

Guide for Using Hazmat Transportation Information: Recommendations and Resources for Local Emergency Planners

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LIST OF ACRONYMS

Acronym	Complete Name
AEGL	Acute Exposure Guideline Level
AIHA	American Industrial Hygiene Association
ALOHA	Area Locations of Hazardous Atmospheres software
BLEVE	Boiling Liquid Expanding Vapor Explosion
CAMEO	Computer-Aided Management and Emergency Operations software
CATS/JACE	Consequence Assessment Tool Set/Joint Assessment of Catastrophic Events
CCPS	Center for Chemical Process Safety
CERT	Community Emergency Response Team
CFS	Commodity Flow Study
DDC	Disaster District Committee
DSHS	Texas Department of State Health Services
DYNASMART-P	Dynamic Network Assignment-Simulation Model for Advanced Road Telematics (Planning version)
EMS	Emergency Medical Services
EOP	Emergency Operations Plan
EPA	U.S. Environmental Protection Agency
ERG	Emergency Response Guidebook
ERPG	Emergency Response Planning Guideline
ETIS	Evacuation Traffic Information System
FEMA	Federal Emergency Management Administration
FHWA	Federal Highway Administration
HPAC	Hazard Prediction and Assessment Capability
LEPC	Local Emergency Planning Committee
LPG	Liquefied Petroleum Gas
MASSVAC	Mass eVACuation
NETVAC	Network Emergency Evacuation
NIOSH	National Institute for Occupational Safety and Health
NOAA	National Oceanic and Atmospheric Administration
NRHM	Non-Radioactive Hazardous Materials
OEM	Office of Emergency Management
OREMS	Oak Ridge Evacuation Modeling System
OSHA	Occupational Safety and Health Administration
PAC	Protective Action Criteria
PHMSA	Pipeline and Hazardous Materials Administration
RLO	Regional Liaison Officer
TCEQ	Texas Commission on Environmental Quality
TDEM	Texas Division of Emergency Management
TEEL	Temporary Emergency Exposure Limit
TrEPS	Traffic Estimation and Prediction System
TTI	Texas A&M Transportation Institute
UN/NA	United Nations/North America
VCE	Vapor Cloud Explosion

1. INTRODUCTION

Local government is the first line of defense during emergencies and disasters. A hazardous materials (hazmat) commodity flow study (CFS) helps communities identify specific transportation hazards in their jurisdiction. However, identifying materials and transit routes is only the first step. Further analysis is needed to determine how those hazards affect public safety and how communities can prepare to respond to those hazards. This document helps local decision makers address both these responsibilities. It describes general and functional area recommendations, tools for evaluating risk, and describes other references and resources for emergency planners.

Many of the questions and recommendations described in this report will apply to your jurisdiction, and some will not. The intention of this report is not to imply that a jurisdiction is not addressing these questions and recommendations, but rather to specifically identify them to help jurisdictions review and evaluate the risks that communities are potentially exposed to through hazmat transportation, and take actions to ensure population, environmental, and infrastructure protection.

Emergency management officials and local emergency planning committees (LEPCs) can use the following list of possible actions as a starting point for implementing changes and incorporating the data obtained from commodity flow studies.

- Use the data from your CFS with the recommendations in this document to identify significant hazards in your community and which roadway segments they travel along.
 - Re-evaluate your community's Hazard and Risk Analysis, or conduct a new one.
 - Use computer aided tools and other resources to create and evaluate various incident scenarios along the routes and materials identified in your CFS to evaluate potential impacts in the event of an accident.
 - Identify critical infrastructure or special needs facilities that may be impacted by incidents along identified route.
- Review both Annex Q (Hazardous Materials) and Annex D (Radiological Response) of your jurisdiction's Emergency Operations Plan (EOP) to ensure that response organizations can adequately respond to incidents involving the hazards identified in your Hazardous Materials CFS.
 - Ensure that resources exist within all response organizations (police, fire, and emergency medical services [EMS]) to address the hazards identified in your CFS and that resources are appropriately stationed to speed response to high risk areas and transportation corridors.
 - Note where there is a resource shortfall and identify outside resources available from state agencies, grant programs, the private sector, or via mutual aid to address those hazards.
 - Ensure immediate mitigation and environmental protection resources are available to responders especially in sensitive environmental areas and areas where population densities are high.

- Conduct training and exercises that incorporate scenarios using materials identified in your CFS.
 - Work with response agencies to review training requirements and frequency for first responders. Use the CFS to identify hazard-specific training requirements you can incorporate into those programs.
 - Work with community partners in the manufacturing and distribution sector that are responsible for the hazards identified in your CFS. Identify training opportunities for their employees and first responders.
 - Contact railroad and pipeline operators in your jurisdiction to establish communication and identify training and exercise opportunities for first responders.
- Ensure decontamination resources and facilities can address specific hazards identified in your CFS.
 - Ensure that decontamination plans for both Annex Q and Annex D address both mass casualty and limited casualty decontamination, in addition to the personnel decontamination plan that is included in the stock plan provided by the Texas Division of Emergency Management.
 - Conduct a review of decontamination facilities and resources within the community, including hospitals, clinics, and other medical facilities.
 - Note which facilities could perform decontamination for which hazard, their casualty flow volume, and any associated resources.
 - Identify the facilities designated to receive contaminated casualties and ensure that procedures and plans are in place to notify medical facilities immediately if an incident produces contaminated casualties, especially if some of those casualties may self-evacuate to medical care.
 - Develop jurisdictional standards for decontamination based on a tiered system using capacity or other measures to categorize facilities by their decontamination capabilities.

While not the focus of this document, a hazmat CFS has have several other uses, which may or may not apply to your jurisdiction, including:

- Identifying facilities or transportation routes with hazardous materials traffic that might not appear on Tier 2 reports.
- Determining the effectiveness of hazardous materials corridors and decision making about roadway hazmat restrictions.
- Evaluating overall truck traffic levels on community roads.
- Determining truck traffic time of day traffic flow patterns.
- Evaluating truck traffic around specific facilities like ports and shipping hubs.
- Assisting in the development of transportation construction and maintenance plans and proposals.

The following sections offer ideas and recommendations designed to go deeper into the action items and uses introduced above. An additional section discusses computer aided tools for hazard analysis and the use and selection of protective action criteria (PAC). After the conclusion, there is an appendix with references on where to look for further resources and information.

2. GENERAL RECOMMENDATIONS

The sections below are mainly for the use of multi-agency groups, senior leadership, LEPCs, and elected officials. They offer recommendations and a series of questions designed to help communities think about the information in their hazmat CFS and their own response plans and disaster preparation.

As you read through these sections, it is a good idea to keep a notepad nearby to jot down some of the answers and ideas that come to mind as you ask yourself the questions these sections pose. After reading through, go back and look at your notes and the questions that sparked them. Identify any commonalities or areas of significant concern and rank them. Consider bringing up your most important two or three questions at the next meeting of your LEPC, agency meeting, or other forum where they might spark discussion and form a basis for action.

Taking it further, as you discuss these questions with others and examine your own responses, begin to form an action plan—how can you and your community influence and sponsor change in your organization, agency, city, or county?

2.1. Hazard and Vulnerability Assessments

Effective emergency planning and communication depends on knowing where risks are greatest and who and what are most vulnerable. Sometimes a risk or vulnerability assessment can identify whether traffic controls (such as speed reductions or enhanced enforcement) or hazmat restricted routes are necessary. A CFS provides information about the type and amount of hazardous materials transported.

In addition, you may evaluate incident histories, transportation networks, and traffic levels. Along with using the information in your CFS, conduct a re-evaluation of hazmat facilities and carriers within your community. Ensure that these are up to date in EOPs and evaluate plans provided by regulated facilities to ensure they are up to date and consistent with local planning. When combined with other information from the EOP—such as population density, locations of special populations or critical infrastructures, and response team capabilities—nearly all of the most important parts of a hazmat risk analysis are covered. Consider the following in your evaluation and assessment:

- Where are priority locations for doing a hazmat transportation risk and vulnerability assessment? What locations appear to be risk hotspots that are primary candidates for evaluation? What information from the hazmat CFS can be used and by whom? What information from other emergency, community, or public works plans is necessary? Where are the information gaps, and are they important?
- What information from the risk and vulnerability assessment should you communicate to decision makers and community stakeholders? What is their feedback?
- How does the information compare with previous ideas about risks and vulnerabilities in your community? How can hazmat transportation affect critical community functions? Do these functions require change in order to mitigate those effects?
- Develop a plan and schedule to re-evaluate and re-access data. Incorporate that schedule into your EOP. Consider spot checks on data contained within this plan and in facility and vulnerability assessments at various intervals to determine their continued validity.

Incorporate these into your EOP and assign specific responsibilities for these to relevant agencies and positions within the EOP.

- Consider additional commodity flow studies, and plan for them by location and frequency. It is not necessary to do the entire jurisdiction all at once. By looking at select parts of the community on a regular cycle, it is possible to keep the information current and reduce uncertainty about whether hazards are changing. Pick a corridor to evaluate every year. Collect the data and evaluate it for the type and amount of hazmat traffic, traffic levels, and types of vehicles; it does not have to be an extremely complicated analysis. Focus on data quality and collecting specific information at consistent locations, over a range of days and times of day, using half-hour or one-hour intervals. Some simple spreadsheets, data filters, and summaries should be enough to compare these new data with the results of this study.
- Regularly examine changes or developments, either industrial or residential, along transportation corridors that may presage changes in commodity flow. This may affect emergency plans as well. Involve volunteers such as elected officials, Community Emergency Response Teams (CERTs), local agency personnel, industry members, students and faculty from colleges or universities in the area, or service group members and let them know how important the information is for the LEPC and the community. Use these organizations and involve them in data collection. This can increase visibility for emergency planning and leverage volunteer resources in pursuit of a community goal.

2.2. Planning and Communication

Integrate the information in your CFS into other community plans. The hazmat CFS contains a lot of information. Some of it may be useful for other community planning efforts—roadway maintenance and planning, economic development, infrastructure planning (e.g., locations of schools, hospitals, arenas, detention facilities, and other special populations), drinking water and storm water pollution prevention and environmental planning, and land use and zoning. Make sure that other agencies are aware of the information resource your office might provide. Use your hazmat CFS as a means to foster communication. Remember that some information in the hazmat CFS may have distribution restrictions:

- The process of planning is usually more important than the plan that is produced. Use the information in the CFS as a springboard to bring together a wide range of participants to re-evaluate EOP risk assessments, and encourage participation in future planning efforts. The more agencies, organizations, and people involved in planning, the more likely they are to know and execute plan contents.
- Sharing this plan's information with relevant parties and drawing them into the planning process is consistent with the goals and mission of LEPCs. A CFS is not a means to an end, but the beginning of a process and offers a means to improve emergency planning throughout your jurisdiction.

Emergency planners and responders who are responsible for public safety along different corridors should review and evaluate the big picture about what the information means. When reviewing the information for specific roadway segments, think about the types of transport these roads service:

- Are they primarily through routes?
- Do they serve as connectors to facilities that are sources and consumers of hazardous materials?

- Do the observations confirm expectations about hazmat transport, or was there hazmat traffic that was not expected?
- Is the truck and hazmat traffic likely to change in different seasons of the year?
- How can the information enhance emergency planning, training, and response?

Similarly, emergency planners and responders should evaluate site-specific observations provided in the CFS, as applicable, with an understanding of the limitations of the data used to draw those conclusions. Consider alternative means of verifying these observations and gathering additional data to support decision making, including:

- Spot checks by responders and local officials: Consider collecting half hour snapshots using methods similar to those used for your CFS at the same or similar locations. Compare new data to the data contained within your CFS. The additional data can verify or show changes in traffic patterns when collected on different days and at different times.
- Additional commodity flow studies: Consider establishing a schedule for commodity flow studies, establishing in advance where to target them and how often to repeat them, in order to address all major roadways of concern over an extended period, as funding becomes available. Incorporate commodity flow studies into a schedule and plan for reviewing community and jurisdictional hazard assessments in advance of regularly scheduled EOP reviews.
- Enforcement activities: Planners and responders can coordinate with federal, state, and local law enforcement, and other agencies and activities like weights and measures and traffic control entities, to develop a plan to target specific roadway segments for additional data collection. Target road segments where specific hazard, carrier, and shipper/destination data can provide additional insight into hazardous materials transported in the area, their origin, and their destination.
- Plot protective action distances for the hazards of greatest concern along each roadway segment observed in your CFS and evaluate evacuation and shelter-in-place criteria in the area, especially for special needs facilities, schools, and other sites that fall within the isolation zones.
- Typically, some roadway segments will have significantly more hazmat transport than others; consider evaluating hazmat response capabilities near these locations accordingly.

2.3. Resource Management and Acquisition

The right equipment and supplies are critical to effective emergency response and protecting responders, property, the public, and the environment when incidents happen. When acquiring equipment and supplies through budgetary and grants funding processes, the case for these requests is stronger when based on real-world information, not guesswork. Examine the Personal Protective Equipment (PPE) recommendations in the CAMEO database, NIOSH Pocket Guide, and North American Emergency Response Guide (ERG) for some of the hazards identified in your CFS. Does your community have those? How many? Does your community have the appropriate equipment necessary to detect and identify hazardous materials contamination or vapors in the event of a spill? What kinds of equipment and supplies are necessary to respond to risks in your community? How will contaminated equipment and supplies be disposed of? Do facilities have some of the needed equipment?

Evaluate your requirements for the following, using your CFS as a guide:

- PPE.
- Chemical and radiation detection sensors.
- Equipment and supplies for spill confinement and containment (e.g., tractors, dozers, tarps, soil, drums, plugs/patches).
- Equipment and agents for neutralization, extinguishing, and dilution (e.g., hoses, pumps, nozzles, tanks, apparatus, foam, bases).
- Decontamination and cleanup equipment and supplies (e.g., showers, storage bags, brushes, soaps).

A fundamental component of emergency resource management is the use of contractors and mutual aid. Local officials should evaluate the following, using the data from their CFS:

- Current contracts related to hazmat incident response and cleanup. Do these contractors have the capabilities and resources necessary to handle the hazards identified within your CFS? Consider specifying specific hazard requirements in future contracts.
- Evaluate mutual aid agreements. Do existing agreements include agencies and jurisdictions with special capabilities that may be necessary in the event of a hazmat transportation incident involving the hazards identified within your CFS? Consider additional arrangements where necessary.
- Evaluate and coordinate incident response activities with the Texas Commission of Environmental Quality (TCEQ) Strike Team and other TCEQ representatives in your area.
- Work with the District Disaster Chair and Texas Division of Emergency Management (TDEM) District Coordinator to ensure that state officials are aware of the hazards within your jurisdiction, and identify resources and plan requests for aid based on those hazards.

A critical component of resource management is the pre-staging and scheduling of resources in accordance with the risk and identified hazards. Hazmat incident risks may be especially high at certain times of the day, days of the week, or seasons of the year. Risks may vary from location to location. Understanding when, where, and what risks are highest can help operations and logistics personnel better plan, schedule, and pre-position resources (e.g., personnel, apparatus, equipment, supplies). Your CFS provides valuable information useful for evaluating resource staging and scheduling. Note:

- Risk levels may not directly match responder shift schedules. Nationally, the number of hazmat incidents peaks in the late morning, and again between midnight and 3 a.m.
- Your CFS identifies several other peak periods by location and time of day. Incorporate this information into your scheduling and resource allocation.
- Several resources provide information about hazmat transportation accidents that have occurred in your community, including state and federal databases. Note: state and federal data sometimes can be problematic and non-specific for local use. We recommend that jurisdictions develop a system to maintain a record of hazmat incidents and response, if one is not already in place. Historical data that identify when and where cargo transport accidents have happened in the past, in conjunction with the information in a CFS, can provide a deep and valuable resource for emergency planning, resource allocation, and acquisition strategies. They can also be used to bolster grant requests for additional equipment or training.

- Evaluate what personnel and resources are available to respond to incidents based on the information in your CFS and historical data to determine any shortfalls. Reallocate personnel and resources based on that evaluation. Additionally, data may suggest areas where efficiencies in resources are possible, though additional data collection is highly recommended.

2.4. Protective Action and Public Education

Contrary to assumptions, studies have consistently shown that the public does not panic when informed of hazardous events. However, research has shown that the public WILL ignore protective action instructions or seek out other sources of information—and often get the wrong information—if they are uncertain of the threats and risks, or distrust the messenger providing the information. Consistent, clear, and straightforward information from trusted sources can help prevent the spread of rumors, avoid unnecessary disasters, and make the jobs of responders easier.

- What public communication and education strategies are now in place in your community? Based on information in your CFS, what additional areas should you target for trust-building and education activities that increase the efficacy of risk communication in vulnerable zones?
- Who coordinates evacuations and shelter-in-place warnings in your community? What warnings do you need along identified transport routes? What populations are present at different times? Are there pre-designated locations for evacuations?
- Are there shelter and evacuation protocols, assembly points, and accounting procedures for schools, day cares, hospitals, detention facilities, and other special facilities located in vulnerable zones? How do you handle concerned parents of schoolchildren?
- Who are influential and trusted leaders or sources of information that can assist with getting the word out in emergencies? What role will the media play? Have public information statements been prepared in advance?
- Are there some in the community with language, culture, or mobility barriers that may be hard to reach? Are there vulnerable populations who may not be able to take action without assistance (e.g., economically disadvantaged, elderly, infirm)?

2.5. Training and Exercise

Officials should evaluate training and exercise scenarios and requirements in connection with the information contained within their hazmat CFS. Start with priority materials—those with highest levels of hazmat transport. Different roadway segments may have different hazardous materials, and depending on the size of a jurisdiction, training needs may not be the same for all agencies or within agencies in the community depending on their specific response area.

Exercise emergency plans against scenarios based on data within your CFS, and implement necessary changes that emerge as a result. Use the following list of questions to assist in evaluating or creating your jurisdiction’s training and exercise program.

- Do exercise plans in your jurisdiction incorporate opportunities to train against known hazards within the community as identified in Tier II reports or a CFS? How frequently do key officials and responders practice against these hazards? Are current plans and frequencies adequate to address the risk?

- What resources are available? For example, the U.S. Environmental Protection Agency (EPA) has numerous emergency management databases and tools that are available to help first-responders address emergencies. Most major railways also offer training cars and other resources to communities for training their responders. These resources can be used in training and real-time incidents, and help give the public a better understanding about hazardous materials that are present in their communities. A link to these resources is at <http://www.epa.gov/oem/tools.htm>.
- How will law enforcement officers identify hazmat when arriving on scene? How will they handle traffic control? Does dispatch understand who to contact for hazmat transport emergencies and how to use the 2012 Emergency Response Guidebook?
- How will volunteer and paid fire departments respond to hazmat incidents? What kind of training do emergency responders need, and how often?
- Are public health and disaster response organizations equipped to handle potential incidents? Are emergency medical practitioners aware of hazmat risks? Do they possess the resources and capability to address them? Are they familiar with associated symptoms?
- How can you coordinate training and response with carriers and industry—trucking companies, railroads, pipelines, ports, petroleum terminals, refineries, and factories?
- Can the local Incident Command System handle hazmat transport incidents? How long will it take to determine whether local resources are sufficient to deal with an incident? Are important individuals and offices in emergency assistance channels familiar with hazmat transport risks and potential resource requests?
- Do responders (fire and police) have clearly defined training objectives and plans consistent with the hazards identified within your CFS? What additional training and regulatory requirements can improve capabilities?
- Do response organizations have sufficient resources allocated to meet their training and exercise requirements? Do they have the necessary resources to respond to and train against the hazards identified within your CFS?
- What capabilities and response coordination mechanisms exist between cross-jurisdictional boundaries, to include federal, state, and military installations? What agreements exist with the jurisdiction in the event an incident occurs at or near one of these facilities that might affect adjacent neighborhoods?

3. FUNCTIONAL AREA RECOMMENDATIONS

This section contains recommendations on how different individuals and agencies in your jurisdiction can use a Hazardous Materials CFS. The best way for these individuals to coordinate their efforts is through an LEPC. If your community has an inactive or low activity LEPC, a CFS is one way to spark interest and get an LEPC moving forward.

Each of the following areas contains several different recommendations for individuals, based on their function in the community. Not all of these recommendations are applicable to all circumstances.

Individuals in any given functional area should evaluate these ideas, in addition to their own, and develop a list of three essentials they wish to accomplish on the back end of a CFS report or EOP review. Rank the three in descending order of importance to the community and with the other members of your LEPC. Use the LEPC to determine which of these essentials are shared across different organizations and responsibilities. Create an action plan to accomplish your top two goals, in concert with those working in the same area/LEPC.

3.1. Elected Officials

- Develop an action plan for implementation of recommendations with executive and agency heads.
- Support Hazardous Material Route designations or revisions if warranted.
- Connect with regional leaders and support regional plans of action that coordinate hazmat response across jurisdictional lines, including adjacent communities and any state, federal, and/or military jurisdictions, as applicable.
- Reassess current resource sharing and cooperation agreements in light of new information.
- Seek and support additional funding from state and federal transportation and emergency management programs to provide for planning and data collection efforts as follow-up to your CFS as well as hazmat response training and exercises.
- Attend training and practice emergency management media relations and hazard communication during exercises.
- Support and encourage the implementation of a jurisdictional training and exercise program for hazmat incident response.
- Participate in the LEPC.

3.2. Executive and Agency Heads

- Transportation – In conjunction with your jurisdiction’s Office of Emergency Management (OEM) and emergency planners, assess hazmat traffic flows in the jurisdictions in relation to daytime population densities, special needs facilities (schools, nursing homes, hospitals, jails, etc.), designated evacuation shelters, critical infrastructure, and environmentally sensitive areas (aquifers, streams, rivers, etc.). Consider alternate designated hazmat traffic routes, if needed.¹

¹ When examining population densities in relation to observed hazmat commodity flows, taken in daytime, it is important to estimate daytime, workday population densities. Most census data are nighttime population data as it focuses on households. There are datasets that can assist in daytime population estimates. See

- Legal – Examine and evaluate any hazmat alternate routing, community zoning, or other mitigation measures deemed necessary based on information contained within your CFS.

3.3. Emergency Planners/OEM Staff

- In conjunction with transportation officials, examine hazmat traffic flows in the jurisdictions in relation to daytime and nighttime population densities, special needs facilities (schools, nursing homes, hospitals, jails, etc.), designated evacuation shelters, critical infrastructure, and environmentally sensitive areas (aquifers, streams, rivers, etc.). Consider alternate designated hazmat traffic routes, if needed.
- In conjunction with the private sector (transportation carriers and petrochemical facilities), assess the potential for impacts of hurricanes on hazmat transportation, including need to evacuate/relocate transportation equipment containing hazmat loads or residual quantities.
- Address continuity of designated hazmat routes, and consider whether NRHM route designations should be requested from Texas Department of Transportation.
- Incorporate this study’s findings into jurisdictional hazard assessments and EOP assumptions conducted in emergency planning and part of EOPs.
- Conduct a review of local, county, and facility EOPs based on the specific hazards identified by this study. EOP reviews should initially focus on the Basic Plan and Annex Q – Hazardous Materials before examining other planning areas.
- Develop future hazmat training and disaster exercise scenarios using the most common materials, special hazard materials, and/or high-risk locations presented in your CFS.
- Contacts with new operators, carriers, and industry should be established and incorporated into plans.
- Due to the use of radioactive material at research and medical facilities, as well as radioactive tracers, pigs, and other materials used in pipeline operations, ensure that Annex D and Annex Q of the EOP are consistent, and address both hazardous and radioactive materials appropriately. If required, update any appendix to Annex D addressing transuranic waste.
- Obtain licensing and location information for radioactive sources and carriers from the Texas Department of Health Services – Radiation Control Program (www.dshs.state.tx.us/radiation). Incorporate these into your planning for Annex D and in your assessments in Annex J of the EOP. Because non-destructive testing companies and carriers frequently cross-jurisdictional lines and are often not placarded, consider coordinating this action with adjacent counties in order to obtain the most accurate information possible.
- Coordinate with local and state traffic enforcement, weights and measures, traffic control, and law enforcement agencies to develop a data collection plan from enforcement operations to supplement these data and improve planning. List identified facilities and carriers in Annex Q appendices to the jurisdiction’s EOP.

<http://www.census.gov/hhes/commuting/data/calculations.html> for methods to estimate daytime population. See also Chapter 4.

- In addition to this study, local planners should review new TDEM and TCEQ plans and guidelines prior to reviewing local EOPs.² Planners can eliminate most EOP deficiencies by following the TDEM planning notes when preparing and reviewing EOPs.
- Identify and coordinate with special facilities, research/medical centers, and private sector facilities with high daytime populations. Account for their specific security and other requirements, especially for shelter-in-place and evacuation scenarios, in plans and response protocols. Assess site-specific vulnerability/risk associated with hazmat incidents along roadways in their vicinity. Communicate those risks and plan for them at both the jurisdictional and facility level.

3.4. Fire and Police Services

- Re-examine equipment, training, and stationing of hazmat response personnel in the jurisdiction. Adjust according to the observed threats. Planners and responders should pay special attention to the stationing of hazmat response equipment and trained personnel in proximity to areas of highest threat.
- Ensure that all first responder personnel have the appropriate training. Train all responders, including law enforcement, to follow initial response and site control procedures, including the use of PPE.
- Develop future hazmat training and disaster exercise scenarios using the most common materials, special hazard materials, and/or high-risk locations presented in your CFS.
- Ensure that decontamination planning and evacuation of contaminated casualties accounts for the chemicals identified in your hazmat CFS and other significant chemicals that may be present in the community. Decontamination plans should account for both mass decontamination of ambulatory and non-ambulatory victims and small-scale decontamination for smaller events with few casualties.
- Coordinate with medical facilities in the jurisdiction to ensure that dispatch, fire, police, EMS and medical facilities designated to receive contaminated casualties are coordinated and procedures are in place to ensure a seamless activation, identification, and transmittal of information to all parties. Use your CFS to identify chemicals that require decontamination capabilities and ensure these capabilities are adequate. Test these systems in exercises using some of the chemicals identified in your CFS.

3.5. Communications and Media Relations

- Focus public education and risk communication strategies on higher-risk areas identified in the study. Ensure efforts reach both daytime and nighttime populations through workplace, business, and household training and outreach. Consider warning signage or other notices in or around high-risk locations.
- Coordinate with and conduct public information campaigns with CERT programs, or consider starting a CERT team if one does not exist. Public information campaigns achieve significant advantages by working with such organizations and groups, which can carry out much of the work needed to make a program effective.

² See the newly updated TDEM Annex Q at <http://www.txdps.state.tx.us/dem/documents/planState/annexq.pdf>. TCEQ information is at <http://www.tceq.state.tx.us/response/spills.html>. For additional resources visit http://www.tpwd.state.tx.us/landwater/water/enviroconcerns/damage_assessment/response.phtml.

3.6. Traffic Enforcement and Control

- Areas of higher risk are often due to higher volumes of truck traffic and percentages of placarded vehicles. Traffic enforcement and control entities should concentrate enforcement and observation activity on these areas during periods of peak traffic.
- Traffic enforcement operations in areas where there are high numbers of non-specific (e.g., Flammable, Corrosive) placarded traffic may collect data on specific materials along these routes, shippers, points of origin and destination, and carriers and share these data and information with emergency planners and responders as part of a coordinated effort. Local and state license-and-weight law enforcement personnel may be able to assist.

3.7. Medical Facilities/Hospitals/Emergency Medical Services

- Determine if routes with high hazmat traffic levels are adjacent to or nearby medical facilities/hospitals. Officials at these facilities should evaluate the risk posed to these facilities based on information in your CFS and coordinate with local emergency management to mitigate risks.
- Information contained within your CFS may identify specific hazards likely to be involved in incidents along roadways. Hospitals with decontamination capabilities should evaluate their resources and treatment facilities to ensure they are capable of handling and treating contaminated casualties exposed to these hazards.
- Hospitals and EMS should coordinate with emergency management and first responders, and evaluate their own planning based on your CFS. Ensure coordination and communication among medical facilities and response agencies provides seamless response, transportation of contaminated casualties, and treatment. Properly resource and plan based on the hazards your CFS identifies.
- Medical facilities/hospitals should have a plan to deal with casualties that evacuate on their own (self-evacuating contaminated casualties). They should ensure that these plans account for facilities not usually accustomed to receiving such casualties/victims, including urgent care facilities.

3.8. School Officials

- Determine if hazmat routes observed in your CFS are adjacent to schools or colleges, or are along established school bus routes. School officials should evaluate the risks posed to their facilities based on information in your CFS and coordinate with local emergency management to mitigate those risks. Bus routes may require modification based on data in your CFS, and route and alternate route planning incorporated into existing operations.
- Based on identified risks, school officials should evaluate and revise existing shelter-in-place and evacuation planning and consider conducting drills and tests of those plans in order to validate facility readiness to deal with the effects of a hazmat transportation incident near those facilities.

3.9. Special Facilities

- Research and bio-medical facilities may contain, receive, and ship hazardous, radioactive, and biohazard materials in small enough quantities that this CFS would not capture those shipments. Because some of these materials may be extremely hazardous or require special handling due to security or other considerations, these institutions should coordinate with their jurisdiction's OEM and the LEPCs and share information that allows community

planners to account for the special requirements associated with responding to incidents related to these materials.

3.10. Private Sector

- In conjunction with emergency management officials, assess potential for impacts of hurricanes on hazmat transportation, including the need to evacuate/relocate transportation equipment containing hazmat loads or residual quantities.
- Corporate and industrial facilities may pose particular problems for evacuation and/or shelter-in-place due to hazmat incidents at or near their location. Higher daytime population locations and their property managers should assess their risk and vulnerability related to the data contained within your CFS, obtained from the LEPC, and ensure their evacuation and shelter-in-place planning is adequate to address their risk.
- Annual events can have similar issues related to shelter-in-place or evacuation that may pose particular problems since the majority of attendees are likely to be outdoors and individual vehicle evacuation might pose a significant traffic problem. Planners should coordinate with facility operators and event planners to ensure that their planning accounts for these large temporary population centers and assess the risks posed by hazmat flows in their vicinity. Site emergency plans should incorporate these risks and plans should include adequate mitigation measures to protect patrons, and the public.
- Property management of large business complexes along major roadways where hazmat traffic flows are high should coordinate their jurisdiction's OEM to ensure they have adequate plans to address both shelter-in-place and evacuation.
- Private sector firms should consider involvement in their LEPC as a means of information exchange, and in order to increase their own and their communities' resilience.

4. TOOLS FOR EVALUATING RISK

There are many methods to evaluate the risk posed by potential hazards, which may vary by the circumstances of any particular incident, the weather, location, and time of day.

While the tendency is to focus on information in the ERG, planners and responders should consider additional tools to assist them in responding to ongoing releases, an area where EOP reviews have found significant deficiencies.

Additional resources include the NIOSH pocket guide, information from the American Industrial Hygiene Association (AIHA), models provided by industry in your area developed as part of their planning, permitting, or regulatory compliance, or other reference material (see the Appendix for more information).

4.1. Computer Aided Tools

In addition to the EPA's CAMEO program with ALOHA and MARPLOT, planners may find the following computer aided tools useful for planning and predicting evacuation areas and traffic flows related to road closure and other necessary protective actions. These include:³

- **Consequence Assessment Tool Set/Joint Assessment of Catastrophic Events (CATS/JACE)** — The Federal Emergency Management Administration and the Defense Threat Reduction Agency developed this model. The CATS/JACE software provides disaster analysis in real time with an array of information integrated from a variety of sources. The software is deployable for actual emergencies with capabilities including contingency, logistical planning, and consequence management. The CATS program integrates hazard prediction, consequence assessment, and emergency management tools with critical population and infrastructure data. It uses tools and data that predict the hazard areas caused by manmade events and natural disasters, including earthquakes and hurricanes. CATS assists with estimating collateral damage to facilities, resources, and infrastructure, and creates mitigation strategies for responders. Civil Support Teams and military facilities/units have access to this software, and to its companion Hazard Prediction and Assessment Capability software.
- **Dynamic Network Assignment-Simulation Model for Advanced Road Telematics (Planning version)—DYNASMART-P**—The Federal Highway Administration (FHWA) supported the development of this model by the University of Maryland to support network planning and traffic operations decisions through the use of simulation-based dynamic traffic assignment. FHWA is examining the application of this model for emergency transportation management analysis.
- **Evacuation Traffic Information System (ETIS)**—FHWA currently supports the ETIS, which is a web-based program that facilitates the sharing of evacuation and traffic information among coastal states in the Gulf Coast and southeast from Texas to Virginia. The ETIS supports decisions such as evacuation type (e.g., voluntary, mandatory, staged) and implementation of contra flow or lane-reversal operations. The U.S. Army Corps of

³ For a list of other monitoring and prediction tools, including those related to natural disaster planning see the U.S. Department of Transportation, Federal Highway Administration, "Evacuation, Weather, and Assessment Monitoring and Prediction Tools," August 2013, http://ops.fhwa.dot.gov/publications/evac_primer/23_monitoring.htm (accessed June 2014).

Engineers originally developed the ETIS, but it is now under FHWA sponsorship, and operated by its private developers.

- MASS eVACuation—This is a macro-level model originally developed for modeling nuclear power plant evacuations. More recently, it tested operational strategies for hurricane evacuations in Virginia.
- Network Emergency Evacuation (NETVAC)—NETVAC evolved from the reaction to the Three-Mile Island nuclear reactor incident in 1979. While strong in terms of a response to a Point-A-to-Point-B situation, it is limited in application to hurricane evacuation, which often includes multiple Points A and B. However, transportation and emergency managers may use this model to analyze route selection, intersection controls, and lane management.
- Oak Ridge Evacuation Modeling System—This is an evacuation analysis tool designed to simulate traffic flow during various defense-oriented emergency evacuations. The model can estimate clearance times and identify operational traffic characteristics and other information such as evacuation routes and times necessary to develop evacuation plans. It also allows users to experiment with alternate routes, destinations, traffic control and management strategies, and evacuees' response rates.
- Computer Plume Modeling Tools—These are models used to predict where a plume may travel from its release location. Radiological releases, chemical releases, smoke from fires, or any situation that causes airborne contaminants can produce plumes of dangerous gases or particulate matter. There are many plume models in use and most are specific to a particular type of event and require data inputs of site-specific data such as wind speed, direction, and others factors affecting the spread of the plume. Computer based models are important in determining where a plume may spread and how fast it may travel, and in defining a geographic area for evacuation or an area for occupants to shelter-in-place. There are a variety of these tools available, though ALOHA and MARPLOT, offered for free by the EPA is the most common in most jurisdictions.
- Traffic Estimation and Prediction System (TrEPS)—FHWA has been working on Dynamic Traffic Assignment research projects. The main objective of the research projects is to develop a deployable real time TrEPS.

One additional resource worth mentioning that provides useful data for determining evacuation thresholds and other important data is the National Oceanic and Atmospheric Administration (NOAA) database at <http://http://cameochemicals.noaa.gov>. This resource combines several others, comes from the CAMEO database, and provides ready access to ERG, NIOSH, and other data.

4.2. Evacuation Thresholds

One question often faced by planners is which threshold to use for evacuation and shelter-in-place decision making. There are sometimes different thresholds established for various chemicals by different organizations. The U.S. Department of Energy's PAC thresholds are one the most readily available and useful tools in this regard for the majority of chemicals of concern, and are included in the CAMEO database and readily accessible via the aforementioned NOAA website.

When assigning the risk posed by toxic materials, PACs can be essential components for planning and response to uncontrolled releases of hazardous chemicals. These criteria, combined with estimates of exposure, provide the information necessary to evaluate chemical release events and take appropriate protective actions. During an emergency response, these criteria offer a measure to evaluate the severity of the event, to identify potential outcomes, and to decide on protective actions.⁴ PAC values for emergency planning for chemical release events draw on the following exposure limit values:

- Acute Exposure Guideline Level (AEGL) values published by EPA.
- Emergency Response Planning Guideline (ERPG) values produced by the AIHA.
- Temporary Emergency Exposure Limit (TEEL) values developed by SCAPA.
- The following hierarchy of PAC values determines the various thresholds:
 - Use AEGLs (including final or interim values) if they are available.
 - If AEGLs are not available, use ERPGs.
 - If neither AEGLs nor ERPGs are available, use TEELs.

AEGLs, ERPGs, and TEELs have three common benchmark values for each chemical (PAC-1, -2, and -3). Each successive benchmark is associated with an increasingly severe effect that involves a higher level of exposure. The three benchmarks, identified as PAC-1, -2, and -3, identify threshold levels for:

- PAC-1: Mild, transient health effects.
- PAC-2: Irreversible or other serious health effects that could impair the ability to take protective action.
- PAC-3: Life-threatening health effects.

For the bulk of hazard placards observed in your Hazardous Materials CFS, Class 2 and 3 hazards, the major concern may not be health effects but the flammability or potential for an explosion of the material involved. Here again, CAMEO and the NOAA database are particularly useful as they combine several of the resources likely to contain important information such as lower/upper explosive limits, flashpoints, and other relevant information.

One major concern is the risk of flash fire, boiling liquid expanding vapor explosion (BLEVE), pressure vessel burst, or vapor cloud explosion. Many resources provide additional information on these risks, including the Center for Chemical Process Safety publication *Guidelines for Vapor Cloud Explosion, Pressure Vessel Burst, BLEVE, and Flash Fire Hazards*, available through various publishers and sources.

⁴ Oak Ridge Institute for Science and Education, U.S. Department of Energy, “Protective Action Criteria for Chemicals - Including AEGLs, ERPGs, & TEELs,” Emergency Management Issues Special Interest Group, February 2012, <http://orise.orau.gov/emi/scapa/chem-pacs-teels/default.htm> (accessed June 15, 2014).

5. CONCLUSION

Plans are worthless, but planning is everything. – Dwight D. Eisenhower

A hazmat CFS offers communities a sizeable amount of information. Processing this information can seem like a daunting task, but it need not be so. Limited resources, time, and manpower mean that no community can hope to prepare for every eventuality. In order to achieve the biggest bang for your buck, communities conducting a CFS should determine two or three important questions they want to answer as a result of the study. It is likely those questions are some of the ones asked in this document.

From those questions, communities can break down the CFS into usable information depending on their own needs. When each functional area (see Section 3) and the LEPC work together to coordinate their actions and goals, each focusing on one or two priority improvements, significant change can occur throughout the community. The CFS can be a powerful means to incentivize and reinvigorate organizations like an LEPC. It can form the basis for lasting change in a community that affects the way the most junior members of the police and fire department operate all the way up to the way a community's highest ranking elected officials process information and make decisions about emergencies in their own neighborhood.

Such change is possible and not nearly as difficult or expensive to implement as it might initially appear. The mere act of convening an LEPC meeting to discuss a CFS study and its outcomes can be a catalyst that produces change throughout a community by bringing together different agencies, departments, the private sector, and elected officials to talk and think about the issues a CFS report raises.

Talking and thinking about emergency preparedness is one of the most important parts of the planning process, as the man who planned the D-day invasion noted, way back in 1957. Dwight D. Eisenhower's remarks are as valid today as they were when he was President:

I tell this story to illustrate the truth of the statement I heard long ago in the Army: Plans are worthless, but planning is everything. There is a very great distinction because when you are planning for an emergency you must start with this one thing: the very definition of "emergency" is that it is unexpected, therefore it is not going to happen the way you are planning.

So, the first thing you do is to take all the plans off the top shelf and throw them out the window and start once more. But if you haven't been planning you can't start to work, intelligently at least.

That is the reason it is so important to plan, to keep yourselves steeped in the character of the problem that you may one day be called upon to solve—or to help to solve.⁵

Your CFS is just another way to remain "steeped in the character of the problem." More importantly, it helps your community identify part of the problem you will "one day be called on to solve!"

⁵ Dwight D. Eisenhower, *Remarks at the National Defense Executive Reserve Conference*, November 14, 1957, The American Presidency Project, <http://www.presidency.ucsb.edu/ws/?pid=10951> (accessed September 28, 2016).

APPENDIX A. OTHER RESOURCES AND REFERENCES

The following annotated source and reference list is not comprehensive or exhaustive, but it does offer planners and responders a great place to start researching additional information, or to update their own reference materials. We consulted many of these sources in the preparation of your CFS, and cited several in previous sections. Consider disseminating this list along with other materials from your CFS to various agencies and organizations that may find this list useful. It is useful either as a reference to the information contained within your CFS, or as a stand-alone list.

Not listed here are a number of plans, laws, and regulations that govern hazardous materials, emergency planning, and other related topics. EOP reviews frequently note that many EOPs references to such information are out of date or no longer valid. As you review your EOP using information from your CFS, consider updating that data and including other references like these where appropriate.

If you have a resource or information source that you regularly consult, or you think future report consumers would find useful, and you do not see it listed here, please contact the authors directly so that we may include that information in future reports.

A.1. Hazardous Materials

Cameo Chemicals, NOAA, U.S. Department of Commerce, <http://cameochemicals.noaa.gov>

A searchable database of chemicals contained within the CAMEO software (provided by EPA) with a simple and easy to use interface. Also includes a reactivity application that allows users to mix chemicals and predict results. This site provides ERG information and chemical specific data sheets that combine data from a variety of resources. It is one of the most comprehensive and usable response databases available on the internet.

2016 Emergency Response Guidebook, by Michael Cloutier and George Cushmac, <http://hazmat.dot.gov>

The standard response handbook for first responders used throughout North and parts of South America. Data from the ERG are also available at the above website.

NIOSH Pocket Guide to Chemical Hazards, by the Centers for Disease Control, <http://www.cdc.gov/niosh/npg/>

Provides technical and response data on a wide variety of chemicals of concern. Data contained within the NIOSH Pocket Guide is also available via the NOAA Cameo Chemicals database.

Protective Action Criteria for Chemicals - Including AEGLs, ERPGs, & TEELs, Oak Ridge Institute for Science and Education, U.S. Department of Energy, Emergency Management Issues Special Interest Group, <http://orise.orau.gov/emi/scapa/chem-pacs-teels/default.htm>

This source provides an explanation of and link to the most recent PAC dataset, which combines PAC from the U.S. EPA, AIHA, and SCAPA.

Southeast Texas Poison Center (<http://www.utmbhealth.com/oth/Page.asp?PageID=OTH001144>) or other regional poison centers, as applicable

Includes contacts and guidance/information about a wide range of poisons, including hazmat.

A.2. Grant Programs

Texas Division of Emergency Management, Texas Department of Public Safety, *Hazardous Materials Emergency Preparedness (HMEP) Grant Program*, <http://www.txdps.state.tx.us/dem/Preparedness/hmepGrantPrgm.htm>

TDEM administers the HMEP Grant program that funds Commodity Flow Studies. For additional information about the program, see the website above.

Texas Division of Emergency Management, Texas Department of Public Safety, *Grants and Resources*, <http://www.txdps.state.tx.us/dem/GrantsResources/>

In addition to the HMEP program, TDEM administers several other programs of interest. Information is available at the link above.

U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration, *Hazardous Material Grant Program*, <http://www.phmsa.dot.gov/hazmat/grants>

The HMEP Program that funded in your hazmat CFS is one of several grant programs funded by the US Department of Transportation. The above website outlines these and provides additional information of interest. See also the TDEM links above.

A.3. Commodity Flow Studies

Guidebook for Local Hazardous Materials Commodity Flow Studies, by David H. Bierling, George O. Rogers, Deborah L. Jasek, Anna A. Protopapas, Jeffrey E. Warner, and Leslie E. Olson. Transportation Research Board of the National Academy of Sciences, Washington, D.C. 2011. http://onlinepubs.trb.org/onlinepubs/hmcrp/hmcrp_rpt_003.pdf

This guidebook provides a comprehensive look at the methodology and conduct of a CFS project.

A.4. Hazard Analysis

Battelle, *Comparative Risks of Hazardous Materials and Non-Hazardous Materials Truck Shipment Accidents/Incidents, Final Report*. Federal Motor Carrier Safety Administration, March 2001. http://www.phmsa.dot.gov/pv_obj_cache/pv_obj_id_2F1F1A79D0F916679838CDE369E5600B20733400/filename/hazmatriskfinalreport.pdf

An older report on the comparative risks associated with hazardous materials shipments. Establishes several key data points on the frequency and impact of hazardous materials transportation accidents by hazard class.

U.S. Environmental Protection Agency, "Making it Work – Hazards Analysis," <http://nepis.epa.gov/Exe/ZyPDF.cgi/10003M8P.PDF?Dockey=10003M8P.PDF>

This is older but still highly relevant information on conducting and using a hazard analysis in preparing EOPs.

A.5. Emergency Operations Plans and Planning

State of Texas Local Emergency Management Planning Guide. TDEM-10, Revision A. Texas Division of Emergency Management, Texas Department of Public Safety, Austin, TX. 2008. Available online at <http://www.txdps.state.tx.us/InternetForms/Forms/TDEM-10.pdf>

This is the official guide to emergency management planning in the State of Texas.

State of Texas Local Emergency Planning Committee Handbook.

http://www.txdps.state.tx.us/dem/CouncilsCommittees/lepc/lepc_handbook_texas_0726200A.pdf

An excellent resource and supplement to the Emergency Management Planning Guide listed above, it is designed for LEPCs and Emergency Management Coordinators and focused on hazardous materials and EPCRA responsibilities.

Developing and Maintaining Emergency Operations Plans: Comprehensive Preparedness Guide (CPG) 101, Version 2.0. Federal Emergency Management Agency, U.S. Department of Homeland Security, Washington, D.C. 2010. Available online at http://www.fema.gov/pdf/about/divisions/npd/CPG_101_V2.pdf.

This is the federal guide to emergency management planning.

Emergency Planning, by Ronald W. Perry and Michael K. Lindell. John Wiley & Sons, Inc., Hoboken, NJ. 2007.

A textbook and academic work on emergency planning based on research studies.

Measuring Progress in Chemical Safety: A Guide for Local Emergency Planning Committees and Similar Groups. U.S. Environmental Protection Agency. Available online at http://www.epa.gov/oem/content/epcra/spi_guidance_for_lepc.pdf

A guide to evaluating improvements in chemical safety related to EPCRA and LEPC planning requirements.

A.6. Oil Spill and Hazardous Materials Transportation Response

Texas Parks and Wildlife, Oil Spill and Hazardous Substance Response Agencies

http://www.tpwd.state.tx.us/landwater/water/environconcerns/damage_assessment/response.phtml

A comprehensive listing of agencies, programs, and contacts related to spill response in the state of Texas.

Texas General Land Office, Oil Spill Prevention and Response Program

<http://www.glo.texas.gov/what-we-do/caring-for-the-coast/oil-spills/index.html>

A guide to information and programs in Texas related to oil spill prevention and response.

Texas Commission on Environmental Quality, Emergency Response

<http://www.tceq.state.tx.us/response/spills.html>

Outlines TCEQ emergency response role and provides information on spill/release reporting, cleanup and management, and rules, regulations, and regulatory agencies related to spills and releases of hazardous materials.

Hazardous Materials: Managing the Incident, 4rd Edition, by Gregory G. Noll, Michael S. Hildebrand, Glen Rudner, and Rob Schnepf. Jones and Bartlett Learning. 201A.

This is one of the primary training and reference manuals for first responders and emergency management officials on managing hazardous Materials Incident Response.

National Fire Protection Association (NFPA) 472: Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents. National Fire Protection Association, 2013.

This is the NFPA standard for Hazardous Materials Response certification and training.

Hazardous Materials/Weapons of Mass Destruction Response Handbook. Edited by Tom McGowen. National Fire Protection Association, 2013.

Includes NFPA 472 and 473 (which addresses EMS competencies) and provides guidance on applying the standards to incident response. The latest version includes a new section on response to petrol drilling/fracking related incidents.

A.7. Radioactive Material Transportation and Incident Response

Texas Department of Health Services – Radiation Control Program.

<http://www.dshs.state.tx.us/radiation/>

TDHS-RCP provides certification and licensing of radiation sources and transportation companies in the state of Texas. In addition, they provide training and support to responders. They also are the primary state agency in support of incidents related to Annex D of an EOP.

U.S. Department of Energy, *Radioactive Materials Transportation and Incident Response – Questions and Answers about Incident Response*, 2010.

<http://energy.gov/sites/prod/files/em/TEPP/RadioactiveMaterialTransportationandIncidentResponse-QABook.pdf>

This is a useful and detailed guide to planning and incident response for radioactive material incidents and transportation.

A.8. Risk Communication

Communicating Environmental Risk in Multiethnic Communities, by Michael K. Lindell and Ronald W. Perry. Sage Publications, Inc., Thousand Oaks, CA. 2004.

This source provides a comprehensive examination of risk communication in multi-ethnic communities based on research studies.

Crisis and Emergency Risk Communication, 2012 Edition, U.S. Department of Health and Human Services, Centers for Disease Control and Prevention.

http://emergency.cdc.gov/cerc/pdf/CERC_2012edition.pdf

A comprehensive guide to Crisis and Emergency Management Risk Communication in part based on the CDC's experience during the Anthrax Attacks of 2001.

A.9. Training

Guidelines for HazMat/WMD Response, Planning, and Prevention Training: Guidance for Hazardous Materials Emergency Preparedness (HMEP) Grant Program, Federal Emergency Management Agency, April 2003,

<http://www.usfa.fema.gov/downloads/pdf/publications/hmep9-1801.pdf>

A comprehensive, though somewhat dated, examination of HMEP Training Guidance.

Texas Department of Emergency Management Training Unit,

<http://www.txdps.state.tx.us/dem/Preparedness/TrainingUnit.htm>

Provides links to TDEM training calendar and course/exercise list, as well as FEMA courses.

A.10. Routing

Highway Routing of Hazardous Materials: Guidelines for Applying Criteria, Publication Number FHWA-HI-97-003. National Highway Institute, FHWA, U.S. Department of Transportation, Washington, D.C. 1996.

Management of Hazardous Materials Transportation, Literature Summary, by Jeffery E. Warner, et al. February 2008, Texas Transportation Institute.

<http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/0-5929-P2.pdf>

A thorough literature review/annotated bibliography of literature related to Hazardous Materials Transportation issues as of 2008.

Non-Radioactive Hazardous Materials Routing Publications, Texas Department of Transportation, <http://www.txdot.gov/inside-txdot/forms-publications/publications/nrhm.html>

Lists and links to maps and information on existing non-radioactive hazmat routes in Texas and applicable federal regulations.

Understanding and Managing the Movements of Hazardous Material Shipments through Texas Population Centers, by Jeffery E. Warner, et al. Texas Transportation Institute, February 2009. <http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/0-5929-1.pdf>

This is a scholarly study of methodologies for managing hazardous materials movement across multiple modes of transport.

A.11. Estimating Daytime Populations

Calculating Daytime Population Estimates, U.S. Census Bureau.

<http://www.census.gov/hhes/commuting/data/calculations.html>

This website provides methods for calculating daytime population estimates based on census datasets and provides a list of datasets available at American Factfinder for that purpose.

Daytime Population, U.S. Census Bureau.

<https://www.census.gov/hhes/commuting/data/daytimepop.html>

This website explains daytime population and provides links to datasets.

Estimating Daytime and Nighttime Population Distributions in U.S. Cities for Emergency Response Activities, by Timothy N. McPherson and Michael J. Brown. The American Meteorological Society, 2004. <https://ams.confex.com/ams/pdfpapers/74017.pdf>

This is a scholarly paper on estimating daytime and nighttime population as it relates to emergency response useful for GIS technicians.

A Day-Night Population Exchange Model for Better Exposure and Consequence Management Assessments, by Timothy N. McPherson, Jonathan F. Rush, Hari Khalsa, Austin Ivey, and Michael J. Brown. 86th AMS (American Meteorological Society) Annual Meeting, Atlanta, GA. 2006. http://www.researchgate.net/publication/255537979_A_DAY-NIGHT_POPULATION_EXCHANGE_MODEL_FOR_BETTER_EXPOSURE_AND_CONSEQUENCE_MANAGEMENT_ASSESSMENTS/file/e0b4952a3e115ba35e.pdf

This is another scholarly paper, from the same researchers, on a different model, useful for GIS professionals.