INSTITUTE FOR HOMELAND SECURITY

Sam Houston State University

IMPROVING TEXAS HOMELAND SECURITY:

A PRACTICAL FRAMEWORK FOR JOINT HOSPITAL-CHEMICAL INDUSTRY EMERGENCY PLANNING

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Improving Texas Homeland Security: A Practical Framework for Joint Hospital-Chemical Industry Emergency Planning

"A secure and resilient nation with the capabilities required across the whole community to prevent, protect against, mitigate, respond to, and recover from the threats and hazards that pose the greatest risk." (United States, National Preparedness Goal)

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Contents

Abstract:

Given the high concentration of petroleum and chemical industry in Texas, a new approach to joint industry/hospital planning for the healthcare response to chemical accidents is needed. The novel aspect of this framework is that it applies the concepts of a chemical risk assessment – and a risk prioritization to readiness - and adds to the risk assessment process the need and availability of medical countermeasures. In treating chemical incidents, it is imperative that the patient get to the right hospital as quickly as possible. The right hospital means that the hospital has conducted joint planning and exercises with the industry. The hospital knows what chemicals are used at the plant, they know how to treat the injuries, and they have the correct medical countermeasures for the chemicals involved. To illustrate the importance of this concept, in a 1986 incident a plant worker was exposed to hydrogen fluoride gas. He was first transported to a nearby nursing home for oxygen. When this was not effective, he was transported to a small community hospital. When they realized they could not care for him he was again transported to a regional hospital that had the ability to treat the patient, but unfortunately too much time had passed, and the patient died shortly after arrival. If taken to the right hospital first, he would have survived.

The proposed framework for joint industry/hospital planning will be described and can be used in a practical way for planning, training, and exercise development at any Texas location that includes chemical industry and a nearby hospital.

The basic process is:

- Conduct an inventory of toxic industrial chemicals in use and do a risk prioritization of those chemicals (based on volume and toxicity)
- Determine if specific medical countermeasures (MCM) are required for medical treatment for priority risk chemicals
- Model release scenarios to estimate the volume of medical countermeasures that might be needed
- Inventory the volume of that MCMs available in the region, if sufficient supplies are not available – work with Industry on contingencies
- Conduct joint planning and exercises with industry for occupational exposures and community exposures guided by modeled scenarios

The work presented is based on work done with a gasoline refinery in Texas. The plant uses large volumes of Hydrogen Fluoride in their process. Calcium Gluconate is the medical countermeasure needed for treatment, but it had been on the National Pharmaceutical Shortage list and generally is not held by hospitals in large volumes. Joint readiness would benefit workers at the plant that might suffer occupational exposure, but it would also be applicable to a larger release that could affect the fence-line community. An incentive to the Chemical Sector to collaborate with the Healthcare Public Health Sector would be the potential for better healthcare treatment for either occupational or community exposures and therefore the possible mitigation of damage from a release incident. While cross-sector planning and exercises between the

Chemical Sector and Healthcare Public Health Sector would make sense, a search for examples provides no specific examples.

Introduction and Overview

Purpose:

This paper is written for practitioners in healthcare and the chemical industry primarily as a guide to develop joint planning and exercises in order to better optimize a response to a real chemical release incident. An added benefit of doing so is that an effective response capability to either a deliberate or accidental chemical release mitigates the negative consequences of such an incident. Potentially having a strong response capability could even be a disincentive to terrorist groups to use chemicals as weapons. The paper provides a comprehensive review of the topic but seeks to avoid the use of technical jargon. For those that need additional technical details on one or more topics, links to authoritative sources are included in the text so that they can be easily found and used without the need to sort through footnotes.

Overview

The problem this paper addresses is the relatively low level of healthcare preparedness for chemical incidents - given the high risk that a chemical terrorist attack or accident could pose. Chemical facilities present a lucrative target for terrorists. The attack could be on a chemical facility, pipeline, barge, road or rail transport. The attack could take place in or near a densely populated urban area. In addition to the human costs, the national impact of a major attack in say the Houston-Galveston Metropolitan area or along the Houston Ship Channel would be significant. In areas with a dense petrochemical presence, there could be cascading effects to nearby plants if a toxic vapor cloud is released. Healthcare has a role in the overall homeland security framework. By seeking to optimize the healthcare and public health response with a goal of *zero preventable deaths* from the attack, effective healthcare mitigates or blunts the overall

success of the terrorist attack. If strengthened, the Local Emergency Planning Committee (LEPC) could provide the venue for joint Industry and Healthcare collaboration to improve preparedness. At this point however, the LEPC is a largely unfunded mandate without the resources to make a major contribution to preparedness. The paper offers a framework that could be used in Texas to foster improved preparedness and collaboration between industry and healthcare through the local LEPC. The framework focuses on local risk assessments and risk prioritization of chemicals present; the identification of any specific medical countermeasures or antidotes needed; and if necessary, local customization of the *ChemPack* based on risk. Setting up joint exercises between healthcare and industry is explored; and finally, from the population health perspective, the topics of baseline and post-incident health and environmental data collection; and community and emergency response air monitoring is explored as a next step in preparedness.

Gap Assessment / Problem Statement

Joint Chemical Industry-Hospital Planning and Exercises are rare

The Chemical Sector is required to conduct exercises and they do. The trouble is that in most cases the scenario ends where transport arrives to pick up the patients. Rarely does the scenario include:

- the transport of the victims to the hospital were a secondary (more rigorous) decontamination is given prior to entry into the Cold Zone of the hospital Emergency Room
- triage with a physician deciding where in the hospital the patient should be transported for the best care (e.g., Trauma Center, Burn Unit)
- use of patient cards describing the vitals, signs, and symptoms of each patient or moulage (simulated injuries) so that nurses and physician can describe what care that individual patient should receive.
- the delivery of medical countermeasures from hospital pharmacy to the point of care.

This situation results in two problems. Chemical safety and emergency preparedness officials develop an unrealistic expectation on the number of patients a given hospital can handle; and hospitals do not get a chance to rehearse what they would do in a real chemical release incident and work to continuously improve those plans.

Local Emergency Planning Committees (LEPC): Current Status and Room for Improvement

Federal legislation created the Local Emergency Planning Committees (LEPC), however the LEPC is often an unfunded mandate, and often, even in regions with a dense concentration of chemical industry, the LEPC does not have the resources or expertise to assure preparedness. If

industry does not comply with federal law regarding providing annual updates on emergency response plans or notifying the LEPC of a release of an Extremely Hazardous Substance, the LEPC has no real recourse.

Joint Hospital – Industry Preparedness Program

As part of its required *Risk Mitigation Plan*, industrial chemical companies are supposed to share chemical information with local hospitals. It is rare that this occurs. Because of lack of communication between industry and healthcare, industry may not understand how healthcare is organized and if they do send chemical information, it is to the nearest community hospital, not understanding that they should be doing detailed joint planning with the regional Level One Trauma Center or Level One Burn Unit. Sending a patient to the wrong hospital may cause a preventable death.

Public Health Emergency Preparedness

Public Health Emergency Preparedness Program and Guidance

(https://www.cdc.gov/orr/readiness/phep/index.htm is a preparedness program administered by *Centers for Disease Control and Prevention*. The program generally provides grant funding to state and local public health agencies and these funds are usually used to hire a public health emergency planner. The current gap is that few if any of these planners have the level of technical training needed to develop adequate community plans in areas with a dense chemical industry footprint.

Case Study: Sequoya Fuels Incident

"Sequoyah Fuels Corporation had not arranged in advance with Sequoyah Memorial Hospital to treat workers in such an emergency. After Harrison inhaled hydrofluoric acid, he was driven 13 km to a nursing home for a canister of oxygen before he was taken to Sequoyah Memorial Hospital, which was 18 km away. However, Memorial Hospital was unequipped to treat Harrison and sent him to a larger hospital, Sparks Regional Medical Center in Fort Smith, Arkansas, another 34 km away. Harrison died at 3:00 pm, soon after arriving at the emergency

room at Sparks Regional Medical Center”
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1963288/

Topic Discussion

Relevance to Texas Homeland Security

The scale and scope of Texas Energy and Chemical Industry is immense:

"*Texas has about one-fourth of the nation's operable crude oil refineries and nearly one-third of the total U.S. refining capacity. The state's 32 petroleum refineries can process a combined total of more than 5.9 million barrels of crude oil per calendar day. The majority of the Texas refineries are clustered near ports along the Gulf Coast, giving that region the largest concentration of oil refineries in the United States. The largest U.S. refinery is in Port Arthur, Texas, and it alone can process about 626,000 barrels of crude oil per calendar day. Many of the Texas refineries are complex facilities that can process a wide variety of crude oil types into high-value products, such as motor gasoline, and into feedstocks for the chemical industry. Texas petroleum products are sent from the state's refineries by interstate pipeline, barge, and tanker to U.S. markets, primarily in the eastern and central states, and some are shipped to foreign markets.*" https://www.eia.gov/state/analysis.php?sid=TX

"As the nation's top chemical producer, Texas also is its top exporter. Chemicals represented the third-largest export from Texas in 2020, with a value of around $40 billion, or 14.3 percent of the state's total exports . . . The chemical manufacturing sector produces a host of chemicals including petrochemicals, pharmaceuticals, paints, fertilizers, cleaners and more. The Gulf Coast specializes in "basic chemical manufacturing," a subset of that sector, which produces basic building blocks such as ethane, ethylene, methanol and benzene. https://comptroller.texas.gov/economy/economic-data/supply-chain/2021/chem.php

"*The state's location quotient (LQ) indicates that basic chemical production is 2.66 times more concentrated in Texas than in the total United States, with high employment and high average wages . . .In the basic chemical industry, Texas contributes over a third of the national GDP and about the same proportion of its exports."* https://comptroller.texas.gov/economy/economic-data/supply-chain/2021/chem.php

A major terrorist attack or large industrial accident on this sector could have a crippling effect on the overall US economy. Prevailing winds along the Texas Coast are southeasterly and a chemical plume coming from the Galveston Bay area would in many cases move into the densely populated Houston metropolitan area.

Why is *Healthcare* an issue of Texas Homeland Security?

"*The large-scale production of TICs [toxic industrial chemicals], the potential for widespread exposure and significant public health impact, together with their relative ease of acquisition, makes deliberate release an area of potential concern*." (Russell, Simpson 2010)

From a security perspective – effective healthcare and public health response mitigates the negative effects of an attack on the homeland, and this is reflected in Presidential Policy and the *National Response Framework*. *Presidential Policy* Directive 21(PPD-21) defines the 16 critical

infrastructure sectors "*whose assets, systems, and networks, whether physical or virtual, are considered so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national economic security, national public health or safety, or any combination thereof.*"

Presidential Policy Directive 21 (PPD-21): *Critical Infrastructure Security and Resilience* advances a national policy to strengthen and maintain secure, functioning, and resilient critical infrastructure. The two critical infrastructure sectors relevant to this discussion are the *Healthcare and Public Health Sector*; and the *Chemical Sector*.

Chemical Sector*: "DHS [Department of Homeland Security] was identified as the Chemical Sector Risk Management Agency (SRMA) in Presidential Policy Directive (PPD) 21. CISA [Cybersecurity and Infrastructure Security Agency] performs the Chemical Sector SRMA responsibilities on behalf of DHS. CISA leads the Chemical Sector's public-private partnership and works with companies to develop tools and resources that enhance the sector's security and resilience."*

Healthcare and Public Health Sector: *"The Healthcare and Public Health Sector focuses on population health and provides the response and recovery actions needed after large-scale hazards such as terrorism, infection disease, and natural disasters."*

Healthcare as Critical Infrastructure

In addition to Presidential Policy Directive 21 which specifically lists Healthcare and Public Health as one of 16 critical infrastructure sectors, one can also look to the inclusion of Healthcare and Public Health in the National Response Framework: *The National Response Framework (NRF) is a guide to how the nation responds to all types of disasters and emergencies. It is built on scalable, flexible, and adaptable concepts identified in the National Incident Management System to align key roles and responsibilities. The NRF is structured to help jurisdictions, citizens, nongovernmental organizations and businesses.* https://www.fema.gov/emergency-managers/national-preparedness/frameworks/response

National Response Framework: Emergency Support Functions: Emergency Support Function 8:

Under the *National Response Framework, Emergency Support Function* 8 addresses healthcare and public health.

Healthcare: generally, involves care for the individual patient. There are both private and public healthcare providers. Each may be either for profit or not for profit organizations.

Public Health: generally, addresses the health of the local population. Examples of public health efforts include: planning the public health response to chemical incidents; providing treatment guidance; engaging in public information; collecting baseline and post incident data; conducting epidemiological investigations, and distribution of medical countermeasures.

Flash to Bang /Left of Boom / Right of Boom

"Since 9/11, law enforcement, intelligence services and first responders have used the term "left of boom" as a point of reference to stay ahead of and avert terrorist attacks. In contrast to "left of boom," "right of boom" is the time directly following a terrorist attack" https://www.acamstoday.org/flash-to-bang-left-of-boom-right-of-boom/

More specifically, *flash to bang* refers to the time between when the first sign of an attack is seen and when the munition lands or explodes. Left of bang would be on a timeline before a terrorist incident occurs. Ideally an attack can be thwarted left of flash or left of boom through intelligence, preemptive attacks on the terrorist group, or enhanced security. Events after the attack on the timeline are referred to as right of boom. **Healthcare is right of boom in that it is in response to an attack occurring. This concept helps in understanding the homeland security role of healthcare.**

Optimal healthcare is an issue of national security because an optimal healthcare/public health response mitigates the negative consequences of the attack. For example, the effects of a deliberate (e.g., terrorist) attack on any other critical infrastructure sector (e.g., the Chemical Sector) - would be mitigated by having an effective healthcare and public health response where the goal is to better assure *zero preventable deaths* (a goal in healthcare emergency planning)

Zero Preventable Deaths

If security and prevention strategies fail, then an important strategy for crisis and consequence mitigation includes an optimal healthcare and public health response with a goal of having *zero preventable deaths*.

"*The National Academies of Science, Engineering and Medicine (NASEM) landmark report, A National Trauma System: Integrating Military and Civilian Trauma Systems to Achieve Zero Preventable Deaths after Injury*, called upon a broad multidisciplinary group of trauma professionals and laid out an ambitious roadmap to achieve zero preventable injury deaths.

A goal of zero preventable deaths would be an effective strategy to mitigate the effects of any terrorist Chemical, Biological, Radiological, Nuclear, or Explosives attack.

https://www.facs.org/quality-programs/trauma/systems/achieving-zero-preventable-deaths/

Chemical Facilities and Transport: Lucrative Target for Terrorists

Post-911 standards such as the Chemical Facility Anti-Terrorism Standards (https://www.cisa.gov/resources-tools/programs/chemical-facility-anti-terrorism-standards-cfats/cfats-process#:~:text=The%20Chemical%20Facility%20Anti%2DTerrorism,concentration%20listed%20in%20Appendix%20A. seek to prevent incidents such as:

- Release of toxic industrial chemicals as a weapon against the population
- Attacks on the industry for ideological or political reasons
- Attacks to disrupt the economy through the cascading effects of the attack
- Attacks on chemical facilities or transport as part of a *Complex Coordinated Terrorist Attack*

Chemicals as Terrorist Weapons

"The chemical industry is global, and many chemicals are synthesized and transported in vast quantities. Many of these chemicals are toxic and readily available, necessitating the need for identifying and assessing hazard and risks and subsequently planning and preparing for the deliberate release of TICs." (Russell)

Chemicals have been used in warfare and terrorist attacks

A terrorist attack may be directed at Texas energy and chemical facilities because of the importance of the sector to the national economy and the cascading financial effects the loss of a major facility or pipeline could cause. The goal of a terrorist attack could include the release of a toxic industrial chemical in order to cause fatalities and injuries. An energy/chemical target could be included in a Complex Coordinated Terrorist Attack (CCTA scenario) ("*A Complex Coordinated Attack (CCA), also known as a Complex Coordinated Terrorist Attack, is a violent assault or series of assaults by one or more individuals or groups using one or more type of weapons with the intent to inflict harm on large numbers of people*.") https://www.cisa.gov/sites/default/files/2022-11/Action%20Guide%20CCA%20508%20FINAL%2020190905.pdf)

"*Deliberate chemical incidents occur when terrorists release a chemical in order to kill or injure humans or animals, to destroy crops or to cause extreme economic or environmental damage."* (Blakey et al.)

"*In 1994 Aum Shinrikyo became the first terrorist group to produce and use the nerve agent sarin when it released sarin outdoors in the city of Matsumoto, killing 7 individuals and injuring 262. In March 1995 Aum again released sarin, this time in the Tokyo subway, killing 12 individuals and causing 5,498 to seek medical attention."* (Blakey et al.)

According to the World Health Organization:

1. A release of a gas or aerosol into the atmosphere, resulting in an inhalational exposure, is likely to cause the maximum number of casualties

2. Chemical incidents can cause injury through four basic injury mechanisms (fire, explosion, toxicity and the experience of traumatic events)

(World Health Organization (WHO): Manual for the public health management of chemical incidents. Geneva: 2009. http://www.who.int/environmental_health_emergencies/publications/Manual_Chemical_Incidents/en/index.html)

"Terrorists can use toxic, flammable or explosive chemicals. They may also develop agents that can be produced from readily available chemicals." (Blakey)

See also Zanders JP: Assessing the risk of chemical and biological weapons proliferation to terrorists. The Nonproliferation Review 1999 Fall:17–34 [http://cns.miis.edu/npr/pdfs/zander64.pdf].

https://www.nonproliferation.org/wp-content/uploads/npr/zander64.pdf

National Preparedness Goal

The existing National Preparedness Goal provides an adequate framework to address the gaps identified.

The National Preparedness Goal describes five mission areas — prevention, protection, mitigation, response and recovery — and 32 activities, called core capabilities, that address the greatest risks to the nation. Each of these core capabilities is tied to a capability target. These targets recognize that everyone needs the flexibility to determine how they apply their resources, based on the threats that are most relevant to them and their communities.

Examples of Relevant Core Capabilities:

*"**Planning:** Mission Areas: All: Conduct a systematic process engaging the whole community as appropriate in the development of executable strategic, operational, and/or tactical-level approaches to meet defined objectives."*

*"**Operational Coordination**: Mission Areas: All: Establish and maintain a unified and coordinated operational structure and process that appropriately integrates all critical stakeholders and supports the execution of core capabilities."*

*"**Threats and Hazards Identification**: Mission Area: Mitigation: Identify the threats and hazards that occur in the geographic area; determine the frequency and magnitude; and incorporate this into analysis and planning processes so as to clearly understand the needs of a community or entity."*

*"**Community Resilience**: Mission Area: Mitigation: Enable the recognition, understanding, communication of, and planning for risk and empower individuals and communities to make informed risk management decisions necessary to adapt to, withstand, and quickly recover from future incidents"*

*"**Public Health, Healthcare, and Emergency Medical Services**: Mission Area: Response: Provide lifesaving medical treatment via Emergency Medical Services and related operations and avoid additional disease and injury by providing targeted public health, medical, and behavioral health support, and products to all affected populations"*

*"**Health and Social Services**: Mission Area: Recovery: Restore and improve health and social services capabilities and networks to promote the resilience, independence, health (including behavioral health), and well-being of the whole community."*

Way Forward:

What Would Optimal Healthcare and Public Health Response Look Like?

Effective and Efficient:

- Gross Decontamination at the scene, triage, and patient distribution (Get the right patient to the right hospital as quickly as possible)
- Decontamination and triage process at the hospital – ideally informed by accurate information on the chemicals involved.
- Use of specific medical countermeasures for chemicals that require a specific antidote (like Hydrogen Fluoride or Hydrogen Cyanide)
- Access to accurate baseline and post-incident health and environmental data
- Establishment of a registry and completion of an epidemiological study of those affected.

An optimal response would only be possible if there was close industry/hospital collaboration before the incident that included planning, training, and exercises. Unfortunately, this type of collaboration is more the exception than the rule.

An Effective Local Emergency Planning Committee Role

Origins of the Community Right to Know Act

Case Study: Methyl Isocyanate (MIC)

1984, Bhopal India

The Emergency Planning and Community Right-to-Know Act (EPCRA) was created in response to what is widely considered the worst industrial chemical disaster in history. Beginning on December 2, 1984, methyl isocyanate gas was accidentally released from a chemical plant in Bhopal, India. That night, thousands of people died and many more were injured. In the following months and years, thousands more died, and survivors of the accident continue to suffer with permanent disabilities. Approximately six months after the Bhopal accident, a serious chemical release occurred at a similar plant in West Virginia. These two events raised concern about lack of local preparedness for chemical emergencies and the availability of information on toxic chemicals. EPCRA establishes requirements for federal, state and local governments, Indian tribes, and industry regarding emergency planning and "Community Right-to-Know" reporting on hazardous and toxic chemicals. https://www.epa.gov/trinationalanalysis/more-epcra#:~:text=The%20Emergency%20Planning%20and%20Community,chemical%20plant%20in%20Bhopal%2C%20India.

1985 Virginia, United States

Union Carbide also manufactured MIC is at its *Institute* plant in the Kanawha Valley of West Virginia. This was one of two places in the world where MIC was produced.

"A week after the Bhopal accident, on December 11, 1984, Hank Karawan, then plant manager of the Union Carbide's Institute facility, held a press conference at which he expressed his confidence in the safety of the Institute plant's operations. Despite Mr. Karawan's vote of confidence for the safety of the MIC operations at his plant, Union Carbide elected to shut down production of the deadly chemical until it could make $500 million worth of safety improvements. On May 4, 1985, Union Carbide resumed production of MIC. On August 11, 1985, on the heels of the completion of the safety improvement program just a few months before, 500 gallons of aldicarb oxime ***and highly toxic MIC leaked from the Institute plant"*** [emphasis added]. One hundred and thirty-four people were treated at local hospitals. https://en.wikipedia.org/wiki/Emergency_Planning_and_Community_Right-to-Know_Act

1986 Emergency Planning and Community Right-to-Know Act

The United States Congress passed the Emergency Planning and Community Right-to-Know Act (EPCRA) in 1986 in response to the rising crescendo of chemical incidents, "around the time of the Bhopal disaster, 6,928 chemical accidents occurred in the United States within a five-year

period. https://en.wikipedia.org/wiki/Emergency_Planning_and_Community_Right-to-Know_Act

Establishment of the Local Emergency Planning Committee

State Emergency Response Commissions in the U.S.

The Governor of each state or leader of each tribe has designated a State Emergency Response Commission (SERC) that is responsible for implementing the Emergency Planning and Community Right-to-Know Act (EPCRA) provisions within its state or tribe

https://www.epa.gov/epcra/state-emergency-response-commissions

The Texas State Emergency Response Commission

"*Required under federal law, in Texas the SERC* [State Emergency Response Commission] *is synonymous with the Texas Division of Emergency Management. The TCEQ [Texas Commission on Environmental Quality] receives reports about accidental releases*"

https://www.tceq.texas.gov/response/serc

"As a first step, each state had to establish a State Emergency Response Commission (SERC). In turn, the SERC designated local emergency planning districts. For each district, the SERC appoints, supervises and coordinates the activities of a Local Emergency Planning Committee (LEPC). The LEPC must, in turn, develop an emergency response plan for its district and review it annually. The membership of the LEPC includes representatives of public and private organizations as well as a representative from every facility subject to EPCRA emergency planning requirements.

The plan developed by the LEPC must:

- *identify affected facilities and transportation routes;*
- *describe emergency notification and response procedures;*
- *designate community and facility emergency coordinators;*
- *describe methods to determine the occurrence and extent of a release;*
- *identify available response equipment and personnel;*
- *outline evacuation plans;*
- *describe training and practice programs and schedules; and*
- *contain methods and schedules for exercising the plan."*

Local Emergency Planning Committees (LEPC) in Texas.

Local Emergency Planning Committees and Fire Departments

"A Local Emergency Planning Committee (LEPC) is a legally mandated organization that is established in an Emergency Planning District designated by the State Emergency Response Commission (SERC). Most Texas counties have a single LEPC, but some counties may have multiple LEPCs that serve individual cities or communities.

There are three broad categories of communication required under law between chemical facilities and the LEPC:

1. On the 5-year renewal of the facility's Risk Management Plan and Annual Coordination
2. Annual Tier II reporting
3. Notification of a release of an extremely hazardous substance (EHS)

Note that 40 CFR§ 355.42 specifically requires that the emergency coordinator for the LEPC be notified of a release.

Facility Risk Management Plans

Section 112(r) of the 1990 Clean Air Act amendments calls for the implementation of *Risk Management Programs* in facilities that use extremely hazardous substances. Plans must be updated and submitted to EPA every five years https://www.epa.gov/rmp The 1989 Phillips Disaster in Pasadena, Texas was a major factor in the requirements for Risk Management Program rules being included in the 1990 update to the Clean Air Act.

Case Study: Phillips disaster of 1989

On October 23, 1989, a massive explosion demolished the Phillips 66 Company polyethylene plant in Pasadena, TX, (a Houston suburb) when more than 85,000 lbm of flammable material was instantaneously released into the atmosphere. This massive gas cloud was ignited within less than two minutes. The initial explosion threw debris as far away as six miles and registered between 3 and 4 on the Richter scale on Rice University seismographs. There were many secondary explosions. In all, 23 lives were lost and 314 people were injured. Capital losses were initially estimated at over $715 million. Business disruption losses were nearly as great, $700 million.

One of the principle findings was that ***worst-case scenario*** [emphasis added], *such as the massive series of explosions,* ***had not been considered in developing the emergency plan****. Crisis management planning had been initiated at the corporate level but was not complete when the explosion occurred. The incident reinforced the necessity and value of continuous employee training in emergency-response procedures. Phillips management found that participation in a* ***cooperative emergency training and response network such as CIMA and LEPC was essential*** *in providing the necessary manpower and equipment to the site in response to the emergency. Responders from the community and other industries were effective, not only because of their own training, but also because of mutual training in potential problems at each other's sites. (Bethea, Robert M., Explosion and Fire at the Phillips Company, Houston Chemical Complex, Pasadena, Texas Chemical Engineering Department Texas Tech University. https://www.lsu.edu/mpri/files/sache.pdf)*

The importance of joint planning with the LEPC and local responders such as the *Channel Industries Mutual Aid* (CIMA) organization (https://www.cimatexas.org/Home.aspx) was highlighted in reviews of the 1989 Phillips disaster. Joint planning is now required as part of the *Risk Management Program*. As a part of the hazard assessment requirements Under 40 CFR Part 68, Subpart B hazard assessments the facility must analyze worst-case release scenarios and document the analyses in their *Risk Management Plan* (RMP). https://www.epa.gov/rmp/how-many-worst-case-release-scenarios-must-be-analyzed-and-documented-rmp . Guidance to industry on Risk Management Planning is available at https://www.epa.gov/rmp/general-rmp-guidance-chapter-9-risk-management-plan.

According to EPA the facility should contact their LEPC to verify whether the facility is currently included in the community emergency response plan. This includes a review and update of the procedures for notifying local emergency responders in an emergency.
https://www.epa.gov/sites/default/files/2013- 11/documents/chap-09-final.pdf

Obligation under law for Chemical Industry using extremely hazardous chemicals to plan with the LEPC and Hospital

General guidance on *Risk Management Programs* for chemical accident prevention is addressed in Title 40 Code of Federal Regulations Part 68. Section 68.93 addresses emergency response coordination. Key excerpts that touch on information that **must be provided** to the Local Emergency Planning Committee and hospitals include:

For facilities with Program 2 or 3 covered processes, emergency response coordination with local officials must occur at least annually, and more frequently, if necessary, to address changes at the facility, in the emergency response plan or emergency action plan, and in the community emergency response plan.

To begin coordination, you must open communications with local emergency planning and response officials, particularly your local emergency planning committee (LEPC) *if one exists. Because your LEPC consists of representatives from many local emergency planning and response agencies, it is likely to be the best source of information about the critical emergency response issues in your community. . .* https://www.epa.gov/sites/default/files/2013-11/documents/chap-08-final.pdf

You must coordinate annually with the LEPC, local response organizations, local hospitals, and other response organizations (e.g., state hazmat team) and offer them a copy of the emergency response or action plan . . . it may be appropriate to send a hospital only the sections of your plan that address emergency medical procedures and decontamination.
https://www.epa.gov/sites/default/files/2013-11/documents/chap-08-final.pdf

Communicating with Local Responders and your Surrounding Community

Effective communication with the public and local emergency planners and responders can be an opportunity to develop robust emergency response efforts at your facility, in coordination with the community and local responders. Relationships thrive and trust is gained when you consider the needs and challenges facing those potentially affected by accidents at your facility
https://www.epa.gov/sites/default/files/2013-11/documents/chap-08-final.pdf

Tier II Reporting

What is a Tier II report?

Under Section 312 of the *Emergency Planning and Community Right-to-Know Act* of 1986 (EPCRA) submission of Tier II form is required. "*The purpose of this form is to provide state, tribal, and local officials,* ***and the public*** [emphasis added] *with specific information on potential hazards."* The reports include the locations and amount, of hazardous chemicals present at facilities during the previous calendar year (https://www.epa.gov/epcra/tier-ii-forms-and-

instructions#:~:text=The%20purpose%20of%20this%20form,specific%20information%20on%20potential%20hazards)

In Texas, the Tier II Chemical Reporting Program requires submission of all reports through the *State of Texas Environmental Electronic Reporting System* (STEERS). *https://www.tceq.texas.gov/permitting/tier2/local-emergency-planning-committee.html* .

Facilities that submit a Tier II report through STEERS **must also provide a copy to their LEPC and fire department.**

Notification of a Release

Extremely Hazardous Substance Release Notification are regulated under Title 40 Chapter I, Sub-chapter J, Part 355 of the Code of Federal Regulations https://www.ecfr.gov/current/title-40/chapter-I/subchapter-J/part-355 Section *355.40* details the information that must be provided in the notification. In order to comply with federal law, the company must make two separate notifications. An immediate notification must be made and then a written follow-up notification is needed as more information becomes available.

As much of the information as is available at the time must be included in the immediate notification:

(1) Chemical name

(2) Whether the substance is an Extremely Hazardous Substance

(3) An estimate of the quantity

(4) The time and duration of the release.

(5) The medium into which the release occurred.

(6) Known or anticipated acute or chronic health risks / advice regarding medical attention needed if exposed.

(7) Precautions such as evacuation

(8) Contact name and telephone number for further information

Note that under the law notification of a release must be sent to: "**The community emergency coordinator for the LEPC** of any area likely to be affected by the release . . . and (2) The SERC of any State likely to be affected by the release.

"Failure to notify the proper authorities may result in civil penalties of up to $25,000 per day for each day of non-compliance and criminal penalties of up to $25,000 in fines and prison sentences of up to two years." *https://en.wikipedia.org/wiki/Emergency_Planning_and_Community_Right-to-Know_Act*

Grass Roots / Whole Community Preparedness

Even if CISA and the Sector-specific councils to not take a leadership role in cross-sector preparedness, local industry, hospitals, and the public health agency can work together to improve local whole-community preparedness – because it is in their mutual best interest to do so. It is also required under federal law. The *Local Emergency Planning Committee* is a good venue to begin this work because the local chemical industry are members and hospitals, and public health should participate as part of the preparedness activities they would do for the *Hospital Preparedness Program* (HPP) under the Administration for Strategic Preparedness and Response https://aspr.hhs.gov/HealthCareReadiness/HPP/Pages/about-hpp.aspx ; and the *Public Health Emergency Preparedness* (PHEP) program under Centers for Disease Control and Prevention. https://www.cdc.gov/orr/readiness/phep/index.htm . Hospitals that receive reimbursements for direct patient care through the Center for Medicare and Medicaid Services (CMS) (https://www.cms.gov/) have to comply with CMS standards for emergency management. The standards (often surveyed by the Joint Commission (https://www.jointcommission.org/) require that the hospital have a risk-based emergency preparedness program. If there were a chemical facility in the vicinity of a hospital and risk of a release were not included in the hospital risk assessment, and the hospital did not have plans for that priority risk, a Joint Commission Survey of the hospital would likely find the hospital's

emergency management program to be out of compliance with Joint Commission and CMS standards.

"Emergency planning and preparedness. Risk-prioritized emergency planning is a tool for identifying gaps, enhancing communication and collaboration, and for policy development. It also serves to enhance preparedness, a necessary prelude to preventing or mitigating the public health risk to deliberate release. Planning is an iterative and on-going process that requires multi-disciplinary agency input, culminating in the formation of a chemical incident plan complementary to major incident planning. Preparedness is closely related and reflects a state of readiness. It is comprised of several components, including training and exercising." (Russell, Simpson 2010)

Whole Community Preparedness

The Federal Emergency Management Agency (FEMA) defines Whole Community Preparedness

Preparedness is a shared responsibility; it calls for the involvement of everyone — not just the government — in preparedness efforts. By working together, everyone can help keep the nation safe from harm and help keep it resilient when struck by hazards, such as natural disasters, acts of terrorism, and pandemics.

According to FEMA whole community members include:

- *Individuals and families, including those with access and functional needs*
- *Businesses*
- *Faith-based and community organizations*
- *Nonprofit groups*
- *Schools and academia*
- *Media outlets*
- *All levels of government, including state, local, tribal, territorial, and federal partners*

Also from FEMA: *The phrase "whole community" appears a lot in preparedness materials, as it is one of the guiding principles. It means two things:*

- *Involving people in the development of national preparedness documents.*
- *Ensuring their roles and responsibilities are reflected in the content of the materials*.

The concept of Whole Community Preparedness applies to chemical release incidents. One can see the advantage of including the members listed above in preparedness activities (such as local schools and businesses.

Healthcare Coalitions

The Healthcare Coalition is another foundational concept for effective local disaster response.

The U.S. Department of Health and Human Services, Administration for Strategic Preparedness and Response (ASPR) defines the Healthcare Coalition as:

". . . useful for all phases of Comprehensive Emergency Management, but its primary mission should be to support healthcare organizations during emergency response and recovery. An element of this mission is promoting integration of Coalition member organizations into the broader community response."

According to ASPR the objectives for a robust *Healthcare Coalition* are to:

- *Facilitate information sharing among participating healthcare organizations and with jurisdictional authorities to promote common situational awareness.*
- *Facilitate resource support by expediting the mutual aid process or other resource sharing arrangements among Coalition members and supporting the request and receipt of assistance from local, State, and Federal authorities.*
- *Facilitate the coordination of incident response actions for the participating healthcare organizations so incident objectives, strategy, and tactics are consistent for the healthcare response.*
- *Facilitate the interface between the Healthcare Coalition and relevant jurisdictional authorities to establish effective support for healthcare system resiliency and medical surge.*

Coalition members include but are not limited to *the full range of healthcare assets that provide "point of service" medical care and other medically related services during a mass casualty and/or mass effect incident. Depending on how a particular Healthcare Coalition is constructed, this may include hospitals, community health centers, integrated healthcare systems, private physician offices, outpatient clinics, dialysis and other specialty treatment centers, and long-term care facilities (nursing homes, other skilled nursing facilities), and home care/hospice."*

https://www.phe.gov/Preparedness/planning/mscc/healthcarecoalition/chapter2/Pages/overview.aspx

Nothing would preclude a chemical industry plant physician, physician's assistant, EMS director, industrial hygienist, or safety official from being part of the local or regional Healthcare Coalition. As one example, using the concept of *immediate bed availability* (https://asprtracie.hhs.gov/technical-resources/58/hospital-surge-capacity-and-immediate-bed-availability/0) in disaster situations, hospitals could transfer some of their existing patients to

long term care facilities (Coalition members) in order to make space and resources available for the incoming surge of patients from the chemical release incident.

Robust local chemical disaster response capabilities would make use of *Local Emergency Planning Committees* using a *Whole Community* approach to preparedness and including all members of the *Healthcare Coalition*.

Chemical Inventory, Risk Assessment and Prioritization

"*Because of the millions of distinct chemicals, it is not realistic to plan and prepare for all chemicals. Risk must be prioritized so that the chemicals of greatest concern provide the basis for subsequent prevention, emergency planning and preparedness, detection and alert, response and recovery activities*." (Blakey et al. A screening tool to prioritize public health risk associated with accidental or deliberate release of chemicals into the atmosphere)

Inventory

The first step in the risk assessment process is to inventory to the degree possible the chemicals that are used in the area or transported through the area by various means.

Sources of information about chemicals in the region:

- LEPC: Tier 2 Reports (*Submission of Tier II form is required under Section 312 of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA). The purpose of this form is to provide state, tribal, and local officials, and the public with specific information on potential hazards. This includes the locations, as well as the amount, of hazardous chemicals present at facilities during the previous calendar year*. https://www.epa.gov/epcra/tier-ii-forms-and-instructions)
- Commodity Flow Studies: Commodity flow studies are conducted to provide detailed information about the type, quantity, volume, and spatial distribution of hazardous materials traveling through your counties via highways and rail. https://www.epa.gov/system/files/documents/2022-01/chapter-19-commodity-flow-study.pdf)
- LEPC industry members
- Web-based searches
- Industry Risk Management Plans / Worst Case Scenarios (Once access is granted, viewing the report is typically in a controlled environment at a Federal Court House. Copies may not be made.)
- Environmental Protection Agency: Chemical Release Data

"*. . . chemicals are produced, used, stored, disposed of and transported widely and have the potential to harm the health of the public as a consequence of both acute and chronic health effects. Therefore, it is essential that countries develop emergency plans and prepare for chemical incidents at the local, regional, national and international level. Prioritization of risk is essential if resources are to be used efficiently*" (Blakey et al.)

Risk Prioritization

"The large numbers of chemicals, together with the large number of potential release scenarios means that the number of possible forms of chemical incident are almost infinite. Therefore, prior to undertaking emergency planning and preparedness, it is necessary to prioritize risk and subsequently mitigate." (Russell, Simpson 2010)

Preparedness should include a regional risk prioritization of chemicals. The chemicals should be ranked by risk by factoring both the toxicity and volume of chemicals in use or being transported through the air. For instance, Hydrogen Fluoride (HF) is a potentially dangerous chemical. It might be used in a local glass etching business in relatively low volumes (and therefore low risk) – or it may be used in a gasoline refinery with potentially millions of pounds (enormous risk if released).

Approaches to Prioritizing Chemicals for Risk Assessment and Risk Management

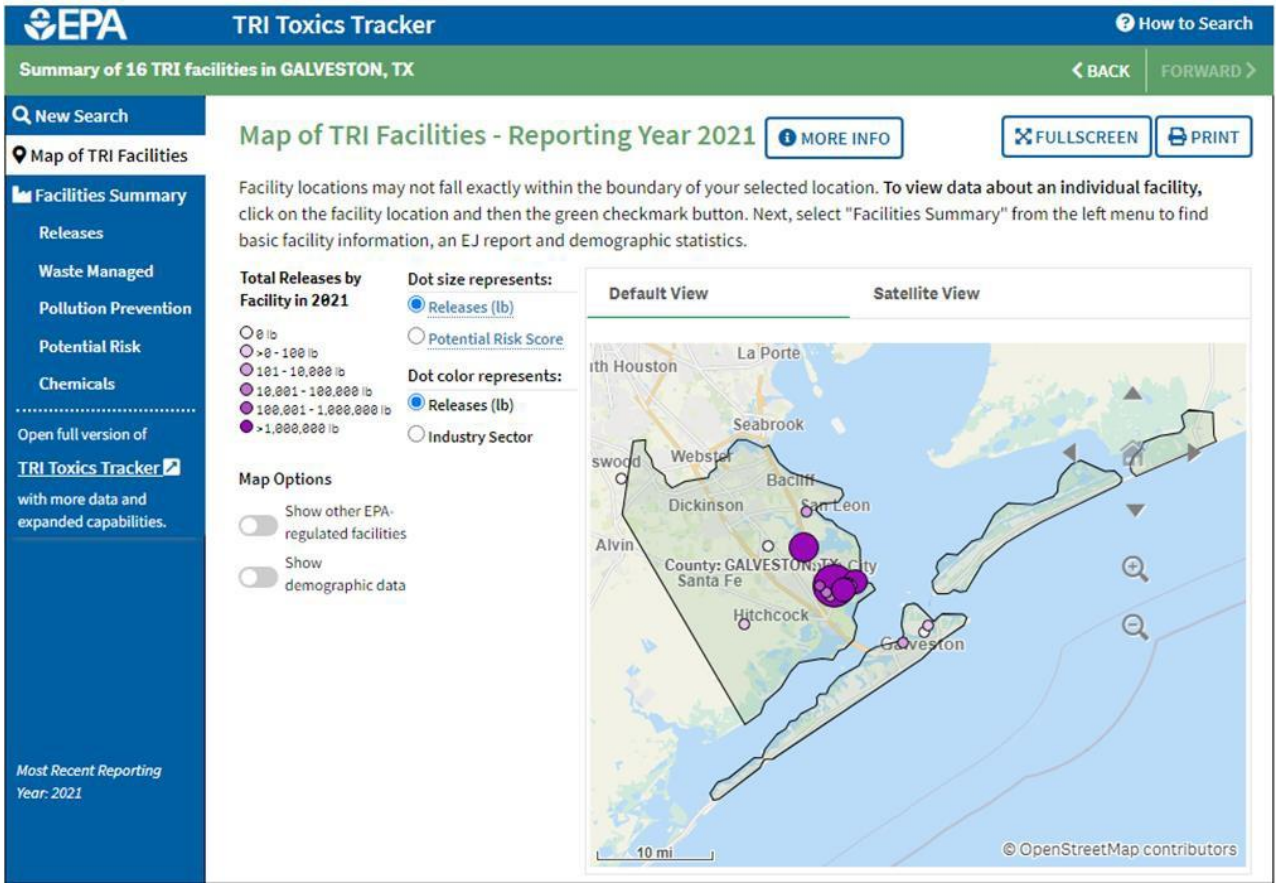
https://www.ncbi.nlm.nih.gov/books/NBK268887/

Environmental Protection Agency: Toxic Release Inventory Data

https://www.epa.gov/toxics-release-inventory-tri-program

The EPA Toxic Release Inventory is a useful tool in assessing chemical risk for a given area. Queries can be run on the TRI datasets using the jurisdiction as a filter. Below are examples of runs for Galveston County, Texas. The results will help to validate that the local inventory of chemicals present is complete. Though there is a time lag in data reporting, TRI can provide the volumes of dangerous chemical releases. There are also tools to help the local planner quantify risk.

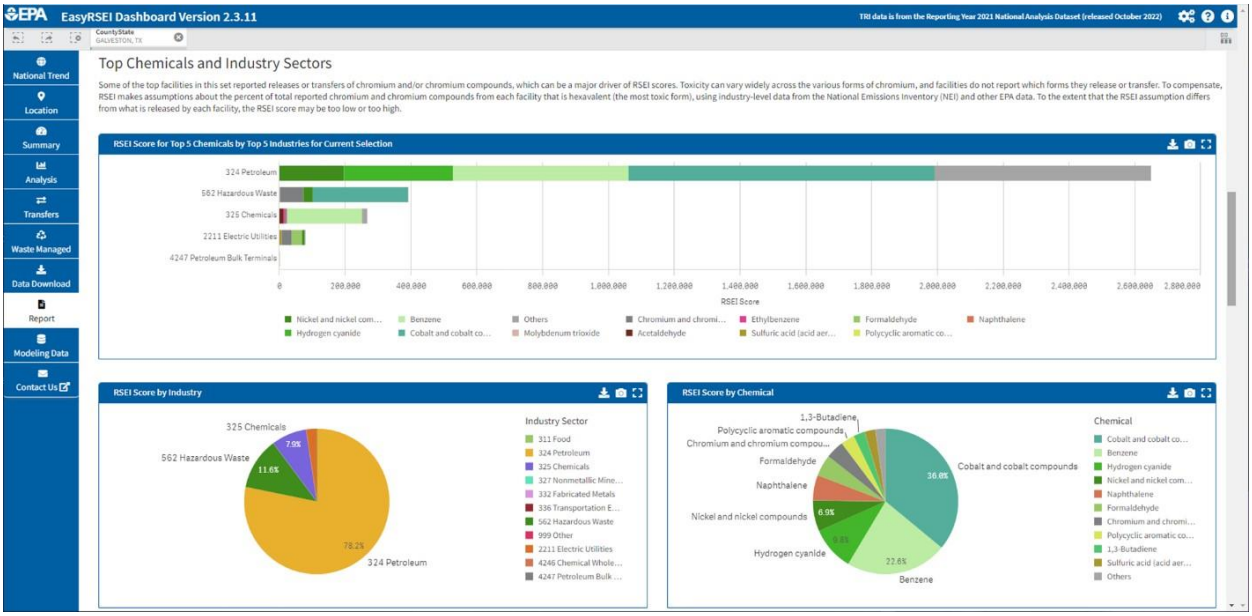
Sample EPA Toxic Release Inventory Data for Galveston County Texas



Environmental Protection Agency: Risk-Screening Environmental Indicators (RSEI) Model

Sample output that can be used as part of the Community Chemical Risk Prioritization:

Galveston County Texas



EPA's Risk-Screening Environmental Indicators (RSEI) model helps policy makers, researchers, and communities explore data on toxic chemicals being managed by industrial and federal facilities. RSEI incorporates information from the Toxics Release Inventory (TRI) on the amount of toxic chemicals released or transferred from facilities, together with factors such as the chemical's fate and transport through the environment, each chemical's relative toxicity, and potential human exposure. RSEI model results can be used to help establish priorities for further investigation and to look at changes in potential human health impacts over time https://www.epa.gov/rsei

Once the chemicals are inventoried, they should be rank ordered by risk. This will create the

Priority Risk Chemicals for the region.

Assessing Risk for Specific Chemicals

"it is essential that countries develop emergency plans and prepare for chemical incidents at the local, regional, national and international level. Prioritization of risk is essential if resources are to be used efficiently. Hazards must be identified, risks prioritized and risk reduction strategies

developed. Having a well-developed plan for risk prioritization and risk reduction can help adapt and focus preparedness efforts on chemicals of greatest concern for a given jurisdiction and ultimately, reduce casualties and hasten recovery" (Blakey http://www.biomedcentral.com/1471-2458/13/253 *)*

CEWG [Chemical Events Working Group] *suggests that public health authorities undertake a detailed determination of all chemicals produced, used, stored, disposed of or transported through their area of responsibility so that the actual local/regional availability of the chemicals can be known. This survey would also note the location of each chemical, the quantity at that location, the state and security of the location, the adjacent population density and location of vulnerable facilities such as schools and hospitals*. (Blakey)

One low tech way to assess the chemicals identified in your region would be to check the chemical name on the *Chemical Priority Lists for Acute Exposure Guideline Levels* (AEGLs)

https://www.epa.gov/aegl/chemical-priority-lists-acute-exposure-guideline-levels-aegls

Factors that go into a risk assessment include:

- Toxicity
- Volume
- Reactivity
- Flammability
- Requirement for Specific Medical Countermeasure

According to Blakey et al. "*HPV* [High production volume] *gases and high vapor pressure liquids, that are highly toxic, flammable or reactive, are ranked extreme risk (e.g., chlorine, hydrogen cyanide, methane, fluorine)."*

Federal Tools

The Federal Government has developed a variety of tools that would be useful to local jurisdictions to conduct chemical risk assessments. These systems are classified, so a local jurisdiction would need to submit a request for support generally through the state.

Chemical Consequence and Threat Desktop Tool

The Homeland Security Presidential Directive-22 (HSPD-22), Domestic Chemical Defense, requires an analysis of Chemical Terrorism as a critical element of the nation's domestic chemical defense policy. The Department of Homeland Security Science and Technology Directorate Chemical Security Analysis Center (CSAC) developed a suite of models to identify, assess and prioritize the threat, vulnerability and consequences of a chemical attack against the

U.S. homeland. As part of this program, the consequence and medical mitigation modules have been incorporated into a fast-running classified desktop tool . . . which allows the user to evaluate the severity of an event and the impact of various response and mitigation strategies. The Tool allows the user to select from a library of 184 chemicals for release in 37 representative targets from six main categories (indoor, outdoor and chemical supply chain, food and water contamination and dermal contact hazards). For more information on the tool contact csacinfo@st.dhs.gov (https://www.dhs.gov/publication/st-chemical-consequence-and-threat-desktop-tool-fact-sheet)

"When planning for accidental releases, several measures such as conducting a survey of chemicals produced, used, stored, disposed of and transported through the area of concern combined with population data, allow public health practitioners to estimate the quantity of chemical that could be released and the number of individuals that could potentially be exposed and their duration of exposure. When planning for deliberate releases, additional measures such as ease of importing or producing an extremely hazardous chemical and identification of locations where release of the chemical could cause maximum harm must be considered. Ideally, all factors collectively designed to reduce the likelihood of a chemical release and to manage the release and impacts, should be considered to determine residual risks and assess vulnerabilities." (Blakey)

Accessing Risk Management Plan

Part of the Community Risk Assessment should include review of the Tier II reports submitted to the LEPC and to the State of Texas through STEERS. Additionally, the risk assessment should include review of the individual company's *Risk Management Plan* and emergency response plans. Currently there are limits on how many *Risk Management Plans* can be viewed by one individual and there are substantial penalties for violating rules.

(https://www.epa.gov/rmp/accessing-rmp-data

"Risk Management Plans (RMPs) prepared and submitted pursuant to CAA [Clean Air Act] section 112(r) are, by statute, available to the public. Members of the general public may obtain RMP data by visiting a designated federal reading room or by contacting their SERC [State Emergency Response Commission] or LEPC [Local Emergency Planning Committee] public contact. Information on federal reading rooms for RMPs is available. A member of the general public may also submit an official FOIA [Freedom of Information Act] request to obtain non-OCA [Office of Consequence Analysis] RMP data. Information on how to submit a FOIA request is available at the following URL: www.foia.gov In addition, any person may contact a facility directly to request the facility's RMP information. However, facility owners and operators are not required to give their facilities' RMP information directly to the public. The RMP Reporting Center can be reached at (703) 227-7650 or RMPRC@epacdx.net "

Scenario Modeling

Plume models that are generally available to LEPCs and local emergency managers are accurate enough to use as the basis of scenario planning, training, and exercises. Scenarios should include for example different wind directions and release amounts. Local Fire Departments and HAZMAT generally have modeling capabilities that help them determine the potential extent of the plume. This will aid them in any assessments regarding orders to shelter indoors or to evacuate. The closest National Weather Services can provide spot weather updates to first responders, and if provided with accurate details about the chemical release, they can generally provide additional model output for use by the Emergency Operations Center/Incident Command or Unified Command.

Federal Resources and Support

For major incidents, additional federal assets can be brought to bear.

IMAAC

The Interagency Modeling and Atmospheric Assessment Center (IMAAC) (https://www.fema.gov/emergency-managers/practitioners/hazardous-response-capabilities/imaac) coordinates and disseminates atmospheric plume modeling and hazard prediction produced by various federal agencies. Modeling can be done for scenario planning, exercises, or real incidents (such as the Arkema Fire that occurred in the northeast Houston area as a result of flooding and power outages caused by Hurricane Harvey. For more information on the Arkema incident see https://www.csb.gov/arkema-inc-chemical-plant-fire-/)

IMAAC support is supposed to be available to state, local, and federal officials by contacting the IMAAC Technical Operations Hub, at the Defense Threat Reduction Agency, at (703) 767-2003 or emailing IMAAC@fema.dhs.gov."

NARAC

National Atmospheric Release Advisory Center: (NARAC) provides emergency planning support for planning or real incidents with plots of atmospheric releases of nuclear, radiological, chemical, biological, and hazardous natural materials. NARAC is located at the Department of Energy/National Nuclear Security Administration's (DOE/NNSA) Lawrence Livermore National Laboratory (LLNL). https://narac.llnl.gov/

Local Modeling Tools and Resources

CAMEO

Computer-aided management of emergency operations (CAMEO): First responders, the LEPC, and emergency planners have access to the CAMEO Suite of tools. *CAMEO is "a set of tools designed to help first responders and emergency planners access and manage crucial chemical property and emergency response information for hazardous chemical releases."* CAMEO is maintained by the National Oceanic and Atmospheric Administration and the Environmental Protection Agency. All of the applications can be freely downloaded at *http://www2.epa.gov/cameo* .

The CAMEO suite includes four core programs:

- ALOHA (Areal Locations of Hazardous Atmospheres) is a modeling tool that can estimate the threat zones associated with chemical releases to include toxic gas plumes, fires, and explosions.
- CAMEO Chemicals is a database with response datasheets for hazardous chemicals. Each sheet provides information on hazards, physical properties, and response recommendations. A reactivity prediction tool is included for when several chemicals are involved in the incident and may mix.
- CAMEOfm is a database applications that includes several modules to assist with the data management requirements under the Emergency Planning and Community Right-to-Know Act (EPCRA). Data can be entered on local facilities with hazardous chemicals as well as emergency contact information.
- MARPLOT (Mapping Application for Response, Planning, and Local Operational Tasks) is a mapping program. MARPLOT has a GIS interface that can be used to import objects, draw map objects, and manage the data associated with those map objects to customize the map view.

Downloads are available at: *(http://cameochemicals.noaa.gov)*
(http://m.cameochemicals.noaa.gov). *https://www.meted.ucar.edu/dispersion/hysplit_v2/st2.php*

Hysplit

The name Hysplit is derived from the concept of a *hybrid computational approach.* It is not an acronym.

"HYSPLIT is a complete system for computing simple air parcel trajectories, as well as complex transport, dispersion, chemical transformation, and deposition simulations. HYSPLIT continues to be one of the most extensively used atmospheric transport and dispersion models in the atmospheric sciences community" https://www.arl.noaa.gov/hysplit/

Unlike CAMEO, HYSPLIT can account for changes in weather over time. There is a web-version and downloadable version. With the downloadable version, users need to input their own meteorological data, so the best option would be for the LEPC to collaborate with the nearest National Weather Service (NWS) local office.

In Texas, local NWS offices are in:

Amarillo	Texas	AMA	1900 English Rd, Amarillo, TX 79108
Austin/San Antonio	Texas	EWX	2090 Airport Rd, New Braunfels, TX 78130
Brownsville	Texas	BRO	20 S Vermillion Ave, Brownsville, TX 78521
Corpus Christi	Texas	CRP	426 Pinson Dr, Corpus Christi, TX 78406
El Paso	Texas	EPZ	7955 Airport Rd, Santa Teresa, NM 88008
Fort Worth-Dallas	Texas	FWD	3401 Northern Cross Blvd, Fort Worth, TX 76137
Houston/Galveston	Texas	HGX	1353 FM646, Dickinson, TX 77539
Lubbock	Texas	LUB	2579 S Loop 289 #100, Lubbock, TX 79423
Midland/Odessa	Texas	MAF	2500 Challenger Dr, Midland, TX 79706
San Angelo	Texas	SJT	7654 Knickerbocker Rd, San Angelo, TX 76904

https://en.wikipedia.org/wiki/List_of_National_Weather_Service_Weather_Forecast_Offices

Which is better? Cameo? Hysplit?

The meteorology training site Comet (https://www.meted.ucar.edu/index.php) has information on the differences between Cameo and Hysplit. There are several technical differences between the two models, but for local emergency planning the key difference is that Hysplit is better suited for buoyant gases and not heavier than air gases. *"In desktop ALOHA, the dispersion model is a short range, short duration model, and it has separate heavy gas and Gaussian dispersion models. HYSPLIT/ALOHA uses a different mesoscale dispersion model and it* ***does not include a heavy gas model*** [emphasis added]." (Comet) A major advantage to Hysplit is that meteorological data can be input into the model. In contrast Cameo assumes the weather does not change. So if there is a major weather change such as wind speed or direction, Cameo needs to be run again with the updated weather. Examples of Heavier than air gases include: Chlorine, Hydrogen Fluoride, Hydrogen Sulfide, Phosgene, and Sulfur Dioxide.

Acute Exposure Guidelines and Casualties

(AEGL) (Pronounced like ‘Eagle’)

“Acute exposure guideline levels (AEGLs) describe the human health effects from once-in-a-lifetime, or rare, exposure to airborne chemicals. Used by emergency responders when dealing with chemical spills or other catastrophic exposures, AEGLs are set through a collaborative effort of the public and private sectors worldwide.” https://www.epa.gov/aegl

AEGLs are assigned 1, 2, or 3 according to severity of effects

AEGLs are developed for five exposure periods – 10 minutes, 30 minutes, 1 hour, 4 hours, and 8 hours. AEGL “levels” are determined by the level of toxic effects caused by the exposure. Level 1 is the least severe and Level 3 is the most severe.

Levels are expressed as parts per million or milligrams per cubic meter (ppm or mg/m3).

Level 1

Notable discomfort, irritation, or certain asymptomatic non-sensory effects. The effects are not disabling and are reversible after the exposure ceases.

Level 2

Irreversible or serious health effects. Exposure to this level may impair the ability to escape.

Level 3

Life-threatening health effects or death.

Below are samples of the model output for Levels 1, 2, and 3.

Image 1: Acute Exposure Guideline Level One (Discomfort and Irritation). Note the population potentially affected in the red circle. See text below on reasons the modeling tends to overestimate the number affected compared to a real incident. With CAMEO modeling, note that the plume is truncated at 10 kilometers from the release point. In actuality the plume would extend beyond this but because the initial weather conditions input into the model would likely change, CAMEO addresses this by truncating the plume.

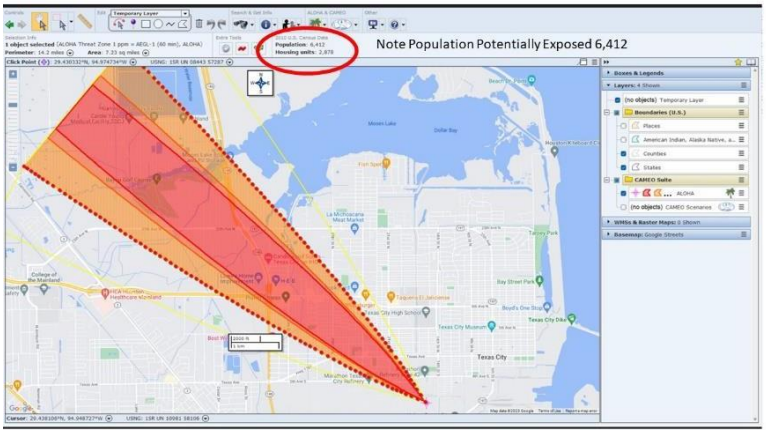


Image 2 Acute Exposure Guideline Level Two: (Irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape) Orange Plume

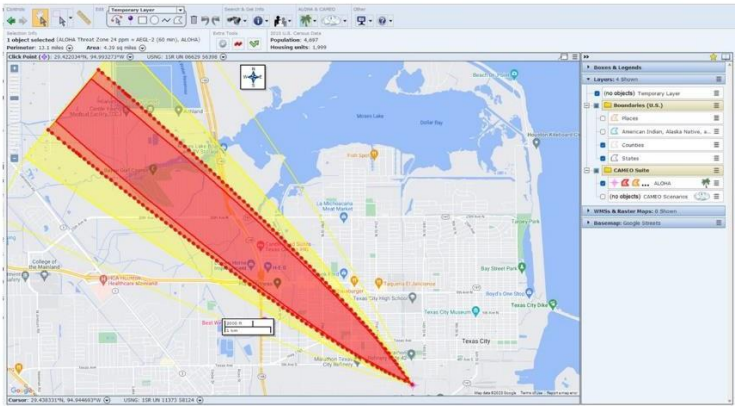
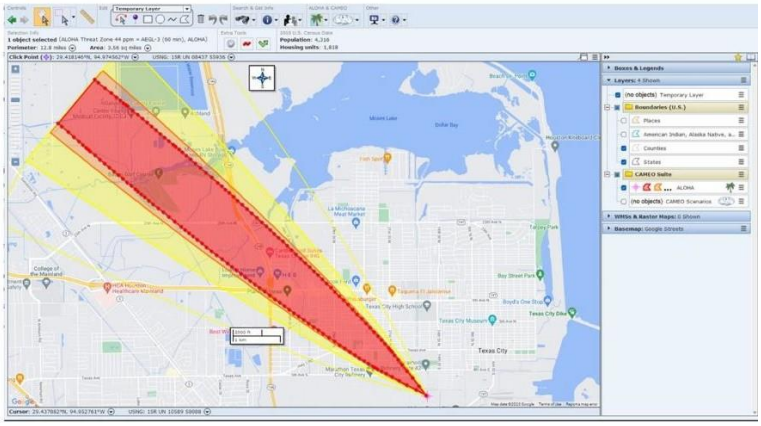


Image 3: Acute Exposure Guideline Level Three (Life-threatening health effects or death). Red Plume



Over-estimation of casualties

While the modeling tends to overestimate the number of casualties, the output is nonetheless helpful in that exercise participants can visualize the effects of the release and for example the effects on streets and roads, which in turn affects the routes that responders and Emergency Medical Services can take. It can also show what hospitals are potentially affected by the plume and therefore unavailable to treat patients. The model output shows census data under the plume. Being indoors in many cases can provide significant protection from exposure. At night, most people are indoors in their homes. During the day, many are indoors at work. So, the number of people actually exposed in a release incident is generally different from those that would be potentially exposed. If a chemical company needed to do a *Worst Case Scenario* as part of their *Risk Mitigation Plan*, they would likely use the higher *potentially exposed* figure (assuming they use CAMEO for modeling).

In real world incidents, use of CAMEO tends to result in overestimates as well. This is due to a few reasons. One reason is that the model is purposely designed to be conservative and err on the side of caution. This is because first responders will use the output to identify the *hot zone* and potential shelter or evacuation zones. This is not something one would want to underestimate.

Another reason is that in the initial response to a release incident, modelers often do not have accurate information about details of the leak such as the size and height of the release point. They may not even have accurate information about the chemicals involved. They would therefore have to use conservative defaults or estimates. They could refine these inputs as more accurate information becomes available.

In the sample, another variable is the amount of the chemical released. This particular model was designed to show a worst-case scenario for a deliberate terrorist attack where the terrorists disabled the mitigation equipment such as de-inventorying equipment and water-curtain equipment. Unless the modelers are specifically looking for the worst reasonable case scenario, it would be best to start the exercise scenario planning modeling with lower amounts. This could be based on historical data from similar events or based on industry recommendations.

In planning the exercise scenario, an approximation of the number of people exposed (at each AEGL level) could be estimated by reducing the CAMEO results by one to two orders of magnitude. The first exercise scenario should be challenging to area hospitals given their capabilities and capacities. Starting an exercise program with a scenario on the scale of an Incident of National Significance (See National Response Framework) https://www.fema.gov/pdf/emergency/nrf/NRF_FAQ.pdf) would likely be counterproductive.

Strategic National Stockpile – CHEMPACK

"CHEMPACKs are containers of nerve agent antidotes placed in secure locations in local jurisdictions around the country to allow rapid response to a chemical incident. These medications treat the symptoms of nerve agent exposure and can be used even when the actual agent is unknown." https://aspr.hhs.gov/SNS/Pages/CHEMPACK.aspx

Why is it important for industry to know about the CHEMPACK system? Aside from the fact that the CHEMPACK contains antidotes that would be used for patients exposed to a nerve agent in a terrorist attack, the antidotes would also be affected in a release of certain industrial chemicals such as organophosphates or insecticides.

Local Customization of the ChemPack based on Risk

The other important point is that a community may choose to develop strategies for a local or regional Chempack that is based on Priority Risk Chemicals that might require specific antidotes. In reality, the actual ChemPack is part of a federal program and there is no need to have local kits of antidotes stored in the same container or room for that matter. The ChemPack concept is to have antidotes for chemical exposure readily available when needed. For instance, in the Galveston and Brazoria County region, two of the highest risk industrial chemicals are Hydrogen Fluoride (HF) and Hydrogen Cyanide. As it turns out, both of these chemicals require a specific antidote (HF requires treatment with Calcium Gluconate; and Hydrogen Cyanide requires treatment with Hydroxocobalamin, an injectable form of vitamin B-12). Hospitals can within reason, assure that a supply is on hand to treat these exposures. Industry partners can assist. HF suppliers and users in the region have agreed to make a best effort at supplying Calcium Gluconate if needed. There was a recent case in Southeast Texas where someone was exposed to cyanide. The hospital where they were sent did not have the antidote needed and it could not be secured in time, resulting in a fatality (a preventable death).

Antidotes and Medical Management

The Agency for Toxic Substances and Disease Registry (ATSDR) provides a web-based Toxic Substance Portal (https://wwwn.cdc.gov/TSP/index.aspx) with an alphabetical listing of toxic chemicals. The information for each chemical includes actions to take in the hot zone, decontamination, and medical management. The medical management section would be the place to check to see if any specific medical countermeasures or antidotes are needed. This information can be used to assess the need for any local caches of antidotes.

Distribution of Medical Countermeasures

There is somewhat of a disconnect at the federal, state, and local level about plans to distribute medical countermeasures outside the hospital in the event of a large chemical release where a specific antidote is needed, e.g., Calcium Gluconate for a large HF release. Hospital plans generally only include treating patients that arrive at the hospital. The medical countermeasures in the hospital ChemPack (Atropine Sulfate, Pralidoxime Chloride, Diazepam) would be administered to those exposed to a nerve agent who are patients within the hospital. Texas hospitals generally do not have plans to deploy teams to administer medical countermeasures to the general population. If your community needs the capability to deploy medical countermeasures for a chemical incident or attack, then a plan likely needs to be developed.

Exercises

Sample Offer to Industry through the LEPC

Below is a sample communication that a hospital can send out through the LEPC to industry partners to invite them to participate in a joint exercise.

Dear LEPC Industry Members:

For companies that have particular chemicals they are concerned about, we can set up exercises fairly quickly.

An initial tabletop discussion should include the plant's emergency coordinator, safety official, industrial hygienist, plant physician or physician assistant.

Discussion topics would include:

- *Chemical of concern and treatment for exposure*
- *Decontamination and first aid on site*
- *Notification to the Emergency Room Dispatcher and contact information from Plant Physician*
- *Any medical treatment initiated on site*
- *Transport and patient distribution*
- *Secondary decontamination at the hospital*
- *Triage*
- *Trauma, burns, combined injuries*
- *Communications and protected health information*

A functional exercise could include

- *Notification to Emergency Room*
- *Transport*
- *Decontamination*
- *Triage*
- *Movement to trauma center or burn unit*
- *Treatment (patient card for each patient with vitals, signs, symptoms, any photos of real injuries)*
- *Communications and protected health information*

We recommend that for toxic or highly toxic chemicals, that we conduct refresher training and exercises at least every two years.

Please contact _____if you would like to plan an exercise.

Thank you,

The Homeland Security Exercise and Evaluation Program

The Homeland Security Exercise and Evaluation Program (HSEEP) program provides useful references and planning guides to develop any type of emergency management exercise. (https://www.fema.gov/emergency-managers/national-preparedness/exercises/hseep) and can be used to develop joint chemical industry – healthcare exercises.

Basic Preparedness Scenarios

Occupational Exposures

Generally, plant or transportation workers have a higher probability that injuries could include exposure to high concentrations of liquid or gas chemicals. Incidents may include fire or explosion. For plant scenarios, victims of the exposure are limited to within the plant fence line. If a fire or explosion is involved, injuries could include trauma and thermal burns in addition to any chemical burns.

Community Exposures

Exercises involving a chemical release that extends outside of the plant fence line could include community members not affiliated with the chemical facility. The plume from a chemical release incident from a plant or transport asset affects the surrounding community. Incidents can include airborne dispersion, water contamination, fire or explosion. Planning and conducting exercises is of mutual benefit to the hospital and industry. It is less likely that community members would be directly exposed to highly concentrated liquid chemicals. These scenarios would more typically involve exposure to the gaseous form of the chemical, particularly if it were a heavier than air gas like chlorine.

Transport Incidents:

Chemicals are transported by road, rail, pipeline, barge.....An incident resulting in a release can occur with any mode of transport. In contrast to plant accidents where major chemical facilities can have specialized emergency responders and fire fighters ready on short notice; and where

risk may be mitigated by the availability of special equipment and de-inventorying systems, availability of these specialized resources at a transport incident would be rare. Along transport routes the first responders could consist of volunteer fire departments without specialized training and equipment.

Initial Joint Planning Discussion for Occupational Exposures

Initial discussions would typically include emergency response capabilities at the facility and the local jurisdiction; and the capacity and capabilities of local hospitals in terms of decontamination and ability to care for patients with chemical exposure. For example, is one of the hospitals a Level One Trauma or Burn Unit? If so, this hospital would receive the most critical patients. The goal should be to have an effective initial distribution of patients so that every patient would be able to receive the appropriate level of care and no one hospital would be overwhelmed by receiving too many patients. Ideally, local Emergency Medical Services or a Regional Trauma Advisory Council would have the capability to efficiently and effectively manage this initial patient distribution. Sending patients to the wrong level of care could necessitate a secondary distribution effort that would delay definitive care, use more resources, and potentially divert resources from primary patient transport and treatment efforts.

Terrorist attacks, besides industrial and transportation accidents, can instantaneously generate a large number of casualties at a concentrated location. To minimize mortality, the response to such mass casualty incidents (MCI)—reaching the incident location, performing triage, and evacuating the casualties to medical facilities—needs to be performed in a rapid and smooth manner. However, MCIs pose several challenges to emergency and healthcare services. Mass casualty incidents are unpredictable in terms of their time and location of occurrence. After an MCI occurs, the aim is to identify critically injured casualties (triage) and rapidly evacuate the casualties, which are conflicting priorities. The greater the number of casualties, the more time it may take to find those who need immediate care, and the greater the likelihood of preventable deaths that are caused due to treatment delays. But the focus on rapid scene clearance to reduce treatment delays can result in triage errors, which can increase critical mortality. Performing triage effectively also needs skilled and experienced teams . . .

(https://link.springer.com/article/10.1007/s13753-020-00260-3) "Mass-Casualty Distribution for Emergency Healthcare: A Simulation Analysis"

Communications between the plant and hospital are a major success factor in the response. For the most seriously injured patients, a plant physician or safety official should contact the Emergency Room dispatcher to advise them on the number of patients arriving, the nature of injuries including the chemicals involved, the estimated time of arrival and mode of transport (e.g. ambulance or company safety vehicle), and importantly, a call back number in case the treating physician at the hospital has any questions.

Potential Scenarios could include: accidental release; deliberate release (terrorist attacks); industrial plant incident; pipeline incident; road or rail transport incident.

Planners should decide on general characteristics of the scenario and model the release scenario. The LEPC, industry, local fire departments, a local National Weather Service, or nearby Academic Medical Center may be able to provide plume modeling for the incident and describe the limitations of the modeling.

Planners would have to decide the start and ending points for the simulated incident. For instance, the exercise could begin at the plant, where injured workers are deconned and potentially provided with an initial treatment by the plant physician or physician's assistant and then transported to the ER. The exercise could begin when either plant begins arriving at the ER. The exercise could end when for instance, the patients receive decontamination, are triaged and then treated by the physician and nurses based on moulage, patient cards with vitals, signs and symptoms or both. Below is a discussion of Family Reception /Reunification Resilience Centers. Consideration should be given to joint exercises implementing these centers.

Initial Joint Planning Discussion for Community Exposures:

Additional Participants could include: jurisdiction officials to include the Emergency Coordinator, Police, Fire, EMS, HAZMAT, Public Health, Schools, Mental Health services, and representatives of the Local Emergency Planning Committee (LEPC). The exercise planning committee should decide on the goals of the exercise. This could include the emergency response phase or phases to be covered. For instance, a Chemical Terrorism exercise could include the prevention actions that local industry and officials could take on receipt of a warning or threat that an incident were about to occur, and the healthcare response mounted if the attack were able to be carried out. The specific scenario for the exercise could be informed by plume modeling of the chemical(s) released. In the case of community exposure, typically the chemical plume would extend beyond the chemical facility fence line into the community. The health effects on community members would depend on the toxicity and concentration of the chemicals involved. As discussed in the section on Acute Exposure Guideline Levels above, exposure to the chemical agent could result in everything from mental health effects, mild eye and skin irritation, up to serious incapacitating injuries and deaths. Patient distribution discussions will be complicated by large numbers of self-referring patients. An example of this was during the Sarin gas chemical attack by a terrorist group on the Tokyo subway system. Ultimately five people were killed, but approximately 5,000 people rushed to area hospitals for evaluation. Other health-related topics that should be planned for are the consequences of the chemical release on plant and animal agriculture; and human and animal food supplies. In the September 2012 Gumi City, Korea release of Hydrogen Fluoride (HF), agricultural materials were destroyed as a precaution because there was no definitive information on the health effects of possibly HF-tainted ingredients entering the food supply chain.

Chemical incident modeling tools do not currently estimate the number of people that will have legitimate mental health concerns that may need assessment and counseling. Often times these people are characterized by the term *worried well*. This term seems to imply that they are in fact *well* and therefore don't require treatment, so their requests for assistance are somehow unnecessary and a diversion to responders. An optimal preparedness plan would address their legitimate requests for support. While modeling tools do not estimate this number, a good initial order of magnitude planning figure would be the population included in the AEGL-1 area. One planning option would be to deploy assessment teams into the potentially affected zones.

The exercise could address the shelter-indoors or evacuation decision. Evacuations are extremely difficult to implement. Cities and urban areas are simply not designed from the perspective of the need for rapid evacuation and relocation of large numbers of people. Evacuation during darkness in nighttime hours is even more difficult and many residents with functional needs may not have the physical ability to comply with an evacuation order. One consideration might be the probability that the initial incident will cause a major fire or explosion, or cascading releases. The shelter/evacuation decision will always involve judgements on the relative risk of each option. Advanced exercises should include this topic and how it will be done under duress and by whom. A variation of this would be a scenario such as occurred in East Palestine where local officials had minutes to decide whether to do a 'controlled burn' of derailed tanker cars in order to avoid a BLEVE as occurred in the 1983 Murdock, Illinois Train Wreck:

On September 2, 1983, a Baltimore and Ohio Railroad train derailed at about 3:30 p.m., starting a fire. The fire heated tanks filled with liquefied petroleum gas, resulting in two large boiling liquid expanding vapor explosions. The force of the first explosion catapulted one of the tanker cars 3,630 feet (1,110 m) into the wilderness. As night fell, the fire continued to burn, and the second explosion created a blinding light as if it was daylight at night

Boiling Liquid Expanding Vapor Explosion (BLEVE) Scenarios

A BLEVE scenario, under time pressure would be another advanced exercise scenario that industry, responders and healthcare could consider. Chemicals to use in the scenario could be selected from Tier II reports or commodity flow studies. Priority risk BLEVE incidents could be identified in advance and responses could be rehearsed through planning and exercises. Local officials would be better prepared to react to information from company or federal agencies that a BLEVE is possible, and they have minutes to decide to implement a controlled burn. Exercises and planning could go into some depth: including for instance the byproducts on the chemical burn and the resulting health and environmental effects of those byproducts being distributed over waterways, agriculture, and houses.

"A boiling liquid expanding vapor explosion (BLEVE) is an explosion caused by the rupture of a vessel containing a pressurized liquid that has reached a temperature above its boiling point. Because the boiling point of a liquid rises with pressure, the contents of the pressurized vessel can remain a liquid as long as the vessel is intact. If the vessel's integrity is compromised, the loss of pressure drops the boiling point, which can cause the liquid to convert to a gas expanding rapidly. If the gas is combustible, as in the case with hydrocarbons and alcohols, further damage can be caused by the ensuing fire."

Unknown Chemical Incidents

Hopefully, by developing a high state of readiness through regular community preparedness activities with the LEPC, hospitals, and industry all response partners will be familiar with the chemicals that could be involved in a real release incident, and they will know when a specific medical countermeasure or antidote is needed for medical treatment. But what happens when the chemical agent(s) involved are initially unknown? This could be due to several reasons such as a train derailment where it is difficult to get placard information from the tankers; the release may be at night where the first sign is a chemical odor or health effects and the origin is unknown; or it may be the result of a covert terrorist attack making use of a variety of possible toxic chemical agents, including nerve agents. In this case, some emergency room physicians, toxicologists, or

specialists at the regional Poison Control Centers can be of assistance in identification of the chemical by working backward from the symptoms that patients are presenting with. One good example of this is the set of symptoms associated with exposure to a nerve agent or other organophosphate chemical. The acronym for this set of symptoms is SLUDGE, which stands for salivation, lacrimation (eyes tearing), urination, defecation and gastrointestinal emesis (vomiting). The technical term for these sets of symptoms is toxidromes or toxic syndromes. Additional details on toxidromes are available at https://chemm.hhs.gov/toxicsyndromes.htm for anyone wanting more information.

Poison Centers in Texas

Texas Poison Center Network (TPCN) was created in 1993. Texas has six regional poison centers that provide 24-hour access to free immediate medical advice for Texans. Anyone can access these services by calling a 24-hour, toll-free hotline [800-222-1222] , any day of the year. Physicians, pharmacists, nurses, and educators trained in toxicology answer all calls.

These centers help provide the public, hospitals, emergency responders, and health care providers with information and treatment for:

- *Poisonous substances*
- *Hazardous substances*

TPCN provides other services that include:

- *Answering public questions during health emergencies*
- *Referring callers to the nearest hospital and assisting in the treatment*

Texas Locations:

- Central Texas Poison Center
  Scott & White Memorial Hospital – Temple
- North Texas Poison Center
  Dallas County Hospital District – Dallas
- Texas Panhandle Poison Center
  Texas Tech University Health Sciences Center – Amarillo
- Southeast Texas Poison Center
  The University of Texas Medical Branch at Galveston

- South Texas Poison Center
  University of Texas Health Science Center at San Antonio
- West Texas Regional Poison Center
  University Medical Center and El Paso County Hospital District

[Above excerpted from https://www.dshs.texas.gov/environmental-surveillance-toxicology/home-poison-epidemiology/tpc-poison-epidemiology]

The Southeast Texas Poison Center at the University of Texas Medical Branch at Galveston participates with regional LEPCs in planning and exercises and has responded to numerous real incidents. The national system of Poison Control Centers https://www.poison.org/ is also a good resource for real incidents. There is a national system of call centers that can respond to thousands of calls if needed from residents in the potential affected area, as well as from physicians and other health professionals that need information assistance in treating patients. Parenthetically a recent incident that the Southeast Texas Poison Center handled involved cyanide exposure. The local hospital where the patient was being treated did not have the antidote needed to treat the exposure and unfortunately the patient became a fatality. This points to the importance of hospitals having a good sense of the chemicals in their patient catchment area, and if there is a specific medical countermeasure needed to treat an exposure to a priority risk chemical, that the medical countermeasure be available or quickly obtainable.

The Southeast Texas Poison Center is also on call for release incidents involving a federal response and they participate in the Unified Command to provide toxicological expertise for responders.

Next Steps-Follow on areas for improvement

Community Preparedness: East Palestine and Texas City

Unfortunately, the incidents in East Palestine, Ohio and the 1987 release of Hydrogen Fluoride in Texas City, Texas share one characteristic – the residents affected by the exposure where left with little information regarding the possible long-term health effects of the exposure; ". . . *on February 3, 2023, a Norfolk Southern freight train derailed in East Palestine, Ohio, about a quarter-mile west of the Ohio-Pennsylvania state line. Twenty of the affected cars contained hazardous materials, including vinyl chloride, ethylene glycol, ethylhexyl acrylate, butyl acrylate and isobutylene.* https://www.epa.gov/east-palestine-oh-train-derailment

After the 1987 hydrogen fluoride release in Texas City, many of those exposed wondered about the long-term health effects and some challenged the assertion that there were no effects. Local and state health officials attempted to do epidemiological studies, but a key problem for them was that they had no baseline health or environmental data that would have made a more compelling case for causality. The company involved brought in a physician with some experience in treating patients for HF exposure who relayed anecdotal evidence that there was little concern for long-term health effects.

After 4,000 people were evacuated as a result of a leak of hydrofluoric acid from a refinery, questions are still being asked about potential hazards here and in other cities where the same chemical is used.

Those questions center both on the long-term effects on those exposed to the Oct. 30 leak from the Marathon Petroleum Company here and on the degree of risk faced by workers and residents living near 68 plants around the country where the potentially lethal chemical is used. More than 1,000 residents were treated for eye and respiratory problems after a pipeline ruptured here, sending a cloud of gas into nearby residential neighborhoods.
https://www.nytimes.com/1987/12/20/us/acid-leak-in-texas-leaves-a-residue-of-questions.html

A prerequisite to the ability to connecting exposure from an incident to possible long-term health effects would be a community capability to collect baseline health and environmental data – as well as the ability to respond to a release incident to collect post incident human health and

environmental data. In areas with a high density of chemical industry and transport, the capability to do community-based air monitoring and post incident emergency response air monitoring would be critical to identifying the population exposed. The monitoring needs to be able to capture data at the peak concentration by time and location (rather than say, the next morning at nearby locations).

Family Reception / Resilience / Reunification Centers

Hospital Family Reception Centers

Hospital emergency planners typically assume that in any mass casualty/fatality incident, the number of family members of victims could outnumber victims by a ten to one ratio. For these reasons, hospitals should have a Family Reception Center. (The exact name of the center may vary by region but the concept is the same.) The basic idea is to avoid the Emergency Room (ER) being overrun and consequently interrupting the provision of healthcare services. So typically a Family Reception Center is set up with some separation from the ER – but close enough so that family members don't sense that they are being shunted aside. A key to a successful reception center is that a regular flow of information is provided to those arriving. Many are coming to the ER because they cannot find their family member and may believe that they are now patients in the hospital. Other factors in a successful reception center are that wireless internet and phone services are available; and food and beverages are available. Ultimately the ER will wind down operations and help the family members transition to services provided by either the jurisdiction or industry Family Resilience Center.

Industry Family Resilience Center

Assuming that the chemical incident occurred at a chemical industry facility, that company would be expected to set up a longer-term support system for family members of workers or community members injured in the incident. Industry should coordinate with the jurisdiction in

regard to social services and mental health counseling available. The jurisdiction Medical Examiner/Coroner may also be involved in efforts to identify missing people from the incident. As appropriate, family members should be directed to that resource. Contracted childcare service might be an option to consider for occasions when adults/parents may need to meet with officials or counselors.

Jurisdiction Family Reunification Centers

Local Emergency Managers will have plans to reunify family members after a major incident. This is particularly true for children separated from their parents by the incident. Children often do not carry identification and may not be able to provide their parents' names or address. The centers will need resources for unaccompanied children, and processes for identifying the adults so that children can be returned to their parents.

Communication and Coordination Exercises

Without formal plans that have been practiced and exercised, the processes of family reunification and assistance will be chaotic – therefore aggravating the experience of the victims. Good practice would demand that community-based exercises be held so that processes and communications can be streamlined.

Binary Chemical Agents

Binary chemical agents were developed by the Soviet Union and United States. The concept was that two inherently less dangerous chemicals would be used and not mixed to form the more deadly chemical agent until just before striking the target. An example would be Methylphosphonyl difluoride (DF). The mixing typically occurs within the munition after it is fired. The advantage of a binary weapon to a terrorist group would be that transport to the target area would be safer for the terrorist. It would also prevent premature detonation and therefore

missing the primary or most lucrative target. On a small scale, perhaps for an indoor target, the binary agents could include a salt of cyanide and an acid.

Healthcare v Public Health

Healthcare and public health are terms that are often conflated and misunderstood in the emergency management field. In the post-911 years an effort was made to provide National Incident Management System/Incident Command System (NIMS/ICS) training to public health agencies and to better integrate public health officials into local implementations of e.g. a unified command. Public Health and Healthcare have related but different roles for chemical release incidents. Generally speaking, healthcare deals with the delivery of healthcare services to an individual patient. The Public Health role is more focused on the health of a population.

Blakey has identified specific tasks that public health agencies should do to better prepare for chemical incidents. He organizes the tasks in categories very similar to the four phases of emergency management; and the five mission areas of the National Preparedness Goal. The specific categories that he uses include: prevention, emergency planning and preparedness, detection and alert, response, and recovery.

Under prevention he lists such tasks as: identifying the chemical hazards and risk, determining the health impact on release scenarios, communicating chemical risk information to the public, supporting restrictions on land use and chemical storage quantities, encouraging substitution of inherently dangerous chemicals and processes with safer ones, supporting improved security at chemical plants, as well as law enforcement and intelligence efforts to prevent incidents.

Under planning and preparedness, Blakey sees public health as contributing to the effective design and implementation of the emergency response infrastructure and contributing to overall emergency response planning while providing specific public health response plans. Public

health would also develop databases that would improve response capabilities [e.g. baseline health and environmental data]; develop information on medical countermeasures and organize a local inventory of where they are located; and they would conduct training and participate in local exercises [with healthcare and local industry].

In terms of detection and alert, public health would support the implementation of [public] detection and alarm systems [including air monitoring] and provide chemical incident recognition training. [Detection of local incidents can also be linked to Poison Control and their call volume in a given geographic area.] Blakey also suggests a role for public in developing phone or Web-based hotline public information systems for incident reporting and incident alert. [At the Academic Medical Center/School of Public Health level] public heath could improve diagnostic technologies [and lab tests] for chemical exposure.

In the response phase, public health officials would implement the public health aspects of the response plan [including communication and coordination with healthcare in the region, e.g. establish a virtual Joint Information Center for public information]; provide advice to the Unified Command on incident control options; set up a registry of those potentially exposed [including responders]; collect post-incident health and environmental data and likely exposure levels for the population; and conduct epidemiological investigations. [For a covert terrorist chemical attack, some level of a joint public health/law enforcement investigation may be needed.]

According to Blakey, the public health role in recovery from a chemical incident would include "organizing healthcare, including mental health, to treat victims." In Texas, local public health does not have the authority or role to direct hospitals or mental health agencies on treating patients. An appropriate role would be in disseminating treatment guides and if applicable, supporting hospitals that submit resource requests through the state and federal government for

e.g. replenishment of medical countermeasures from the *Strategic National Stockpile*; or supporting requests through the State for activation of the Texas *Emergency Medical Task Force* System, or the *Emergency Management Assistance Compact* for requests to nearby states; or for State requests to activate the *National Disaster Medical System* (which would include for instance: *Disaster Medical Assistance Teams*, *Trauma and Critical Care Teams*, *Victim Information Center Teams*, *Disaster Mortuary Operations Response Teams*, *National Veterinary Response Teams*).

Other public health roles in the recovery phase according to Blakey include: risk and health outcome assessments, remediation and restoration actions, compiling epidemiological data, and participating in after-action reviews.

Artificial Intelligence Toolsets for Major Complex Incidents

Current reach back capabilities for technical expertise in dealing with potential major complex attacks on technology targets such as chemical facilities are not really adequate, especially when decisions must be made under severe time constraints. Consider for example, information from the National Transportation Safety Board field investigation into the East Palestine Train Derailment:

". . . the second session turned attention to the events that followed and was titled "Circumstances that Led to the Decision to Vent and Burn Five Vinyl Chloride Tank Cars." East Palestine Fire Chief Keith Drabick gave the NTSB and those who attended the second session insight into how little time he was given to make that decision as daylight was dwindling, weather patterns were shifting and temperatures were changing. After being told of the rising threat, Drabick met with Gov. Mike DeWine. "Thirteen minutes, that's how much time we had,"

Drabick said. "When we got taken down to that room, we were told we had 13 minutes to make that decision.""

(https://www.salemnews.net/news/local-news/2023/06/east-palestine-fire-chief-13-minutes-to-decide-on-vent-and-burn/)(Elverde)

Circumstances like this occurring in future chemical incidents, whether accidental or deliberate, are foreseeable. Artificial Intelligence toolsets to aid in short fuse decision making should be developed for U.S. responders.

Cybersecurity and Infrastructure Security Agency's Role in Cross-Sector Preparedness

(CISA): CISA has an overall mission to "lead the national effort to understand, manage, and reduce risk to our cyber and physical infrastructure," (https://www.cisa.gov/about) but it has a specific role related to the Chemical Sector. As part of the Department of Homeland Security, CISA has been assigned the lead federal government role to coordinate partnerships and enhance the security and resilience of the Chemical Sector: "CISA leads the Chemical Sector's public-private partnership and works with companies to develop tools and resources that enhance the sector's security and resilience." To date, there does not seem to be a formal effort underway at CISA to encourage cross-sector collaborative planning between the Chemical Sector and the Healthcare Public Health Sector.

While CISA does describe the role of the Healthcare and Public Health sector in protecting all other sectors, there is no specific guidance in how this could be accomplished for the Chemical Sector.

"*The Healthcare and Public Health Sector protects all sectors* [emphasis added] *of the economy from hazards such as terrorism, infectious disease outbreaks, and natural disasters. Because the*

vast majority of the sector's assets are privately owned and operated, collaboration and information sharing between the public and private sectors is essential to increasing resilience of the nation's Healthcare and Public Health critical infrastructure."

https://www.cisa.gov/topics/critical-infrastructure-security-and-resilience/critical-infrastructure-sectors/healthcare-and-public-health-sector

As demonstrated, major accidental industrial chemical releases, or deliberate attacks on chemical facilities are a *homeland security* risk. One way to mitigate the risk is through collaborative planning between industry and healthcare/public health. Reducing the number of injuries or fatalities reduces the impact of the incident. Perhaps a good first step toward industry and healthcare collaboration would be through the respective *Sector-Specific Councils*.

Industry and hospitals should collaborate in emergency preparedness programs that includes: planning, training, and exercises. Ideally this would be in the context of the LEPC; and ideally CISA would take a role in fostering this partnership among the two critical infrastructure sectors.

Modeling Response Capacity and Capability

In addition to modeling chemical releases, it is also possible to inventory a jurisdiction's response resources and response times. The net result is that the jurisdiction's response to a challenging release scenario can be modeled, and the results can be used as a tool to identify response gaps. Modeling can help determine the return on investment (bang for the buck) on acquiring additional resources. Response Risk Assessments like this were run for Galveston County, and Texas City, Texas. This effort was done as part of the Complex Coordinated Terrorist Attack (CCTA) grant that Galveston County received from the Federal Emergency Management Agency. The rationale behind the grant proposal was that given the high concentration of the chemical industry in Galveston County, and the potential lethality of some

of the chemicals that are used in large volumes there, a CCTA that included chemical facilities like chemical plants, pipelines, road or rail tanker transport, or chemical barges would be an incident on national significance and could result in extremely high casualties.

Chemical Incident Maturity Models

Maturity Modeling is used in domains like Organizational Resilience. Typically, maturity models are five-point scales (e.g., 0-4, or 1-5). If applied to a jurisdiction in the field of chemical incident preparedness, the basic idea is to evaluate the level of maturity of response capability and capacity against risk. For example, in an area with virtually no-chemical risk, a very low level of response maturity would be required. In an area, like Galveston County, Texas City, Baytown, et c., where the risk of a disaster is very high, then correspondingly, the maturity level must be high. Generally speaking, the lowest level of maturity indicates that there is no documentation of plans and processes. The highest level of maturity would indicate that the jurisdiction documents all plans and processes and subjects them to continuous testing (or evaluation against real incidents) and formally manages continuous improvement. In the chemical incident domain for instance, rigorous risk assessments would identify any specific medical countermeasures needed, and a system would be devised to assure that sufficient supplies were available. A risk management approach like this would avoid the one size fits all mistakes and tailor the level of effort needed for preparedness to the risk.

Additional Resources for Emergency Planners

- Agency for Toxic Substances and Disease Registry (ATSDR). Provides an alphabetic listing of toxic chemicals with the corresponding medical management for each one:
    - https://wwwn.cdc.gov/tsp/substances/SubstanceAZ.aspx
    - https://wwwn.cdc.gov/tsp/substances/ToxChemicalClasses.aspx
- FEMA: Managing the Emergency Consequences of Terrorist Incidents https://www.fema.gov/pdf/plan/managingemerconseq.pdf
- Key Planning Factors and Considerations for Response and Recovery from a Chemical Incident (June 2022): https://www.fema.gov/sites/default/files/documents/fema_chemical-incident-kpf-2022.pdf
- Planning and Decision Framework for Chemical Incident Consequence Management (July 2022) https://www.fema.gov/sites/default/files/documents/fema.gov_planning-framework-for-chemical-incident-consequence-management-2022_20221109.pdf
- Wireless Information System for Emergency Responders (WISER): The National Library of Medicine discontinued WISER on 28 February 2023. Those who downloaded WISER to a mobile device or desktop will still have access, but data will no longer be updated.
- Chemical Companion (https://www.chemicalcompanion.org/) Emergency Response Decision Support System (ERDSS)
- Administration for Strategic Preparedness and Response's (ASPR) Chemical Hazards Emergency Medical Management (CHEMM - https://chemm.hhs.gov/)
- Department of Transportation's (DOT) Pipeline and Hazardous Materials Safety Administration Emergency Response Guidebook (https://www.phmsa.dot.gov/training/hazmat/erg/emergency-response-guidebook-erg)
- *National Oceanic and Atmospheric Administration's CAMEO Chemicals (https://response.restoration.noaa.gov/cameochemicals*
- Tools Sponsored by the Office of Emerging Threats https://www.fema.gov/emergency-managers/practitioners/hazardous-response-capabilities/oet-tools

Works Cited

Blakey, David H. et al. *A screening tool to prioritize public health risk associated with accidental or deliberate release of chemicals into the atmosphere*. BMC Public Health. 2013; 13: 253. Published online 2013 Mar 21. doi: 10.1186/1471-2458-13-253

Bethea, Robert M. *Explosion and Fire at the Phillips Company Houston Chemical Complex*, Pasadena Texas, Chemical Engineering Department. Texas Tech University

Elverd, Stephanie. "*East Palestine fire chief: 13 minutes to decide on vent and burn*" Salem News, June 27, 2023

Jat, M.N., Rafique, R.A. *Mass-Casualty Distribution for Emergency Healthcare: A Simulation Analysis*. Int J Disaster Risk Sci 11, 364–377 (2020). https://doi.org/10.1007/s13753-020-00260-3

Russell, David, and John Simpson. "*Emergency planning and preparedness for the deliberate release of toxic industrial chemicals*" Clinical Toxicology. 2010 Mar 48(3):171-6. doi: 10.3109/15563651003698042.

World Health Organization (WHO): *Manual for the public health management of chemical incidents*. Geneva: 2009. http://www.who.int/environmental_health_emergencies/publications/Manual_Chemical_Incidents/en/index.html

Zanders JP: *"Assessing the risk of chemical and biological weapons proliferation to terrorists."* The Nonproliferation Review 1999 Fall:17–34 [http://cns.miis.edu/npr/pdfs/zander64.pdf].

Webinar Notes

If presented as a webinar, the Learning Objectives would include:

On completion of the webinar, the participant should be able to:

- State why high concentrations of toxic industrial chemicals pose a homeland security threat and give examples of how chemicals could be used by terrorists.
- Discuss why advance planning by healthcare and industry is particularly important to Texas and the Texas economy given the scale and scope of the Texas energy and chemical industrial sector.
- Describe in general terms how joint preparedness efforts among hospitals and the chemical industry can help achieve elements of the National Preparedness Goal.
- Discuss how planning and exercising to achieve *zero preventable deaths* will mitigate the effects of a terrorist attack or industrial accident.
- Describe the difference between planning for chemical *occupational vs community exposure* scenarios.
- Describe why chemical risk prioritization is a fundamental concept in chemical incident preparedness.

Resources for Webinar

- Plume Model HF Release for discussion

INSTITUTE FOR HOMELAND SECURITY

Sam Houston State University

The Institute for Homeland Security at Sam Houston State University is focused on building strategic partnerships between public and private organizations through education and applied research ventures in the critical infrastructure sectors of Transportation, Energy, Chemical, Healthcare, and Public Health.

The Institute is a center for strategic thought with the goal of contributing to the security, resilience, and business continuity of these sectors from a Texas Homeland Security perspective. This is accomplished by facilitating collaboration activities, offering education programs, and conducting research to enhance the skills of practitioners specific to natural and human caused Homeland Security events.

Institute for Homeland Security
Sam Houston State University

Mastrangelo, M. (2023) Improving Texas Homeland Security: A Practical Framework for Joint Hospital - Chemical Industry Emergency Planning. (Report No. IHS/CR-2023-1019). The Sam Houston State University Institute for Homeland Security. https://doi.org/10.17605/OSF.IO/U4DFR