these facilities should set measurable goals and timelines to eliminate the possibility of a catastrophic chemical release. Where alternatives are not identified, industries that share vulnerable technologies should collaborate in multi-stakeholder initiatives to identify safer and more secure options.

- The Surface Transportation Board should clarify by policy or regulation the ability of railroads to recover the unique costs, such as major liability insurance, of transporting toxic inhalation hazard, or TIH chemicals. Railroads are required under common carrier obligations to carry TIH shipments at reasonable rates, yet a single major release could be financially ruinous. Requiring shippers to share liability insurance costs would create a market-based incentive for chemical producers and users to adopt proven alternatives.

- The Securities and Exchange Commission and the Federal Accounting Standards Board should require chemical companies to regularly provide investors with information on financial worst-cases associated with a catastrophic chemical release, including assets at risk and potential liabilities.

- The Chemical Safety and Hazard Investigation Board should examine potential alternatives that can prevent the consequences of a chemical release as part of its root cause investigations into serious chemical releases. The consideration of safer, more secure technologies should be a standard element of the Board's incident investigations, reports, and recommendations.

Numerous security experts and the Department of Homeland Security have repeatedly warned that terrorists could use industrial chemicals as improvised weapons of mass destruction. The recommendations above take these warnings seriously. At the same time, they are reasonable and obtainable.

There is no reason that chemical facilities cannot evaluate safer and more secure alternatives and determine whether such alternatives are cost-effective. Many chemical facilities have already switched to safer, more secure alternatives. These conversions have been affordable, and in many cases have generated cost savings.

Where alternatives are viable and cost-effective, they should be implemented, particularly at facilities with extremely large vulnerability zones—like the facilities identified in this report. Taking these actions would enhance the safety and security of millions of Americans.

Appendix A

List of most dangerous 101 facilities and solutions*

Facility Name	Parent Company	City	State	Process	Potential Alternative	Vulnerability Zone Population**	Congressional Districts***
Hill Brothers Chemical Co.–Phoenix Facility 2006	Hill Brothers Chemical Co.	Phoenix	AZ	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	1,750,000	AZ 2--5, 7
DPC Enterprises, L.P.		Glendale	AZ	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	1,666,456	AZ 2--5, 7
AMVAC Chemical Corporation	American Vanguard Corporation	Los Angeles	CA	Pesticide manufacturing plant uses chlorine in chlorination of pentachloronitrobenzene, a soil fungicide.	Generate chlorine as needed without bulk storage or co-locate with an as-needed source of chlorine.	2,222,511	CA 29, 32--35, 37, 38, 39
Clorox Products Manufacturing Company	The Clorox Company	Los Angeles	CA	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas.	5,552,300	CA 26, 28--40, 42, 46
JCI Jones Chemicals Inc.–Torrance		Torrance	CA	Facility uses bulk shipments of sulfur dioxide gas in producing sodium bisulfute, and bulk chlorine gas in producing liquid bleach.	Produce sodium bisulfite from sulfur-burning equipment without storing sulfur dioxide gas; produce bleach from salt and electricity without storing chlorine gas.	4,542,819	CA 30, 32--40, 46
KIK SO-CAL	KIK International	Santa Fe Springs	CA	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas.	4,900,000	CA 26, 29, 31--35, 37--40, 42, 46, 47
Pioneer Americas LLCd/b/a Olin Chlor Alkali Produc	Pioneer Companies, Inc.	Santa Fe Springs	CA	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	5,017,475	CA 26, 29, 31--35, 37--40, 42, 46, 47
Joseph Jensen Filtration Plant	Metropolitan Water District of So. California	Granada Hills	CA	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	1,700,000	CA 24, 25, 27--30
Chem Lab Products, Inc.		Ontario	CA	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas.	1,417,392	CA 26, 38, 41--44
GATX Rail–Colton, CA Tank Car Facility	GATX Rail Corporation	Colton	CA	Railroad tank car service center repairs, maintains, and cleans railcars; at different times railcars on-site may contain any of nearly 60 extremely hazardous substances.	Relocate routine maintenance on railcars containing toxic inhalation hazard (TIH) chemicals away from densely populated areas; over time, phase out TIH rail shipments.	2,349,000	CA 26, 38, 41--45, 49
General Chemical Bay Point Works	General Chemical West LLC/GenTek, Inc.	Pittsburg	CA	Chemical manufacturing facility produces high purity electronic grade hydrofluoric acid (concentration 49% to 70%) for use in semiconductor and silicon manufacturing industries.	Use and supply less concentrated electronic grade hydrofluoric acid (<50 percent concentration) to semiconductor and silicon manufacturers.	2,099,957	CA 3, 7, 9--11
KIK (Denver) Inc.	KIK International Inc.	Denver	CO	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas.	1,714,800	CO 1, 2, 6, 7
Honeywell–Delaware Plant	Honeywell International Inc.	Claymont	DE	Specialty chemical manufacturing facility uses concentrated hydrofluoric acid in producing fluosulfonic acid.	No alternative identified.	2,080,361	DE 1; NJ 1, 2; PA 1, 2, 6, 7, 16
JCI Jones Chemicals Inc.–Jacksonville		Jacksonville	FL	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	1,064,810	FL 3, 4, 6, 7
John E. Preston Water Treatment Plant	Miami-Dade Water and Sewer Department	Hialeah	FL	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	1,893,169	FL 17, 18, 20, 21, 25

* Three additional facilities rank among the top 101, but are not included for the following reasons: Clark Refinery, Blue Island, Ill is closed; the Chemical Unloading Facility (Metropolitan Water District of Southern California), Perris, Calif., is currently unused; and Agriform, Woodland, Calif. greatly overstated its vulnerable population.

** Vulnerability zone figures, submitted by facilities to EPA, indicate residential populations within range of a worst-case toxic chemical release. These figures are not forecasts of potential casualties.

*** Congressional districts identified here are located, at least in part, within the facility's vulnerability zone.

Appendix A (continued)

Facility Name	Parent Company	City	State	Process	Potential Alternative	Vulnerability Zone Population	Congressional Districts
Sentry Industries, Inc.		Miami	FL	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas.	2,113,410	FL 17, 18, 20, 21, 25
Allied Universal Corporation		Miami	FL	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	1,840,283	FL 17, 18, 20, 21, 25
Alexander Orr Water Treatment Plant	Miami-Dade Water and Sewer Department	Miami	FL	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	1,643,691	FL 17, 18, 20, 21, 25
Fiveash Water Treatment Plant	City of Fort Lauderdale	Fort Lauderdale	FL	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	1,526,000	FL 17, 19, 20, 22, 23
City of Tampa–Howard F. Curren AWTP		Tampa	FL	Facility uses anhydrous sulfur dioxide (and chlorine gas) to treat wastewater.	Treat wastewater with ultraviolet light, or use sodium bisulfite in place of anhydrous sulfur dioxide and liquid bleach in place of chlorine gas.	1,042,000	FL 9--12
Clorox Products Manufacturing Company	The Clorox Company	Forest Park	GA	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas.	1,077,700	GA 4, 5, 8, 13
ExxonMobil Oil Corporation Joliet Refinery	Exxon Mobil Corporation	Channahon	IL	Petroleum refinery uses hydrofluoric acid in the alkylation process of turning crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	975,905	IL 1, 2, 11, 13, 14
Stepan Company	Stepan Company	Elwood	IL	Facility uses sulfur trioxide in manufacturing sulfonic acids that are sold or further processed into surfactants for household and industrial detergents and cleaners.	Use sulfur-burning equipment to generate sulfur trioxide on-site as needed for direct use into the process.	1,200,000	IL 1--3, 11, 13, 14
PDV Midwest Refining, LLC	CITGO Petroleum Corporation	Lemont	IL	Petroleum refinery uses hydrofluoric acid in the alkylation process of turning crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	3,100,000	IL 1--7, 11, 13, 14
K.A. Steel Chemicals, Inc.		Lemont	IL	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas.	1,411,632	IL 1, 3, 4, 6, 7, 11, 13
Willow Springs Terminal	Rowell Chemical Corporation	Willow Springs	IL	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	2,000,000	IL 1, 3--7, 13
Pelron		Lyons	IL	Specialty chemical manufacturing facility uses ethylene oxide in producing polyols for use in urethane products.	Produce biopolyols from soy rather than petrochemical polyols from ethylene oxide.	1,650,568	IL 1, 3--7, 13
PVS Chemical Solutions, Inc.	PVS Chemicals Incorporated	Chicago	IL	Chemical manufacturing facility produces and distributes anhydrous sulfur dioxide and other sulfur chemicals.	No single-facility alternative identified; however, point-of-use production and substitute chemicals (e.g., sodium bisulfite or metabisulfite) can replace distribution of sulfur dioxide gas.	3,300,000	IL 1--4, 7, 11, 13; IN 1
Clorox Products Manufacturing Company	The Clorox Company	Chicago	IL	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas.	4,013,600	IL 1--7, 9, 13
Afton Chemical Corporation	NewMarket Corporation	Sauget	IL	Chemical manufacturing facility uses chlorine gas in producing additives for lubricating oils and fuels.	Generate chlorine as needed without bulk storage or co-locate with an as-needed source of chlorine.	1,300,000	IL 12, 19; MO 1--3
Solutia W. G. Krummrich Plant	Solutia	Sauget	IL	Chemical manufacturing facility uses chlorine gas in producing intermediate chemicals used primarily to make dry stabilized chlorine water treatment products.	Generate chlorine as needed or co-locate with an as-needed source; eliminate or minimize storage.	1,200,000	IL 12, 19; MO 1--3
Vertex Chemical Corporation Dupo, IL		Dupo	IL	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas.	1,000,000	IL 12; MO 1--3
JCI Jones Chemicals, Inc Beech Grove, IN		Beech Grove	IN	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	1,450,430	IN 4--7
Kemira Water Solutions, Inc.	Kemira Water Solutions, Inc.	East Chicago	IN	Chemical manufacturing facility uses chlorine gas in producing ferrous chloride and ferric chloride for use by the water treatment industry.	Produce ferrous chloride from hydrochloric acid (<37 percent concentration) and scrap steel, oxidized with liquid hydrochloric acid and oxygen to ferric chloride.	3,250,000	IN 1; IL 1--3, 7

Appendix A (continued)

Facility Name	Parent Company	City	State	Process	Potential Alternative	Vulnerability Zone Population	Congressional Districts
Dover Chemical–Hammond Works Operated by Keil	Dover Chemical Corporation	Hammond	IN	Chemical manufacturing facility uses chlorine gas in producing chlorinated paraffins for use in diverse industries.	Generate chlorine as needed without bulk storage or co-locate with an as-needed source of chlorine.	1,882,494	IN 1; IL 1--4, 7
Chalmette Refining, L.L.C.	Chalmette Refining, L.L.C [ExxonMobil]	Chalmette	LA	Petroleum refinery uses hydrofluoric acid in the alkylation process of turning crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	1,066,418	LA 1--3
Murphy Oil USA, Inc. Meraux Refinery	Murphy Oil Corporation	Meraux	LA	Petroleum refinery uses hydrofluoric acid in the alkylation process of turning crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	1,056,000	LA 1--3
Hawkins Point Plant	Millennium Inorganic Chemicals Inc.	Baltimore	MD	Chemical manufacturing facility uses chlorine gas in producing titanium dioxide pigments.	Produce titanium dioxide pigments using the sulfate process; also, chlorine can be generated as needed without bulk storage.	1,440,017	MD 1--3, 7
JCI Jones Chemicals, Inc Riverview Facility		Riverview	MI	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	2,774,433	MI 9, 11--15
Taminco–Riverview, MI Plant	Taminco Higher Amines, Inc.	Riverview	MI	Chemical manufacturing facility uses ethylene oxide in producing industrial chemicals, primarily alkanolamines used in diverse industries.	No alternative identified.	2,500,000	MI 9, 11--15
Detroit WWTP–Chlorination/ Dechlorination Facility	City of Detroit	Detroit	MI	Facility uses anhydrous sulfur dioxide (and chlorine gas) to treat wastewater.	Treat wastewater with ultraviolet light, or use sodium bisulfite in place of anhydrous sulfur dioxide and liquid bleach in place of chlorine gas.	2,100,000	MI 9, 11--15
PVS Technologies, Inc. (Detroit)	PVS Chemicals, Inc.	Detroit	MI	Chemical manufacturing facility uses chlorine gas in producing ferrous chloride and ferric chloride for use by the water treatment industry.	Produce ferrous chloride from hydrochloric acid (<37 percent concentration) and scrap steel, oxidized with liquid hydrochloric acid and oxygen to ferric chloride.	2,000,000	MI 9, 10, 12--15
MacDermid, Inc.		Ferndale	MI	Chemical manufacturing facility uses formaldehyde in making specialty chemicals.	No definitive alternative identified; however, shipping and storing formaldehyde chilled as a gel or solid until needed minimizes the consequences of a release.	1,500,000	MI 9, 10, 12--14
Marathon Petroleum Company LLC, MN Refining Div.	Marathon Petroleum Company LLC	St. Paul Park	MN	Petroleum refinery uses hydrofluoric acid in the alkylation process of turning crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	2,200,000	MN 2--6; WI 3
St. Paul Regional Water Services–McCarron	St. Paul Regional Water Services	Maplewood	MN	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	1,300,000	MN 2--6
Hawkins Water Treatment Group–Red Rock	Hawkins, Inc.	St. Paul	MN	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	1,132,985	MN 2--6; WI 3
Midland Resources, Inc.	Kemiron	St. Louis	MO	Chemical manufacturing facility uses chlorine gas in producing ferrous chloride and ferric chloride for use by the water treatment industry.	Produce ferrous chloride from hydrochloric acid (<37 percent concentration) and scrap steel, oxidized with liquid hydrochloric acid and oxygen to ferric chloride.	1,251,079	MO 1--3; IL 12, 19
JCI, Jones Chemicals, Inc., Charlotte		Charlotte	NC	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	1,413,909	NC 8--10, 12; SC 5
JCI Jones Chemicals, Inc. Merrimack		Merrimack	NH	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	1,208,739	NH 1, 2; MA 1, 5, 6
Kuehne Chemical Co., Inc.		South Kearny	NJ	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	12,000,000	NJ 7--11, 13; NY 5, 7--16
Infineum USA L.P. Bayway Chemical Plant	Infineum USA Inc.	Linden	NJ	Chemical manufacturing facility uses chlorine gas in producing dispersant additives for engine oils and transmission fluids.	Generate chlorine as needed without bulk storage or co-locate with an as-needed source of chlorine.	4,200,000	NJ 6--11, 13; NY 8--14
DuPont Chambers Works	E.I. DuPont de Nemours and Co., Inc.	Deepwater	NJ	Major chemical manufacturing facility uses chlorine gas to make phosgene as needed in producing aramid polymers.	Generate chlorine as needed or co-locate with an as-needed source; eliminate or minimize storage.	2,000,000	NJ 1, 2; PA 1, 2, 6, 7, 16; DE 1; MD 1
Valero Refining Co.–New Jersey	Valero Energy Corporation	Paulsboro	NJ	Petroleum refinery uses hydrofluoric acid in the alkylation process of turning crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	3,170,000	NJ 1--3; PA 1, 2, 6, 7, 13, 16; DE 1

Appendix A (continued)

Facility Name	Parent Company	City	State	Process	Potential Alternative	Vulnerability Zone Population	Congressional Districts
Thorofare Plant	Solvay Solexis, Inc.	West Deptford	NJ	Plastics material and resin manufacturing facility uses concentrated hydrofluoric acid in producing vinylidene fluoride and polyvinylidene fluoride.	No alternative identified.	4,165,831	NJ 1--4; PA 1, 2, 6--8, 13, 16; DE 1
Thatcher Company of Nevada, Inc.		Henderson	NV	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas.	995,700	NV 1--3
Pioneer Americas LLC	Pioneer Americas LLC	Henderson	NV	Major chlor-alkali manufacturing facility produces and distributes chlorine, as well as caustic soda, hydrochloric acid, and liquid bleach.	No single-facility alternative identified; facility ships chlorine gas, but alternate processes and distributed point-of-use production remove demand for such shipments.	1,100,000	NV 1--3; AZ 2
JCI Jones Chemical Inc. Warwick,NY		Warwick	NY	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	1,285,145	NY 17--19, 22; PA 10; NJ 5, 8, 9, 11
Occidental Chemical Corporation–Niagara Plant	Occidental Petroleum Corporation	Niagara Falls	NY	Major chlor-alkali manufacturing facility produces and distributes chlorine, as well as caustic soda, hydrochloric acid, and liquid bleach.	No single-facility alternative identified; facility ships chlorine gas, but alternate processes and distributed point-of-use production remove demand for such shipments.	1,100,000	NY 26--28
Olin Corporation–Niagara Falls, New York Plant	Olin Corporation	Niagara Falls	NY	Major chlor-alkali manufacturing facility produces and distributes chlorine, as well as caustic soda, hydrochloric acid, and liquid bleach.	No single-facility alternative identified; facility ships chlorine gas, but alternate processes and distributed point-of-use production remove demand for such shipments.	998,200	NY 26--28
Olin Corporation, Niagara Falls, NY–Foote Yard	Olin Corporation	Niagara Falls	NY	Facility-controlled rail yard holds chlorine railcars awaiting shipment to customers.	No single-facility alternative identified; facility holds chlorine gas shipments, but alternate processes and distributed point-of-use production remove demand for such shipments.	980,000	NY 26--28
Ross Incineration Services, Inc.	Ross Consolidated Corp.	Eaton Township	OH	Hazardous waste facility receives and incinerates furan and many other chemicals; storage amounts vary at any one time.	Use administrative controls to maintain inventory below danger threshold amounts.	1,347,531	OH 5, 9--11, 13, 14, 16
JCI Jones Chemicals Inc.–Barberton, Ohio		Barberton	OH	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	1,286,164	OH 13, 14, 16--18
PPG Industries, Barberton	PPG Industries, Inc.	Barberton	OH	Chemical manufacturing facility uses phosgene in making chloroformate to produce plastic resin monomers used in optical lenses.	No alternative identified; however, modifying reactor may prevent phosgene from accumulating.	1,305,894	OH 13, 14, 16--18
DuPont Fort Hill Plant		North Bend	OH	Chemical manufacturing facility produces and sells oleum (fuming sulfuric acid) as a co-product of producing and regenerating sulfuric acid.	No single-facility alternative identified; facility is an oleum supplier, but many consumer industries produce or regenerate sulfur compounds on-site or use alternate chemicals.	1,329,683	OH 1, 2, 8; KY 4; IN 6, 9
Rohm & Haas Cincinnati Facility	Rohm & Haas Company	Cincinnati	OH	Chemical manufacturing facility uses chlorine gas in producing specialty intermediate chemicals used as additives in polyvinyl chloride (PVC) plastics.	Generate chlorine as needed or co-locate with an as-needed source of chlorine.	1,200,000	OH 1--3, 8; KY 4
Univar USA Inc.–Cincinnati Branch	Univar USA Inc.	Cincinnati	OH	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	966,117	OH 1--3, 8
Appleton Papers Inc., West Carrollton Mill	Appleton Papers Inc.	West Carrollton	OH	Paper mill uses chlorine gas in bleaching recycled paper pulp.	Bleach pulp with chlorine-free processes (oxygen, hydrogen peroxide, ozone) or use chlorine dioxide as needed without bulk storage.	1,200,000	OH 2, 3, 7, 8
Trainer Refinery	ConocoPhillips	Trainer	PA	Petroleum refinery uses hydrofluoric acid in the alkylation process of turning crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	2,400,000	PA 1, 2, 6, 7, 16; DE 1; NJ 1, 2
Sunoco Philadelphia Refinery	Sunoco, Inc.	Philadelphia	PA	Petroleum refinery uses concentrated hydrofluoric acid in processing crude oil into gasoline; facility plans to convert to modified (less volatile) hydrofluoric acid.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	4,400,000	PA 1, 2, 6--8, 13, 16; DE 1; NJ 1--4
Omohundro Water Treatment Plant	Metro Water and Sewer Department	Nashville	TN	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	973,663	TN 4--7
Penn Specialty Chemicals, Inc. [Penn A Kem]	[PennAKem/Minakem Group]	Memphis	TN	Specialty chemical manufacturing facility produces furan, which it sells or uses to synthesize furan-based fine chemicals for use in diverse industries.	No alternative identified.	970,000	TN 7--9; AR 1; MS 1

Appendix A (continued)

Facility Name	Parent Company	City	State	Process	Potential Alternative	Vulnerability Zone Population	Congressional Districts
DuPont Memphis Plant	E. I. DuPont de Nemours and Company	Memphis	TN	Chemical manufacturing facility uses oleum (fuming sulfuric acid) in producing potassium monopersulfate, an oxidizer used primarily in swimming pool treatment products.	Use sulfur-burning equipment to eliminate oleum railcars by producing sulfur compounds on-site as needed.	1,054,025	TN 7--9; AR 1; MS 1
NTMWD Regional Water Treatment Plant		Wylie	TX	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	2,138,034	TX 3--5, 24, 26, 30, 32
Eastside Water Treatment Plant	Dallas Water Utilities	Sunnyvale	TX	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	1,800,000	TX 3--6, 30, 32
Central Regional Wastewater System	Trinity River Authority of Texas	Grand Prairie	TX	Facility uses anhydrous sulfur dioxide (and chlorine gas) to treat wastewater.	Treat wastewater with ultraviolet light, or use sodium bisulfite in place of anhydrous sulfur dioxide and liquid bleach in place of chlorine gas.	3,931,692	TX 3, 5, 6, 12, 17, 24, 26, 30, 32
Petra Chemical Company	Petra Chemical Company	Dallas	TX	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas.	2,300,000	TX 3, 5, 6, 24, 26, 30, 32
Bachman Water Treatment Plant–2007	Dallas Water Utilities	Dallas	TX	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	1,100,000	TX 3, 5, 24, 30, 32
Tarrant County Water Supply Project	Trinity River Authority of Texas	Euless	TX	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	1,303,125	TX 6, 12, 24, 26, 30, 32
Rhodia, Houston Plant	Rhodia Inc.	Houston	TX	Chemical manufacturing facility produces and sells oleum (fuming sulfuric acid) as a co-product of producing and regenerating sulfuric acid.	No single-facility alternative identified; facility is an oleum supplier, but many consumer industries produce or regenerate sulfur compounds on-site or use alternate chemicals.	3,451,932	TX 2, 7--10, 14, 18, 22, 29
Arkema Inc.	Arkema Delaware Inc.	Houston	TX	Chemical manufacturing facility produces hydrogen sulfide and mercaptans; carbon disulfide is a byproduct shipped to off-site customers.	No single-facility alternative identified; facility is a major supplier of carbon disulfide.	2,000,000	TX 2, 7, 9, 14, 18, 22, 29
ALTIVIA Greens Bayou		Houston	TX	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	3,400,000	TX 2, 7, 9, 18, 22, 29
GB Biosciences Corporation/Greens Bayou Plant	Syngenta Crop Protection, Inc.	Houston	TX	Pesticide manufacturing facility uses chlorine gas in producing chlorothalonil agricultural fungicides.	Generate chlorine as needed or co-locate with an as-needed source; eliminate or minimize storage.	1,213,554	TX 2, 7, 9, 18, 22, 29
Stolthaven Houston Inc.	Stolt-Nielsen Transportation Group Inc.	Channelview	TX	Chemical shipping terminal stores and transfers acrylonitrile for manufacturing at other facilities into synthetic rubber, resins, and fibers.	No single-facility alternative identified; facility is a major storage terminal.	1,000,000	TX 2, 7--9, 14, 18, 22, 29
DXI Industries, Inc.	DPC Industries, Inc.	Houston	TX	Facility repackages bulk shipments of anhydrous sulfur dioxide into smaller containers.	Phase out bulk distribution of anhydrous sulfur dioxide gas; generate and/or distribute alternatives such as sodium bisulfite and metabisulfite.	1,408,353	TX 2, 7, 9, 14, 18, 22, 29
East Water Purification Plant		Houston	TX	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	1,300,000	TX 2, 7, 9, 14, 18, 22, 29
Clorox Products Manufacturing Company	The Clorox Company	Houston	TX	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas.	1,868,700	TX 2, 7, 9, 18, 22, 29
Akzo Nobel Surface Chemistry LLC Houston Plant	Akzo Nobel Chemicals Inc.	Houston	TX	Specialty manufacturing facility uses ethylene oxide in making surfactants and detergents for diverse consumer and industrial applications.	No alternative identified.	1,100,000	TX 7, 9, 14, 18, 22, 29
KIK (Houston) Inc.	KIK International Inc.	Houston	TX	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas.	2,127,533	TX 7, 9, 14, 18, 22, 29
Houston Plant	Ethyl Corporation	Pasadena	TX	Chemical manufacturing facility uses chlorine gas in producing dispersant additives for oil-based lubricants.	Generate chlorine as needed without bulk storage or co-locate with an as-needed source of chlorine.	1,100,000	TX 2, 7, 9, 14, 18, 22, 29
Houston Ammonia Terminal, L.P.	Terra Mississippi Nitrogen, Inc./PCS Nitrogen	Pasadena	TX	Marine cargo terminal receives, stores, and transfers several hundred million pounds of anhydrous ammonia each year.	No single-facility alternative identified; facility is a major terminal.	2,400,000	TX 2, 7, 9, 14, 18, 22, 29

Appendix A (continued)

Facility Name	Parent Company	City	State	Process	Potential Alternative	Vulnerability Zone Population	Congressional Districts
Agrifos Fertilizer Inc.		Pasadena	TX	Facility stores and uses anhydrous ammonia in producing ammonium phosphate and ammonium thiosulfate fertilizers.	No single-facility alternative identified; facility is major producer of ammonia fertilizers, but may be able to reduce ammonia storage.	3,146,219	TX 2, 7--9, 14, 18, 22, 29
Clear Lake Plant	Celanese, Ltd.	Pasadena	TX	Facility is a major producer of ethylene oxide, which is used on-site to produce ethylene glycol or sold to other manufacturers.	No alternative identified.	1,400,000	TX 2, 9, 14, 18, 22, 29
Bayer MaterialScience–Baytown	Bayer MaterialScience	Baytown	TX	Petrochemical and chlor-alkali facility produces, receives, and uses chlorine gas in manufacturing industrial chemicals and products.	Generate additional chlorine as needed or use pipeline delivery without bulk storage.	1,100,000	TX 2, 8, 9, 14, 18, 22, 29
Oxy Vinyls, LP–Deer Park VCM Plant	Occidental Petroleum Corporation	Deer Park	TX	Chemical manufacturing facility uses anhydrous hydrogen chloride in producing vinyl chloride monomer, primarily for use in polyvinyl chloride (PVC) plastics.	No immediate alternative identified; however, diverse available substitutes may replace PVC plastics.	2,600,000	TX 2, 7--9, 14, 18, 22, 29
Clean Harbors Deer Park, LP	Clean Harbors Environmental Services, Inc.	Deer Park	TX	Hazardous waste facility receives and incinerates furan and many other chemicals; storage amounts vary at any one time.	Use administrative controls to maintain inventory below danger threshold amounts.	2,400,000	TX 2, 7--9, 14, 18, 22, 29
Oxy Vinyls, LP–Battleground Chlor-Alkali Plant	Occidental Petroleum Corporation	La Porte	TX	Major alkalies and chlorine manufacturing facility produces and stores chlorine gas, primarily for use at other facilities in producing polyvinyl chloride (PVC).	No immediate alternative identified; however, diverse available substitutes may replace PVC plastics.	2,300,000	TX 2, 7--9, 14, 18, 22, 29
INVISTA Intermediates LaPorte Plant	INVISTA S.a.r.l.	LaPorte	TX	Chemical manufacturing facility uses formaldehyde solution in producing butanediol and tetrahydrofuran, intermediate chemicals used to manufacture spandex fibers and other materials.	Produce butanediol without bulk toxic inhalation hazard chemicals, or minimize potential formaldehyde release from delivery pipelines and storage.	1,889,251	TX 2, 7, 9, 14, 18, 22, 29
Oxy Vinyls, LP–La Porte VCM Plant	Occidental Petroleum Corporation	La Porte	TX	Chemical manufacturing facility uses anhydrous hydrogen chloride in producing vinyl chloride monomer, primarily for use in polyvinyl chloride (PVC) plastics.	No immediate alternative identified; however, diverse available substitutes may replace PVC plastics.	1,400,000	TX 2, 9, 14, 18, 22, 29
La Porte Plant	DuPont	La Porte	TX	Chemical manufacturing facility is a major producer of hydrofluoric acid, used in various fluorochemical product industries.	No alternative identified.	1,600,000	TX 2, 7, 9, 14, 18, 22, 29
Central Valley Water Reclamation Facility	Central Valley Water Reclamation Facility Board	Salt Lake City	UT	Facility uses chlorine gas (and anhydrous sulfur dioxide) to treat wastewater.	Treat wastewater with ultraviolet light, or use liquid bleach in place of chlorine gas, and sodium bisulfite in place of anhydrous sulfur dioxide gas.	1,334,000	UT 1--3
JCI Jones Chemicals, Inc		Tacoma	WA	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	1,889,626	WA 1, 6--9

Appendix B

List of 202 additional facilities and solutions

Facility Name	Parent Company	City	State	Process	Potential Alternative	Vulnerability Zone Population*	Congressional District**
Bermco Aluminum	Berman Brothers Iron and Metal Company, Inc.	Birmingham	AL	Secondary aluminum smelter uses chlorine gas in fluxing operations to remove impurities from aluminum alloys.	Remove impurities by fluxing with solid magnesium chloride salts injected with nitrogen gas.	200,000	7
Harcros Chemcials Inc.–Muscle Shoals		Muscle Shoals	AL	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	120,000	5
DPC Enterprises, L.P.		Mobile	AL	Facility repackages bulk shipments of anhydrous sulfur dioxide and chlorine gas to smaller containers, and produces liquid bleach.	Produce sulfur chemicals from sulfur-burning equipment and liquid bleach from salt and electricity; phase out distribution of anhydrous sulfur dioxide gas and chlorine gas.	365,719	1
Domtar Industries Inc. Ashdown Mill		Ashdown	AR	Paper mill generates chlorine dioxide for use in the pulp bleaching process.	Bleach pulp with oxygen with hydrogen peroxide or ozone, or use up chlorine dioxide with minimal accumulation.	129,750	4
23rd Avenue Wastewater Treatment Plant	City of Phoenix	Phoenix	AZ	Facility uses chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace chlorine gas with liquid bleach.	176,343	4
Union Hills Water Treatment Plant	City of Phoenix, Water Services Department	Phoenix	AZ	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	131,937	3
Val Vista Water Treatment Plant	City of Phoenix, Water Services Department	Mesa	AZ	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	139,857	6
Silver Lake Chlorination Station	City of Los Angeles Department of Water and Power	Silver Lake	CA	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	380,000	33
ExxonMobil Torrance Refinery	Exxon Mobil Corporation	Torrance	CA	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	255,524	36
San Jose Creek Water Reclamation Plant	County Sanitation Districts of Los Angeles County	Whittier	CA	Facility uses anhydrous sulfur dioxide and chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace anhydrous sulfur dioxide with sodium bisulfite and chlorine gas with liquid bleach.	103,660	38
Los Coyotes Water Reclamation Plant	County Sanitation Districts of Los Angeles County	Cerritos	CA	Facility uses anhydrous sulfur dioxide and chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace anhydrous sulfur dioxide with sodium bisulfite and chlorine gas with liquid bleach.	222,041	39
Ultramar Inc. d/b/a Valero Wilmington Refinery	Valero Energy Corporation	Wilmington	CA	Petroleum refinery uses modified (less volatile) hydrofluoric acid in the alkylation process of turning crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	360,000	46
BP Carson Refinery	BP West Coast Products LLC	Carson	CA	Petroleum refinery uses anhydrous ammonia in among other uses power plant equipment to control nitrogen oxide emissions.	Reduce emissions with cleaner combustion or control emissions using aqueous ammonia or urea instead of anhydrous ammonia.	259,270	37
Los Angeles Aqueduct Filtration Plant	City of Los Angeles Department of Water and Power	Sylmar	CA	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	290,000	27
Hasa Inc.–Saugus		Saugus	CA	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without bulk shipping or storage of chlorine gas.	801,205	25
OLS Energy–Chino Cogeneration Facility	OLS Power, LLP	Chino	CA	Power plant uses anhydrous ammonia in equipment to control nitrogen oxide emissions (a component of smog).	Reduce emissions with cleaner combustion or control emissions using aqueous ammonia or urea instead of anhydrous ammonia.	108,084	42

* Vulnerability zone figures, submitted by facilities to EPA, indicate residential populations within range of a worst-case toxic chemical release. These figures are not forecasts of potential casualties.

** This indicates the congressional district in which the facility is located.

Appendix B (continued)

Facility Name	Parent Company	City	State	Process	Potential Alternative	Vulnerability Zone Population	Congressional District
Custom Alloy Light Metals, Inc.		Industry	CA	Secondary aluminum smelter uses chlorine gas in fluxing operations to remove impurities from aluminum alloys.	Remove impurities by fluxing with solid magnesium chloride salts injected with nitrogen gas.	960,000	38
F. E. Weymouth Water Treatment Plant	Metropolitan Water District of So. California	La Verne	CA	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	304,873	26
Alvarado Water Treatment Plant	City of San Diego Water Department	La Mesa	CA	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	109,600	52
City of Escondido/Vista Water Treatment Plant	City of Escondido/Vista Irrigation District	Escondido	CA	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	130,000	50
Vista Metals Corp.	Alpert and Alpert	Fontana	CA	Secondary aluminum smelter uses chlorine gas in fluxing operations to remove impurities from aluminum alloys.	Remove impurities by fluxing with solid magnesium chloride salts injected with nitrogen gas.	390,000	43
TST Inc.		Fontana	CA	Secondary aluminum smelter uses chlorine gas in fluxing operations to remove impurities from aluminum alloys.	Remove impurities by fluxing with solid magnesium chloride salts injected with nitrogen gas.	804,625	43
Henry J. Mills Water Treatment Plant	Metropolitan Water District of Southern California	Riverside	CA	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	115,600	44
Moreno Valley Regional Water Reclamation Facility	Eastern Municipal Water District	Moreno Valley	CA	Facility uses chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace chlorine gas with liquid bleach.	323,700	45
Perris Valley Regional Water Reclamation Facility	Eastern Municipal Water District	Perris	CA	Facility uses chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace chlorine gas with liquid bleach.	208,356	49
San Jacinto Valley RWRF	Eastern Municipal Water District	San Jacinto	CA	Facility uses chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace chlorine gas with liquid bleach.	106,937	41
Michelson Water Reclamation Plant	Irvine Ranch Water District	Irvine	CA	Facility uses chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace chlorine gas with liquid bleach.	685,097	48
Snowden Enterprises–Fresno	Snowden Enterprises, Inc.	Fresno	CA	Facility repackages bulk shipments of anhydrous sulfur dioxide into smaller containers.	Phase out bulk distribution of anhydrous sulfur dioxide gas by generating sulfur compounds on-site for distribution as sodium bisulfite, metabisulfite, and other alternatives.	660,000	20
Palo Alto Regional Water Quality Control Plant		Palo Alto	CA	Facility uses anhydrous sulfur dioxide and chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace anhydrous sulfur dioxide with sodium bisulfite and chlorine gas with liquid bleach.	191,998	14
Clorox Products Manufacturing Company	The Clorox Company	Fairfield	CA	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without bulk shipping or storage of chlorine gas.	233,400	10
Cement Hill Water Treatment Plant	Suisun-Solano Water Authority	Fairfield	CA	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	207,775	10
Hasa Inc.–Pittsburg		Pittsburg	CA	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without bulk shipping or storage of chlorine gas.	488,269	7
Calpine Pittsburg		Pittsburg	CA	Power plant uses anhydrous ammonia in equipment to control nitrogen oxide emissions (a component of smog).	Reduce emissions with cleaner combustion or control emissions using aqueous ammonia or urea instead of anhydrous ammonia.	120,000	7
San Jose/Santa Clara Water Pollution Control Plant	City of San Jose	San Jose	CA	Facility uses anhydrous sulfur dioxide and chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace anhydrous sulfur dioxide with sodium bisulfite and chlorine gas with liquid bleach.	245,000	15
Sierra Chemical Co., Stockton Facility		Stockton	CA	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	364,261	18
City of Stockton Tertiary Treatment Plant	City of Stockton, Municipal Utilities Department	Stockton	CA	Facility uses chlorine gas and anhydrous sulfur dioxide to treat wastewater.	Treat wastewater with ultraviolet light, or replace chlorine gas with liquid bleach and replace anhydrous sulfur dioxide with sodium bisulfite.	430,200	18
Stockton CoGen Company, Inc.	Air Products and Chemicals, Inc.	Stockton	CA	Power plant uses anhydrous ammonia in equipment to control nitrogen oxide emissions (a component of smog).	Reduce emissions with cleaner combustion or control emissions using aqueous ammonia or urea instead of anhydrous ammonia.	151,795	18

Appendix B (continued)

Facility Name	Parent Company	City	State	Process	Potential Alternative	Vulnerability Zone Population	Congressional District
Pioneer Americas LLC dba Olin Chlor Alkali Product	Pioneer Companies, Inc.	Tracy	CA	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	888,435	11
Snowden Enterprises–Modesto	Snowden Enterprises, Inc.	Modesto	CA	Facility repackages bulk shipments of anhydrous sulfur dioxide into smaller containers.	Phase out bulk distribution of anhydrous sulfur dioxide gas by generating sulfur compounds on-site for distribution as sodium bisulfite, metabisulfite, and other alternatives.	460,000	18
Secondary Wastewater Treatment Plant	City of Modesto	Modesto	CA	Facility uses anhydrous sulfur dioxide and chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace anhydrous sulfur dioxide with sodium bisulfite and chlorine gas with liquid bleach.	450,780	18
Dry Creek Regional Wastewater Treatment Plant	City of Roseville, Roseville, California	Roseville	CA	Facility uses chlorine gas and anhydrous sulfur dioxide to treat wastewater.	Treat wastewater with ultraviolet light, or replace chlorine gas with liquid bleach and replace anhydrous sulfur dioxide with sodium bisulfite.	626,000	4
Carson Energy Cogeneration Plant		Sacramento	CA	Power plant uses anhydrous ammonia in equipment to control nitrogen oxide emissions (a component of smog).	Reduce emissions with cleaner combustion or control emissions using aqueous ammonia or urea instead of anhydrous ammonia.	134,625	5
Metro Wastewater Reclamation District		Denver	CO	Facility is converting from anhydrous sulfur dioxide and chlorine gas used to treat wastewater.	Complete conversion from anhydrous sulfur dioxide to sodium bisulfite, and from chlorine gas to liquid bleach; a potential long-term alternative is ultraviolet light.	925,000	7
H. Krevit & Co., Inc.		New Haven	CT	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without bulk shipping or storage of chlorine gas.	290,000	3
McMillan Water Treatment Plant	Washington Aqueduct/US Army Corps of Engineers	Washington	DC	Facility uses chlorine gas to treat drinking water	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate	98,000	1
Kuehne Chemical Co., Inc.–Delaware City	Kuehne Chemical Co., Inc.	Delaware City	DE	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without bulk shipping or storage of chlorine gas.	480,000	1
Dupont–Edge Moor, DE Facility	E.I. duPont DeNemours & Company	Edge Moor	DE	Chemical manufacturing facility uses chlorine gas in producing titanium dioxide pigments.	Produce titanium dioxide pigments using the sulfate process; also, chlorine can be generated as needed without bulk storage.	158,717	1
Georgia-Pacific Corporation, Palatka Operations	Georgia-Pacific Corporation	Palatka	FL	Pulp and paper mill generates chlorine dioxide for use in the bleaching process.	Bleach pulp with oxygen with hydrogen peroxide or ozone, or use up chlorine dioxide with minimal accumulation.	148,315	3
Smurfit-Stone Container Corp., Panama City Mill	Smurfit-Stone Container Corp. Enterprises, Inc.	Panama City	FL	Pulp mill generates chlorine dioxide for use in the bleaching process.	Bleach pulp with oxygen with hydrogen peroxide or ozone, or use up chlorine dioxide with minimal accumulation.	133,607	2
Brenntag Mid-South, Inc.	Brenntag U.S.A.	Orlando	FL	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	867,151	8
Harris Field Water Treatment Plant		Homestead	FL	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	106,708	25
Wittkop Park Water Treatment Plant		Homestead	FL	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	106,459	25
Clorox Products Manufacturing Company	The Clorox Company	Tampa	FL	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without bulk shipping or storage of chlorine gas.	633,600	11
Hillsborough River Water treatment Plant-Tampa, FL		Tampa	FL	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	508,760	11
Chemical Formulators Inc.		Tampa	FL	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	931,820	11
Harcros Chemicals Inc.–Tampa		Tampa	FL	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	780,000	11

Appendix B (continued)

Facility Name	Parent Company	City	State	Process	Potential Alternative	Vulnerability Zone Population	Congressional District
DPC Enterprises, L.P.		Tampa	FL	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	754,116	11
Bayside Power Station	Tampa Electric Company/ TECO Energy Company	Tampa	FL	Power plant uses anhydrous ammonia in equipment to control nitrogen oxide emissions (a component of smog).	Reduce emissions with cleaner combustion or control emissions using aqueous ammonia or urea instead of anhydrous ammonia.	218,375	11
Brenntag Mid-South, Inc.	Brenntag U.S.A.	Clearwater	FL	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	830,000	10
Mcintosh Power Plant/ Northside WWTP	City of Lakeland	Lakeland	FL	Power plant uses anhydrous ammonia in equipment to control emissions; adjacent wastewater plant uses chlorine gas to disinfect wastewater.	Control power plant emissions with aqueous ammonia or urea; treat wastewater with liquid bleach or ultraviolet light.	131,000	12
KIK (Florida) Inc.	KIK International Inc.	Auburndale	FL	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without bulk shipping or storage of chlorine gas.	354,389	12
Allied Universal Corporation		Ft. Pierce	FL	Facility repackages anhydrous sulfur dioxide and produces sodium bisulfite, and repackages chlorine gas and produces liquid bleach.	Produce sodium bisulfite from sulfur-burning equipment and liquid bleach from salt and electricity; phase out distribution of anhydrous sulfur dioxide gas and chlorine gas.	160,030	23
KIK (Georgia) Inc.	KIK Custom Products	Hampton	GA	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without bulk shipping or storage of chlorine gas.	369,619	8
Tronox Pigments (Savannah) Inc.	Tronox LLC	Savannah	GA	Chemical manufacturing facility uses chlorine gas in producing titanium dioxide pigments.	Produce titanium dioxide pigments using the sulfate process; also, chlorine can be generated as needed without bulk storage.	230,000	12
Hydrite Chemical Co.– Waterloo	Hydrite Chemical Co.	Waterloo	IA	Chemical manufacturing facility burns elemental sulfur to produce anhydrous sulfur dioxide, for distribution or processing into bisulfites or other sulfur chemicals.	Phase out bulk distribution of anhydrous sulfur dioxide gas; distribute alternatives such as sodium bisulfite and metabisulfite.	153,000	1
Penford Products Co.	Penford Corporation	Cedar Rapids	IA	Wet corn milling facility uses anhydrous sulfur dioxide as a processing aid and to inhibit bacteria during corn steeping.	Process corn using sodium bisulfite or metabisulfite, or generate sulfur dioxide on-site for use as needed without bulk storage.	216,264	2
ADM Corn Processing– Cedar Rapids	Archer Daniels Midland Company	Cedar Rapids	IA	Wet corn milling facility uses anhydrous sulfur dioxide as a processing aid and to inhibit bacteria during corn steeping.	Process corn using sodium bisulfite or metabisulfite, or generate sulfur dioxide on-site for use as needed without bulk storage.	130,000	2
Rock Island Water Plant	City of Rock Island	Rock Island	IL	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	153,618	17
Rock Island Wastewater Treatment Plant	City of Rock Island, Illinois	Rock Island	IL	Facility uses chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace chlorine gas with liquid bleach.	145,000	17
Ameren Edwards		Bartonville	IL	Power plant uses anhydrous ammonia in equipment to control nitrogen oxide emissions (a component of smog).	Reduce emissions with cleaner combustion or control emissions using aqueous ammonia or urea instead of anhydrous ammonia.	120,000	18
CWLP's Dallman Power Station	City of Springfield	Springfield	IL	Power plant uses anhydrous ammonia in equipment to control nitrogen oxide emissions (a component of smog).	Reduce emissions with cleaner combustion or control emissions using aqueous ammonia or urea instead of anhydrous ammonia.	110,000	19
GAC MidAmerica, Inc [General Chemical/ Gentek]	GAC MidAmerica, Inc.	Indianapolis	IN	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without bulk shipping or storage of chlorine gas.	895,348	7
Alexander Chemical Corporation		Kingsbury	IN	Facility repackages bulk chlorine gas and produces liquid bleach, and repackages bulk anhydrous sulfur dioxide and produces sodium bisulfite.	Produce liquid bleach from salt and electricity and sodium bisulfite from sulfur-burning equipment; phase out distribution of chlorine gas and anhydrous sulfur dioxide gas.	379,260	2
OnLine Packaging, Incorporated– Michigan City		Michigan City	IN	Facility uses bulk shipments of chlorine gas in producing liquid bleach and windshield washer solution.	Produce bleach on-site from salt and electricity without bulk shipping or storage of chlorine gas.	233,800	2
Alcoa Inc.– Warrick Operations	Alcoa Inc.	Newburgh	IN	Aluminum smelting facility uses chlorine gas to remove impurities during re-smelting operations in producing aluminum alloys.	Remove impurities by fluxing with solid magnesium chloride salts injected with nitrogen gas.	385,217	8

Appendix B (continued)

Facility Name	Parent Company	City	State	Process	Potential Alternative	Vulnerability Zone Population	Congressional District
Brenntag Mid-South, Inc.	Brenntag U.S.A.	Terre Haute	IN	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	116,180	8
A.E. Staley Manufacturing Company–Lafayette South	A.E. Staley Manufacturing Company	Lafayette	IN	Wet corn milling facility uses anhydrous sulfur dioxide as a processing aid and to inhibit bacteria during corn steeping.	Process corn using sodium bisulfite or metabisulfite, or generate sulfur dioxide on-site for use as needed without bulk storage.	160,000	4
A.E.Staley Manufacturing Company–Sagamore	A.E.Staley Manufacturing	Lafayette	IN	Wet corn milling facility uses anhydrous sulfur dioxide as a processing aid and to inhibit bacteria during corn steeping.	Process corn using sodium bisulfite or metabisulfite, or generate sulfur dioxide on-site for use as needed without bulk storage.	105,000	4
Topeka Water Treatment Plant	City of Topeka, Kansas	Topeka	KS	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	173,925	2
Water Treatment Plant	City of Wichita,Kansas	Wichita	KS	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	130,000	4
Forth Technologies, Inc.		Louisville	KY	Custom chemical processing and toll manufacturing facility uses bulk shipments of oleum (fuming sulfuric acid) in producing specialty perylene chemicals.	Produce sulfur chemicals on-site as needed from sulfur-burning equipment.	161,714	3
Crescent Hill Water Treatment Plant	Louisville Water Company	Louisville	KY	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	675,100	3
Kentucky American Water Co Richmond Rd Station	American Water Works Service Company, Inc.	Lexington	KY	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	105,797	6
Catlettsburg Refining, LLC	Marathon Petroleum Company, LLC	Catlettsburg	KY	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	300,000	4
Brenntag Mid-South, Inc.	Brenntag U.S.A.	Henderson	KY	Facility repackages bulk chlorine gas and produces liquid bleach, and repackages bulk anhydrous sulfur dioxide and produces sodium bisulfite.	Produce liquid bleach from salt and electricity and sodium bisulfite from sulfur-burning equipment; phase out distribution of chlorine gas and anhydrous sulfur dioxide gas.	239,151	1
ConocoPhillips Company Alliance Refinery	ConocoPhillips Company	Belle Chasse	LA	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	845,059	3
Marathon Petroleum Company LLC LARefiningDivision	Marathon Petroleum Company LLC	Garyville	LA	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	378,730	3
East Bank Wastewater Treatment Plant	Sewerage & Water Board of New Orleans	New Orleans	LA	Facility uses chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace chlorine gas with liquid bleach.	726,185	2
Carrollton Water Purification Plant	Sewerage and Water Board of New Orleans	New Orleans	LA	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	892,320	2
Louisiana Pigment Company, L.P.	KRONOS Louisiana, Inc./ Tioxide Americas, Inc.	Westlake	LA	Pigment manufacturing facility uses titanium tetrachloride in producing titanium dioxide.	Produce titanium dioxide pigments using the sulfate process.	160,000	7
Placid Refining Co. L.L.C.–Port Allen Refinery		Port Allen	LA	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	330,000	6
Harcros Chemicals Inc.–St. Gabriel	Harcros Chemicals Inc.	St. Gabriel	LA	Facility repackages bulk anhydrous sulfur dioxide and produces sodium bisulfite, and repackages bulk chlorine gas and produces liquid bleach.	Produce sodium bisulfite from sulfur-burning equipment and liquid bleach from salt and electricity; phase out distribution of anhydrous sulfur dioxide gas and chlorine gas.	380,000	6
Port Hudson Operations	Georgia-Pacific Consumer Operations LLC	Zachary	LA	Pulp and paper mill generates chlorine dioxide for use in the bleaching process.	Bleach pulp with oxygen with hydrogen peroxide or ozone, or use up chlorine dioxide with minimal accumulation.	520,000	6
Central Wastewater Treatment Plant	City of Baton Rouge–East Baton Rouge Parish	Baton Rouge	LA	Facility uses chlorine gas and anhydrous sulfur dioxide to treat wastewater.	Treat wastewater with ultraviolet light, or replace chlorine gas with liquid bleach and replace anhydrous sulfur dioxide with sodium bisulfite.	136,223	6
Clorox Products Manufacturing Company	The Clorox Company	Aberdeen	MD	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without bulk shipping or storage of chlorine gas.	229,400	2

Appendix B (continued)

Facility Name	Parent Company	City	State	Process	Potential Alternative	Vulnerability Zone Population	Congressional District
Ashburton Chlorinator Station	City of Baltimore–Department of Public Works	Baltimore	MD	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	101,800	7
Druid Lake Effluent Chlorinator Station	City of Baltimore–Department of Public Works	Baltimore	MD	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	130,000	7
Druid Lake Influent Chlorinator Station	City of Baltimore–Department of Public Works	Baltimore	MD	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	120,000	7
Montebello Filtration Plant Chlorinator Station	City of Baltimore–Department of Public Works	Baltimore	MD	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	108,000	7
GAC Chemical–New England	GAC Chemical Corporation	Searsport	ME	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without bulk shipping or storage of chlorine gas.	144,671	2
High-Po-Chlor, Inc.		Romulus	MI	Facility uses bulk shipments of chlorine gas in producing liquid bleach.	Produce bleach on-site from salt and electricity without bulk shipping or storage of chlorine gas.	135,000	15
BASF Corporation–Wyandotte Site	BASF Corporation	Wyandotte	MI	Chemical manufacturing facility uses ethylene oxide in producing polyols for use in urethane products.	Produce biopolyols from soy rather than petrochemical polyols from ethylene oxide.	105,000	13
DPC Industries, Inc.	DX Holding Company	Rosemount	MN	Facility repackages bulk shipments of anhydrous sulfur dioxide and chlorine gas to smaller containers, and produces liquid bleach.	Produce sulfur chemicals from sulfur-burning equipment and liquid bleach from salt and electricity; phase out distribution of anhydrous sulfur dioxide gas and chlorine gas.	918,762	2
Covanta Hennepin Energy Resource Company, L.P.	Covanta Hennepin Energy Resource Company, L.P.	Minneapolis	MN	Power plant uses anhydrous ammonia in equipment to control nitrogen oxide emissions (a component of smog).	Reduce emissions with cleaner combustion or control emissions using aqueous ammonia or urea instead of anhydrous ammonia.	182,538	5
Fridley Filter Plant	Minneapolis Water Works	Minneapolis	MN	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	337,000	5
American Crystal Sugar Company-Moorhead	American Crystal Sugar Company	Moorhead	MN	Sugar manufacturing facility uses anhydrous sulfur dioxide in producing crystal sugar from sugar beets.	Generate sulfur dioxide on-site with a sulfur burner for use as needed without bulk storage.	130,000	7
Kansas City, Missouri Water Treatment Plant		Kansas City	MO	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	720,000	6
Brenntag Mid-South, Inc.	Brenntag, Inc.	Kansas City	MO	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	643,000	5
KCPL–Hawthorn Generating Facility	Kansas City Power & Light/Great Plains Energy	Kansas City	MO	Power plant uses anhydrous ammonia in equipment to control nitrogen oxide emissions (a component of smog).	Reduce emissions with cleaner combustion or control emissions using aqueous ammonia or urea instead of anhydrous ammonia.	160,000	5
Leaf River Cellulose, LLC	Koch Cellulose, LLC	New Augusta	MS	Pulp mill generates chlorine dioxide for use in the bleaching process.	Bleach pulp with oxygen with hydrogen peroxide or ozone, or use up chlorine dioxide with minimal accumulation.	103,010	4
DuPont DeLisle Plant	E.I. du Pont de Nemours & Co., Inc.	Pass Christian	MS	Chemical manufacturing facility uses titanium tetrachloride and chlorine gas in producing titanium dioxide.	Produce titanium dioxide pigments using the sulfate process; also, chlorine can be generated as needed without bulk storage.	250,000	4
ConocoPhillips Billings Refinery	ConocoPhillips Company	Billings	MT	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	116,704	1
Blue Ridge Paper Products, Inc.	Blue Ridge Holding Corporation	Canton	NC	Pulp and paper mill generates chlorine dioxide for use in the bleaching process.	Bleach pulp with oxygen with hydrogen peroxide or ozone, or use up chlorine dioxide with minimal accumulation.	260,363	11
Florence Water Treatment Plant	Metropolitan Utilities District	Omaha	NE	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	390,000	2
DPC Industries, Inc.	DX Holding Company	Omaha	NE	Facility repackages bulk shipments of anhydrous sulfur dioxide and chlorine gas to smaller containers, and produces liquid bleach.	Produce sulfur chemicals from sulfur-burning equipment and liquid bleach from salt and electricity; phase out distribution of anhydrous sulfur dioxide gas and chlorine gas.	661,982	2

Appendix B (continued)

Facility Name	Parent Company	City	State	Process	Potential Alternative	Vulnerability Zone Population	Congressional District
Bayonne Plant Holding L.L.C.		Bayonne	NJ	Power plant uses anhydrous ammonia in equipment to control nitrogen oxide emissions (a component of smog).	Reduce emissions with cleaner combustion or control emissions using aqueous ammonia or urea instead of anhydrous ammonia.	112,728	13
Southside Water Reclamation Plant	Albuquerque Bernalillo County Water Utility Author	Albuquerque	NM	Facility uses chlorine gas and anhydrous sulfur dioxide to treat wastewater.	Treat wastewater with ultraviolet light, or replace chlorine gas with liquid bleach and replace anhydrous sulfur dioxide with sodium bisulfite.	120,000	1
DPC Industries, Inc	DX Holding Company	Albuquerque	NM	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	548,334	1
Sierra Chemical Co., Sparks Facility		Sparks	NV	Facility repackages anhydrous sulfur dioxide and produces sodium bisulfite, and repackages chlorine gas and produces liquid bleach.	Produce sodium bisulfite from sulfur-burning equipment and liquid bleach from salt and electricity; phase out distribution of anhydrous sulfur dioxide gas and chlorine gas.	246,826	2
Surpass Chemical Company, Inc. Bridge Street Plant		Albany	NY	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without bulk shipping or storage of chlorine gas.	517,748	21
Finch Paper, LLC	Finch Paper Holdings LLC	Glens Falls	NY	Pulp and paper mill uses anhydrous sulfur dioxide in the pulping process digester, ordinarily generated on-site without storage but occasionally supplemented with truck or rail deliveries.	Improve reliability of on-site generation of anhydrous sulfur dioxide to eliminate truck or rail deliveries.	130,000	20
City of Buffalo Water Facility		Buffalo	NY	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	514,360	27
JCI Jones Chemicals Inc.–Caledonia		Caledonia	NY	Facility repackages bulk shipments of chlorine gas and anhydrous sulfur dioxide to smaller containers, and produces liquid bleach.	Produce liquid bleach from salt and electricity without storing chlorine gas; phase out distribution of chlorine gas and anhydrous sulfur dioxide gas.	878,368	26
Ashtabula Complex Plant 2	Millennium Inorganic Chemicals Inc.	Ashtabula	OH	Chemical manufacturing facility uses chlorine gas in producing titanium dioxide pigments.	Produce titanium dioxide pigments using the sulfate process; also, chlorine can be generated as needed without bulk storage.	102,000	14
Ashtabula Complex Plant 1	Millennium Inorganic Chemicals, Inc.	Ashtabula	OH	Chemical manufacturing facility uses chlorine gas in producing titanium dioxide pigments.	Produce titanium dioxide pigments using the sulfate process; also, chlorine can be generated as needed without bulk storage.	102,000	14
Ohio Refining Division MPC	Marathon Petroleum Company LLC	Canton	OH	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	940,000	16
Pilot Chemical Company of Ohio Lockland Plant	Pilot Chemical Company of California	Lockland	OH	Specialty chemical manufacturing facility uses sulfur trioxide in producing synthetic detergents, surfactants, emulsifiers, and sulfonic acids.	Use sulfur-burning equipment to generate sulfur trioxide on-site as needed for direct use into the process.	110,000	1
City of Del City Water Treatment Plant		Del City	OK	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	180,088	5
Brenntag Southwest, Inc. Port of Catoosa	Brenntag, Inc.	Catoosa	OK	Facility repackages bulk shipments of anhydrous sulfur dioxide and chlorine gas to smaller containers, and produces liquid bleach.	Produce sulfur chemicals from sulfur-burning equipment and liquid bleach from salt and electricity; phase out distribution of anhydrous sulfur dioxide gas and chlorine gas.	385,000	2
Solvay Fluorides--Catoosa Plant	Solvay Fluorides, L.L.C.	Catoosa	OK	Facility stores concentrated hydrofluoric acid (70 percent) in producing brazing flux, sold for industrial brazing such as aluminum heat exchangers.	Transport and store less concentrated hydrofluoric acid for use as dilute acid solutions in the manufacturing process.	348,699	2
Mohawk Water Treatment Plant	City of Tulsa	Tulsa	OK	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	308,829	1
A.B. Jewell Water Treatment Plant	City of Tulsa	Tulsa	OK	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	245,622	1
Univar USA Inc., Bunola Branch 4-05	Univar USA Inc.	Bunola	PA	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	645,107	12
W.P.J.W.A. Treatment Plant	Wilkinsburg-Penn Joint Water Authority	Verona	PA	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	100,200	14

Appendix B (continued)

Facility Name	Parent Company	City	State	Process	Potential Alternative	Vulnerability Zone Population	Congressional District
W.P.J.W.A. Nadine Road Pump Station	Wilkinsburg-Penn Joint Water Authority	Verona	PA	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	100,000	14
James Austin Company		Mars	PA	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without bulk shipping or storage of chlorine gas.	240,000	4
Univar USA Inc., Middletown Branch	Univar USA Inc.	Middletown	PA	Facility repackages bulk shipments of anhydrous sulfur dioxide and chlorine gas to smaller containers, and produces liquid bleach.	Produce sulfur chemicals from sulfur-burning equipment and liquid bleach from salt and electricity; phase out distribution of anhydrous sulfur dioxide gas and chlorine gas.	558,778	17
Bristol Borough Wastewater Treatment Plant		Bristol	PA	Facility uses chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace chlorine gas with liquid bleach.	145,000	8
Bristol Township Wastewater Treatment Plant		Croydon	PA	Facility uses chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace chlorine gas with liquid bleach.	174,000	8
Univar USA Inc., Providence Branch	Univar USA Inc.	Providence	RI	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without bulk shipping or storage of chlorine gas.	955,427	2
KapStone Charleston Kraft LLC	KapStone Kraft Paper Corporation	North Charleston	SC	Paper mill uses chlorine gas to treat incoming process water.	Treat process water with liquid bleach instead of chlorine gas.	400,829	6
Bowater Incorporated	Abitibibowater Inc.	Catawba	SC	Pulp mill generates chlorine dioxide for use in the bleaching process.	Bleach pulp with oxygen with hydrogen peroxide or ozone, or use up chlorine dioxide with minimal accumulation.	157,780	5
Dry Creek Wastewater Treatment Plant	Metro Water and Sewer Department	Madison	TN	Facility uses chlorine gas and anhydrous sulfur dioxide to treat wastewater.	Treat wastewater with ultraviolet light, or replace chlorine gas with liquid bleach and replace anhydrous sulfur dioxide with sodium bisulfite.	103,610	5
Central Wastewater Treatment Plant	Metro Water and Sewer Department	Nashville	TN	Facility uses chlorine gas and anhydrous sulfur dioxide to treat wastewater.	Treat wastewater with ultraviolet light, or replace chlorine gas with liquid bleach and replace anhydrous sulfur dioxide with sodium bisulfite.	965,468	5
K. R. Harrington Water Treatment Plant	Metro Water and Sewer Department	Nashville	TN	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	151,736	5
Whites Creek Wastewater Treatment Plant	Metro Water and Sewer Department	Nashville	TN	Facility uses chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace chlorine gas with liquid bleach.	133,753	5
DPC Enterprises, L.P.		Chattanooga	TN	Facility repackages bulk shipments of anhydrous sulfur dioxide and chlorine gas to smaller containers, and produces liquid bleach.	Produce sulfur chemicals from sulfur-burning equipment and liquid bleach from salt and electricity; phase out distribution of anhydrous sulfur dioxide gas and chlorine gas.	386,098	3
Brenntag Mid-South, Inc.	Brenntag U.S.A.	Chattanooga	TN	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	328,026	3
Jarden Zinc Products, Inc.	Jarden Corporation	Greeneville	TN	Manufacturer of zinc-based metal products uses chlorine to treat industrial wastewater.	Replace chlorine gas with liquid bleach.	270,000	1
Buckeye Technologies Inc.–Memphis Plant	Buckeye Technologies Inc.	Memphis	TN	Pulp mill uses chlorine gas to make bleach for brightening specialty cellulose from cotton fibers.	Brighten pulp using liquid bleach without transporting or storing chlorine gas, or use chlorine free alternatives.	639,180	9
The Premcor Refining Group Inc., a Valero Company	Valero Energy Corporation	Memphis	TN	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	791,888	9
Vertex Chemical Corporation Memphis, TN		Memphis	TN	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without bulk shipping or storage of chlorine gas.	560,000	9
Elm Fork Water Treatment Plant	Dallas Water Utilities	Carrollton	TX	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	790,000	24
Ten Mile Creek Regional Wastewater System	Trinity River Authority of Texas	Ferris	TX	Facility uses chlorine gas and anhydrous sulfur dioxide to treat wastewater.	Treat wastewater with ultraviolet light, or replace chlorine gas with liquid bleach and replace anhydrous sulfur dioxide with sodium bisulfite.	359,371	30
Forney Pump Station	Dallas Water Utilities	Sunnyvale	TX	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	580,000	5

Appendix B (continued)

Facility Name	Parent Company	City	State	Process	Potential Alternative	Vulnerability Zone Population	Congressional District
Central Wastewater Treatment Plant	Dallas Water Utilities	Dallas	TX	Facility uses chlorine gas and anhydrous sulfur dioxide to treat wastewater.	Treat wastewater with ultraviolet light, or replace chlorine gas with liquid bleach and replace anhydrous sulfur dioxide with sodium bisulfite.	930,000	30
Dallas Water Utilities Southside WWTP	Dallas Water Utilities	Dallas	TX	Facility uses anhydrous sulfur dioxide and chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace anhydrous sulfur dioxide with sodium bisulfite and chlorine gas with liquid bleach.	770,000	30
Village Creek Wastewater Treatment Plant	City of Fort Worth	Arlington	TX	Facility uses anhydrous sulfur dioxide and chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace anhydrous sulfur dioxide with sodium bisulfite and chlorine gas with liquid bleach.	241,540	26
DPC Industries, Inc.	DX Holding Company	Cleburne	TX	Facility repackages bulk shipments of anhydrous sulfur dioxide and chlorine gas to smaller containers, and produces liquid bleach.	Produce sulfur chemicals from sulfur-burning equipment and liquid bleach from salt and electricity; phase out distribution of anhydrous sulfur dioxide gas and chlorine gas.	140,183	17
South Holly Water Treatment Plant	City of Fort Worth	Fort Worth	TX	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	219,448	12
North Holly Water Treatment Plant	City of Fort Worth	Fort Worth	TX	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	216,573	12
Rolling Hills Water Treatment Plant	City of Fort Worth	Fort Worth	TX	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	428,447	26
Eagle Mountain Water Treatment Plant	City of Fort Worth	Fort Worth	TX	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	103,699	12
Jasper Water Treatment Plant	City of Wichita Falls	Wichita Falls	TX	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	100,000	13
Drilling Specialties Company LLC, Alamo Plant	Chevron Phillips Chemical Company LP	Conroe	TX	Chemical manufacturing facility uses sulfur trioxide as a sulfonating agent in producing drilling fluid additives for oil and gas production.	Use sulfur-burning equipment to generate sulfur trioxide on-site as needed for direct use into the process.	668,520	8
Crown Central Petroleum, Houston Refinery	Crown Central Petroleum Corporation	Pasadena	TX	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	620,000	29
AES Deepwater	AES Corporation	Pasadena	TX	Power plant uses anhydrous ammonia in equipment to control nitrogen oxide emissions (a component of smog).	Reduce emissions with cleaner combustion or control emissions using aqueous ammonia or urea instead of anhydrous ammonia.	416,374	29
E. R. Carpenter L.P.–Powell Plant	Carpenter Urethanes I, LLC	Pasadena	TX	Chemical manufacturing facility uses ethylene oxide in producing polyols for use in urethane products.	Produce biopolyols from soy rather than petrochemical polyols from ethylene oxide.	410,000	22
City of South Houston		South Houston	TX	Facility uses anhydrous sulfur dioxide and chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace anhydrous sulfur dioxide with sodium bisulfite and chlorine gas with liquid bleach.	180,000	29
Marathon Petroleum Company Texas Refining	Marathon Petroleum Company LLC	Texas City	TX	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	210,000	14
BP America, BP Texas City Site	BP Products North America Inc.	Texas City	TX	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	550,000	14
Valero Refining–Texas, L.P.	Valero Energy Corporation	Texas City	TX	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	535,000	14
MeadWestvaco Texas LP	MeadWestvaco	Evadale	TX	Pulp and paper mill generates chlorine dioxide for use in the bleaching process.	Bleach pulp with oxygen with hydrogen peroxide or ozone, or use up chlorine dioxide with minimal accumulation.	242,313	8
Premcor Port Arthur Refinery	The Valero Energy Corporation	Port Arthur	TX	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	330,000	2
Market Street Pumping Station	San Antonio Water System	San Antonio	TX	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	109,000	20

Appendix B (continued)

Facility Name	Parent Company	City	State	Process	Potential Alternative	Vulnerability Zone Population	Congressional District
Mission Pumping Station	San Antonio Water System	San Antonio	TX	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	115,000	20
34th Street Pumping Station	San Antonio Water System	San Antonio	TX	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	122,000	20
CITGO Corpus Christi Refinery East Plant	CITGO Refining and Chemicals L.P.	Corpus Christi	TX	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	315,420	27
Valero Refining Co.–Texas, L.P.–West Plant	Valero Energy Corporation	Corpus Christi	TX	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	340,000	27
Flint Hills Resources, LP–CC West Refinery	Koch Industries, Inc.	Corpus Christi	TX	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	350,000	27
O.N. Stevens Water Treatment Plant	City of Corpus Christi	Corpus Christi	TX	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	360,000	27
South Texas Chlorine, Inc.		Harlingen	TX	Facility repackages bulk shipments of chlorine gas into smaller containers.	Convert chlorine distribution to liquid bleach.	150,000	15
Lubbock Water Treatment Plant	City of Lubbock, TX	Lubbock	TX	Facility uses anhydrous ammonia (and chlorine gas) to treat drinking water.	Use aqueous ammonia in place of anhydrous ammonia; replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	113,019	19
Grimes Treatment Plant	City of Abilene	Abilene	TX	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	100,000	19
Woods Cross Refinery	Holly Refining & Marketing Company	Woods Cross	UT	Petroleum refinery uses modified (less volatile) hydrofluoric acid in the alkylation process of turning crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	216,294	1
Thatcher Company		Salt Lake City	UT	Facility repackages bulk chlorine gas and produces liquid bleach, and repackages bulk anhydrous sulfur dioxide and produces sodium bisulfite.	Produce liquid bleach from salt and electricity and sodium bisulfite from sulfur-burning equipment; phase out distribution of chlorine gas and anhydrous sulfur dioxide gas.	888,815	1
ChevronTexaco Salt Lake Refinery	ChevronTexaco Corporation	Salt Lake City	UT	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	680,000	1
JCI Jones Chemicals Inc.–Milford		Milford	VA	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	272,741	1
City of Richmond Water Purification Plant	City of Richmond	Richmond	VA	Facility uses chlorine gas to treat drinking water.	Replace chlorine gas with liquid bleach or generate bleach on-site, with ozone or ultraviolet light as appropriate.	704,630	7
City of Richmond Wastewater Treatment Plant	City of Richmond	Richmond	VA	Facility uses anhydrous sulfur dioxide and chlorine gas to treat wastewater.	Treat wastewater with ultraviolet light, or replace anhydrous sulfur dioxide with sodium bisulfite and chlorine gas with liquid bleach.	722,769	3
Univar USA Inc	Univar USA Inc	Suffolk	VA	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	475,000	4
KIK (Virginia) Inc.	KIK International Inc.	Salem	VA	Facility uses bulk shipments of chlorine gas in producing liquid bleach (sodium hypochlorite).	Produce bleach on-site from salt and electricity without bulk shipping or storage of chlorine gas.	227,000	6
Kimberly-Clark Everett Mill	Kimberly-Clark Worldwide	Everett	WA	Pulp mill produces and stores sulfur dioxide gas for use in ammonium bisulfite batch digesters in the pulp making process.	Extend use of sulfur burner to avoid truck delivery and minimize storage of anhydrous sulfur dioxide.	244,406	2
ConocoPhillips Company	ConocoPhillips Company	Ferndale	WA	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	120,000	2
Pioneer Americas LLC Tacoma Bleach Plant	Pioneer Companies, Inc.	Tacoma	WA	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	917,716	9

Appendix B (continued)

Facility Name	Parent Company	City	State	Process	Potential Alternative	Vulnerability Zone Population	Congressional District
Olympic Chemical Corporation	Univar USA Inc.	Tacoma	WA	Facility uses bulk shipments of anhydrous sulfur dioxide in producing sodium bisulfite.	Use sulfur-burning equipment to produce sodium bisulfite without storing sulfur dioxide gas.	900,000	9
Georgia-Pacific Consumer Products (Camas) LLC	Georgia-Pacific Consumer Products Holdings LLC	Camas	WA	Pulp and paper mill uses chlorine dioxide, as well as oxygen and hydrogen peroxide, in bleaching processes.	Bleach pulp fully with oxygen with hydrogen peroxide or ozone.	400,000	3
Chemtrade Performance Chemicals Kalama Plant	Chemtrade Logistics	Kalama	WA	Facility uses anhydrous sulfur dioxide in producing sodium hydrosulfite.	Use sulfur-burning equipment to produce sodium hydrosulfite without storing sulfur dioxide gas.	148,000	3
Murphy Oil USA Superior Refinery	Murphy Oil USA, Inc.	Superior	WI	Petroleum refinery uses hydrofluoric acid in the alkylation process of refining crude oil into gasoline.	Produce alkylate using available sulfuric acid technologies or commercialize a solid acid catalyst method.	180,000	7
Hydrite Chemical Co.–Oshkosh	Hydrite Chemical Co.	Oshkosh	WI	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	277,863	6
Brenntag Mid-South, Inc.	Brenntag U.S.A.	Nitro	WV	Facility uses bulk shipments of anhydrous sulfur dioxide in producing sodium bisulfite for distribution.	Use sulfur-burning equipment to produce sodium bisulfite without storing sulfur dioxide gas.	224,198	2
Brenntag Mid-South, Inc.	Brenntag U.S.A.	St. Albans	WV	Facility uses bulk shipments of chlorine gas in producing liquid bleach and repackaging to smaller containers.	Produce bleach on-site from salt and electricity without shipping or storing chlorine gas; phase out distribution of chlorine gas.	259,148	2

Appendix C
Methodology

This report investigates whether reasonably available alternatives could remove the possibility of a worst-case chemical release at the nation's highest-hazard chemical facilities. To determine the highest-hazard facilities, we examined Risk Management Plans, or RMPs, submitted to the EPA as of Oct. 28, 2008, and identified the facilities that report the largest surrounding vulnerable populations. We gathered this information over many months through regular visits to federal reading rooms.

"Vulnerability zone" data are presented for each facility listed in Appendices A and B. These numbers are facility-generated estimates of the residential population within range of a worst-case toxic gas release. They are not forecasts of casualties. The names of facilities listed in the appendices appear as they do in RMP reports. For some facilities, additional information is provided in brackets for identification purposes.

The vulnerability zones of some facilities overlap. In determining the total number of Americans living within range of a worst-case toxic gas release, we did not "double count" people by simply adding up all vulnerability zone data. Rather, we counted only once the population of any census block that falls within the vulnerability zone of more than one facility. That gave us the number of 80 million Americans threatened by the top 101.

The facilities listed in this report are presumed to have up-to-date RMP registrations. The RMP program requires covered facilities that no longer hold threshold amounts of certain extremely hazardous substances to notify EPA by submitting a "deregistration." Facilities do not always deregister as required. Yet the number of high-hazard RMP facilities in this report matches the number in a recent Congressional Research Service analysis of RMP facilities.[50] This report excludes facilities that deregistered after the CRS analysis, but might not include all subsequent new registrations by high-hazard RMP facilities.

To determine how facilities use and transport extremely hazardous substances we consulted company websites, trade association publications, news reports, RMPs, Securities and Exchange Commission filings, patent information, facility permits, community advisory panels, and other public sources. In some cases we contacted facilities by phone. In a few cases we inferred the means of transportation from the nature of the facility.

Information on possible alternative chemicals and processes came primarily from interviews. The author interviewed personnel at facilities that operate without large vulnerability zones; vendors of less hazardous technologies; and individuals with professional, workplace, or academic knowledge and interest in safer and more secure technologies.The following reports by public interest organizations helped by documenting safer and more secure alternatives across diverse industries:

- "Preventing Toxic Terrorism: How Some Chemical Facilities are Removing Danger to American Communities," Center for American Progress, 2006
- "Toxic Trains and the Terrorist Threat: How Water Utilities Can Get Chlorine Gas Off the Rails and Out of American Communities," Center for American Progress, 2007
- "Eliminating Hometown Hazards: Cutting Chemical Risks at Wastewater Treatment Facilities," Environmental Defense, 2003
- "Needless Risk: Oil Refineries and Hazard Reduction," U.S. Public Interest Research Group Education Fund, 2005
- "Pulp Fiction: Chemical Hazard Reduction at Pulp and Paper Mills," U.S. Public Interest Research Group Education Fund, 2007
- "Unnecessary Dangers: Emergency Chemical Release Hazards at Power Plants," Working Group on Community Right-to-Know, 2004

Appendix D
Dangers of selected extremely hazardous substances

ACRYLONITRILE

Acrylonitrile is a flammable and reactive liquid, clear or slightly yellowish in color, with a faint odor. It is used to make synthetic fibers and polymers. Acute exposure irritates the eyes, nose, throat and lungs. High exposure levels can cause weakness, headache, confusion, nausea, vomiting, and collapse. At the highest exposure levels fluid buildup in the lungs (pulmonary edema) may lead to death. Chronic exposure may interfere with the thyroid gland. Acrylonitrile is a probable human carcinogen.

AMMONIA (ANHYDROUS)

Anhydrous ammonia is a corrosive colorless gas with a strong odor. It is used primarily in fertilizers, but also in chemical intermediates and refrigeration. Acute ammonia exposure can irritate the skin; burn the eyes, causing temporary or permanent blindness; and cause headaches, nausea, and vomiting. High levels can cause fluid in the respiratory system (pulmonary or laryngeal edema), which may lead to death. Chronic exposure damages the lungs; repeated exposure can lead to bronchitis with coughing or shortness of breath.

BROMINE

Bromine is a dark, reddish-brown fuming liquid or vapor. It is used in fire retardants, drilling fluids, dyes, photographic chemicals, water treatment, fumigants, and pharmaceuticals. Vapors are highly corrosive and toxic. Contact can severely burn the skin and eyes. Inhaling bromine can irritate and damage the nose, throat, and lungs leading to headache, coughing, and nosebleed; higher levels can lead to fluid buildup in the lungs (pulmonary edema) and death.

CARBON DISULFIDE

Carbon disulfide is a flammable colorless or faintly yellow liquid with a strong, disagreeable odor. It is used in manufacturing viscose rayon, cellophane, carbon tetrachloride, and flotation agents. Acute exposure can severely irritate the eyes, skin, and nose, and can cause headaches, nausea, dizziness, unconsciousness, and death. Chronic exposure can damage a developing fetus, and may cause spontaneous abortions in women and sperm abnormalities in men. Repeat exposures can also damage the nervous system with symptoms that may include tingling, weakness, and severe mood, personality, and mental changes that can last for months or years.

CHLORINE

Chlorine is a greenish-yellow gas with a strong, irritating odor. It is used in making other chemicals, as a disinfectant, in bleaching, and for purifying water and sewage. Acute exposure can severely burn the eyes and skin, causing permanent damage, and may cause throat irritation, tearing, coughing, nose bleeds, chest pain, fluid buildup in the lungs (pulmonary edema), and death. Chronic exposure can damage the teeth and irritate the lungs, causing bronchitis, coughing, and shortness of breath. A single high exposure can permanently damage the lungs.

ETHYLENE OXIDE

Ethylene oxide is a colorless gas that is highly flammable, reactive, and explosive. It is used to make antifreeze, polyesters, and detergents, and is used for industrial sterilization. Acute exposure can irritate the eyes, skin, nose, throat, and lungs, and may cause shortness of breath, headache, nausea, vomiting, diarrhea, drowsiness, weakness, and loss of muscle control. Higher exposure levels may cause loss of consciousness, fluid in the lungs (pulmonary edema), and death. Chronic exposure to ethylene oxide may cause cancer and birth defects, as well as damage to the liver, kidneys, and nervous system.

FORMALDEHYDE

Formaldehyde is a flammable, colorless gas with a pungent, suffocating odor. It is used in manufacturing plastics and other chemicals, such as adhesive resins in particleboard, plywood, foam insulation, and other products. Acute exposure irritates and burns the skin, eyes, nose, mouth, and throat. Higher levels can cause a build-up of fluid in the lungs (pulmonary edema) or spasm in the windpipe, either of which may be fatal. Chronic exposure may cause both an asthma-like allergy and bronchitis with symptoms of coughing and shortness of breath. Formaldehyde causes cancer of the nasal passages in animals and is a probable human carcinogen.

FURAN

Furan is a clear, colorless liquid with a pleasant odor. It is used in making chemicals, resins, pharmaceuticals, and insecticides. Vapors are explosive and heavier than air. Acute inhalation exposure can irritate the nose, throat, and lungs, leading to headache, fatigue, depression, nausea, vomiting, unconsciousness, and respiratory paralysis. Higher exposures may cause a buildup of fluid in the lungs (pulmonary edema) and death.

HYDROGEN CHLORIDE (HYDROCHLORIC ACID)

Hydrogen chloride is a corrosive colorless to slightly yellow gas with a strong odor. It is used in chemical manufacturing, metal processing, oil well extraction, and semiconductor etching, among other applications. Acute exposure to hydrogen chloride can cause severe burns of the skin and eyes, leading to permanent damage and blindness. Breathing hydrogen chloride vapor irritates the mouth, nose, throat, and lungs, causing coughing, shortness of breath, fluid buildup in the lungs (pulmonary edema), and possibly death. Chronic exposure damages the lungs and may erode the teeth.

HYDROGEN FLUORIDE (HYDROFLUORIC ACID)

Hydrogen fluoride is a corrosive colorless fuming liquid or gas with a strong irritating odor. It is used in etching glass and in making other chemicals and refining gasoline. Breathing the vapor causes extreme respiratory irritation (with cough, fever, chills, and tightness) that may be fatal. Contact can severely burn the skin and eyes, resulting in permanent eye damage or blindness. Long-term exposure may damage the liver and kidneys, and causes fluorosis, with symptoms of weight loss, malaise, anemia, and osteosclerosis.

OLEUM (FUMING SULFURIC ACID)

Oleum is a solution of sulfur trioxide mixed with sulfuric acid. See description of sulfur trioxide for health effects.

PHOSGENE

Phosgene is a colorless gas, or a clear to yellow volatile liquid used in making isocyanates, pesticides, resins, polyurethane, dyes, and other chemicals. Phosgene is highly corrosive. Short-term exposure can irritate and severely burn the skin and eyes, causing permanent damage. Breathing phosgene can irritate the nose, throat, and lungs; higher levels can cause fluid to build up in the lungs (pulmonary edema), a medical emergency. Repeated exposures to even very low levels can cause permanent lung damage (including emphysema, bronchitis).

SULFER DIOXIDE (ANHYDROUS)

Sulfur dioxide is a colorless gas with a sharp pungent odor. It may be shipped and stored as a compressed liquefied gas. Sulfur dioxide is used in the manufacture of sulfuric acid, sulfur trioxide, and sulfites; as a bleaching agent; in food processing; and to de-chlorinate wastewater, among other uses. Acute exposure irritates the eyes and air passages. High exposures to the skin and eyes can cause severe burns and blindness, and breathing high levels can lead to permanent lung damage and death.

SULFUR TRIOXIDE

Sulfur trioxide is a corrosive colorless liquid that fumes in the air, forming sulfuric acid vapor or mist. Its health effects in the air are essentially those of sulfuric acid mist and are similar to sulfur dioxide and to oleum. Sulfur trioxide vapor can severely irritate and burn the skin, eyes, throat, and lungs. Eye damage can include blindness. Breathing the vapor can lead to choking, spasm, and pulmonary edema. Exposure can cause bronchitis, emphysema, and permanent lung damage.

Endnotes

1 Homeland Security Council and Department of Homeland Security, "National Planning Scenario 8: Chemical Attack—Chlorine Tank Explosion" (2005).

2 Agencies and organizations that have warned about the chemical terror threat include, among others, the Department of Homeland Security, Department of Justice, Government Accountability Office, Agency for Toxic Substances and Disease Registry, Congressional Budget Office, Congressional Research Service, Army Surgeon General, Environmental Protection Agency, Naval Research Laboratory, Brookings Institution, Rand Corporation, American Chemistry Council, PACE International Union (United Steelworkers), International Brotherhood of Teamsters, Environmental Defense, U.S. Public Interest Research Group, and Center for Strategic and International Studies.

3 International Brotherhood of Teamsters, "High Alert: Workers Warn of Security Gaps on Nation's Railroads" (2005).

4 The Safe Drinking Water Act, as amended by the Bioterrorism Act of 2002, requires some drinking water facilities to prepare a security vulnerability assessment, but does not require these water facilities to prepare or carry out a comprehensive security plan.

5 A legislative timeline from 1999 to early 2006 is included in: Center for American Progress, "Preventing Toxic Terrorism: How Some Chemical Facilities are Removing Danger to American Communities" (2006).

6 Center for American Progress, "Preventing Toxic Terrorism: How Some Chemical Facilities are Removing Danger to American Communities" (2006).

7 Center for American Progress, "Toxic Trains and the Terrorist Threat: How Water Utilities Can Get Chlorine Gas Off the Rails and Out of American Communities" (2007).

8 Working Group on Community Right-to-Know/Right-to-Know Network, "Chemical Plant Security Breaches in the News" (2007).

9 National Research Council, "Making the Nation Safer: The Role of Science and Technology in Countering Terrorism" (2002).

10 See Table 3 in DHS-2006-0073: Department of Homeland Security, "Regulatory Assessment: Chemical Facility Anti-Terrorism Standards Interim Final Rule" (2007).

11 Edward R. Hamberger, Association of American Railroads, Statement before the U.S. House of Representatives, Committee on Transportation and Infrastructure, Subcommittee on Railroads, June 13, 2006.

12 Risk Management Solutions, Inc., "Catastrophe, Injury, and Insurance: The Impact of Catastrophes on Workers Compensation, Life, and Health Insurance" (2004).

13 Center for American Progress, "Preventing Toxic Terrorism."

14 Center for American Progress, "Toxic Trains and the Terrorist Threat."

15 Federal reading rooms are listed at www.epa.gov/oem/content/rmp/readingroom.htm. Portions of the RMPs other than off-site consequences analyses, such as general facility information, can be viewed through the Right-to-Know Network at http://data.rtknet.org/rmp.

16 An early EPA review of RMPs reported that "the median endpoint distance for toxic worst-case scenarios is 1.6 miles, while the median endpoint distance for flammable worst-case scenarios is 0.4 miles." James C. Belke, "Chemical Accident Risks in U.S. Industry: A Preliminary Analysis of Accident Risk Data from U.S. Hazardous Chemical Facilities" (Washington: Environmental Protection Agency, 2000).

17 Disregarding the most dangerous chemical *and* using identified alternatives at each of the top 101 facilities would remove the potential for an off-site toxic gas release from approximately two-thirds of the facilities, either because these facilities have no additional RMP toxic chemicals or because using the identified alternatives would eliminate such chemicals. More than 100 million people would be removed from harm's way if the 303 facilities listed in this report converted to the identified alternatives.

18 Association of American Railroads, "Homeland Security Committee Urged to Consider Safer Chemicals; Chemical Companies Should Stop Manufacturing Extremely Dangerous Chemicals" (2008).

19 Rail shipments of toxic inhalation hazard gases in the United States account for 59 percent of tonnage and 95 percent of ton-miles among all modes of transport. General Accounting Office, "Rail Safety and Security: Some Actions Already Taken to Enhance Rail Security, but Risk-based Plan Needed" (2003).

20 U.S. producers of liquid bleach without bulk transportation or storage of chlorine gas include: Odyssey Manufacturing, Tampa, Fla.; BleachTech, Seville, Ohio, and Petersburg Va. (under construction); Kuehne Chemical, Delaware City, Del.; and K2 Pure Solutions in California and Chicago, Ill. (under development).

21 K2 Pure Solutions, "Making Life Safer" (2008).

22 An additional top-tier facility, not listed in Appendix A, is the Chemical Unloading Facility, Perris, Calif., which supports drinking water treatment through trans-loading chlorine gas from rail to truck. This facility is not currently in use but is under proposal to resume operations.

23 Reported disinfection treatments for public water systems serving more than 100,000 people. Environmental Protection Agency, "Safe Drinking Water Information System" (2007).

24 Center for American Progress, "Preventing Toxic Terrorism."

25 Government Accountability Office, "Securing Wastewater Facilities: Utilities Have Made Important Upgrades, but Further Improvements to Key System Components May be Limited by Costs and Other Constraints" (2006).

26 Government Accountability Office, "Wastewater Facilities: Experts' Views on How Federal Funds Should Be Spent to Improve Security" (2005); National Drinking Water Advisory Council, "Findings of the Water Security Working Group," (2005)—conveyed to EPA June 3, 2005; Chemical Safety and Hazard Investigation Board, "Investigation Report: LPG Fire at Valero-McKee Refinery" (2008).

27 These water utilities report holding on-site more than the RMP threshold 2,500 pounds of chlorine gas at any one time, according to the EPA's RMP data as of April 25, 2008.

28 Manufacturers of equipment to produce bleach without bulk storage of chlorine gas include Powell Fabrication and Manufacturing (for larger facilities) and Electrolytic Technologies (for smaller facilities).

29 Euro Chlor, "Chlorine Industry Review 2006-2007" (2007).

30 U.S. Public Interest Research Group Education Fund, "Needless Risk: Oil Refineries and Hazard Reduction" (2005).

31 Solid acid alkylation technologies include InAlk from UOP-Honeywell and AlkyClean, developed jointly by Albemarle Catalysts, Lummus Global, and Neste Oil. An additional process for the regeneration of spent sulfuric acid alkylation catalyst by electrolysis is described in U.S. Patent 5,547,655.

32 Two petroleum refineries that use Reduce Volatile Alkylation Process, or ReVAP, modified hydrofluoric acid are Valero Energy, Wilmington, Calif. and Holly Refining, Woods Cross, Utah. Both refineries report in RMPs submitted to the EPA a vulnerability zone for a worst-case release of hydrofluoric acid that would encompass more than 200,000 people.

33 Three paper mills that converted off chlorine gas for different reasons are listed on pages 12 and 13 of CAP's "Preventing Toxic Terrorism" report.

34 U.S. Public Interest Research Group Education Fund, "Pulp Fiction: Chemical Hazard Reduction at Pulp and Paper Mills" (2007).

35 See Eka Chemicals, www.purate.com.

36 "Medical Management Guidelines for Sulfur Dioxide," available at www.atsdr.cdc.gov/mhmi/mmg116.html (last accessed November 2008).

37 Vendors of sulfur-burning equipment include, among others, MECS Inc. and Chemithon Enterprises Inc.

38 See "Learn More About Sulphur" and "Sulphur 101," available at www.sulphurinstitute.org (last accessed September 2008).

39 See for example Southern Ionics Inc., www.southernionics.com.

40 An additional fertilizer manufacturing facility, Agriform, Woodland, Calif., reports 1,011,979 people within a 12-mile vulnerability zone. However, this vulnerability zone population is plainly overstated within a 12-mile radius of the facility, and for this reason the facility is not included among the top 101 highest-hazard facilities in this report.

41 Direct uses of ammonia as fertilizer can be broken down as: anhydrous ammonia (26 percent); urea/ammonium nitrate solutions (23 percent); urea (20 percent); ammonium nitrate (4 percent); ammonium sulfate (2 percent); other forms (3 percent); and multiple nutrient forms (21 percent). Agency for Toxic Substances and Disease Registry, "Toxicological Profile for Ammonia" (2004).

42 See for example Clean Harbors, Bristol, Conn., in CAP's "Preventing Toxic Terrorism" report.

43 The United Soybean Board lists seven companies that produce vegetable-based polyols at www.soynewuses.org/ProductsGuide/Ingredients_Industrial-Plastics.aspx.

44 For example, PVS Technologies in Augusta, Ga., switched from rail to pipeline supply of chlorine gas, eliminating a worst-case chemical release vulnerability zone that formerly encompassed 290,000 people.

45 European Chemical Industry Council, "Chemistry Sectors/Colourants & Fillers/Titanium Dioxide Manufacturers Association" available at www.cefic.org (September 2008).

46 The first commercial route to butanediol used acetylene and formaldehyde. Other routes include processes used or designed by Mitsubishi Chemicals, Lyondell (propylene oxide), BP/Lurgi, Darien, Aker Kvaerner, Huntsman (maleic anhydride), and Davy Process Technologies.

47 For PVC substitute materials, see Frank Ackerman and Rachel Massey, "The Economics of Phasing Out PVC" (Boston: Tufts University, 2003); web resources from the Healthy Building Network, available at www.healthybuilding.net/pvc/index.html.

48 Joe Thornton, *Pandora's Poison: Chlorine, Health, and a New Environmental Strategy* (Cambridge: MIT Press, 2000); Charles River Associates for the Chlorine Institute, "Assessment of the Economic Benefits of Chlor-Alkali Chemicals to the United States and Canadian Economies" (1993).

49 Vulnerability zones for power plants using anhydrous ammonia average 21,506 people over 3.56 miles, and for power plants using aqueous ammonia 205 people over 0.35 miles. Working Group on Community Right-to-Know, "Unnecessary Dangers: Emergency Chemical Release Hazards at Power Plants" (2004).

50 Congressional Research Service, "Memorandum to the Honorable Edward Markey: RMP Facilities in the United States as of February 2008" (2008).

Acknowledgements

Paul Orum prepared this report. Reece Rushing, director of regulatory and information policy at the Center for American Progress, provided editorial assistance and project oversight. Philip J. Crowley, senior fellow and director of national defense and homeland security at the Center for American Progress, provided guidance and comments. Rich Puchalsky of Grassroots Connection provided valuable data processing. The Right-to-Know Network (www.rtknet.org) provided a useful depth of information. The following individuals provided helpful suggestions or comments, which may differ from views expressed in the report: Liz Hitchcock (U.S. Public Interest Research Group); Darius Sivin (United Auto Workers); Rick Hind (Greenpeace); Lauren Heine (Clean Production Action); Wilma Subra (Subra Company); and Tom McQuiston (USW Tony Mazzocchi Center). The author greatly appreciates the assistance of many other people who responded to inquiries about technologies and opportunities to reduce chemical hazards.

Paul Orum authored two previous reports published by the Center for American Progress: "Preventing Toxic Terrorism: How Some Chemical Facilities are Removing Dangers to American Communities" (2006) and "Toxic Trains and the Terrorist Threat: How Water Utilities Can Get Chlorine Gas Off the Rails and Out of American Communities" (2007).

The Center for American Progress is a nonpartisan research and educational institute dedicated to promoting a strong, just and free America that ensures opportunity for all. We believe that Americans are bound together by a common commitment to these values and we aspire to ensure that our national policies reflect these values. We work to find progressive and pragmatic solutions to significant domestic and international problems and develop policy proposals that foster a government that is "of the people, by the people, and for the people."

Center for American Progress

1333 H STREET, NW, 10TH FLOOR, WASHINGTON, DC 20005 • TEL: 202-682-1611 • FAX: 202-682-1867 • WWW.AMERICANPROGRESS.ORG