1
INTRODUCTION

The transportation of chemicals is necessary for the manufacturing and distribution of products within and across regional and international borders. Many of these shipments are regulated for transportation and are typically referred to as "dangerous goods" or "hazardous materials." These daily shipments via land, sea, and air are critical to economies across the globe, but these activities may also pose a potential risk to public safety and the environment if an accidental or intentional release were to occur during transit.

This book provides a comprehensive framework for managing transportation risks, addressing both safety and security practices. A network of stakeholders from industry and government were engaged in the development of this guideline so it could present currently recognized safety, security, and risk management practices. It is not intended to be an industry standard, but rather to advance the state of the art in chemical transportation safety, security, and risk management strategies, and to provide guidance for the industry.

It is not the intent of the Center for Chemical Process Safety (CCPS) to replace the original *Guidelines for Chemical Transportation Risk Assessment* (CCPS, 1995). The purpose of this book is to build upon and supplement the concepts in the original guidelines, targeting them to the broader range of individuals who are responsible for, or involved in, decisions that impact transportation safety and security on a daily basis. While the original guidelines should continue to be the industry reference for risk specialists conducting detailed quantitative risk assessments, the intent of this book, *Guidelines for Chemical Transportation Safety, Security, and Risk Management*, is to:

- Provide a resource for shippers, carriers, and others involved or interested in the management of chemical transportation risks
- Provide common terminology and understanding of the basic concepts
- Identify the functional areas and supply chain stakeholders who should be involved in transportation risk management activities
- Present a multitiered framework for managing chemical transportation risk and unifying the risk management efforts across the supply chain

- Provide useful tools and examples for the diverse range of transportation professionals
- Supplement the original CCPS transportation guidelines book by identifying new or improved methodologies and data sources
- Develop strategies that may be applied to a wide range of hazardous material and transportation situations
- Integrate safety, security, and logistics into a reference guide for making risk-based decisions

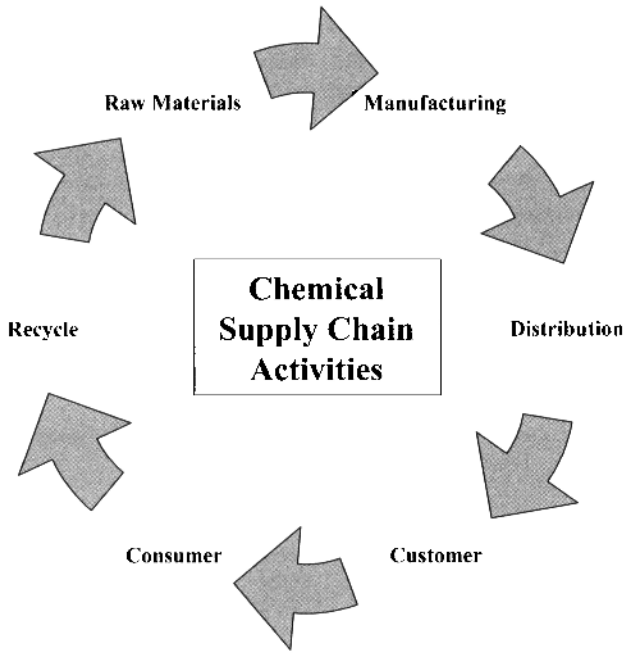
1.1 KEY STAKEHOLDERS IN THE SUPPLY CHAIN AND RISK MANAGEMENT PROCESS

Due to the complexity of a transportation supply chain, as shown in Figure 1.1, risk management is a shared responsibility of all stakeholders. The transportation supply chain should be considered as a single, complete system beginning with the raw material supplier, through the manufacturing and distribution process, to the final end-use customer, and any residuals management, including the transportation network in between. While the roles and responsibilities may differ for each stakeholder and differ within the functional areas of an individual company, these groups need to understand how their activities and actions can impact the risk to the overall supply chain. The goal of this guideline is to assist in the development of transportation risk management (TRM) programs where information from these various groups can together support decision-making that balances risk with operational efficiencies, while optimizing the entire supply chain's activities.

Given the complexities of the chemical industry, the intended audience for this guideline is extensive and not limited to just shippers. To manage the risk across the entire supply chain, the following groups can benefit from the primary management systems, risk concepts, risk assessment tools and techniques, examples, and overarching risk management framework presented in this guideline:

- Logistics service providers and managers
- Shippers
- Chemical manufacturing companies
- Chemical distribution companies
- Carriers
- Business unit managers and owners
- Transportation managers
- Safety professionals
- Security professionals
- Risk professionals
- Regional and global government regulators
- Insurers
- Industry associations

Figure 1.1 Transportation Supply Chain



1.2 TRANSPORTATION RISK MANAGEMENT

A major goal of the safe and secure transportation of hazardous materials is a reduction in incidents that could lead to a release or to misuse. To date, the achievements in safety are the result of regulations, industry standards, individual company initiatives, and emergency response preparedness, as well as investments in training, systems, and technology. Even with the foundation that these programs and activities supporting the day-to-day operating practices provide, the safe transportation of hazardous materials is complex due to a number of issues:

- Number of regulated hazardous materials (thousands are listed in regulations worldwide)
- Regulations that vary by mode, region, and country
- Different hazards classes including toxicity, flammability, corrosivity, and reactivity
- Various modes of transportation including road, rail, marine (including bulk vessels), pipeline, and air
- Multiple packaging types including bulk and non-bulk
- Use of more than one mode during a shipment (intermodal)

- Complexity of the supply chain including multiple parties and changes of custody during transit
- Overlapping and potentially unclear responsibility of various parties
- Transport routes where the risk profile can change depending on proximity to the public or other sensitive areas

The complexity of these activities, even with the current safety regulations and operating practices, is one of the reasons that accidents involving the transportation of hazardous materials occur. Table 1.1 illustrates some recent chemical transportation accidents in various countries and across different modes of transportation around the world.

Table 1.1 Examples of Recent Worldwide Chemical Transportation Accidents

Mode	Location and Date	Chemical Released	Description
Air	United States (7 August 2004)	Lithium-Ion Batteries	A fire destroyed some freight in a container that included lithium-ion batteries at the FedEx hub in Memphis, Tennessee. The freight container had been raised on loading equipment and pushed about halfway onto an airplane bound for Paris, France, when the loading personnel smelled smoke. They stopped loading and removed the smoking freight container.
Marine	Spain (13 November 2002)	Heavy Fuel Oil	The tanker Prestige, laden with 77,000 tons of heavy fuel oil, broke in two off the coast of Galicia (Spain), spilling an estimated 63,000 tons. Approximately 1,900 km of shoreline was affected in Spain and France. Around 141,000 tons of oily waste was collected in Spain and some 18,300 tons in France.
Pipeline	Belgium (30 July 2005)	Natural Gas	A pipeline carrying natural gas from the Belgian port of Zeebrugge to northern France exploded in Ghislenghien, Belgium, resulting in 24 fatalities and over 120 injuries. The cause of the accident was damage to the underground high-pressure pipeline from construction activities.
Rail	United States (6 January 2005)	Chlorine	A freight train traveling through Graniteville, South Carolina, encountered an improperly laid switch that diverted the train onto an industry track where it struck a parked train. The collision derailed 16 cars of the moving train. One car was breached, releasing chlorine gas. Nine people died as a result of chlorine inhalation, with an estimated 250 injuries and evacuation of about 5,400.

Mode	Location and Date	Chemical Released	Description
Road	China (26 October 2008)	Toxic Oil (Creosote)	More than 28,000 people in northern China had their water supply cut off after a truck carrying wash oil experienced brake failure, and overturned by the Yangjiapo reservoir in Shanxi province. About 30 tons of toxic oil were spilled, contaminating two million cubic meters of the reservoir.

In addition to safety considerations, security has become an increasingly greater concern for hazardous materials during transport. Certain hazardous materials could potentially be used as a weapon to spread fear, cause injuries or fatalities, and/or result in negative economic impacts. To address the potential for deliberate misuse, additional security regulations and industry standards continue to be developed.

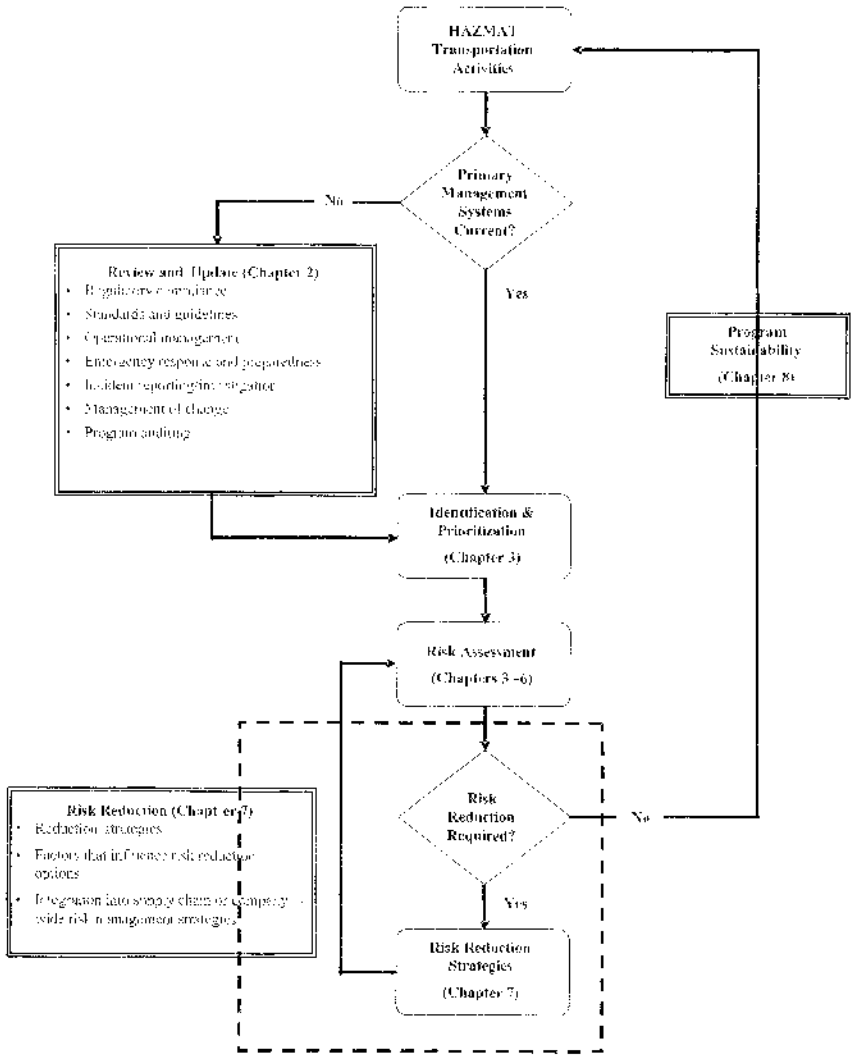
To ensure the safety and security of chemicals in transit, this guideline promotes a comprehensive risk management program covering the entire supply chain. This holistic approach to risk management encompasses involvement from all stakeholders, and includes a general risk management framework highlighted in Figure 1.2.

The framework is designed to be flexible, enabling companies to tailor their TRM process to their individual circumstances and specific applications. The TRM framework is comprised of the following steps:

- *Primary Management System* is the foundation. Ensuring these elements are complete and current is the first step in the process. With the potential for cross-border shipments and international operations, understanding and keeping current with changes in regulations is critical. Chapter 2 presents the primary management elements for transportation of hazardous materials, including regulatory compliance, standards and guidelines, operational management, emergency preparedness and response, incident reporting, management of change, and auditing.
- *Identification and Prioritization* consists of (1) cataloging the hazardous materials and modes of transportation, (2) identifying sensitive areas and potential points of failure along the transit route, and (3) understanding interactions with other stakeholders in the supply chain. This step is a key in the TRM process for the identification of shipments that may require special attention, including additional resources for further evaluation and risk management. Prioritization, along with other risk assessment fundamental concepts, is presented in Chapter 3.
- *Risk Analysis* has been divided across several chapters in this guideline, each focusing on different levels of safety and security analysis. This separation is intended to help users efficiently locate information tailored to the needs and complexity of specific issues. A complete overview of the main risk analysis concepts is covered in Chapter 3. These fundamental concepts are applicable to people new to TRM, or those needing a refresher. Subsequent chapters present, many techniques, from simple, quick, and general to detailed, time-

consuming, and quantitative assessments. Simpler techniques should be the starting point with the more complex and resource-intensive activities conducted on a risk-justified basis. Chapter 4 presents qualitative and semi-quantitative approaches applicable to issues escalated through prioritization. For those issues that require additional detail for decision-making, Chapter 5 summarizes quantitative risk analysis techniques, with the original Guidelines book (CCPS, 1995) continuing to serve as the main reference for quantitative transportation risk analysis. Chapters 4 and 5 are specific to safety concerns, with the unique issues of security risk analysis presented in Chapter 6.

Figure 1.2 TRM Framework



- *Risk Reduction* is the process of determining if the assessed risk is being managed adequately and evaluating/implementing options to reduce risk, as needed. If the risks merit further reduction, methods can be developed for the hazardous material operation, coordinated with the enterprise risk management philosophy of a single company, and/or developed in coordination with other supply chain partners. Chapter 7 discusses the strategy for identification, evaluation, and selection of risk reduction options, as warranted.
- *Program Sustainability* is the final step in the TRM framework and is designed to ensure the risk management process remains current. Presented in Chapter 8, this step includes an ongoing commitment to managing risk, continuously improving, reacting to emerging trends, and keeping current on evolving transportation risk analysis practices.

1.3 USING THESE GUIDELINES

While *Guidelines for Chemical Transportation Safety, Security, and Risk Management* has been developed for a broad range of transportation practitioners, the use of the concepts in this book will differ depending on one's role in the transportation supply chain or the transportation issue being assessed. Table 1.2 is a guide for using this book and presents chapters that are anticipated to be the most relevant for specific roles and responsibilities. Other chapters should be of interest depending on the level of detail required in the risk analysis, on other needs, or on the specific interests of the reader.

Table 1.2 Relevant Chapters of the Guidelines

	Transportation Professional								
Chapter	Logistics Service Providers	Shippers & Customers	Business Unit Managers	Transportation Managers	Safety	Security	Risk Managers	Government Regulators	Industry Associations
1–Introduction	x	x	x	x	x	x	x	x	x
2–Primary Management Systems	x	x	x	x	x	x	x	x	x
3–Risk Assessment Fundamentals	x	x	x	x	x	x	x	x	x
4–Qualitative and Semi-Quantitative Risk Analysis	x	x	x	x	x	x	x		
5–Quantitative Risk Analysis				x	x		x		
6 –Security Considerations	x	x	x	x	x	x	x	x	x

Chapter	Transportation Professional								
	Logistics Service Providers	Shippers & Customers	Business Unit Managers	Transportation Managers	Safety	Security	Risk Managers	Government Regulators	Industry Associations
7 –Risk Reduction Strategies	X	X	X	X	X	X	X	X	X
8–Program Sustainability	X	X	X	X	X	X	X	X	X
Appendices	X	X	X	X	X	X	X	X	X

REFERENCES

Canadian Broadcasting Centre. *Oil spill cuts water to nearly 30,000 people in China.* CBC News Page dated November 1, 2006. www.cbc.ca.

Center for Chemical Process Safety, *Guidelines for Chemical Transportation Risk Analysis,* New York: American Institute of Chemical Engineers, 1995

National Transportation Safety Board, *Cargo Fire Involving Lithium-Ion Batteries, Memphis, Tennessee August 7, 2007,* Hazardous Materials Accident Brief, NTSB/HZB-05/0, 2005

National Transportation Safety Board, *Collision of Norfolk Southern Freight Train 192 with Standing Norfolk Southern Local Train P22 With Subsequent Hazardous Materials Release at Graniteville, South Carolina, January 6 2005.* Railroad Accident Report, NTSB/RAR-05/04, 2005

VROM Inspectorate. *2005 Annual Report,* The Netherlands Ministry of Housing, Spatial Planning and the Environment, 2006

Wadsworth, T., *Evaluation of the Response by Specialized Foreign Vessels to the Release of Oil From Prestige.* ITOPF Ltd., 2005