CHARACTERISTICS AND COMMON VULNERABILITIES INFRASTRUCTURE CATEGORY: CHEMICAL FACILITIES

Protective Security Division
Department of Homeland Security

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Preventing terrorism and reducing the nation's vulnerability to terrorist acts requires understanding the common vulnerabilities of critical infrastructures, identifying site-specific vulnerabilities, understanding the types of terrorist activities that likely would be successful in exploiting those vulnerabilities, and taking preemptive and protective actions to mitigate vulnerabilities so that terrorists are no longer able to exploit them. This report characterizes and discusses the common vulnerabilities of chemical manufacturing facilities that produce and handle large quantities of inherently hazardous materials and manufacture final and intermediate products that are fundamental elements of other economic sectors.

CHEMICAL MANUFACTURING FACILITY CHARACTERISTICS

Common Facility Characteristics

While hazardous and nonhazardous chemicals are stored and used in many industries, the focus of this report is specific to facilities that manufacture chemicals. A chemical manufacturing facility comprises upstream components, process units, downstream components, and product storage. The chemical manufacturing process can be further divided into the following five stages, each of which may contain one or more processing activities: (1) receipt of chemical ingredients, (2) temporarily staging or storing chemical ingredients awaiting use in production, (3) processing chemical ingredients into product, (4) temporarily staging or storing chemical products awaiting shipment, and (5) shipping chemical products. A chemical may not present a security hazard during all activities; for example, a hazardous chemical may be converted to a nonhazardous material during production. One way to determine which processing activities provide the potential for an undesired event is to review the following attributes for each activity. They include

- The type of process activity under way;
- The specific chemicals being used and whether or not they are listed in:
  - 40 CFR 68.130 (Environmental Protection Agency [EPA] list of toxic substances for accident release prevention);

- 29 CFR 1910.119 (Occupational Safety and Health Agency [OSHA] highly hazardous chemicals);
- 49 CFR 172.101 ("hazardous materials" for the purpose of transportation);
- 33 CFR 127, 153.40, and 154 (Coast Guard regulations for dangerous cargo and contiguous waterfront facilities);
- Chemicals governed by the Chemical Weapons Convention (CWC);
- Those identified by the Federal Bureau of Investigation (FBI) as "chemicals for potential misuse as weapons of mass destruction" (FBI-List chemicals);
- Those identified by the Australia Group[11];

- The quantity, form, and concentration of the chemicals;
- The accessibility and recognizability of the chemicals; and
- The potential for off-site release of the chemicals, theft, or product contamination.

Chemical manufacturing facilities differ according to their complexity and physical configuration. Nevertheless, Figure 1 provides an example of the typical process flow for a chemical manufacturing facility [http://www.ncjrs.org/pdffiles1/nij/195171.pdf]. Figure 2 is a photo of an actual chemical manufacturing facility [http://www.saitechinc.net].

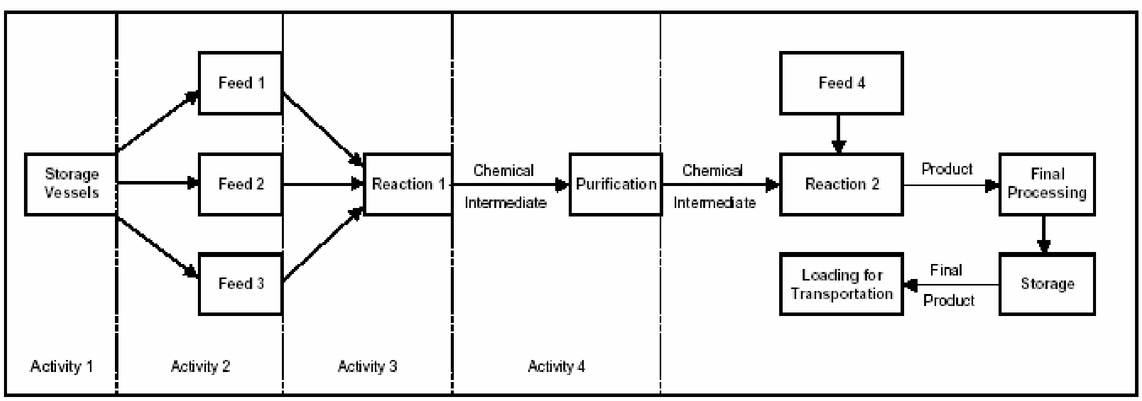

Figure 1 Chemical Manufacturing Process Flow

[1] The Australia Group of countries aim to ensure, through licensing of certain chemicals, biological agents, and dual-use chemical and biological manufacturing equipment, that exports of these items from their countries do not contribute to the spread of chemical and biological weapons (CBWs) without impeding trade of materials and equipment used for legitimate commercial purposes. All states participating in the Australia Group, including the U.S., are parties to the Chemical Weapons Convention and the Biological Weapons Convention.

Figure 2 Chemical Facility

Characterization of the Chemical Manufacturing Industry

This section provides fundamental information about the structure of the industry and the types, numbers, and regional concentrations of chemical manufacturing facilities. The chemical manufacturing industry produces an enormous number of materials. Government sources estimate that there are 15,000 chemicals manufactured in the United States (U.S.) in quantities greater than 10,000 pounds (EPA 2002). The organic chemicals industry, which manufactures carbon-containing chemicals, accounts for much of this diversity.

The Office of Management and Budget (OMB) established the Standard Industrial Classification Industry Group Number (SIC codes)[2] to track the flow of goods and services within the economy. The general structure of the chemical industry by SIC codes is displayed in Table 1. These SIC codes can be aggregated into organic, inorganic, and agricultural segments. The organic and inorganic chemical industries obtain raw materials (from petroleum and mined products, respectively) and convert them to intermediate materials or basic finished chemicals. The remaining industries in SIC 28 convert intermediate materials into a spectrum of specialized finished products.

[2] SIC codes were replaced in 1997 by a similar classification scheme, the North American Industrial Classification System (NAICS) codes. The traditional SIC system is used throughout this report because of its familiarity and because the SIC system is still used in many historical information sources.

Table 1 Structure of the Chemical Industry (SIC 28)

SIC Code	Industry Sector
281	Inorganic chemicals
282	Plastics materials and synthetics
283	Drugs
284	Soaps, cleaners, and toilet goods
285	Paints and allied products
286	Organic chemicals
287	Agricultural chemicals
289	Miscellaneous chemical products

The chemical industry produces many materials that are essential to the economy and modern life (e.g., plastics, pharmaceuticals, and agricultural chemicals). Although these end products have very different characteristics, they are created from a relatively small number of raw materials. These common inputs, or feedstocks, for the industry are supplied by petroleum refiners: ethylene, propylene, benzene, methanol, toluene, xylene, butadiene, and butylene (Szmant 1989). Other feedstocks come from coal, natural gas, and wood. Numerous processes are used to produce a wide range of chemicals from these feedstocks.

Organic Chemicals Industry. The organic chemicals industry accounted for approximately $80 billion in shipments in 2000, one-fifth of the output of the entire chemical industry (U.S. Department of Commerce 2000). Organic chemical manufacturing facilities generally are located in four areas of the U.S. Gum and wood chemical production is found primarily in the Southeast, near wood and pulp production facilities. Other organic chemicals facilities are predominantly located near the Gulf of Mexico, where many petroleum-based feedstocks are produced, and near downstream industrial users in the Northeast and Midwest.

Figure 3 Geographic Distribution of U.S. Organic Chemical Manufacturing Facilities

***Inorganic Chemicals Industry*.** The inorganic chemical industry manufactures more than 300 different chemicals, accounting for about 10% of the total value of chemical shipments in the U.S. Inorganic chemicals include alkalies and chlorine (SIC 2812), industrial gases such as hydrogen, helium, oxygen, nitrogen (SIC 2813), inorganic pigments (SIC 2816), and other industrial inorganic chemicals (SIC 2819).

Approximately two-thirds of the value of shipments for the inorganic chemical industry (including more than 200 different chemicals) is classified under industrial inorganic chemicals not elsewhere classified (SIC 2819). However, the inorganic chemicals industry group does include a significant number of integrated firms that are engaged in the manufacture of other types of chemicals at the same site. Conversely, many manufacturing facilities not categorized in this industry group, especially organic chemical manufacturing facilities (SIC 286), fertilizer plants (SIC 287), pulp and paper mills (SIC 26), and iron and steel mills (SIC 331), produce and use inorganic chemicals in their processes at the same facility. For example, a significant number of inorganic chemical manufacturing processes are part of very large chemical manufacturing or pulp manufacturing facilities, making characterization strictly by SIC code difficult.

Inorganic chemical manufacturing facilities are typically located near consumers and, to a lesser extent, raw materials. The largest use of inorganic chemicals is in industrial processes for the manufacture of chemicals and nonchemical products; therefore, facilities are concentrated in the heavy industrial regions along the Gulf Coast, both the East and West Coasts, and the Great Lakes region. Since the organic chemical manufacturing industry uses a large portion of the inorganic chemicals produced, the geographical distribution of inorganic facilities is very similar to that of organic chemical manufacturing facilities (Figure 4).

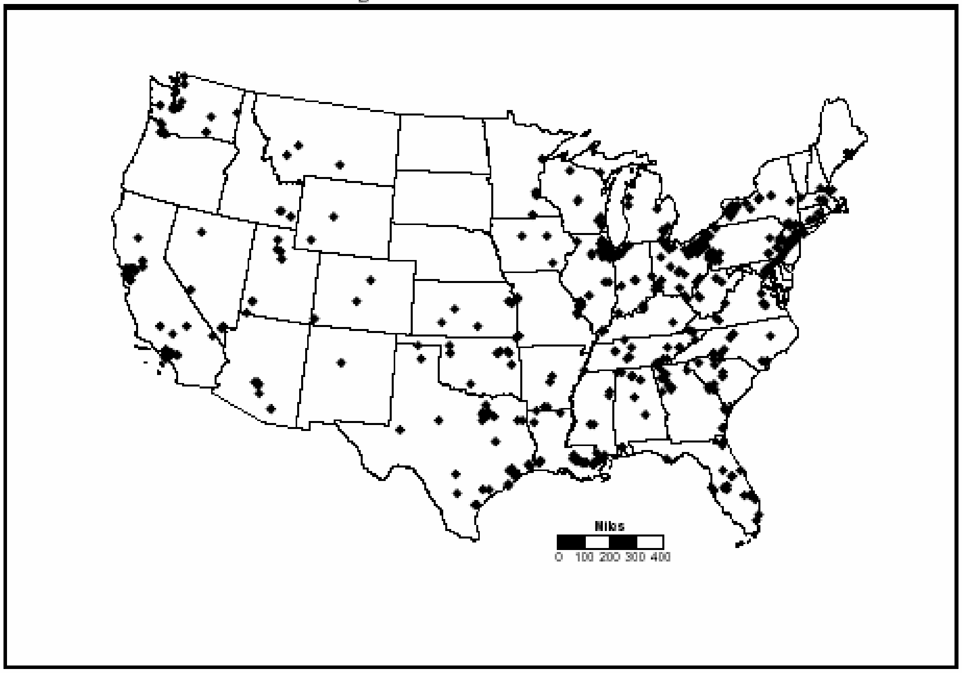

Figure 4 Geographic Distribution of U.S. Inorganic Chemical Manufacturing Facilities

The distribution of the chlor-alkali sector differs from that of the inorganic chemical industry as a whole. Since chlorine and caustic soda are co-products produced in almost equal amounts, the distribution of the caustic soda manufacturing industry is essentially the same as that of the chlorine manufacturing industry. Chlorine is difficult to store and transport economically; therefore, chlorine and caustic soda are produced near the chlorine consumers, which are primarily chemical manufacturers and pulping operations. Consequently, chlor-alkali facilities are concentrated near the chemical industries along the Gulf Coast, followed by the Great Lakes region, as shown in Table 2. In 1989, almost half of the chlorine plants in the U.S. (72% of domestic chlorine production) were located along the Gulf Coast. Two states, Louisiana and Texas, accounted for two-thirds of the domestic chlorine production.

Table 2 Chlorine Facilities Located Primarily Along the Gulf Coast and in the Southeast, Northwest, and Great Lakes Region

State	Number of Chlorine Plants	Annual Capacity (thousand tons)	U.S. Percent of Capacity Operating Total
Louisiana	9	4,068	37
Texas	5	3,314	30
New York	4	652	6
Alabama	5	592	5
Washington	4	503	5
West Virginia	2	392	3
Georgia	3	246	2
Tennessee	1	230	2
Other states (14)	19	1,139	10
U.S. total	52	11,136	100

Source: *Kirk-Othmer Encyclopedia of Chemical Technology,* 4th ed. Vol. 1, 1993.

Agricultural Chemicals. The fertilizer, pesticide, and agricultural chemical industry is classified by SIC group 287. Industry Group 287 includes these SIC codes

2873 Nitrogenous fertilizers,
2874 Phosphatic fertilizers,
2875 Fertilizers (mixing only), and
2879 Pesticides and agricultural chemicals not elsewhere classified (n.e.c).

SIC 2879, pesticides and agricultural chemicals n.e.c., hereafter referred to as pesticides and miscellaneous agricultural chemicals, covers only the formulating, preparing, and packaging of ready-to-use agricultural and household pest control chemicals. This code also includes establishments primarily engaged in the manufacturing or formulating of agricultural chemicals (n.e.c.) such as minor or trace elements and soil conditioners.

Figure 5 shows the U.S. distribution of fertilizer manufacturing and mixing facilities. The geographic distribution of nitrogenous and phosphatic fertilizer manufacturers is determined by natural resources and demand. Seventy percent of synthetic ammonia plants in the U.S. are concentrated in Louisiana, Texas, Oklahoma, Iowa, and Nebraska because of their abundant natural gas supplies. The majority of nitric acid plants are located in agricultural regions, such as the Midwest, South Central, and Gulf States, to accommodate the high volume of fertilizer usage. Florida has the largest phosphate rock supply in the U.S.; thus, phosphoric acid manufacturing is concentrated primarily in Florida and spreads into the Southeast.

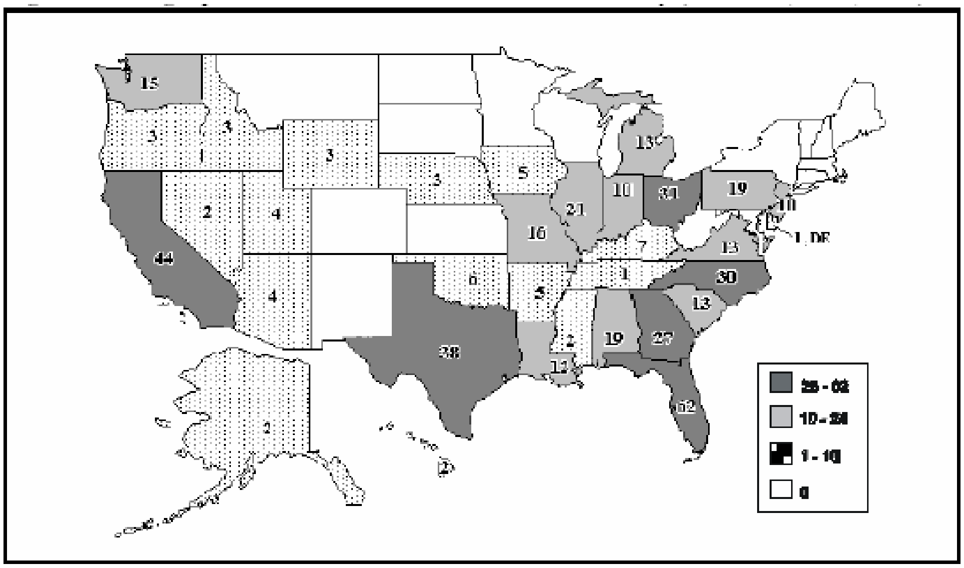

Figure 5 Geographic Distribution of Fertilizer Industry

Source: 1992 Census of Manufacturers, Industry Series: Agricultural Chemicals, U.S. Department of Commerce, Bureau of the Census, May 1995.

The Census of Manufacturers reports 263 establishments that can be defined as producing pesticides and miscellaneous agricultural chemicals. These establishments reportedly account for almost half of the value of shipments for the sector. There are more than 8,000 establishments identified by the EPA that manufacture, formulate, and package pesticides and other agricultural chemicals and that could fall within OMB's SIC code definition for this sector (Sector Notebook Project 22, September 2000). Many of these establishments are small and have as their primary line of business a business other than producing pesticides and other miscellaneous agricultural chemicals. Because the Census Bureau only counts those facilities that report an SIC code as their primary line of business, the number of facilities shown above is not inclusive of all facilities involved in agricultural chemical production.

Figure 6 shows the U.S. distribution of pesticide and miscellaneous agrichemical formulating facilities. It follows the general distribution of the petrochemical industry (the coasts and Great Lakes) upon which the industry relies for its raw materials and the distribution of agricultural production in the U.S. (Midwest and Great Plains states).

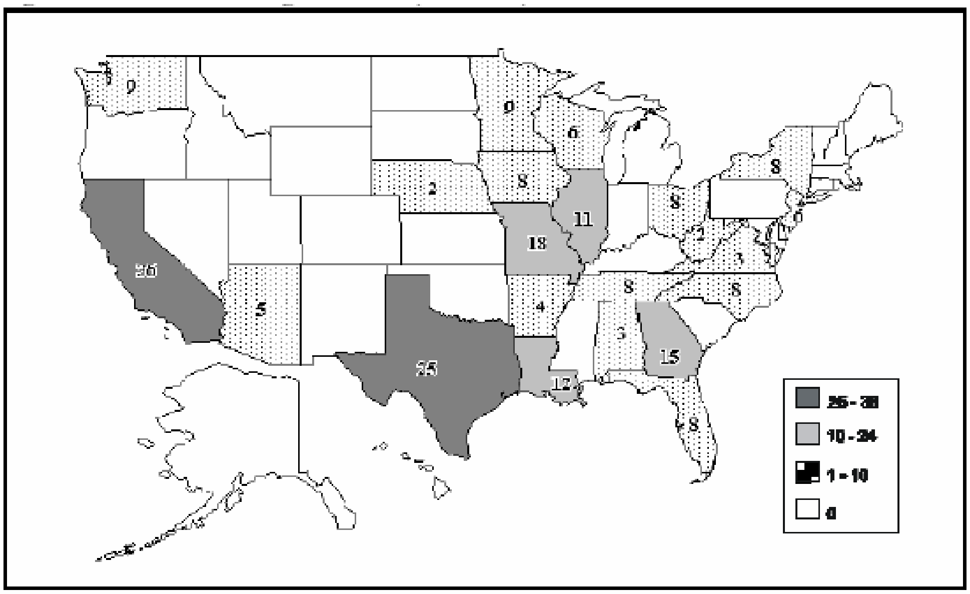

Figure 6 Geographic Distribution of the Pesticide Formulating and Miscellaneous Agrichemical Formulating Facilities (SIC 2879)
Source: 1992 Census of Manufacturers, Industry Series: Agricultural Chemicals, U.S. Department of Commerce, Bureau of the Census, May 1995.

Standards

Regulatory requirements for chemical facilities, including chemical manufacturing facilities, are directed at reducing the environmental impacts of chemical processes. Chemical facilities must comply with all federal and state environmental regulations concerning

- Air emissions from process units and risk management planning (Clean Air Act);
- Toxic Release Inventory reporting and emergency planning in coordination with the Local Emergency Planning Committee (Emergency Planning and Community Right-to-Know Act of 1986 [EPCRA] expanded by the Pollution Prevention Act of 1990);
- Waste and Wastewater Management, including wastewater discharges to water courses (Resource Conservation and Recovery Act, Clean Water Act) and underground injection wells (Safe Drinking Water Act);
- Water withdrawal/treatment and the protection of sole-source aquifers (Safe Drinking Water Act); and
- Remediation of contaminated properties (Resource Conservation and Recovery Act, CERCLA).

Chemical facilities also have to comply with all employee safety and occupational health requirements, including personal protective equipment (PPE) and equipment control and maintenance (Occupational Safety and Health Act). In addition, a chemical plant would have to comply with the regulations for the shipment of hazardous materials (49 U.S.C. 5101) and pipeline transport of hazardous materials (49 U.S.C. 60101). In addition, the chemical industry is governed by the Federal food, Drug and Cosmetics Act, the Food Quality Protection Act, the Chemical Diversion and Trafficking Act, as well as state-specific regulations.

Depending on the products used or produced at the site, a chemical facility may also fall under the jurisdiction of a variety of federal laws designed to prevent the diversion of products for illegal purposes, including the Chemical Weapons Convention and the Drug Enforcement Administration’s List 1 and List 2 precursor counter-diversion program. Many states also regulate the security and records-keeping practices of facilities manufacturing or storing (DEA) listed chemicals.

CONSEQUENCE OF EVENT

The industry has identified three categories of potential consequences of a successful attack on a facility:

1. Uncontrolled release of material,
2. Theft of material, and
3. Contamination of product or process.

Uncontrolled Release of Material

Severity of consequences would depend on (1) the toxicity of the material on the site, (2) the amount of material, (3) the actions of the material if released, (4) the accessibility of the material to attack, and (5) the ability of the facility and community to respond, free from interdiction.

All chemical facilities that use or produce chemicals are required to have a Material Safety Data Sheet (MSDS) that lists those chemicals. They have also developed emergency response plans in collaboration with local fire and other first responders under the requirements of the Emergency Planning and Community Right to Know Act (EPCRA). The lists of chemicals are given to the local emergency planning committee, the state emergency response committee, and the local fire department. Again, the facility emergency response plans may be a useful source of information regarding potential target chemicals plans in place to prevent and mitigate a release.

The Clean Air Act requires facilities with more than a threshold quantity of a listed extremely hazardous substance to have a risk management program in place and to submit a Risk Management Plan (RMP) to the EPA. The List of Regulated Substances includes 77 toxic substances and 63 flammable substances, which can be found in the *Code of Federal Regulations* (40 CFR 68). Information contained in an RMP for a facility of interest—which would include any chemical plant using, storing, manufacturing, or handling toxic or flammable chemicals—can be helpful in understanding the specific facility assets that might be of interest to terrorist groups and the potential consequences of a successful attack.

Unfortunately, until 1999, the executive summaries were available publicly and could have been acquired by terrorist organizations. Currently, RMP executive summaries can no longer be accessed from the EPA website directly. Complete RMPs, including the off-site consequence analysis (OCA), which describes the demographics within a certain radius of the facility as well as environmental receptors within that radius, are kept by the EPA. Other governmental agencies may have access to this information upon special request to the EPA. In addition, complete RMPs (including OCA information) are available (with certain restrictions) for viewing in paper form at EPA and Department of Justice (DOJ) reading rooms located throughout the U.S. Such access is required by Public Law 106-40 (the Chemical Safety Information, Site Security, and Fuels Regulatory Relief Act, Ref. 15). However, RMP information can be obtained for most covered facilities from the Right-to-Know Network [http://d1.rtk.net/rmp/wgrmp.php]. This website could be an important source of information for terrorists to use in selecting targets and estimating the consequences of their attack scenarios.

The executive summaries available on the Internet vary but often provide detailed information that could be useful to terrorists planning an attack. These summaries must, by regulation, include a description of (1) the accidental release prevention and emergency response policies at the facility; (2) the facility and the regulated substances handled; (3) the worst-case release scenario(s), defined below, and the alternative release scenario(s), including administrative controls and mitigation measures to limit the distances for each reported scenario; (4) the general accidental release prevention program and chemical-specific prevention steps; (5) the five-year accident history; (6) the emergency response program; and (7) planned changes to improve safety. Some executive summaries also contain detailed OCA information.

An estimated 15,000 facilities nationwide handle, manufacture, use, or store toxic and flammable substances in quantities above the EPA-regulated thresholds. The worst-case release scenario included in the RMP considers a hypothetical release of toxic or flammable substances that has the greatest exposure distance in any direction. Many facilities exist in populated areas where a chemical release could threaten thousands. The EPA reports that 123 chemical facilities located throughout the nation have worst-case scenarios in which more than 1 million people are within the circle whose radius is equal to the "endpoint distance" of the hypothetical vapor cloud ("vulnerable zone"). Since toxic vapor generally travels only in the downwind direction, only people located under the plume within the vulnerable zone could actually be exposed. Each of about 586 facilities has a vulnerable zone affecting between 100,001 and 1 million people. Each of about 2,000 facilities has a vulnerable zone affecting between 10,001 and 100,000 people.

The chemicals stored, used, and manufactured obviously vary with each type of chemical plant. However, a common example of a worst-case scenario associated with a hazardous chemical release in RMP-covered processes at a chemical facility might be a catastrophic failure of a chlorine railroad tank car that could produce a chlorine plume traveling more than 25 miles before dispersing enough to no longer pose a public hazard. If public receptor locations exist just outside the chemical facility's property, this event could affect members of the public at the closest locations. RMP worst-case scenarios are based on the assumption that the release is accidental. Therefore, an act of malfeasance may produce different results than those contemplated under an RMP. However, RMP executive summaries may provide terrorists with a valuable source of information on potential target chemicals and consequences, as well as steps the facility has taken to prevent a release.

Theft of Material

Consequences of the theft of material are a function of (1) the attractiveness of the material as a weapon, (2) the attractiveness of the material as a means to make a weapon, (3) how the materials are stored or shipped (small, portable units versus large containers), (4) accessibility of material to theft, and (5) the chemistry involved in making a deliverable weapon out of the material in question.

Facilities that use or produce materials that could readily be "weaponized" work closely with the Department of Commerce (chemical weapon precursors), Drug Enforcement Administration, Food and Drug Administration, and FBI to prevent diversion of such materials. The facility's protocols for receipt and shipment of such materials, including protocols for identifying suspicious orders, may be a useful source of information regarding potential theft targets and theft prevention measures. For the most part, these measures are aimed at preventing large-scale diversion of precursor chemicals. This may be sufficient in the case of materials where the weaponization process is complex and requires sophisticated knowledge and equipment. In the case of chemicals that can be weaponized with simple equipment and little training, a more complete counter-theft program is appropriate to complement the counter-diversion programs.

Product Contamination

Product contamination comes in two forms. First, and most obvious, is the introduction of a tainting agent into a chemical that will find its way into public use. The classic example is the addition of cyanide to several bottles of Tylenol. Such sabotage at the root chemical level could have far-ranging consequences, depending on the post-sabotage processing.

Many chemical products go into the nation's food or health care systems. Like water systems, the materials may have few properties that would make them attractive other than as a weapon delivery mechanism. Consequences of product contamination are a function of (1) the use of the material and (2) access to the production, packaging, storage, or shipping functions.

The second, less obvious form of sabotage would be exemplified by the addition of an initiator to a polymerizing chemical (e.g., adding hydrogen peroxide to a railcar filled with acrylic acid). Such sabotage is aimed at the destruction of an asset or possibly at a particular target, depending on the situation wherein the sabotage occurs. This type of sabotage is very costly to protect against.

COMMON VULNERABILITIES

Critical infrastructures and key assets vary in many characteristics and practices relevant to specifying vulnerabilities. There is no universal list of vulnerabilities that applies to all assets of a particular type within an infrastructure category. Instead, a list of common vulnerabilities has been prepared, based on experience and observation. These vulnerabilities should be interpreted as possible vulnerabilities and not as applying to each and every individual facility or asset. Many chemical facilities have instituted security vulnerability assessment protocols, site prioritization processes, and risk-based approaches to improving security performance, including provisions to increase security measures during heightened threat conditions. The security improvements implemented by chemical companies under such protocols may mitigate certain vulnerabilities listed below.

Exhibit 1 Site-Related Vulnerabilities	
Site-related vulnerabilities are conditions or situations existing at a particular site or facility that could be exploited by a terrorist or terrorist group to do economic, physical, or bodily harm or to disable or disrupt facility operations or other critical infrastructures.	
Access and Access Control	
1	Public roads may be in close proximity to critical assets (e.g., storage tanks) or entrance points.
2	Critical assets may be set close to the perimeter fence.
3	Facilities may be located in remote, rural, or semi-rural locations.
4	Public roads or rail lines may pass over some chemical facilities.
5	Rail lines adjacent to or through chemical facilities may make it difficult to define and protect the facility perimeter.
6	Rail lines or spurs pass through or are adjacent to the facility.
7	Railcar storage may be located within or adjacent to a chemical facility.
8	The contents of railcars may not be provided to facility owners.
	Continued on next page.

9	Hazardous and toxic feedstocks, intermediates, and finished chemical products are loaded/unloaded at chemical facilities.
10	Facilities may not have rigorous procedures to inspect railcars for explosives before entering the facility.
11	Facilities typically use contract guard services, and turnover rates in the guard force may be high.
12	Facilities may not have rigorous procedures to inspect trucks for explosives before entering the facility.
13	Heavy truck traffic may come through a chemical facility. Inspections to verify cargo, driver identification, bill of laden, and weight may not be rigorously conducted.
14	Facilities may not provide on-site escorts for all toxic and hazardous chemical shipments routinely coming into a chemical facility.
15	Railcar or truck spills could be caused intentionally and spread throughout a chemical facility requiring facilities to implement its hazardous material spill prevention, response, and mitigation plan.
16	Access control at ports/piers, via either the water or a beach, is difficult to enforce.
17	Gates and critical assets near the perimeter fence line may not be protected by appropriate barriers or other hardening equipment.
18	Many facilities use contract guard services. Guard staff may not be adequately trained, and may not be armed. Company security departments may be understaffed.
19	Critical facilities or assets may not be completely or adequately enclosed.
20	Chemical facilities may not have signs posted to deter vehicles, boats, or pedestrians from entering the facility premises.
21	Camera surveillance may not cover all critical assets.
22	Lighting may be inadequate in certain parts of the chemical facility (e.g., too little, poorly spaced, or improperly directed).
23	Entrances to critical assets within the facility (e.g., control rooms) may not have controlled access. Once someone has gained access to the site, that person may have access throughout multiple areas within the chemical facility.
24	Access identification may not be required or may not be adequately enforced.
25	Employee and visitor parking may be located next to critical buildings.
Operational Security	
26	Risk Management Plan information is publicly available. Worst-case scenario for toxic and flammable release may be readily available.
27	Background checks conducted on employees and contractor personnel may be limited. Some states or even union contracts limit the use of background investigations.
28	There may be gaps in coordination with local, state, and federal agencies on roles/responsibilities.
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29	Websites may provide detailed information on chemical facility locations, critical assets, maps, and other operational data.
30	Hacking may provide adversaries with additional information.
31	Lists of chemical facility locations may be available through public sources.
SCADA & Process Control	
32	Security may be lacking around servers and control rooms.
33	There is a potential for intruders to hack into SCADA/process control through the company enterprise network.
34	There is a potential for a controller to cause an undesirable event.
35	Standardized systems (e.g., Windows) and protocols may be used for SCADA and process control systems such that a vulnerability exploited at one chemical facility may be relevant at multiple chemical facilities.
36	The facility may not maintain a backup control center.
Emergency Planning and Preparedness	
37	Contingency plans may not be exercised on a routine basis.
38	Emergency operation center backup facilities may not be in place.
39	Spare parts that are large and/or expensive may be in short supply. Economic considerations may have reduced these spare part inventories. Some parts have long lead times to obtain or are available only from overseas vendors.
40	On-site aboveground pipelines may be vulnerable to attack causing fire or explosions.
41	Nontraditional fires/explosions may be created at chemical plants that cause additional challenges to first responders.
42	Additional coordination of emergency plans may be needed with industry neighbors and with local, state, and federal government authorities.
Hazardous and Toxic Chemicals	
43	Worst-case scenarios may be included in publicly available RMP filings.
44	Large storage tanks may be easily identifiable from offsite.
45	Many different types of hazardous and flammable chemicals may be stored, processed, and transported at one facility.
46	Certain toxic chemicals pose large loss-of-life scenarios if released.
Other System Operation Considerations	
47	Critical pipelines (e.g., feedstock delivery, on-site pipelines, and manufactured chemical product transportation), manifolds, and valves may be aboveground within the chemical facility premises.
48	Piers may be accessible, particularly at night.

Exhibit 2 Interdependent Vulnerabilities	
Interdependency is the relationship between two or more infrastructures by which the condition or functionality of each infrastructure is affected by the condition or functionality of the other(s). Interdependencies can be physical, geographic, logical, or information-based.	
General	
1	Loss of feedstock may reduce chemical facility operations and even shut down a chemical facility.
2	Ports/docks/piers may be shared by multiple facilities, such that loss of one asset may impact more than one chemical facility.
3	A disruption at one chemical facility could impact other facilities. An output at one facility may be a feedstock at another, and loss of that feedstock could cascade to other facilities.
Natural Gas	
4	Loss of natural gas may reduce or shut down chemical facility operations.
5	Although most natural gas pipelines are underground, valves and other aboveground equipment may be visible and detectable.
6	Natural gas rights-of-way are identified by signs.
Water	
7	Loss of water supply may shut down chemical facility operations (e.g., steam, process water, or fire-fighting resources). Water supply typically may be received from a single-fed pipeline.
8	Spare water pumps may or may not be available. Long lead times may be needed to procure new pumps.
9	Contamination of the water supply could impact chemical facility operations.
10	Quantities of chlorine may be stored on site for water purification and chemical processing.
Electric Power	
11	Off-site electric substations are generally unmanned and remote.
12	Off-site electric substations are easily identified by entry and exit of large high-voltage wires.
13	Although usually enclosed by a fence, critical equipment at on-site electric substations may be identified from off site.
14	Off-site electric substations are usually surrounded by property of third parties, over which the owner electric utility has little or no control or with which it may have little or no cooperation.
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15	At off-site electric substations, a long lead time may be needed to replace transformers because of the wide diversity in transformers installed at substations throughout a utility's service territory, depending on the date of installation and the function at the substation; some are actually unique to the rest of the utility's transformer inventory.
16	Utilities may not maintain an inventory of large spare transformers required for critical high-voltage electric substations.
17	Off-site electric utility transmission lines and support towers are identifiable and vulnerable because of their remote and easily accessed locations.
Telecommunication	
18	Handheld radios may be critical to chemical facility operations. Disruption of communications could reduce chemical facility throughput or even shut down a chemical facility.
19	Frequencies may be able to be scanned by adversaries to determine operating conditions, location of employees, on-going activities, etc.
20	Communication with first responders is crucial to react in a timely manner to incidents. Jamming or other methods may be used to disrupt communication channels.
21	Telecommunications may rely on a public switch network. Telephone congestion may occur during emergencies.

OTHER INFORMATION

Industry Activities to Decrease Vulnerabilities

Facilities whose companies are members of the American Chemistry Council (ACC) or the Synthetic Organic Chemical Manufacturers Association (SOCMA) are required as a condition of membership to implement the industry's Responsible Care Security Code of Management Practices. Not all chemical manufacturers are members, but the organizations estimate that their combined membership makes up about 90% of chemical productive capacity in the country. Familiarity with these industry-developed security requirements may facilitate review and understanding of the facility's security risk profile.

Under the Security Code, facilities are required to conduct Security Vulnerability Assessments (SVAs) using methodologies developed by Sandia National Laboratories, the Center for Chemical Process Safety (CCPA), or a methodology determined by CCPS to exhibit its equivalency criteria. Upon completion of the SVAs, facilities have one year to implement security enhancements to address the vulnerabilities identified. Facilities are also required to develop a security plan that includes (1) emergency response planning, training, and drills; (2) security communications; (3) internal security audits; (4) incident and threat response protocols; (5) management of change; and (6) continuous improvement. Information on the Security Code, vulnerability assessment methodologies, and implementation schedules is available on the web [http://www.responsiblecaretoolkit.com/security.asp].

USEFUL REFERENCE MATERIAL

1. American Chemistry Council website [http://www.americanchemistry.com].

2. U.S. Department of Homeland Security, "Potential Indicators of Threats Involving Vehicle-Borne Improvised Explosive Devices (VBIEDs)," *Homeland Security Bulletin*, May 15, 2003 [http://www.apta.com/services/security/potential_indicators.cfm]. This document includes a table of chemicals and other demolitions paraphernalia used in recent truck bomb attacks against U.S. facilities.

3. U.S. Federal Bureau of Investigation, *FBI Community Outreach Program for Manufacturers and Suppliers of Chemical and Biological Agents, Materials, and Equipment* [http://www.vohma.com/pdf/pdffiles/SafetySecurity/ChemInfofbi.pdf]. This document includes a list of chemical and biological materials likely to be used in furtherance of WMD terrorist activities.

4. Baybutt, Paul, and Varick Ready, "Protecting Process Plants: Preventing Terrorism Attacks and Sabotage," *Homeland Defense Journal*, Vol. 2, Issue 3, pp. 1–5, February 12, 2003 [http://www.homelanddefensejournal.com/archives/pdfs/Feb_12_vol2_iss3.pdf].

5. U.S. Environmental Protection Agency, *Envirofacts Data Warehouse* [http://www.epa.gov/enviro/]. This site has information about EPA-regulated chemical facilities. For example, users can obtain maps showing the facility and lists of toxic chemicals used or produced at the site.

6. Right-to-Know Network, Risk Management Plans, Executive Summaries [http://d1.rtk.net/rmp/wgrmp.php]. This site has information listed by state for all chemical plants that have filed risk management plans. The executive summary includes a description of the worst-case release scenario for regulated toxic chemicals and regulated flammable chemicals.

7. U.S. General Accounting Office, *Homeland Security: Voluntary Initiatives Are Under Way at Chemical Facilities, but the Extent of Security Preparedness is Unknown*, GAO-03-439, March 2003 [http://www.gao.gov/].

8. American Chemistry Council, Chlorine Institute, Synthetic Organic Chemical Manufacturers Association, *Site Security Guidelines for the U.S. Chemical Industry*, October 2001 [http://www.americanchemistry.com/].

9. American Institute of Chemical Engineers, *Guidelines for Analyzing and Managing the Security Vulnerabilities of Fixed Chemical Sites*, Center for Chemical Process Safety, August 2002 [http://www.aiche.org/ccpssecurity/].

10. James M. Tour, "Do-It-Yourself Chemical Weapons," *Chemical & Engineering News*, Vol. 78, No. 28, pp. 42–45 [http://pubs.acs.org/hotartcl/cenear/000710/7828perspective.html].

11. U.S. Chemical Weapons Convention Web Site, Annex on Chemicals [http://www.cwc.gov/treaty/annex_chem/annonchem_html#Sched-B]. This website lists chemicals that are considered toxic or weapons precursors.

12. Belke, James C., *Chemical Accident Risks in U.S. Industry—A Preliminary Analysis of Accident Risk Data from U.S. Hazardous Chemical Facilities*, U.S. Environmental Protection Agency, Chemical Emergency Preparedness and Prevention Office, Washington, DC, September 25, 2000. This paper contains analysis of information provided in the chemical industry risk management plans covering the 1994–1999 time period.

13. U.S. Environmental Protection Agency, Chemical Emergency Preparedness and Prevention Office, *Consolidated List of Chemicals Subject to Emergency Planning and Community Right-to-Know Act (EPCRA) and Section 112(r) of the Clean Air Act*, EPA-550-B-01-03, October 2001 [http://yosemite.epa.gov/oswer/ceppoweb.nsf/vwResourcesByFilename/title3.pdf/$file/title3.pdf].

14. National Fire Protection Association, Hazard Ratings under NFPA 704—Standard System for the Identification of the Hazards of Materials for Emergency Response [http://www.unomaha.edu/~wwwehs/NFPA704/nfpa_704_ratings_for_common_chem.htm].

15. U.S. Environmental Protection Agency, Chemical Emergency Preparedness and Prevention Office, EPA Federal Reading Rooms [http://yosemite.epa.gov/oswer/ceppoweb.nsf/content/readingroom.htm].

16. ACC Responsible Care website, *Security Code of Management Practices* and associated guidance documents [http://www.responsiblecaretoolkit.com/security.asp].

17. American Chemistry Council, *Guide to the business of Chemistry*, (2002).

18. American Chemistry Council, Chlorine Institute, Inc. and synthetic Organic Chemical Manufacturers Association, *Site Security Guidelines for the U.S. Chemical Industry*, October 2001).

19. U.S. Department of Justice, Office of Justice Programs, National Institute of Justice, *A Method to Assess the Vulnerability of U.S. Chemical Facilities*, (November 2002).