A Quest for Safety

An Analysis on the Safety Management Approach of the United States Office of Hazardous Materials Safety

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FREQUENTLY USED ACRONYMS

CSB	Chemical Safety Board
DOT	Department of Transportation
ERG	Emergency Response Guidebook
FAA	Federal Aviation Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
HMEP	Hazardous Materials Emergency Preparedness
HMR	Hazardous Materials Regulations
IAFF	International Association of Fire Fighter
LDWN	Lane Departure Warning System
LEPC	Local Emergency Planning Committee
L-UL	Loading and Unloading
MCA	Motor Carrier Assistance
NSTB	National Safety Transportation Board
OHMS	Office of Hazardous Materials Safety
PHMSA	Pipeline and Hazardous Materials Safety Administration
ROSD	Roll-Over Stability Device
SP&A	Special Permits and Approvals
USCG	United States Coast Guard

EXECUTIVE SUMMARY

This thesis extensively analyzes the United States Office of Hazardous Materials Safety's programme. By studying the strategic safety management approaches, the safety policy as such as well as safety measures of the office, this document tries to give meaning to the complex world of junctions of hazardous materials, transportation, federal and lower-level authorities and the industry with and within their dynamic contexts within the United States (U.S.).

The Office of Hazardous Materials Safety (OHMS) is authorized to issue, modify and determine regulations on the transportation of hazard materials in U.S. commerce. This set of regulations constitutes the pillar of the OHMS programme, which tries to reduce risks that are inherent to the transportation of hazardous materials. Additionally, enforcement, special permits, training, emergency response, outreach and risk analyses are major programmes that have their specific role in the OHMS programme. However, there are some complexities and issues that constitute major future challenges. The complexity of ambiguous and conflicting priorities, miscommunication on the programmatic and operational level, a high level of underreporting of incidents, a lack of harmonized and qualitative data for feedback, the obscurity of root causes of incidents are some important sub optimalities and complexities that the OHMS frequently deals with. Most complexities are the result of the contexts the OHMS operates in, which are mainly political and economic rooted.

Serious highway incidents are quite incomprehensible, which makes the learning process of the OHMS even more complex. However, emphasizing on the inclusion of all relevant public and private actors and networks can enable the OHMS to reduce these issues and become a more effective organization. Since data is of vital importance for most OHMS decisions, a solid and professional data sharing system which includes all sorts of federal, lower-level authorities and private sub systems or networks, can let the OHMS be institutionally more flexible and organizationally more effective at the same time. New political and organizational leaders recently introduced and reemphasized these approaches, which are a fist step towards a more comprehensive and integral safety management approach.

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1. INTRODUCTION: OUR EVERYDAY LIVES

In virtually all countries commerce plays a vital role in the 21st century. Using hairspray, toothpaste, business-ties, candy packagings are everyday realities. Also swimming in a pool or buying fireworks are not unfamiliar interests, especially in highly industrialized western countries. The majority of consumers (and citizens) are probably not aware of the fact that hazardous materials are being used for or required in the production process of these products or services. The transportation of these hazardous materials determine to a large extent our very way of life. However, inherent to the transportation of these hazardous materials there are certain risks and safety issues.

Risk obviously is a rather abstract term, which we also deal with in our everyday lives. An interesting and crucial question is how much risk one thinks is responsible and viable to live with. How far or near should a car be before one crosses the street? Can I still drink my milk if it is one day over time? Should I take the chance of going on a boat trip even though it is cloudy? Even more interesting are questions of risk and safety when they are related to society and politics. How safe is flying with a commercial airplane? Why is smoking not illegal? How much tax money should we spend on the prevention of terrorist attacks? How many serious incidents do the political establishment and the public opinion accepts for their way of life? These questions are political and in most western countries highly influenced by public opinion. Political deliberations and decisions have large implications for e.g. financial resources public institutions have to execute decisions. From an administrative perspective, all sorts of questions arise about public management styles or organizational configuration. This thesis is an attempt to understand how the U.S. OHMS tries to reduce the (inherent) risks associated with the transportation of hazardous materials.

To have a comprehensive understanding, there are some background aspects that need to be described such as risk, the risk society and the politics of risk. These backgrounds (in chapter 2) provide the overall thesis a supportive understanding of a broader context. Consequently the portrayal of the research question (and sub question), which form the keystone for the research, will be discussed in chapter 2. The theoretical framework that is used to assess the approach of the OHMS is described in chapter 3. This theory consists of a hybrid concept of two opposite assumptions ideas and rationales. In chapter 4 the methods and techniques for the research are discussed elaborately. The theories are translated into operational indicators and the methods and techniques of data collection are shaped. The basic notion of chapter 4 is to come to an understanding of how the research question and sub questions are to be answered and how the theories can be applied to the OHMS case. Chapter 5 is the core of the description of the safety management approach of the OHMS. This chapter is quite extensive since I have combined the theoretical framework which is always somewhat selective on social reality. This way an elaborative description of the safety policy of the OHMS apart from theoretical 'restrictions' is provided. Most of the separate appendixes consist of descriptions of some important parts of the safety policy. This addendum is recommended to be used next to this thesis, making the understanding of the way the OHMS reduces risks associated with the transportation of hazardous materials in the U.S. more comprehensive. The theoretical concepts are of main importance in chapter 6 again, which form the analysis of the empirical data of chapter 5. This analysis is the bedrock of the research from a more deductive approach. The conclusions that can be drawn in chapter 7 are the consequence and result of the analyses of the safety management approach of the OHMS. Finally a set of recommendations and reflective notions is provided in chapter 8 that could improve the overall safety management approach of the OHMS. Each consecutive chapter is a result of its previous chapter and most chapters are finished with some concluding remarks.

2. A MEETING WITH RISK

Let us get a glimpse of the most important and relevant background concepts of this thesis: risk as a concept, the risk society, some characteristics of safety politics and management in general and transporting hazardous materials (paragraph 2.1). Afterwards (paragraph 2.2), the background of my research as an intern and consequently the research question and sub questions will be discussed in paragraph 2.3. This way the research question has a more abstract and a practical dimension which are both of relevance for the research. They reinforce each other and reflect the broad approach of this research. Finally some concluding remarks regarding will be made in paragraph 2.4.

2.1 Background concepts

What are the background notions of this thesis? In this introductionary paragraph will be discusses risk as a phenomenon, the risk society and some political and institutional implications for governments that deal with risk.

2.1.1 Risk as a phenomenon

Risk has a rich history in all facets one can imagine. There are all kinds of perspectives and disciplines to view risk. One can study or assess risk from a philosophical, economic, historical, sociological, psychological, juridical, political or even an insurance viewpoint, which often are interrelated. Even the etymology of the word risk itself has no consensus among historians, indicating the complexity of the term as such. Some historians argue that it is derived from the Arabic word *risq* (which means good fortune), whilst others claim it originates from the Latin word *risco* which was used as a navigational term by sailors encountering uncharted water (Mythen, 2004: 13). There are hundreds of definitions of risk, especially since there are also dozens of perspectives to study risk. Hanson (2002) postulated five most common definitions of risk, which vary depending on the background of the issue:

1. Risk is an unwanted event which may or may not occur;
2. Risk is the cause of an unwanted event which may or may not occur;
3. Risk is the probability of an unwanted event which may or may not occur;
4. Risk is the statistical expectation value of unwanted events which may or may not occur;

5. Risk is the fact that a decision is made under conditions of known probabilities ('decision under risk').

All these definitions imply the notion of uncertainty of e.g. information, prediction or decision-making. From a philosophical viewpoint there are epistemological, decision theoretical and moral philosophical perspectives to study risk (Hansson and Peterson, 2000). This uncertainty of knowledge is part of the assumption of the normal accidents approach, which will be discussed in chapter 3. Consequently it has implications for the decision and the deliberation of risk analysis. Finally there are some moral implications which can have a high political impact. This philosophy of risk interacts with other risk-related disciplines such as economics, psychology, statistics, probability theory, and the various scientific and technological disciplines that contribute to the characterization of risks and risk abatement measures (Hansson et al, 2000). Again, this indicates the multi-disciplinary character of risk and lenses to examine risk, but when it involves real life activities and politics it becomes even more interesting.

2.1.2 Risk society

Closely related to the phenomenon of risk are the social, cultural and political dimensions in a historic view. An influential author in this field is Beck (1992). The well known phrases of Beck: 'The risk society begins where nature ends' and 'Risk society starts when tradition ends', indicate an enormous impact in perception of risk related to culture and politics. There is a certain duality between nature and humans. When exactly this duality was born is quite difficult to assess, but the end of perceiving risk as an inherent part of nature explained by mystical, religious and traditional cultural notions (i.e. 'pre-industrial society') was to a large extent the product of the Enlightment paradigm. This notion of the abolishment of traditional and hierarchical structures also has implications for the perception of risk. This rationality, which argues that logic reasoning should be dominant resulted in a paradigm shift in the perception of risk in the social, cultural and political domain. This is reflected in the ideas of the French Revolution at the end of the 19th century. Ewald (1987) has described this idea very well when he stated that 'risk is a way of controlling or, one could say, colonizing the future.' If we accept this interpretative notion, it is a small step to modern risk societies. In the risk society a distinction is made between 'a natural hazard and a manufactured risk' (Mythen, 2004: 180). Exactly in the perception of a manufactured risk lies the social and political dimension of risk in modern societies. The Industrial Revolution has changed the societal configuration dramatically, but most relevant in this context is the fact that it has led to the emergence of large scale industries within capitalists systems. In modern industrialized societies there are commercial and industrial activities that may have 'manufactured risks' in the perception of its citizens. These risks can be very diverse. Risks have consequences for ecology and culture but evidently also risk can lead to injuring people (safety or security). These risks in most modern societies are often part of the social and political domain and discourse. Climate change for instance has had a big social and political priority in 2007 which is to a large extent the result of the industrialization of societies. Beck (1992: 49) stated it very well when he said:

> 'The dream of the class society is that everyone is and ought to have a share of the pie. The utopia of the risk society is that everyone should be spared from poisoning…the driving force in the class society can be summarized in the phrase 'I am hungry!' The driving force in the risk society can be summarized in the phrase 'I am afraid!'

Public perception is thus the cradle of the risk society. This perception is also influenced by the collective moral framework of a society. The 'horizontalization' and democratization of modern societies (including democratic institutionalizations as the media) have led to the increase of influence of public perception on the political agenda and domain.

From pre industrial to industrial societies risk has changed as part of the history and culture. From industrial to risk societies these notions have had impact on the political agenda and domain. The next questions are: how can governments deal with these perceptions? Is there a way to change these perceptions? If not, what are the options, restrictions, contexts, expectations and realities of dealing with risk?

2.1.3 Safety politics and safety management

In modern western risk societies the political context is a very interesting and almost a paradoxical one. If we accept the premise that most modern western countries are to a large extent democracies, a fascinating conclusion can be drawn. Most western democracies have quite some democratic institutions, such as (mass) media, non governmental organizations and all sorts of forums that facilitate social and political discourse. These institutions make it possible for the public to address a problem and/or discontent. Public perception is less remote in modern western democracies than in pre-industrialized and classic industrialized societies (late 19th, first half 20th century). Next to the fact that the public perception is less distanced, it also has some major implications. Representation, trust and accountability are basis concepts in healthy modern democracies. In short these concepts are: *representation* of the people through elections, *trust* of the public and parliamentarians that addressed their through democratic institutions and *accountability* of chosen politicians via elections and critical parliamentarians. The set of institutions or checks and balances are vital for modern democracies to avoid accumulation of power. These concepts are interrelated and facilitate a certain level of monitoring decisions and policies of the politicians. On the one hand the notion of addressing concerns of the public through institutions and on the other hand the notions of representation, accountability and trust lead to a tension in which politicians and senior civil servants have to operate. Incidents or events with a major political magnitude often lead to 'incidentalism of politics', whereas public policies also need some continuity and stability in order to execute a political agenda. An intricacy is that if a politician does not carry out its promised policy or reach its goals the public expects, he will encounter great opposition. A more or less 'safe' path to deal with this complexity is to balance the continuity of a policy and damage control incidents. This 'hostage-scenario' of political leaders indicates the complex political dimension of safety.

If risk is translated from political terms into safety and security in institutional and administrative terms we see an even more complex and paradoxical panorama. First of all safety and security are different concepts. Safety can be defined as dealing with the risk of unintentional consequences, whereas security deals with the risk of intentional consequences. Since the focus is on safety in this thesis, security is not discussed (only partly in chapter 5). One should bare in mind that safety management in public institutions or organizations operate in constant contexts of politics, media, and organizational complexity (as we will see in future chapters). In industrial societies the public often does not trust the industry by itself so politicians should take care of the excesses of industry. Politicians have big administrations and agencies that execute the(ir) policy. Evidently depending on the particular policy field, safety management varies in its characteristics such as its political and institutional context and complexity. In this thesis the policy field is transportation of hazardous materials.

2.1.4 Risk and the transportation of hazardous materials

One might very reasonably ask: why taking the risk of transporting hazardous materials in the first place? However, whether transporting hazardous materials is an issue of a natural hazard or a manufactured risk as part of the industrialized society will not be discussed. This thesis has no ambitions beyond understanding the administrative, institutional and organizational complexities and elements of safety policy and management. Still, it is interesting to question whether the industrialized society (and transporting hazardous materials as an exponent of it) is a natural hazard or look at it from a different perspective and see it as a manufactured risk. The next question is: how can the inherent risks and consequences of transporting hazardous materials be reduced?

Transporting hazardous materials has a high degree of complexity and fragmentation with regard to its risk. There are multiple risks in multiple parts of the transportation process. There is for instance packaging, loading, shipping and unloading. During all these activities there are risks depending on for example the hazardous material, the geographic location, the density of people and even the weather. Next to this we have to understand that all activities are carried out by humans, which makes it even more complex if we regard and include cognitive limitations. This set of risks and complexities make the analysis very interesting and especially in the U.S. with its own characteristics of politics, the industry, the public (perception) and public institutions.

2.2 Background thesis

This thesis is the final phase of the Master of International Public Management and Policy and thus the finalization of the study Public Administration. For my research I wanted to go abroad and work in a totally different context and culture, which could enrich my academic experience greatly. I was very fortunate to have got the chance to be an intern at the U.S Department of Transportation (DOT) for three months, more specific at the OHMS[1]. This was a evidently very interesting considering it is part of a big governmental institution as well as the policy field the OHMS deals with, which focuses on the reduction of risks in commercial transportation of hazardous materials[2]. The OHMS is one leg of the Pipeline and Hazardous Materials Safety Administration (PHMSA). The other leg is the Office of Pipeline Safety (OPS). The bifurcation is not yet completed, since the offices are also divided into (sub) offices. The OHMS has seven of these offices (i.e. Office of Hazardous Materials Standards, Office of Hazardous Materials Enforcements, Office of Hazardous Materials Planning and Analysis, Office of Hazardous Materials Technology, Office of Hazardous Materials Special Permits and Approvals, Office of Hazardous Materials Initiatives and Training and Office of International standards[3]). The DOT's mission is differentiated in administrations and offices and 'sub offices' related to the policy fields.

[1] See appendixes AC for the report I produced for the OHMS as an intern.

[2] Source: Website OHMS - http://hazmat.dot.gov/contact/about.htm

[3] Source: http://hazmat.dot.gov/contact/whoweare.htm

Perhaps most interesting from a administrative standpoint is the set of authorities and institutions, decision-making processes of the main policy field of hazardous materials transportation. The topic of risk management in complex institutions is even more exiting for a public administration student for the reason that it has quite some different dimensions and aspects which are all of importance. The public management and policy aspect are very interesting because the political and administrative leaders have to cope with several dilemmas and paradoxes as we will see in upcoming chapters. These leaders are expected to make balanced decisions, but are they always based on complete and scientific information? Their policy is expected to be stable and continuous to a large extent, but what role do big incidents play? And what is the influence of the media and the higher political leaders in this regard? The industry and other public partners have mostly not the same priorities and objectives as they do, but how can everybody go home happy? How do the programmes of the office interact and are there spill-over effects? And how can one manage this with the given budget? These are some questions that need answers almost on a daily basis.

Another interesting and related dimension is the organizational setting. How should the office be organized? Does it need centralization or decentralization of authority and decision-making? How does one recruit and keep sufficient and skilled personnel? How does one train and keep everybody focussed on reducing risk? How does one organize the networks with the industry and convince them of the importance of investing in reducing risk in terms of awareness and response? All of this needs to be seen within the turbulent and ambiguous contexts and the path dependency of the organization itself, which on itself is a complex setting.

Next to that the policy field of safety management itself is fascinating. The way risk as a phenomenon can be positioned in a professional institutional setting to reduce this risk is vastly interesting. Is risk something we can control with professional and sophisticated means? Is there a percentage of fatalities we have to cope with as a highly industrialized society? Is this margin part of the unavoidable nature of complex systems in a society or can we even prevent it? Can we grasp risk, even though there are cognitive, socio-cultural and system complexities and limitations?

All of these questions provided me with a set of interesting and academic challenges. On the one hand the big and complex contextual organizational and institutional environment and on the other hand the content of the policy field as such made this research a great experience and lesson.

2.3 Research question and sub questions

This takes us to the main goal of the research and the research question. A social scientific research is fruitful if it seeks for answers that are yet not there and for questions that are not frequently asked. The main goal of my research is *to understand how a complex governmental institution can be effective in a complex environment*. Even though this question is somewhat 'classic' in the discipline Public Administration, the contexts and characteristics of the U.S. OHMS are fascinatingly challenging. This goal consists of three elements, the complex institutional element, the complex environmental element and their relations. As we will see later in this thesis the exciting combination of the institutional complexity of the DOT and the environmental and operational complexity leads to a synergetic understanding of public management in complex contexts. With this study I have tried to provide insights in how a public institution deals not only with the complexity of governing in a highly fragmented environment, but also with a 'manufactured risk' as the transportation of are hazardous materials. So the understanding of the intersection of governing and organizing with crucial agencies and parties and the more technical element of reducing the risks in a complex transportation system, is the main focus.

Before the research question will be shaped it is important to define the problem governmental institutions face in reducing risk in a very complex society. The crux of the problem analysis is the normative framework and its relation to the empirical framework. The normative framework is the complex of norms and goals of the institution, but also from civil servants, the media, politicians and the public opinion and the *Zeitgeist* of its society. The empirical framework is constituted by outcome of policies and the social and administrative reality. Both frameworks are (socially) constructed and are quite hard to reconstruct objectively. In short the problem statement for my thesis can be formulated as: *How does the OHMS reduces inherent risks and its consequences of hazardous materials transportation in a highly industrialized society?* Obviously this is quite a broad focus, but it indicates the fundamental principal of the problem governmental institutions face in its environments.

A student of Public Administration is expected not to only analyze and conduct a scientific research, but also to add a more pragmatic element. The scientific purpose is to utilize two schools of thought that try to understand organizational behaviour through a lens of rationality versus complexity. These two theoretical concepts will elaborately be discussed in the next chapter. Since the two schools are not just theories, but entire schools of thoughts and parts of developments of the academic discourse of organizational theory and public management, it makes the theoretical aspects of the research even more interesting and deep-seated. The practical aspect is to assess the difficulties the OHMS faces in reducing risks effectively. This perspective focuses on causality which is crucial for the instrumentality of public governance. In the final chapter a set of recommendations will be postulated that are the result of the conclusions of analyses. The OHMS in this thesis serves as a case in the analysis of how modern governmental institutions deal with a highly complex environment within their contexts.

2.3.1 Research question

The research question consequently focused on the way the OHMS tries to reduce the risks within the transportation system with regard to hazardous materials. These risks are posed to the public, the transportation personnel as well as the environment. My research question for this analysis therefore is the following:

Research question:

How does the United States Office of Hazardous Materials Safety reduce the risks associated with the transportation of hazardous, especially with regard to high consequence events?

This research question obviously needs a brief elaboration. Reduction also includes the reduction of the likelihood of the consequences associated with these risks, so an emergency response dimension will also be incorporated. All risks that are mentioned in this thesis are risks associated with the transportation of hazardous materials. Important is the notion that a more narrative analysis on the general OHMS policy and next to that with regard to high consequence events involving the highway mode and serious highway incidents are conducted. As to the high consequence events the centre of attention is on highway incidents to narrow down the focus as much as possible. This will be discussed in chapter 4. The phrase 'reduce risks' is defined as decreasing the range of consequences and associated probabilities. 'Transportation' refers to the transportation system of all modes and highway in particular for the highway case including process of the loading, the actual shipment and the unloading of the hazardous materials. The term 'hazardous materials' will be defined as the U.S. Hazardous Materials Regulations defined it. In the Code Federal Regulations, hazardous materials are separated into the following classes (49 CFR Part 171):

- Class 1 — Explosives
- Class 2 — Gases
- Class 3 — Flammable liquids (and combustible liquids)
- Class 4 — Flammable solids; spontaneously combustible materials and dangerous when wet materials
- Class 5 — Oxidizers and organic peroxides
- Class 6 — Toxic (poison) materials and infectious substances
- Class 7 — Radioactive materials
- Class 8 — Corrosive materials
- Class 9 — Miscellaneous dangerous goods[4].

A more ramified and specified classification can be found in appendix A. Next to a general analysis of the OHMS safety policy, the focus is also on high consequence events. This is part of the analysis of the incidents, which will be discussed elaborately in chapter 4. A high consequence event is defined as: 'a serious hazardous materials incident where there are multiple fatalities, injuries, mass evacuations, and/or major impacts/disruptions to the transportation and economic systems'. Since there is great overlap between the meaning of high consequence events and serious incidents (see paragraph 5.8), I will use these definitions interchangeably. Since the research question is too broad to 'answer' directly after the analysis, it has been differentiated into supportive sub questions that all have a specific role and function in order to answer the research question. In order to 'answer' the research question with a solid, structured an in-depth analysis, important key perspectives are included. However, most importantly are these two conceptual questions, since they shape the core of the analysis.

[4] Report produced by Battelle for the Federal Motor Carrier Safety Administration. Comparative Risks of Hazardous Materials and Non-Hazardous Materials Truck Shipment Accident/Incidents. Final Report, March 2001. (pp. 1-2). For a more extensive list see appendix A or for further specification check the Electronic Code of Federal Regulations 49 part 171 at http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=cb64b2a2c6062c9022b7aa79357c68ff&rgn=div5&view=text&node=49:2.1.1.3.6&idno=49

1. How does the OHMS reduce the risks associated with the transportation of hazardous materials, especially with regard to high consequence events? *(Programmatic level)*

2. How and why did serious highway hazardous materials incidents occur? *(Incidents level)*

The analysis emphasizes on the actual policy strategies, programmes, projects and safety measures as well as the organizational configuration which are intertwined (programmatic level). Secondly, the focus is on actual serious highway incidents that occurred and an analysis on what, how and why went wrong (incidents level). These key questions constitute are the core analysis of this thesis and can be found back in the set of sub questions (i.e. 4 and 5). The programmatic level includes the OHMS policy and the highway programme. The incidents level mainly consists of serious hazardous materials incidents that occurred on the highway. The serious highway incidents serve as cases for the highway mode. The highway mode is a case for the OHMS which serves as case for public institutions with an explicit safety mission. A final note is the distinction between the terms 'accident' and 'incident' which are frequently used in this thesis. 'Accident' refers to an unwanted event that does not have consequences to people and environment, but can lead to for instance damage to the truck. 'Incidents' are escalated accidents that have (serious) consequences for people and the environment.

2.3.2 Sub questions

Now let us take a look at the sub questions which helped me answer the research question and afterwards look at the function and value of each sub question to the research question.

Sub questions:

1. *What is the history of the OHMS programme with regard to reducing the risks associated with the transportation of hazardous materials?*

2. *What options does the OHMS have to reduce the risks associated with the transportation of hazardous materials, especially with regard to high consequence events?*

3. *In what contexts does the OHMS operate in risks associated with the transportation of hazardous materials, especially with regard to high consequence events?*

4. How does the OHMS reduce risks associated with the transportation of hazardous material at the programmatic levels, especially with regard to high consequence events?

5. How and why did incidents occur with transportation of hazardous materials, especially with regard to high consequence events?

6. What are the relations of the programmatic and the incidents level of OHMS with regard to reducing risks associated with the transportation of hazardous materials, especially with regard to high consequence events?

7. What can the OHMS in the future do to reduce risks associated with the transportation of hazardous materials, especially with regard to high consequence events?

Note that the transportation modes are concentrated only on the highway in the U.S. next to a more general analysis. What can these sub questions add the research question and why do they support the analysis?

The first sub question constructs a historical context which gives the analysis a profound background of the OHMS. The second sub question gives the analysis a 'real world' context of policy instruments the OHMS can utilize. This sub question is of importance to assess the feasible aspects of OHMS as suppose to the ideological or strategic elements. The third sub question also endorses the analysis with contextual information. Key background factors are juridical, political, budgetary and the media contexts as well as the OHMS's networks of actors. The fourth sub question tells us more about the strategic and operational level (i.e. programmatic level) of the OHMS. This provides us with information on the strategic positioning and intentions of the OHMS (and its highway programme) as well as the real world safety policy. The fifth sub question helps us understand, on a more detailed and technical level, how and why serious hazardous materials incidents occurred in the highway transportation system. The sixth sub question connects the fourth and the fifth sub question and assesses the relation between the levels. It conjuncts the analysis of the separate(d) levels and constitutes an insight on the effectiveness of the OHMS in reducing risks. The seventh sub question reveals some recommendations that have been formed based on the analysis and the conclustions. The OHMS will be provided some points of reflection and contemplation.

2.4 Concluding remarks

As we have seen risk, risk politics and risk management has a very complex and dynamic character and history, which made the research all the more interesting. The research question is differentiated into two levels for practical and academic reasons. Also the sub questions do reflect this complexity, with the remark that all sub questions are relevant and have their value to the research. As already stated, the core of the analysis is based on the sub questions that analyze the different levels and their relations. The other sub questions give context and support to the main analysis. This is of great importance considering the complexity of the OHMS and the environments the OHMS operates in.

3. THEORETICAL FRAMEWORK

The theoretical framework is characterized by a hybrid and with an emphasis on different theoretical elements of two theories. The basic assumptions and theoretical elements of the two basic schools of thought in organizational theory in relation to safety management, which Sagan (1993) identifies and defines as the high reliability theory and the normal accidents theory, will be discussed in paragraph 3.1. In paragraph 3.2 the high reliability theory will be discussed elaborately. The same holds for the normal accidents theory in paragraph 3.3. Finally, some concluding remarks will be made in paragraph 3.4.

3.1 Introduction: A hybrid approach

There are two main schools of thought in sociology that have addressed the organizational elements of safety (Marais, Dulac and Leveson, 2004). These schools of thought are also influenced by organizational theorists and public management theorists and political scientists. This division is also addressed by Sagan (1993), whose hybrid theoretical concepts form the basis of the theoretical framework. There are a great deal of scholars that advocate the main assumptions and foundations of both theories. Important to note is that not all scholars agree on all elements and they do not use the same terms and definitions consistently, but there is more or less a consensus on the basic principles and elements (Sagan, 1993: 13).

The first school of thought is identified as the high reliability theory. The main and most important scholars of this school of thought are Todd la Porte (1991, 1994, 1996), Gene Rochlin (1987, 1991), Karlene Roberts (1990), Karl Weick (1987, 1993, 1999), Paula Consolini (1991), Marone and Woodhouse (1996) and Aaron Wildavsky (1998). In the next chapters the term high reliability theory has been used as a theory that argues that there is a rational way to prevent and reduce risks in industrialized and modern societies. The basic premise of this school of thought is that accidents of hazardous technologies in the modern world can be prevented if appropriate organizational designs and management techniques are followed (Sagan, 1993: 13). There are several organizational elements that are of great importance to reduce or prevent risks from this ‘optimistic’ perspective, which will be elaborated in the next paragraph.

The opposite school of thought is the normal accidents theory. The main and most influential theorists of this school of thought are Charles Perrow (1977, 1984, 1992, 1995), James March (1977, 1981, 1986), Michael Cohen (1988), Johan Olsen (1977, 1986, 1988), Raymond Levitt (1975), Leo Tasca (1990) and Jack Katz (1977). The main premise of this school of thought is that even though we try to reduce or prevent risks, there are several cognitive, social, cultural and system characteristics form limitations to these attempts. Some measures may even be counterproductive and increase the risk of a serious accident. This more 'pessimistic' approach also has some important theoretical elements.

A final vital note is that Sagan states that members of the high reliability school are usually prudent enough to avoid the extreme claim that organizational perfection is possible. Mare and Woodhouse for example argue that 'there is a good chance…that catastrophes will be prevented'; Roberts only states that there are 'hazardous organizations that engage in nearly error free operations'; and La Porte and Conslini only claims that such organizations have 'a very low error rate and an almost total absence of catastrophic failure.' Similarly, Perrow only claims that engage that disastrous accidents will occur eventually: 'Accidents are inevitable and happen all the time and serious ones are inevitable though infrequent; catastrophes are inevitable but extremely rare.' These eloquent phrases imply that there is a common estimation of both schools on the probability of serious accidents. Normal accidents theorists look at a glass of safety and find it 1 percent empty, high reliability theorists may see the same glass of safety as 99 percent full (Sagan, 1993: 48).

3.2 School of thought 1: High reliability organization theory

Before we examine the theoretical elements Sagan defines and includes in the high reliability theory, there are some general features of the high reliability approach that are important to notice. Roberts (1990a) defines high reliability organizations as the record of high safety over long periods of time (Marais et al, 2004: 1). Robert addresses the question: 'How many times could this organization have failed resulting in catastrophic consequences that it did not?' If the answer is on the order of tens of thousands of times, the organization is reliable (Roberts, 1990b: 160). With this definition one can quite effortless consider almost all organizations high reliable. Another important notion of the high reliability theory is that it is based on optimal rationality, maximum knowledge of technical measures and their interaction. The drive for technical predictability has resulted in relatively stable technical processes that have become quite well understood within each high reliability organization (La Porte and Consolini, 1991: 29-30). The difficult and important key factor for high reliability organizations, Marais et al (2004) argue, is uncertainty.

This is not only technical uncertainty but also organizational and social uncertainty. The task that needs to be executed is not the only high risk, but also the technical, organizational and social structures and systems that are used to perform the task, include significant uncertainty.

Sagan's approach and definition of the high reliability theory is based on 'three major scholarly efforts', as he states it. The first effort Sagan postulates is *Adverting Catastrophe: Strategies for Regulation Risky Technologies* of Marone and Woodhouse (1986). Marone and Woodhouse maintain that 'given the challenge posed by modern technologies, the record is surprisingly good despite dire warnings, no catastrophes have occurred in the United States' (Marone and Woodhouse, (1986: 5). The authors studied the management of toxic chemicals, nuclear power, recombinant DNA research, ozone layer depletion and global warming problems in the United States (Sagan, 1993: 14). They also argue that they found 'complete systems for averting catastrophes, produced by wise management practices. The second key example of high reliability theory Sagan puts forward is a Berkely (University of California) group of scholars that advocate the high reliability theory (e.g. Gossling, La Porte, Roberts, Rochlin, Shulman, Weick). After numerous empirical researches they have developed specific characterizations of how to prevent and manage risks in modern society with processes in complex social organizations. The third important work is Aaron Wildavsky's *Searching for Safety* (1988). This is a more theoretical approach on how to achieve the considerable degree of safety in contemporary society. Wildavsky advocates a more active search for safety instead of a passive prevention of harm because of an increase of entrepreneurial activity. Anticipation and resilience are fundamental. In his work, Wildavsky applies cases as nuclear power plants, the human body's immune system and the U.S. Food and Drug Administration drug approval process.

Even though these three 'theorists' differ in reasoning and research focus, they ultimately agree upon four major elements that contribute to high degrees of safety. These explanatory factors can clarify positive safety records. They argue that rationally and professionally designed organizations are more rational than human beings individually. Scott (1987) has called these organizations 'closed rational systems'. High reliability organization are seen as rational with highly formalized structures and clear and consistent goals. La Porte and Consilini (1991) for state that a characteristic of high reliability organizations is that they have very clear and well-agreed-upon operational goals.

3.2.1 Theoretical elements

The first important and quite evident element is the *prioritization of safety and reliability* as a goal by political elites and the organization's leadership. Both political as well as organizational leaders should prioritize extreme reliability and safety if they want to have a high level of reliability. There are two important arguments related to this principle, namely more financial resources and good communication of the priority on safety and reliability.

- *The richer is safer-argument* (Wildavsky, 1988). An organization with more financial resources can produce and maintain constant levels of redundancy and operational training. Richer also means better quality of data, assessments and prevention of accidents.
- *Communication* of clear objectives is also very important for a high reliability organization. The priority on safety and reliability should be the priority of all members of the organization. When the organization members accept the objectives, an 'organization culture of reliability' can arise. This culture implies an (often more implicit) agreement about the organizations mission. Even though 'culture' is a separate theoretical element of the high reliability theory, communicating the priority on safety and reliability is related to both prioritization and to organizational culture.

An interesting footnote is that Marais et al (2004) argue that we should not speak of a 'culture of reliability' but of a 'culture of safety' when the goal is safety. These authors state that acting reliable is not necessary safe and acting safe is not necessary reliable.

The second element is a very important one and is advocated by the majority of the high reliability theorists. High levels of redundancy in personnel and technical safety measures are of great magnitude to make an organization highly reliable. Redundancy is the anticipation on the sub optimal rationality of human beings. There are cognitive limitations to the rationality of human beings, as demonstrated by several psychological studies (e.g. Kahneman, Slovic and Tversky: 1982; Nisbett and Ross: 1980). Simon (1957, 1990) is well known for his bounded rationality concept which argues that goals can be optimal, whereas resources and behaviour (in order to reach that goal) is always sub optimal. March (1994) also tells us that there are limited or bounded rationalities on the individual and micro level. There are limited forms of rationality and different characterizations of simplification. Neumann (1985) stated that through redundancy 'reliable systems from unreliable parts' can be built. Sagan puts forward two arguments for the rationale of redundancy. Duplication and overlap in personnel and technical safety measures can reduce risks significantly.

- *Duplication* in technical and personnel safety measures. This is when the same function is covered by two different units, which can be considered as a reserve unit when for instance only the main unit is unavailable.
- *Overlap* in technical and personnel safety measures. This exists when units have some functional areas in common. An example is that different communication systems can be used if necessary. Cross-check of each others work by overlapping responsibilities is an additional advantage of overlap.

Even though high levels of redundancy can greatly enhance reliability, it is wise to include several strategic and operational measures in order to avoid stretching the redundant systems beyond their capacity. There are three interrelated factors of operations and management that have been identified in the literature by Sagan that constitute the third element. These 'sub elements' are (1) a considerable degree of decentralization of decision-making authority; (2) a high reliability culture; and (3) the maintenance of continuous operations and training.

Decentralization of decision-making is an important notion in order to permit rapid and appropriate response to hazards by the individuals closest at hand. Sagan also uses some examples of Wildavsky's analysis on nuclear power plants (1988) and La Ports and Concolini's study on U.S. navy aircrafts and U.S. air traffic control system (1988, 1991). The premise is that the responsibility of response lies with the individuals that can act quickly and appropriately. Time-criticalness is the key issue, which is provided best with a decentralized decision-making structure. If even the lowest operational personnel are allowed to abort shipment or the start of a hazardous operation, it indicates that he or she can respond and make decisions when an (near) accident is at hand.

Organizational culture is a very interesting topic for organizational sociologists. It answers to Sagan's question: 'how will lower-level personnel identify situations properly, behave responsibly and take appropriate actions in crises?' The high reliability theory argues that culture is the right instrument to create and maintain a strong culture on safety and reliability. Karl Weick (1960) interestingly stated:

> 'Before you can decentralize, you first have to centralize so that people are socialized to use similar decision premises an assumptions so that when they operate with their own

> units, those decentralized operations are equivalent and coordinated. This is precisely what culture does. It creates a homogenous set of assumptions and decision premises which, when they are invoked on a local and decentralized basis, preserve coordination and centralization.'

With a strong culture the decentralized units can be harmonized, mainly in terms of priority, procedures, expectations, anticipation and responsibility. Investing in this 'culture of reliability' next to decentralization is therefore a crucial element in order to be prepared on and respond appropriate to accidents and hazardous events. This culture of reliability should promote reliability without the hierarchy of extreme centralization. La Porte and Consoline (1991) state that investing in recruiting, socialization and incentives to assure that there is a broad agreement about the organizational mission.

To keep the operational personnel active and experienced, *continuous operations and training* are required. Rochlin, La Porte and Roberts (1987) argue that carelessness and error can be the result of stability, routinization and a lack of challenge and variety. They also state that without continuing training and retraining of personnel, and without sufficient operational time, both effectiveness and safety would suffer. 'Continuous on-the-job training improvements, frequent and realistic simulations of emergencies are required to reduce error rates', as Sagan puts it.

'Decentralized decision-making authority, a high reliability culture and continuous operational training are all part of a theoretical element in the high reliability theory, because they reinforce one another. An interesting analogy of Sagan in this context is that it looks 'like modern industrial factories that have been designed into loosely supervised and semiautonomous production teams.'

The final element of the high reliability theory is *organizational learning*.. Sagan postulates three major learning processes which he identified in empirical and theoretical literature. These two processes are (1) trial and error learning; (2) simulations and imaginations of trial and error; and (3) conducting risk analyses.

- *Trial and error learning* refers to the incremental organizational learning process which is based on minor adjustments of procedures and routines over time. Steinburner (1974) stated that a learning process produces evolutionary progress, if it is not centrally controlled, successful procedures are maintained and unsuccessful ones are eliminated. There is a broad consensus among high reliability theorists as to the value of trail and error learning. Wildakvsy (1988: 17) for instance underscored the importance of trial and error learning as follow: 'without trial there can be no new errors, but without these new errors there is also no new learning.'

- Sagan states that *simulations and imaginations of trial and error* are often an alternative trial and error learning process, since the organizational and social costs of a major accident are extremely high. Woodhouse (1988: 217) call this alternative an important part of a 'sophisticated' trial and error strategy. Through simulations and imaginations there can be gained trials, without large-scale errors. A reconstructing (near) accidents can be very valuable, without large amounts of costs.
- A more technical learning process is the notion of *risk analyses* conducted by engineers. These analyses can identify potential operator and design errors and discover hidden failure modes. These analyses may also include possible solutions which are of use for operators. Marone and Woodhouse (1989: 137) argue that this is a way to 'speed up the learning process', rather that to wait from experience.

To summarize this paragraph, there are four major elements that constitute the high reliability theory. These elements are: (1) the prioritization on safety and reliability by political and organizational leaders; (2) significant levels of redundancy that compensate for failures, which can be overlap or duplication of personnel or (technical) safety measures; (3) the decentralization of decision-making authority, a storing organizational culture and continuous operations and training; and (4) organizational learning through trial and error, simulations and imaginations and risk analyses. An exact mixture of these elements is not provided by high reliability theorists, but these factors should be present. The mixture depends on the nature of the particular problem (Mare and Woodhouse, 1986). Let us now take a look at the opposite school of thought, the normal accidents theory.

3.3 School of thought 2: Normal accidents theory

The normal accidents theory has a totally different perspective on the way we can prevent serious accidents and reduce risks. As supposed to having rational and well structured management strategies advocated by the high reliability theory, the normal accidents theory emphasize on a high influence of social and political forces, cognitive and social limitation that effect the way organizations deal with risks and safety. Normal accidents theorists (influential scholars are Perrow: 1983; March, Cohen and Olsen: 1988; Reason: 1990; Shrivastava: 1987; Tamuz: 1988Starbuck and Milleken: 1988) have studied the same industries as the high reliability theorists and came to an entirely different conclusion. This theory predicts that serious accidents are inevitable even though we use rational management techniques. Sagan (1993: 44) states that the theoretical elements that the high reliability theory advocates are highly ineffective, unlikely to be implemented and sometimes even counterproductive. Normal accidents theorists disagree with the basic premise of the high reliability theory that actors of the organization are rational. They do not have consistent goals and therefore do not learn optimally from prior accidents, as we will see later this chapter. Before we revisit to the four major theoretical elements of the normal accidents theory and view them from a normal accidents perspective, there are some important theoretical notions that need to be considered.

Sagan argues that the normal accidents approach closely fits to the 'natural open systems' tradition. In this approach organizations are not seen as rational systems but as 'natural' and they peruse their own narrow self-interest, such as their own security and survival, and not just their official goals such as profit, production or reliability' (Sagan, 1993: 29). March, Cohen and Olsen (1988) coin an important term in this context, the 'garbage can model'[5]. This model has become well known in social science and explains the behaviour of complex organizations radically different than organizations viewed as rational entities. These 'organized anarchies' have three main characteristics. The first characteristic is that these organizations do not have clear and consistent goals and objectives, but ´inconsistent and ill-define preferences' (March et al, 1988: 295). Second, these organizations use 'unclear technologies' in their operations. Not all the processes are well understood by all the organizations' members. Sagan argues that the causalities of the actions of the organizations are obscure. Third, the participation in the decision-making processes is fluid. There is no optimal attention, continuity and information in these processes. March et al argue that these characteristics explain many of the behaviour of complex

[5] The initial article was published in March 1972 in the Administrative Science Quarterly, 17(1).

organizations. Solutions, problems and participants come together at unplanned and unintended points in time and choice opportunities emerge.

An important and influential theorist of the normal accidents school is Charles Perrow. His most influential efforts are his 1977 essay[6] and his 1983 work *Normal Accidents*: *Living with High Risk Technologies.* He argues that 'complex social systems are greatly influenced by sheer chance, accident and luck; that most decisions are very ambiguous, preference ordering are incoherent and unstable, efforts at communication and understanding are often ineffective, sub systems are very loosely connected and most attempts at social control are clumsy and unpredictable'(Perrow, 1977: 153). Perrow argues that organizations are much more structural and political than high reliability theorists assume. These two factors lead to his conclusion that 'system accidents' are inevitable. The structural component consists of two dimensions, 'interactive complexity and 'tight-coupling'. The theoretical notion on politics implies that because of inter-organizational, between organizations and by the broader political community, conflicting objectives exist, this may lead to a higher frequency of catastrophic accidents. Since interactive complexity and tight-coupling are quite complex but are of interesting significance in this thesis, let us focus some more on the structural dimensions before we turn to the four theoretical elements.

3.3.1 Interactive complexity and tight-coupling

Perrow (1983) formulated two key dimensions from a system theoretical approach. Both dimensions give an insight in the complexity of systems that organizations use with high technology. 'Complex interactions are those of unfamiliar, unplanned or unexpected sequences that often also are not immediately comprehensible' (Perrow, 1983: 79). As systems grow in size and in the number of functions, their interactions with other systems also grow in number. These systems can be social, political or technological. Units are the smallest parts of a system, a functionally collection of parts make a unit, an array of units make up a sub system and a system as a whole consists of sub systems. The interaction of the sub systems may have hidden and unplanned effects, which can lead to more risk. To make it more clear, the opposite of complex interactions are linear interactions. Linear interactions are familiar and the effects are expected. Even when there is an unplanned effect, they are visible. An example of a linear interaction Sagan provides us is an automobile assembly. 'If a broken conveyer belt stops the line, the problem is

[6] 'Three Types of Effectiveness Studies'(1977) , in Goodman, P. and Pennings, J.M., and Associates. *New Perspectives on Organizational Effectiveness.* Jossey-Bass, San Fransisco.

visible to operators and is, relatively speaking, easily comprehensible; and, finally, feedback and information on what is happening on the plant floor is usually direct and simply verified.' But in complex interactive systems this oversight is very difficult, if not impossible. There might be geographical, physical, technological, social, political and/or other reasons that make the interaction much more complex. Perrow describes a system that consists of sub systems, unit and part. 'The complex interactions were not designed into the system by anybody and no one intended them to be linked' (Perrow, 1983: 75).

Tight-coupling is the second dimension of Perrow's notion on structural rooted complexity. Sagan states that 'the condition of tight-coupling is necessary to produce escalation to a full blown accident.' Perrow lets us know that the mechanical term for tight-coupling is no slack or buffer between two items. On the contrary, loosely coupled systems do have slack and there is enough time to improvise. Perrow describes four characteristics of tight-coupling, which Sagan also uses.

- It is a *time dependent process*. When planned and unplanned interactions occur quickly and when items should be moved continuously it leads to tight-coupling.
- The process has a high level of *invariance*. There is only one way the process is conducted and each step is to be made in sequence. Perrow states is as 'B must follow A'(Perrow, 1983: 93).
- The process is characterized by *little slack*. There is a level of precision that is required to make the process successful. Quantities and operations for instance should be used in a specific way and amount.
- Safety devices and redundancies and buffers between parts of the process are for the most part limited to the planned and designed system. Sagan states that due to time-dependent processes, the invariance and the lack of slack there is little time to *improvise*. And recovery is very difficult because of this limitation.

Even though Perrow argues that incidents are rare, this system approach can help us understand the complexity of 'system accidents' as he calls it. These two dimensions vary as to their relevance depending on the organization.

We have seen that the garbage can model is the underlying philosophy of the normal accidents theory and the two concepts of Perrow (interactive complexity and tight-coupling) are highly relevant for the system approach of the normal accidents theory Sagan constitutes. Let us return to the main theoretical elements the high reliability theory and look at them from a normal accidents theory lens.

3.3.2 Theoretical elements

The first element is the prioritization of the political and organizational leaders on safety and reliability. Even though normal accidents theorists do not disagree with thin notion, but Perrow argues that more focus is required on operational safety goals. He additionally argues that political and organizational elites are too remote from the operational level and operators only have 'some effect' on the safety of that system (Perrow, 1983: 21-22). Also, objectives often have poorly defined and inconsistent preferences. There are three background notions that lead to these conflicting objectives.

- In hazardous industries, high production rates are a big priority which can lead to a *violation of safety rules*.
- There might emerge a *tension* between the organizational and broader political priorities. Regulatory agencies that regulate the industry for instance can have a different set of priorities than the political priorities in a certain timeframe.
- Even if organizations have consistent priorities, they might be *misinformed* by operational personnel. This communication gap is explained by normal accidents theorists by the notion that operators wish to keep their job and protect their own interest.

So the normal accidents theory has a more pessimistic view on the prioritization of political and organizational leaders and their communication efforts relative to the high priority theory. These factors can even increase the risk of serious accidents.

The second element that high reliability theorists advocate is that redundancy (i.e. overlap and duplication of personnel and technical safety measures) increases safety. Normal accidents theorists emphasize on the possibility that redundant safety measures can fail simultaneously. In fact, the normal accidents theory argues that the likelihood of a serious accident can increase exactly because of redundant safety measures. There are three reasons Sagan postulates that lead to this conclusion.

- Redundant safety measures are often *less independent* than their designers believe. Safety measures or devices interact in unexpected ways.
- Adding redundancy makes the system more *opaque*. Individual actions are less visible, because they are compensated by redundant safety measures (Sagan,

1993: 39). Small scale errors will remain invisible and may increase the likelihood of serious accidents.

- Redundant safety measures lead to *higher production rates* of the operators. The trust in the safety measures may increase the risk.

The third element that increases safety according to Sagan's high reliability theory consists of three sub elements: decentralization of decision-making, culture and continuity. Perrow argues that in tight coupled systems there is also need for centralization of decision-making. Conformity and standardized operational procedures are of great importance at the same time as decentralization. The 'build-in slack' allows no improvisation time. Especially in complex interactive *and* tight coupled systems, decentralization can increase risks and risk taking. High reliability theorists argue that a strong organizational culture (i.e. high reliability culture) can solve this paradox. A common set of decision-making premises and assumptions and response that is appropriate can help make proper judgements. Normal accidents theorists on the other hand have two major concerns on this rationale.

- The garbage can model helps us understand and explains that higher decision-makers do *not have all the data and information* that is needed to know all the operational activities and their characteristics.
- A high reliability culture is a form of uniformity that Perrow calls a 'military model' (Perrow, 1983). Lower level personnel and operators are to respond in a standardized and identical way they respond. This cultural model has characteristics that are not compatible with *American social values and culture*, according to Perrow.

The third sub element the high reliability theory promulgates of this theoretical element is continuous operations and training. Normal accidents theorists might agree, but also add that there are some major constrains on training. Not all scenarios can be reconstructed, because they are often based on prior incidents which lead to a 'biased' training programme. Next to that the high interactive complexity of the system can not be included in reconstructions. Also some scenarios are simply too dangerous to practice. An additional notion is that some accidents are politically 'highly unpalatable', as Sagan states it. By this he means that the reconstruction of some extremely dangerous scenarios insinuate that there is a possibility it could happen in real life.

The final theoretical element that would increase safety according to the high reliability theory is organizational learning. Sagan is reasoning that there are certain restrictions on effective organizational learning that makes the increase of safety very difficult, if not impossible.

- The causes of accidents are often *unclear*. As a result of this reconstructions are based on preconceptions that fit the organization's mission. These biases restrict the organizational learning process.
- Analyses and reconstructions of real and near accidents take place in a highly politicized context. Because often someone within the organization is to blame, this leads to the conclusion of 'operator errors'. This way *'patriarchical interests are protected'*, as Sagan states it. This mechanism constrains effective learning as well.
- *Faulty reporting* is an important notion that also limits the ability to learn. Without reliable information of the operators, the feedback loop is not reliable and the incentive to improve lacks. Operational personnel often think in terms of 'keeping their jobs' when an accident occurs, instead of reporting it as required. An additional and related 'weakness' is that organizational leaders cover up this faulty reporting, in order to minimize outside criticism, again limiting the learning process.
- A forth constraint of effective organizational learning is *secrecy*. Secrecy between and inside the organization can lead to sub optimal communication of crucial information, which has great implications for the learning process.

We have now seen the normal accidents perspective and it pays great attention to the limitations of the organization, its leaders, its operational personnel and the system characteristics. The garbage can model is the basic underlying rationale for the set of assumptions of the normal accidents theory. Complex interactions and tight-coupling of the system and sub systems can lead to system accidents, even though rational management techniques are being used. All theoretical elements high reliability theorists advocate as safety improvements, have much less (or even counterproductive) effects according to the normal accidents theorists. In table 3.1 a summary of both theories is provided (Sagan, 1993: 46).

Table 3.1 Summary of both theories

	High reliable theory	**Normal accidents theory**
Premise	*Accidents can be prevented through good organizational design and management.*	*Accidents are inevitable in complex and tightly coupled systems.*
1.Objectives	Safety is the priority organizational objective.	Safety is one of a number competing objectives.
2. Redundancy	Redundancy enhances safety: duplication and overlap can make 'a reliable system out of unreliable parts'.	Redundancy often causes accidents: it increases interactive complexity and opaqueness and encourages risk-taking.
3. (De)centralization	Decentralized decision-making is needed to permit prompt and flexible field-level responses to surprises.	Organizational contradiction: decentralization is needed for complexity, but centralization is needed for tight coupled systems.
4. Culture	A 'culture of reliability' will enhance safety by encouraging uniform and appropriate responses.	A military model of intense discipline, socialization and isolation is incompatible with democratic values.
5. Continuity	Continuous operations, training and simulations can create and maintain high reliability operations.	Organizations cannot train for unimagined, highly dangerous or politically unpalatable operations.
6. Learning	Trial and error learning from accidents can be effective and can be supplemented by anticipation and simulations.	Denial of responsibility, faulty reporting and reconstruction of history cripples learning efforts.

3.4 Concluding remarks

In this chapter the theoretical concepts of this thesis have been discussed. The basic framework is derived from Sagan's hybrid theory on high reliability organizations and normal accidents organizations. These two contradictory theoretical concepts reflect two schools of thought of several academic disciplines. The high reliability theory argues that serious accidents can be prevented, as long as the right and appropriate management strategies and techniques are being used. The normal accidents theory however argues that even though rational management techniques are used, there are certain human and system characteristics and constrains that lead to accidents and might even increase the number of serious accidents. Interesting is that these two different approaches look at the same organizations and have totally different observations, which is often caused by different assumptions and perceptions. Let us now take a look at how these theoretical concepts and elements can be translated into operational indicators to assess and analyze the OHMS safety management approach.

4. RESEARCH DESIGN AND METHODS

This chapter shapes the research design which includes the methodology and operational techniques I used in order to collect my data for the analysis. First (paragraph 4.1), some introductionary notions on the oparationalization in general and on the operationalization of the theoretical indicators will be made. Consequently (paragraph 4.2 and 4.3) the operational indicators will be further operationalized per theory with regard to the data collection for these indicators. This step should answer to the question: how does one measure and assess the operational indicators that are derived from the theoretical indicators? In paragraph 4.4, the same thing is done for the incidents level. In paragraph 4.5 the focus is on the methods used per sub question. A brief focus on the implication of the data analysis and its relation with the assessment and definition of the effectiveness of the OHMS safety policy will be provided in paragraph 4.6. The chapter finishes with some concluding remarks on the research design as a whole.

4.1 Translating the indicators

It is important to stress that the data analysis is highly qualitative. This is mainly because the scientific philosophic approach for this thesis is social constructivistic. Since most of the data are words and language based, the frame of reference is interpretationistic. There is also quantitative data incorporated, but this often supports the qualitative data. The highly socialized and contextualized environment of both the OHMS and the research data information is language based and to a large extent inter-subjective and may include hermeneutic elements. Also, the answers of interviewees and the conclusions and argumentation of reports can almost impossibly be reduced to a quantitative analysis, which would do no justice to the academic foundations of social research.

With this in mind let us take a look at the structure and design of the research. First of all it is of importance to note that the research has the purpose to understand how a complex governmental institution can be effective in a complex environment. In order to understand this I wanted to use not just one theory because it would be a meagre analysis and since social science in general and public administration in particular is a multi disciplinary science, more perspectives and theoretical approaches have been utilized. All theoretical perspectives are used as 'lenses'. All (sub) analyses are qualitative which has implications for the (relative share of) methods that have been used.

As we have seen, risk is a complex phenomenon and organizational and system theories have different perspectives on risk. The two central schools of thought in this thesis have a different perspective on social reality and the manageability of it. For this thesis I used the key elements of each theory and translated them into operational indicators. Since the high reliability theory as well as the normal accidents theory consists of a set of organizational and policy elements, these separate elements could be extracted per theory and put into a context of an indicator. Doing so, the theoretical elements turn into more operational indicators. This 'translation' is for a large part a matter of definitions, which are of crucial importance in qualitative research.

These theoretical notions constitute the core of the research and cover sub questions four, five, six and consequently seven. The other supportive and contextualizing sub questions do not need elaborate operationalization, since they already have an operationalized character. I assessed the most important and relevant contexts that are commonly relevant in public administrative contexts (i.e. political, ideological, juridical, administrative, public and private partners, industry, the public and media as well as technology). In order to understand the operationalized theories more structured and in detail I will discuss the high reliability theory and the normal accidents theory indicators separately.

4.2 Translating the high reliability theory

For the OHMS context, the indicators of the high reliability theory will be defined more specified. The first indicator is the priority of the organizational objectives and political and organizational leaders. This priority should be resolutely and decisively aimed at safety and reliability. In the OHMS context, this implies that the Secretary of the DOT as well as the OHMS offices' administrators and leaders should have safety and reliability as a number one priority. This priority should also be communicated throughout the OHMS and with all partners that work with the OHMS. This could be reflected in mission statements and objectives of the organization as well as statements of the DOT and OHMS leaders. Additionally some budgetary aspects of the OHMS have been assessed.

The second indicator is redundancy of (technical) safety measures. For the OHMS context this implies that after a thorough assessment of all the safety measures the OHMS and more specific the highway programme executes and implements, I have assessed where, how and why there is duplication and/or overlap of safety programmes and/or measures.

Decentralization, culture and continuity are separate indicators of the more operational level which will be discussed separately. Decentralization of decision-making in the OHMS context is the degree of decentralization of formalization of the authorization of (important) decisions. Important is the extent that lower level authorities and operators can make their own decisions according to a specific situation. The cultural indicator in the OHMS context is part of the decentralization but also part of a policy that might stimulate a high reliability culture. Continuous operational training is the third indicator of the theoretical element of operational aspects of safety management. This indicator in the OHMS context has been assessed by the number, frequency and diversity of operations and training of carriers of hazardous materials, emergency response teams and other operational personnel of prevention and response.

The final indicator of the high reliability theory is organizational learning. In the OHMS context this is mainly the degree of learning, the possibilities, constrains and the learning process in a more general view. In particular (simulations of) trial and error learning and risk analyses have been assessed.

4.3 Translating the normal accidents theory

In this paragraph the theoretical indicators of the normal accidents theory is put into the OHMS context in order to have a set of indicators for the data collection and analysis. As we have seen, the four theoretical foundations of both theories focus on the same organizational and policy aspects, so there is some overlap in the operationalization of these elements. However, they will be operationalized separately from a normal accidents theoretical perspective and moreover the two important theoretical concepts of interactive complexity and tight-coupling from a system theoretical perspective will to be opertaionalized as well.

The first indicator is the prioritization of organizational and political leaders, which have the same 'OHMS assessment' from a normal accidents theoretical perspective as from a high reliability perspective since the assessment is on the priorities as such.

The second indicator is redundancy of safety measures, which from a normal accidents perspective focuses more on the interactions between and dependency of redundant safety measures on the OHMS and the more operational level.

The third indicator is decentralization of decision-making. From a normal accidents lens for the OHMS context, this implies assessing the problems of decentralization and focusing on the need for centralization. The related indicator is culture, which aims at the more human and societal aspects of a high reliability culture from a normal accidents standpoint. In the OHMS context this will be reflected in the behaviour and perceptions of operational personnel that indicate the lack of 'individual-democratic space'. The fifth indicator is training, which in the OHMS context from a normal accidents viewpoint is the continuous and operational training process in all shapes. The angle here is that this perspective pays more attention to the restrictions of the training process.

The fourth indicator of the normal accidents view is the learning process. In the OHMS context and from a normal accidents perspective this is the set of restrictions the OHMS faces in effective organizational learning. Also for the normal accidents perspective holds that all theoretical nuanced notions and sub characteristics have been assessed elaborately (i.e. unclear causes, partriarchical interests, faulty reportin and secrecy).

Complex interactions in the OHMS context are interactions between the sub systems of the OHMS's safety policy as well as interactions inside the sub systems themselves. These sub systems are for instance the transportation systems (i.e. highway), the safety measures (i.e. technical and personnel), policy projects and programmes or the political system. Each subsystem has its own characteristics, degree of dynamics and most sub systems interact to some extent. This indicator is assessed through a thorough deductive process, which is the result of data analyses of all the sub systems separately. The assessment of complex interactions is highly theoretical and in practice quite difficult, but with profound data analyses of the sub systems and insights of crucial contacts, interesting inferences emerged. The second structural dimension is tight-coupling when an accident occurs. For this indicator in the OHMS context I have looked at the degree of slack and time-dependence of interactions inside and between sub systems. Also this assessment was focussed on the degree of tight-coupling or loose coupling. The assessment of the thigh coupling indicator is also a deductive process after profound analyses of the sub systems. For both system dimensions holds that the nuances of the theoretical implications of Perrow have been utilized. An additionally notion (even though the assessments focus on the question whether the system has linear or complex interactions and loose of tight-coupling) is that the normal accidents perspective assumes complex interactions and tight-coupling lead to system accidents. The indicators complex interactions and tight-coupling of sub systems in the OHMS context are relevant for both levels.

As one might have observed, the perspectives of the high reliability and the normal accidents schools have different lenses which makes the assessments and operational indicators uniform and slightly differentiated. In appendix B, a figure of the indicators for both levels (i.e. programmatic and incidents level) is inserted. On both the programmatic as well as the incidents level all indicators are of importance, however more technical and indicators on the more 'operational level' are more significant. Obviously after the data analysis we are able to see what indicators are most important, significant and relevant and on what level and their relation. The next paragraphs discuss the way the indicators will be 'fed' with what kind of data and how the data was collected.

4.4 Assessing the incidents

For the incidents level I have scrutinized incident reports to assess the cause of the serious incidents. The analyses of the incidents level are case studies, in which every incident serves as a separate case. The case selection is based on a number of criteria:

1. Incidents reports and information should be well documented;
2. Incidents are to be defined as high consequence events;
3. Incidents are no older than 1997;
4. Incidents are highway incidents;
5. Incident reports are selected on random basis.

The first criterion is of crucial importance, since the degree of elaboration on the accidents is the basis for the analysis. I have used the incident reports of the National Transportation Safety Board (NTSB), which are very elaborative and even more important, conduct independent investigations. Selecting high consequence events is related to the research question and in essence is of importance to narrow down the focus of the analysis (as discussed in chapter 2). The incidents should be no older than 1997, which makes the timeframe 10 years, because there is too little to say about the prior period from the core analysis perspective. I drew the line on 1997, because drawing probable causal relations with the OHMS hazardous materials safety policy before 1997 might be very obscure, which is a risk I do not wanted to take for academic reasons. Fourth, all incidents are highway incidents, which is related to the focus on the highway programme. Finally, from a methodological perspective, a random selection of cases is needed to have an honest view of the incidents level. Other case selection methods (e.g. selecting best likely and least likely cases) have some degree of selection (*ergo* exclusion) that 'harms' the assessment of the incidents level as such. I have selected as much cases as possible in order to have a quite high degree of validity of the incidents level analysis, meaning six serious incidents which also is the number of all well documented highway incident reports by the NTSB from 1997 to 2007. Obviously the ideal approach would be including all reported incidents, but this was unfeasible within the given timeframe.

4.5 Data collection: Applying three angles

I will now outline the methodological approach that has been applied to collect the empirical data for the analysis. The methods used are document analysis, interviews and observations. Document analysis implies the scrutiny of mostly policy documents, reports, evaluations of the OHMS or other agencies. Also (scientific) reports of institutes or other organizations have been used. The second method is conducting interviews with key contacts[7]. These interviews were in between open and semi-structured interviews. This was necessary and also a tension, because in order to collect the information I needed the questions were to be quite to the point, but the contextual and complex context of each question made this concisiveness rather complicated. The final data collection method is observation, which implies that through objective observation, listening and transcribing the conversations and discussions of formal meetings; which serves as an additional source of qualitative data. In most parts of the analysis there are either one or two overlaps of data sources, which make the quality of the set of data quite sound. This way the data has a solid foundation (via data triangulation). In appendix D an overview of the research design can be found.

<u>Sub question one</u>

The analysis on the historical context of the OHMS is based on two pillars: document analysis and interview. In order to identify the history of the OHMS programme, evaluation documents, incident reports and strategic documents were of relevance. Additionally interviews with key contacts that have a history at the OHMS and experienced the lessons and the changes were also highly productive.

<u>Sub question two</u>

The policy instruments assessment was also a combination of documents scrutiny, conducting interviews and observations. However, since the OHMS has a quite restricted and predefined

[7] For a list of all interviewees see appendix C.

formal mission (which will be discussed in chapter 5), the U.S. Code Federal Regulations and official documents on how the OHMS is to execute its policy are for the most part significantly important for this analysis. The same holds for the highway mode. Observations were additional significant data source for the perspective of different civil servants.

Sub question three

Contexts are very important in social reality. That is why I used also document analysis as well as interviews and observations to collect the relevant data. Depending on the context the emphasis on a particular method would very. For instance, for the political and media context assessment it is more useful to ask key contacts that have information that is crucial but maybe not publicly available.

Sub question four

This sub question constitutes the basic pillar of the analysis and I used document analysis, interviews and observations. For the programmatic level strategic plans, mission statements and other official policy documents have been scrutinized and information that indicated the strategic position and plan the OHMS has and promulgates. Next to that several key contacts that could inform me on the OHMS's programmes and strategies have been interviewed. The same holds for the analysis of the more operational area of the programmatic level. For this I used policy documents on policy measures, programmes, projects and initiatives. Interviews were also of great importance to get an inside look at the operational perspectives and the way the OHMS actually tries to reduce risks on a day to day basis. The observations of multiple official meetings were of great additional meaning in the relative perspectives of some key contacts I interviewed related to the documents and reports.

Sub question five

Analyzing prior serious highway incidents required an in-depth scrutiny of the incidents. Some crucial questions were addressed in meetings which had significance to the understanding of the cause and background of serious incidents. Also some key questions, addressed to key contacts, were of great importance to get a better understanding of the backgrounds of serious incidents. However, the NTSB reports formed the basis for the analysis of the incidents level.

Sub question six and seven

Analyzing the relation between both levels as well as constituting recommendations required a profound and extensive analysis. These two sub questions resulted from the analysis of all prior sub questions combined. The analysis of the levels includes a discrepancy assessment of the indicators between the programmatic and the incidents level. This broad analysis is combined with the historic, policy instruments and contexts analysis. This has led to a conjunction of all (sub) analyses that constitutes a solid analysis in order to 'answer' the research question.

A basic notion that one should bare in mind at all times is that the methodological approach is hybrid and has an inductive as well as a deductive element. The inductive element is an extensive analysis of the OHMS policy (chapter 5), meaning collecting empirical data through interviews, document analyses and observation. The deductive element is the relation between the empirical data with the hybrid theory of Sagan (chapter 6).

4.6 Analysis and effectiveness

After the presentation of the empirical data, the core part of the research has resulted in the analysis of the safety management approach of the OHMS related to the two theoretical perspectives. Additionally the *effectiveness* of the OHMS safety management approach has been assessed. The effectiveness assessment was based on two 'legs'. First, the discrepancy between the safety objectives and policy of the OHMS and the outcomes of the safety policy in terms of safety measures (especially the incidents). The lower the degree of discrepancy, the more effective the OHMS is (or was). Second, the effectiveness of the OHMS will be assessed related to the theoretical notions of Sagan. The more similarities the OHMS case has with the rationales of both theories in terms of effectiveness, the more effective the OHMS is or was. For instance, if there is a high degree of redundancy of safety measures without interactive complexity the effectiveness from the perspective of the indicator of redundancy is relatively high. Or if there exists a strong organizational culture without significant incompatibilities with democratic-individualistic values, the OHMS 's effectiveness related to the indicator culture is also relatively high.

4.7 Concluding remarks

After our focus on the theoretical dimension of this thesis in the previous chapter we paid attention to the research methods and techniques. The indicators of both theoretical approaches have been translated into the OHMS context. The safety policy of the OHMS has been differentiated in a programmatic and an incidents level. Empirical data has been gathered that answer all supportive sub questions and contextual questions. The data has been related to the OHMS safety management with an emphasis on the main indicators of both theoretical elements. However, the data presentation is quite extensive, which is part of the hybrid (combined) methodological approach of induction and deduction. On the incidents level the cause of all incidents has been assessed and related to all indicators as well. The empirical data has been obtained via document analyses, interviews and observations, which give insights from different data sources on the same topics. Next to that there is also overlap in data sources since several key contacts were interviewed on the same topics as well. This way the reliability of the data has been covered to quite a large extent. The internal validity of the research has been covered by applying the hybrid approach in which the dependent variable (safety management approach) has been analyzed via the independent variables (i.e. all indicators of the theories). This integral method excludes intervening variables. More important and additionally, an extensive inductive approach on the safety management approach of the OHMS in chapter 5, covers the OHMS management safety approach as such. External validity of any social scientific research is problematic, even more so in the OHMS case considering all its specific and characteristic contexts. Since this research has no comparative element as well, a consolidation of a high external validity was not significantly relevant. After an assessment of the relations between both levels within the contexts that have been assessed earlier, an analysis on the safety management approach has been conducted in order to answer the research question and additionally assess the effectiveness of the OHMS safety management approach.

5. DATA PRESENTATION: A COMPLEX FRAMEWORK

In this chapter the empirical data will be put forward, crucial in order to conduct an analysis per sub question that collectively and consequently answers the research question but does not harm the description of the OHMS safety management as such. The empirical data is differentiated per sub question that corresponds to sequential paragraphs. After a description of the history (paragraph 5.1), the OHMS's policy instruments (paragraph 5.2) and the contexts (paragraph 5.3), the core of this chapter research is constituted by programmatic (paragraph 5.4) and the highway programme (paragraph 5.5). Afterwards an operational perspective (paragraph 5.6), policy measures on high consequence events (paragraph 5.7) and the incidents level (paragraph 5.7) will be put forward. Of importance is the notion that the data of the highway mode is presented separately. At occasion safety or policy measures are 'categorized' in preventive or responsive measures in order to make the data more clear and understandable. The description of the OHMS policy does not cover all safety measures extensively, however describes the vast majority of safety programmes and measures. Finally, some concluding remarks will be made.

5.1 History of the OHMS: A ripened programme

The OHMS has a rich history, but it had a different name or form. On a federal level, regulations on hazardous materials date back to the early 1900s. The programme was in control of the Bureau of Explosives, the Interstate Commerce Commission and finally of the DOT. The DOT has ten agencies and all if them consist of separate offices. The DOT was established by an act of the U.S. Congress on October 15, 1966, the Department's first official day of operation was April 1, 1967. By statute the Hazardous Materials Transportation Programme was established in 1974. The programme's objective was to identify and manage risks presented by transportation of hazardous materials in commerce[8]. The OHMS is sharing the Pipeline and Hazardous Materials Safety Administration (PHMSA) with the Office of Pipeline Safety. The PHMSA was created under the Norman Y. Mineta Research and Special Programs Improvement Act (P.L. 108-426) of 2004. U.S. President George W. Bush signed the legislation into law on November 30, 2004. The purpose of the Act was to provide the Department a more focused research organization and establish a separate operating administration for pipeline safety and hazardous materials

[8] Source: http://hazmat.dot.gov/riskmgmt/risk.htm

transportation safety operations[9]. So the professionalization and organizational formalization of procedures within the OHMS as a federal agency are quite recent in relation to the history of the regulations on hazardous materials transportation.
A crucial historic notion is the deregulation of transportation in the U.S. The U.S. federal deregulation of transportation began at the end of the 70s and the beginning of the 80s of the twentieth century. The Airlines in 1978 by means of the Airline Deregulation Act, the Railroads via the Stagger Rail Act of 1980, the Trucking Industry was largely deregulated with the promulgation of the Motor Carrier Act of 1980 and the Bus Industry was regulated with the enactment of the Bus Regulatory Reform Act of 1982 (Dempsey, 1988). These reforms took place during the Carter and the Reagan Administration and were the beginning of a new economic and administrative orientation of the DOT. This new orientation implied taking the industry (even more) serious and including them in the network of partner organizations. The OHMS oversees four modes of transportation, namely highway, railroad, aviation and vessel. This implies that all agencies significantly linked to these modes are included in the network of partners. Next to these main federal partners, the OHMS also meets with state and local authorities.

The events of September 11th 2001 were of high importance for the OHMS and meant a new wasy of thinking and dealing with risks of transporting hazardous materials. Next to safety as a big priority and core focus, now 'security' was added. This had implications for the safety measures, training, operational activities and other fundamental organizational and policy elements as we will see later.

Historically the regulations have been the keystone of the programme, recently an agency (i.e. the OHMS) was created to have a more professionalized programme. The industry has also been involved in several ways, but some new OHMS leaders have explicitly introduced (and reemphasized) a small set of approaches some years ago that could help the further professionalization of the OHMS and the hazardous materials programme.

5.2 Policy instruments: A monopoly and other tools

The policy instruments the OHMS possesses to reduce risks of hazardous materials transportation are quite diverse. The most important federal instrument the office has is the Hazardous Materials Regulations (HMR). The OHMS is authorized to write issue, modify and

[9] Source: http://www.phmsa.dot.gov/about/index.html

determine regulations (49 CFR Parts 100-185). This authority is derived from the Secretary of the DOT, who is authorized by the Federal Hazardous Materials Transportation Law 49 U.S.C. § 5101 et seq., (formerly the Hazardous Materials Transportation Act, 49 App. U.S.C. § 1801 et seq.). On this regulatory instrument the office has the monopoly making it a very interesting and severe instrument.

The OHMS utilizes several tools which are to a large extent related to the regulations for its programme. The most important tools obtained from the HMR are special permits, approvals, safety notices, letters of interpretation, public outreach, enforcement, training and emergency response. In paragraph 5.4 these safety programmes, measures and tools will be discussed elaborately. The policy instruments can be categorized in regulatory, financial, communicative and learning tools (Brikland, 2001). Evidently the fact that the OHMS can issue regulatory is a regulatory tool. Enforcement and the HMEP Grant Programme are the financial tools. Special permits and approvals, safety notices, letters of interpretation, public outreach, training and emergency response brochures are all forms of the communicative tools. Most of these instruments are quite abstract and imaginary, but as soon as they are linked to a programme or a specific safety measure they become practical and dynamic.

5.3 Contexts: Environments that matter

The contexts in which the OHMS operates are of great importance to understand its behaviour and their safety management approach. In this paragraph several notable contexts (i.e. political, public, administrative, industry, ideological, technological, international) will be sketched.

The U.S. political culture and political system are first of all an important context. The way political decisions are made and how their implications affect bureaucracies indicate the political culture in which the OHMS operates. The influence of big and visible incidents with fatalities, injuries mass evacuations and or economic damage gain political attention. Furthermore, the U.S. spoil system leads can lead to a discontinuity of the policy. This system encompasses the idea that whenever a new president is elected, the top layers (i.e. leaders) of all departments are exchanged. A very significant context is the administrative structure. This is closely linked to the political culture which is based on the pillars of decentralization of power, checks and balances in order to avoid accumulation of authority. In practice this implies that all the states have their own government, jurisdiction and administration but only particular issues that need to be standardized or harmonized across the whole country, are governed on the federal level, in this case the transportation of hazardous materials. The OHMS often uses themes to address their importance as an office in the budgeting process. These themes are mainly based on new approaches, programmes or projects. In the U.S. political culture however, too much (and stringent) regulations do not appeal to the public and the private sector in general and the (transportation) industry in particular.

Next to the political context, the public perception of risk and hazardous materials is of great importance for the OHMS. The public perception influences the political decisions which have its affect on budgets and regulatory issues. Moreover, the impact of highly visible big incidents in the media has a big political impact. An interesting example is that in 2007 an ethanol mixed bio fuel tank exploded in Baltimore. This has a big impact on the public perception of hazardous materials transportation and its risk in general. Additionally bio fuel is a political hot item in 2007 and commercially very interesting. Incidents like these can be or become arguments for opponents of bio fuel to reduce of get rid of bio fuel transportations or bio fuel as a whole. This example indicates how public perception and the influence of the mass media also affect the OHMS safety policy and measures.

The OHMS as a bureaucracy is quite ramified and fragmented in terms of formalities, tasks, specialties and authorities. This makes the contact and communication between all offices somewhat difficult. Also within the DOT, there are several agencies that work closely with the OHMS. The most important ones are PSA and their modal sister agencies (i.e. the Federal Aviation Administration (FAA), the Federal Railroad Administration (FRA), the Federal Motor Carrier Safety Administration (FMCSA) but also the United States Coast Guard (USCG). There are inter-modal meetings and multimodal seminars that can harmonize cross sectional policy domains to isolate spill over effects. Next to the internal DOT partners there are quite some federal, state and local partners that work with the OHMS. Mainly the Department of Defence, Department of Energy, Department of Justice, the U.S. Nuclear Regulatory Commission, the Environmental Protection Agency, National Aeronautics and Space Administration and the Department of Homeland Security and equivalent state departments are important public partners, indicate the broad network and institutional environment of the OHMS.

The industry also plays a vital role in the OHMS policy. Most hazardous materials transportation via highway is carried out by private companies. The main focus of the HMR and the OHMS programme is on hazardous materials transportation for commercial means. This makes the inclusion in the safety management of the OHMS important, which is reflected in the enterprise approach as we will see later. Related to the regulations, there is a mutual interest between the industry and the OHMS as a federal agency. Even though regulations and safety measures can cost time and money for companies, the reduction of incidents and risks is also in their interest with regard to their public relations or product safety. Related to this is the dynamics of the hazardous materials market. Depending on demand and supply of hazardous materials on the world market, OHMS programmes can change. A good example is the increase of the demand of alternative fuel (ethanol) which also is politically hot in 2007. In 2007 some fire-fighters were not able to put out an ethanol fire with a certain type of foam in Baltimore. After the accident and an assessment, an emphasis was put on training emergency response personnel for this (new) type of hazard.

Perhaps most underestimated but crucial context to understand to 'OHMS behaviour' is the ideological context of the OHMS. The OHMS serves in a sense as a 'service' for the industry. Since the regulations of the transportation of hazardous materials must ensure safety as well as a security and improve the U.S. economy, this indicates the ideology that exist latent in the OHMS programme. The role of the industry in the U.S. in general is crucial in a free capitalistic system. Transporting hazardous materials defined as commodities for all sorts of end products for world markets, is perhaps the best example of this. Increasing safety in this context always is related with considering the economic costs of regulations, initiatives and programmes for the industry.

The transportation system in the U.S. is characterized by quite some technical and technology aspects. In the highway system these factors have influence on the safety measures, which we will see from an operational perspective. Also the hazardous materials packaging and the construction of e.g. cargo tanks for instance have implications on the technical but also the personnel safety measures. The OHMS deals with a highly technical and detailed policy field, since chemical substances need to be understood inside out by OHMS policy makers. The large number of engineers at the OHMS indicates this very well.

A final important and influential context is the internationalized world of hazardous materials regulations. A fine example is that the U.S. and many other countries have developed a Globally Harmonized System for the Classification and Labelling of Chemicals (GHS). The GHS is the culmination of more than a decade of work. A United Nations Economic and Social Council Subcommittee adopted the Globally Harmonized System for Classification and Labelling recommended that it these standards were to be disseminated throughout the world. The intention is twofold, namely enhancing public health and environmental protection as well as reducing trade barriers (i.e. enhancing a level playing field for the hazardous materials industry). This is indicative for the ambiguity of regulations or programmes for hazardous materials transportations. This international harmonization also impacts the U.S. situation. Within the U.S., key federal agencies that are related to the regulations and international affairs have formed an interagency committee coordinated by the Department of State. Besides the DOT's PHMSA, other agencies which participate in the effort including the Consumer Product Safety Commission, Department of Commerce, Food and Drug Administration, Environmental Protection Agency, Occupational Safety and Health Administration, Office of the U.S. Trade Representative, Department of Agriculture, and National Institute of Environmental Health Sciences. The interagency committee and individual agencies have also solicited the participation of key private sector groups, companies and trade associations, worker representatives, health and safety professionals, and environmental and public interest groups[10].

Some of these contexts do also hold for high consequence events with even more intensity, especially the political and media context, which makes serious incidents publicly known and put them on the public and political agenda. This has implications for the regulations and consequently for all the OHMS and FMCSA programmes, which consequently has impact on the organizational configuration. All these consequences also affect the industry.

5.4 Programmatic level: The OHMS case

The OHMS is differentiated in several offices that all have their specific function. This differentiation reflects the diversity of policy instruments and safety measures the OHMS utilizes.

5.4.1 Regulations: The OHMS keystone

The HMR form the basic pillar of the overall OHMS's safety programme. The purpose of the Federal Hazardous Materials Transportation Law is to provide adequate protection against the risks to life and property inherent in transporting hazardous materials in commerce by improving the regulatory and enforcement authority of the Secretary of Transportation.

[10] Source: http://hazmat.dot.gov/regs/intl/globharm.htm

The hazardous materials regulations have changed significantly over the last several years. These changes were first introduced in Docket HM-181 which provided for the harmonization of the United States' HMR with international standards in order to facilitate foreign trade and maintain the competitiveness of U.S. goods. The applicability of the HMR was extended to all intrastate shipments of hazardous materials by highway effective October 1, 1998, as published in the final rule, Docket HM-200 dated January 8, 1997. This final rule also provided exceptions for 'materials of trade', 'agricultural operations' and certain non-specification packaging used in commerce[11].

The HMR are divided into several segments (see appendix E). These regulations result in strategic programmes of the OHMS. Each mode has its own specific regulations, related to the transportation system characteristics. The regulations are divided in four special areas[12]:

- Hazardous materials identification and classification;
- Hazard communication; [Shipping papers, markings, labels, and placards are used to communicate hazards of the materials to emergency responders, as well as, to those who handle hazardous materials routinely];
- Packaging requirements;
- Operational rules.

All these regulatory areas are reflected in the safety programmes of the OHMS. The OHMS also issues letters of interpretations (clarifications) of the HMR and rulemakings and federal registers notices. This way the HMR are clarified, sine the HMR can be quite complex and formal and therefore sometimes difficult to understand for some people.

5.4.2 Priorities: Safety and ambiguities

The priorities of political and organizational leaders are outlined in this sub paragraph. The U.S. President G.W. Bush stated in his speech on the Transportation Act on August 10th, 2005 in Montgomery, Illinois, the following:

> '(…) and that's why I'm proud to be here to sign this transportation bill, because our economy depends on us having the most efficient, reliable transportation system in the world. If we want people working in America, we've got to make sure our highways and roads are modern. We've got to bring up this transportation system into the 21st century. (…) This road system that we have is going to be modernized through the Transportation Equity Act. It provides more than $286

[11] Source: http://www.fmcsa.dot.gov/safety-security/hazmat/complyhmregs.htm#appendixc

[12] Document: 'How to use HMR 2002', US DOT, Research and Special Prorgams Administration.

> billion over six years to upgrade our nation's network of roads and bridges and mass transit systems. The Transportation Act will finance needed road improvements, and will ease traffic congestion in communities all across this country. (…) this bill is going to help modernize the highway system and improve quality of life for a lot of people. And these projects will require workers. This bill upgrades our transportation infrastructure, and it will help save lives. The bill establishes a safety belt incentive grant program, which will provide incentives for states to adopt laws that increase seat belt usage. Under this bill, the National Highway Traffic Safety Administration will set stability standards to help prevent vehicle rollovers. In other words, this is more than just a highway bill; it's a safety bill. The American people expect us to provide them with the safest possible transportation system, and this bill helps fulfil that obligation. This law makes our highways and mass transit systems safer and better, and it will help more people find work. And it accomplishes goals in a fiscally responsible way. We are not raising gasoline taxes in order to pay for this bill.'

This quote gives a good indication of the priorities of a major U.S. political leader. The transportation network is of crucial importance for U.S. commerce and employment, next to that safety is of importance. Commerce (and the private sector in general) is a cornerstone of the U.S. society. The economy (e.g. entrepreneurship, monetary and political economic issues) is a major priority for the U.S., which is also indicated by these quotes:

> 'We've got an entrepreneurial spirit that is infectious and strong, and alive and well. We are the best place to do business in the entire globe[13].'

> 'I think you can tell that I believe free trade is necessary for economic development, that free trade is essential to prosperity[14].'

Next to this priority in the field of transportation there is a combination of safety and commerce, which are intertwined in goals, objectives, missions and strategies in the DOT in general. Let us take a look at the priorities of the DOT and its leaders.

The subtitle of the DOT's Strategic Plan 2003-2008 is called 'Safer, Simpler, Smarter Transportation Solutions'. The Secretary at that time (Norman Y. Mineta) stated that the plan provides a blueprint for achieving the DOT's strategic objectives in safety, mobility, global

[13] Source: President Discusses Economic Stimulus with National Association of Manufacturers, Office of the Press Secretary, October 31, 2001, Washington D.C., US.

[14] Source: President's Remarks at CEO Summit Closing Session, Office of the Press Secretary November 20, 2004 Santiago, Chile.

connectivity, environmental stewardship and security, the Department's top priorities. He also uttered to keep the travelling public safe, increase their mobility and ensure that the transportation system enables the U.S. economic growth and development[15].

Maria Coni, the acting Secretary of the DOT in the DOT Strategic Plan 2006-2011 in September 2006, stated that: 'President George W. Bush and I recognize that transportation improves our quality of life and fuels the engine of economic growth. (…) Although the economy is robust and jobs are being created, this growth cannot be sustained without a safe, reliable and efficient transportation system. We start this journey by reaffirming our commitment to improved transportation safety — the Department's premier goal. This Strategic Plan describes how we will target our safety initiatives to improve safety levels and take advantage of technological advances.' Next to this priority a set of strategic goals is presented in the strategic plan which has implications for all DOT agencies, administrations and offices. In November 2006 the Transportation, Research and Technology Strategic Plan 2006-2010 also articulated the set of DOT's strategic and organizational goals: safety; reduce congestion; global connectivity; environmental stewardship; security, preparedness and response; and organizational excellence. These goals are explained as: '(1) safety to enhance public health and safety by working toward the elimination of transportation-related deaths and injuries; (2) reduce congestion and other impediments to using the U.S. transportation system; (3) facilitate an international transportation system that promotes economic growth and development; (4) promote transportation solutions that enhance communities and protect the natural and built environment; (5) balance transportation security requirements with the safety, mobility, and economic needs of the U.S. and be prepared to respond to emergencies that affect the viability of the transportation sector; and (6) advance the Department's ability to manage for results and achieve the goals of the President's Management.' This set of strategic of goals is also adopted by the DOT Information Resource Management Plan 2006-20011. On November 15th of 2006 the Secretary of the DOT (Mary E. Peters) formulated her priorities: 'My top priorities at DOT are to keep the travelling public safe and secure, increase their mobility, and have our transportation system contribute to the Nation's economic growth[16].'

The DOT website promulgates the mission of the department, which is: 'Serve the United States by ensuring a fast, safe, efficient, accessible and convenient transportation system that meets our

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[15] Source: The US DOT's Strategic Plan 2003-2008.

[16] Source: Performance and Accountability Report 2006. United States of Transportation.

vital national interests and enhances the quality of life of the American people, today and into the future[17].' If we go even deeper into the organization and focus on the strategic goals of PHMSA and OHMS we see the following. The Strategic Plan for PHMSA 2007-2011 states that it is their mission to 'protect people and the environment from the risks inherent in transportation of hazardous materials by pipeline and other modes of transportation. We are above all, a safety agency, but in carrying out our mission we also play an important role in helping to ensure the reliability of the system the American public depends on[18].' The OHMS website formulates their mission as: 'to promulgate a national safety programme that will minimize the risks to life and property inherent in commercial transportation of hazardous materials[19].' This looks quite direct, but a good indication of the dual mission of the OHMS is stated in their risk management programme: (…) 'A further challenge is to strike a proper balance between levels of safety and costs that result from regulations, special permits, and approvals[20].'

A good example of the operational complexity of the political ambiguous goals of the DOT and the OHMS is that after a hazardous materials accident, the DOT strongly emphasizes on reducing congestion. This might have implications for emergency response personnel.

5.4.2 Strategic approaches: Introducing and reemphasizing rationality and integrality

On a more strategic level there are multiple programmes that aim at reducing or minimizing the risks. There are also several strategic programmes that are described as 'approaches', which indicate a certain way of thinking. The most important approaches are the performance based approach, data-driven approach, risk-based approach, the enterprise approach and the safety integrity approach. Most approaches and terminologies were introduced in 2004-2005 by new organizational leaders. Prior to this, to some extent the same approaches were used, but less explicit promoted and prioritized.

The hazardous materials safety programme has a history of prescriptive regulations. A gradual development towards performance based regulations is perhaps the biggest shift in the OHMS management philosophy. The regulations traditionally prescribe the shippers and carriers often to adhere to (strict) protocols or rules. The aim of the performance based approach on the other hand is to let the regulations be less encumbered for the industry by requiring that hazardous

[17] Source: Website DOT: http://www.dot.gov/mission.htm

[18] Source: PHMSA policy document: 'A Strategic Plan for Pipeline and Hazardous Materials Safety (2007-2011).

[19] Source: Website OHMS: http://hazmat.dot.gov/contact/about.htm

[20] Source: Website OHMS: http://hazmat.dot.gov/riskmgmt/risk.htm

materials should be transported *safely* from point A to point B. However, penalties or fines for non-compliance are higher for performance based than for prescriptive based regulations. Basic requirements (often less technical) of prescriptive regulations often focus on: (1) performance; (2) standards for performance; (3) compliance (e.g. documentation) and; (4) enforcement implications (penalties).

The data-driven approach is an abstract and a practical concept simultaneously and an umbrella term for most programmatic approaches. This approach encompasses the idea that in essence all decisions related to risk should be based on data. This data should be the source for decisions, which implies that the data collection process should be structured rationally. The OHMS tries to obtain as much validated data of high quality as possible on prior incidents, risks, from multiple sources such as the industry and lower-level authorities, incident reports and various databases. In the appendixes F and G, information charts are inserted that indicate the rationality of this data-driven approach.

Another important strategic approach in order to prioritize the allocation of resources, personnel and efforts is the risk-based approach. This approach is based on the thought that through risk analyses the highest risks and their consequences should have more priority than lower risk issues. There are two dimensions in this context: the dimension of the probability of the risk as such and the dimension of the consequence of the risk. There are four basic categories to be made.

Figure 5.1 Quadrants of risk priorities

		Consequences of risk	
		High	Low
Probability of risk	High	A	B
	Low	C	D

Quadrants A and C are the main concern and are the priority of the OHMS. These risks are assessed through analyses and the data that is needed for these assessments are a good indication of the data-driven approach and the relation of the strategic approaches.

A good example of the data-driven approach is the root-cause-analysis which aims at reducing risks by focussing on the root cause of incidents. To generate methods to improve the availability and quality of hazardous materials transportation, incident data are of the essence in this analysis. Also the identification of gaps and redundancies in reporting requirements and providing an estimate of the under-reporting of serious incidents are part of the objective of this analysis[21]. Every five years the OHMS conducts an evaluation on data that is collected and assessed which agencies or organizations should be engaged for data sharing. Also the involvement and assistance of industrial parties to supply the OHMS with important data is intertwined.

Another important approach is the enterprise approach, which to some extent can be compared to the spirit of the Dutch *polder-model*, which experienced its heydays in the 1980s and 1990s but has a rich history. In the OHMS context the same philosophy is used, which embraces the premise of inclusion of parties that have an overlap of interests to find common ground and consequently make agreements for next steps. The enterprise approach from the OHMS perspective mainly is the inclusion of industrial parties. The inclusion of other federal agencies or non-private organizations (e.g. the FRA, the FMCSA, the NTSB, the Chemical Safety Board (CSB) in the decision-making process is not new for the OHMS as well as involving the industry. But since a few years ago, when new organizational leaders introduced and reemphasized this set of approaches, the industry has been involved even more in the decision-making process. The U.S. Administrators Procedures Act forbids any federal agency to be engaged with individual parties in the rule making process. So before the rulemaking stage all kinds of stakeholders are invited to define the problems and solutions. Important is to get the right people to the table. Recently the OHMS is more pro-active in this selection process. Previously, the OHMS was not reaching out to state and local officials efficiently. Also the emergency response community (e.g. volunteer fire-fighters, fire chiefs, paid fire-fighters, police officers, emergency medical personnel) is now involved more.

A perfect example of this enterprise approach is the Loading and Unloading project. This project is a result of risk analyses which stated that a third to a half of the overall risk (probability) of serious incidents in hazardous materials transportation[22]. There are several gaps within the set of

[21] Source: OHMS policy document: 'Hazardous Materials Transportation Incident Data for Root Cause Analysis', 2006.

[22] Source: OHMS policy document: 'A summary Evaluation of Risk Associated with Bulk Loading/Unloading of Hazmat', March 2007.

data for the L-UL programme. The most important features of the L-UL programme can be found in appendix H. Since the focus of the OHMS is mostly on hazardous materials transportation in commerce, industrial partners are of crucial importance to be involved to meet the goals of the OHMS to minimize the risks of hazardous materials transportation. Next to industrial partners other federal agencies and independent organizations are part of the 'enterprise'. A workshop has been arranged to address the problem and find suggestions for possible solutions. Finding consensus on the problem was to large extent no issue and the intentions of all parties at the workshop mostly were to find common ground to tackle the 'problem'. On a more operational level, this approach involves the idea of sharing of e.g. data, information, thoughts, suggestions for possible solutions and best practices. This can be linked to the data-driven approach and the risk-based approach, since the importance of data for risk analyses and decision-making is essential. Another good example of the enterprise approach in combination with the data-driven approach is the recent initiative to select and manipulate data more easily via an electronic system (Oracle Business Tools). The technologic development has helped the facilitation of data sharing with the emergency response community to learn from prior incidents. The aim of the OHMS leaders is to professionalize the OHMS in a way that every single person at the office should be (partly) a data analyst. This data management idea aims at simplifying the data system and making it more transparent in order to address the problems more easily, which should result in self corrective actions of emergency response and companies as well.

An even more recent (2007) initiative is the safety integrity approach, which in essence is a system approach on the transportation of hazardous materials. Al sub systems and parts of the system are assessed on their risk. Private partners need to voluntary agree with this. The purpose of this approach is to let the companies think for themselves about safety and take their responsibility. A good example or case of this system approach is the cargo-tank roll stability study (which will be discussed later in this chapter).

An interesting fact is that the OHMS faces great underreporting rates of hazardous materials incidents. In 2005 nine fatal incidents were found in the media and other information sources, which was 75% more than was reported to the OHMS. An important notion is that the incidents that are reported to the OHMS might represent only 10-40% of all incidents that are actually occurring. This implies that the OHMS is missing from 60% (26,000 incidents/year) to 90% (151,000 incidents/year). Appendix I shows some additional information of the gravitas of this issue. The OHMS database registers about 17,000 incidents/year[23]. In 2007 there has been a great focus on tackling this problem. Sometimes the cause is that lawyers, defending the companies, argue that the data is sensitive since an employee can sue its employer for negligence.

Finally, The Risk Management Self-Evaluation Framework (RMSEF) can be identified as a strategic way of thinking namely to let organizations also assess risks on their own, see appendix N.

All the approaches are interrelated. An interesting link is that the enterprise approach enables the OHMS to acquire more and better data, which improves the risk-based approach and analyses.

5.4.3 Safety programmes and measures: Pillars of hazardous materials safety

In this sub paragraph the major programmes of the OHMS will be discussed. They often are derived from the HMR and sometimes (more recently) intertwined with and based on the strategic approaches. I have assessed and categorized six major programmes: the Special Permits and Approvals Programme, the enforcement programme, the emergency response programme, the training programme, the risk management programme and the outreach programme.

<u>Special Permits and Approvals Programme</u>

The Special Permits and Approvals (SP&A) programme dates back from the HMR in the early 1900s. A Special Permit or Approval is a document which authorizes a person to perform a function that is not currently authorized under the authority of the HMR. The main difference between a special permit and an approval is the fact that an approval document can only be issued if there is a specific approval cite in the regulations i.e., approved by the Associate Administrator for Hazardous Materials Safety. If there is no approval cite, one must apply for a special permit[24]. The issuance is based on a certain level of safety which is assessed in the process after the application of public and private organizations. If an applicant wishes to obtain a special permit or a modification of a special permit he is required to provide requested information, which is determined regulatory. Indicative information is a detailed description of the applicant, the shipment plan, packaging and safety measures for probable and relevant risks. For approvals these requirements are more related to the HMR. There are several exemplary programmes that are part of the approvals programme, which are lighters, fireworks and cylinders. The most

[23] Source: policy report on underreporting 'Estimating the Extent of Under-reporting of Hazmat Incidents', May 2007.

[24] Source: website hazmat: http://hazmat.dot.gov/sp_app/approvals/exsys.htm

important notion is that special permits as well as approvals will be issued only if there exists compliance with the HMR or if the Office of Hazardous Materials Special Permits and Approvals decides there is sufficient reason to believe a special permit can be issued, depending on the fact whether an applicant does or does not meet the criteria. Interesting is the recent focus on user fees. Hazardous materials transportation companies pay fee for their activities and the higher the risks and probable consequences, the more fees the company should pay. The baseline is that the applicant is most important for the SP&A programme. Depending on their input and necessities the process and issuance is determined. The SP&A office receives about 10-15 new applications per month.

After the Value Jet Crash in 1996, more emphasis was put on oxygen generators. Also lithium batteries and new technologies are recent focuses. It is important that Special Permits allow new technology to enter the market before it is incorporated in the HMR (e.g. fibre glass cylinders). Interestingly, the Department of Defence (DOD) is an important and big partner, because the DOD uses commercial carriers which fall under the authority of the OHMS. Periodically Special Permits are reviewed and are sometimes included in the HMR (e.g. the packaging of the oxygen generator). All modes are also included in the process of scrutinizing and evaluating the application. Sometimes a mode even drafts the permit (e.g. FRA), but the OHMS always issues it, for consistency sake. A quite recent programme of the OHMS's SP&A programme is the UN cylinders' programme which is included in the HMR, indicating a quite direct interaction with the international standards. Also all special permits are published on the OHMS website, which makes the information on special permits rather transparent.

There is a major inconvenience the programme is facing. Sharing information is difficult, especially with the modes, since the data sharing system is not harmonized, even though there is an inter-modal portal. The modal agencies do not have the same system as the SP&A, which is a technical 'weakness'. Within the OHMS the data systems are not integrated fully as well. There are for instance incidents report system, the enforcement system and the registration system. Also the enforcement system which also includes the modes is not harmonized. This can lead to a lack of important information sharing, which leads to a sub optimal efficiency of the data sharing within the OHMS and the DOT on a whole.

The Enforcement Programme

A second vital part of the OHMS safety policy is the enforcement programme. It is the task of PHMSA's inspection and enforcement staff to determine compliance with safety and training standards by inspecting entities that offer hazardous materials for transportation; and that manufacture, requalify, rebuild, repair, recondition, or (re) test packaging (other than cargo tanks and tank cars) used to transport hazardous materials. The Office of Hazardous Materials Enforcement of the OHMS also enforces the following requirements: (1) to have valid authority when operating under a DOT special permit or approval; (2) to be registered with PHMSA as a shipper or carrier of hazardous materials; and (3) to submit a telephonic and/or written report (DOT Form 5800.1) following the unintentional release of hazardous materials in transportation[25]. Penalties are differentiated in civil ('knowingly violating regulations') and criminal penalties ('wilful violating regulations'). A civil penalty could cost from 250 dollar per violation to 27,500 dollar violation per day. A criminal penalty can be 500,000 dollar and five years imprisonment at the maximum. All these standards and penalties are stated clearly in the HMR as well as the penalty assessment criteria. Important and interesting criteria are: extent and gravity of violation, degree of respondent's culpability, respondent's history of prior violations, respondent's ability to pay and the effect of penalty on respondent's ability to stay in business[26]. The enforcement personnel assess and investigate the compliance and optionally a penalty is the result of an investigation. Sometimes cases end up at the court, indicating the sometimes harsh side of the enforcement programme. In 2003, three investigators in California have even been shot by a company owner, because he believed the government came too close. So next to e.g. intern-personal communication, investigation techniques, questioning, photography, note-taking, investigators are also trained on self-defence by national field coordinators.

The focus of the enforcement has always been on high risks, but since 2006 this has been more formalized resulting in a New National Business Strategy (NNBS) in 2007. This is a risk-based enforcement plan which is the basis for prioritization, since there are few resources (i.e. across the U.S. there are 'only' about 40 investigators in 2007). A good example is that all companies, shippers and carriers that were involved in incidents on 2004, 2005 and 2006 were charted and number one priority were entities that were on the 2004, 2005 and 2006 lists, number two priority were entities that only were on 2 lists and the number three priority were the ones on only one list. The focus is based on frequency of non or low level compliance. There are also a great

[25] Source: http://hazmat.dot.gov/enforce/hmenforce.htm

[26]Source: Document: 'An Overview of the Federal Hazardous Materials Transportation Law (Federal hazmat law)'.

number of questions asked to assess the level of compliance to check, so the assessment is quite nuanced and in-depth. Investigations however cost a lot of time. There are five regions in the U.S. and each region chief develops an own list, because there are different risks per region (e.g. more nurse tanks in the Midwest, more propane in the north than in the south). Another example is that the most hazardous material (N204 also used for activating space shuttles) is made in Pittsburg (Missisippi) and the frequency of the departure of space shuttles across the U.S. has impact on the transportation of N204 in that area.

Risk analyses are very important for enforcement, risks with a focus on e.g. quantity, form, exposure, route, mode of hazardous materials and transportation. The recent focus on the formalization and standardization of enforcement is rather different than the prior approach. In the past, inspections and investigations were based on complaints and because investigators simply have not been to an area for over e.g. one year. The data that is needed for the lists and risk analyses is not always shared optimally with other nodal agencies which can be described as miscommunication and sub optimal data sharing with modal partners. There are even cases when OHMS enforcement personnel stop by at a company which was already inspected by a modal agency several months earlier. There is a discrepancy in depth of the analysis of the OHMS enforcement and the modal agency enforcement personnel. The enforcement personnel of modal sister agencies is also not as specialized as the OHMS enforcement office. There are formal agreements, but in practice the enforcement programmes are not integrated very well. This miscommunication has direct implications for the budgets as well, since the budget is performance based (on quantity not quality). Nevertheless there are also joint inspections conducted (when OHMS and modal agencies together to also learn from each other). Enforcement also works with several federal and state partners next to the modal partners.

The Compliance Partnership Review Programme (CRV) is a programme with a focus on a broader in-depth analysis, observations and cooperative follow-up investigations with stakeholders, which is quite recent. This way the entire transportation process is included and leads to an alternative for penalization. Before 2005 there was mainly a focus on enforcement, not this alternative approach. The mindset has shifted from defence to offence, which is supported by higher level leaders. The enforcement office includes recommendations in all their reports, which are addressed to the appropriate OHMS office and consequently closes the loop of the backside of the programme.

The Training Programme

At the creation of the Hazardous Materials Safety Programme in 1973, the training programme also started. This programme was quite stable till the mid 1980s, which put clear and direct emphasis on training and led to a substantial growth till the early 1990s. In the 1990s the growth became less significant. In 2000, field staffs were added which are called Hazardous Materials Safety Teams (HMST's). These major shifts were mainly caused by the dynamic character of political agenda's. When a new president is elected, the administration also changes. The HMST's were responsible for training 14.000 hazardous materials employees in 2006 and responsible for several millions of brochures a year. The HMTS's visit associations, States, local governments and Local Emergency Response Committees (LEPC's), which are local committees that have quite some influence in the local emergency response plans. The HMTS's subsequently assess the local needs. Uniformity is reached by including all partners (e.g. by multi-modal sessions). Organizations that offer training on hazardous materials (e.g. the International Association of Fire Fighters) are the pillar of the training programme. The employees of hazardous materials transportation companies are responsible for sufficient and constant (i.e. every 90 days) training of their personnel. The OHMS training programme often ´fill the gaps' by taking the top 10 -15 of the enforcement list of priorities.

The OHMS defines training as a means a systematic programme (i.e. consistent approach, testing, and documentation) that ensures that a hazardous materials employee has knowledge of hazardous materials and the HMR, and can perform assigned hazardous materials functions properly[27]. The HMR have two major pillars in the context of training: basic requirements and common-sense reminders. The basic requirements are focused on:

- *Training*. The OHMS offers free trainings throughout the year which result in certifications of attendees[28].
- *Classification and identification of hazardous materials.* All hazardous materials all categorized and have specific characteristics which are of crucial importance if one transports hazardous materials. A hazardous materials table enlist all these details, which is of crucial importance for carriers and enforcement personnel in determining compliance with the regulations**.** For each entry, a table specifies the proper shipping name, hazard class or division, identification number, packing group, required hazard

[27] Source: website OHMS: http://hazmat.dot.gov/training/training.htm

[28] See appendix L for a more elaborate description of the training requirements.

warning labels, packaging authorizations, per-package quantity limitations for passenger and cargo aircraft, and special provisions.

- *Protective packaging.* The packaging required for a hazardous material is rather important in ensuring that the material is not released during transportation. An inadequately packaged hazardous material may not be offered for transportation, accepted or transported according to the HMR. The HMR state that different hazardous materials should have different packaging requirements, depending on their hazard.
- *Hazard communication*. Essential elements of hazard warning information are required to be communicated through shipping documents, package markings and labels, placards on transport vehicles and bulk packagings, written emergency response information, and emergency response telephone numbers to be used in the event of an emergency involving the hazardous material. Also the `shipper's certification' is a positive endorsement that the shipper is required to provide when tendering a shipment of hazardous materials to a carrier for transportation. The person signing the certification must be trained in appropriate areas of the HMR as appropriate to the shipment.
- *Incident reporting and modal-specific requirements*. The HMR require carriers to report incidents involving hazardous materials. These incident reports are maintained by PHMSA in its automated Hazardous Materials Information System (HMIS) database. PHMSA uses this information to identify problems, such as inadequate or improper packagings; operational problems occurring during loading, unloading, or handling of packages; and inadequate blocking, bracing, or securing of packages within transport vehicles, freight containers, and cargo holds. When potentially serious problems are detected, regulatory or enforcement actions may be initiated. Furthermore, there are modal-specific rules, such as quantity limitation requirements for transportation by passenger aircraft.

There are some common sense-reminders which mainly aim at:

- Knowing the customer, the hazardous material and the quantity;
- Packaging, which is targeted at the question: Is each hazardous material packaged in an authorized packaging that conforms to a DOT specification or United Nations standard, or other packaging authorization of the HMR?
- Proper hazardous materials description.

  Most important questions in this context are: Does the shipping description used match the proper shipping name, hazard class or division, identification number, and packing group listed in the Hazardous Materials Table? Is there a conflict between the documentation and the package marking? Is there an emergency response telephone number on the shipping paper? Does emergency response information accompany the shipping paper? Is the shipper's certification entered on the shipping paper?

- Visually inspecting shipments
  Is there damage to a package that makes it unsuitable for transportation? Are hazardous materials warning labels clearly visible? Is the transport vehicle, freight container, or bulk packaging properly marked and placarded?
- Reporting HMR violations.
  The OHMS has a toll-free telephone number which is intended to communicate (suspicion of) violations of HMR. Consequently relevant and appropriate action will be conducted.

The OHMS training office offers all companies a training package to provide them basic information on training and let them know the DOT also assesses the level of compliance, one could say as a 'hint'. Since it is almost impossible to chart whether all hazardous materials personnel are trained, the training office (consisting of 17 people of which 5 HMTS heads in the safety regions) works closely with the industry to produce guidelines. An example of a guideline (in 2006-2007) is to improve the quality of instructors by letting companies know how they can evaluate whether a private consultant is skilful enough as a training instructor (by looking at their experience and enjoyed trainings). Federal agencies or companies have their own training programme, for instance the Department of Energy or the Federal Bureau of Investigation (which do disposal or take hazardous materials to their lab). Even though in the training programme there is more emphasis on materials like radioactive materials and ethanol, there is no specific programme or separate focus on high consequence events or hazardous materials. On the OHMS website questions and comments can be addressed with regard to training information. This measure is created to have feedback from hazardous materials employers or employees.

In July 2002, PHMSA hosted a strategic planning workshop to better understand state and local hazardous materials transportation community training and education needs and to explore methods to better meet these needs. Participants included representatives from the FMCSA, the FRA and the USCG along with other public sector partners, enforcement, emergency response personnel and representatives from major public and private sector associations. There was a general consensus that there is a continued need for PHMSA to provide hazardous materials outreach and training to state and local government organizations. Specifically, it was recommended that PHMSA:

- Get out to the 'Grass Roots' - take hazardous materials transportation training out to ten Federal regions;
- Use state and local expertise to identify and recommend training to be offered;
- Develop training resources using various media;
- Establish a method to share these training resources;
- Partner with other agencies and organizations to provide or share information and training.

In support of the DOT and PHMSA, the Transportation Safety Institute (TSI) Hazardous Materials Division trains federal, state and local enforcement agencies, emergency response personnel and industry (shippers, carriers, manufacturers). The TSI offers all sorts of hazardous materials regulation classes and seminars that cover all modes of domestic and international transportation. Students are instructed on regulations of 49 CFR for the transportation of hazardous materials by air, rail, highway and water. The TSI also offers specialized regulation classes on dealing with awareness for initial response to hazardous material incidents, transportation of hazardous materials and recurrent training, hazardous wastes and substances, cargo tanks, portable tanks, intermediate bulk containers, cylinders, United Nations performance-oriented packaging , instructor training, radioactive materials, explosives, and the military airlift of hazardous materials[29].

Finally, there exists a separate format which shares information on hazardous materials transportation safety and security issues, identify training needs, and to capitalize PHMSA resources to meet state and local government education needs is. To achieve this, PHMSA is working in cooperation with state and local government representatives to co-sponsor regional or state-wide workshops.

The Emergency Response Programme

For the emergency response dimension in the regulations (derived from the Emergency Planning and Community Right-to-Know Act of 1986), non-federal agencies and partners are of crucial importance. The Hazardous Materials Emergency Preparedness (HMEP) Grant Programme is intended to provide financial and technical assistance as well as national direction and guidance

[29] http://www.tsi.dot.gov/divisions/hazmat/hazmat.aspx

to enhance state, territorial, tribal, and local hazardous materials emergency planning and training. The HMEP Grant Programme distributes fees collected from shippers and carriers of hazardous materials to emergency responders for hazardous materials training and to LEPC's for hazardous materials planning[30]. This programme provides financial and technical assistance to local emergency responders and development of guidance documents. The HMEP grants programme allows states to design their own emergency response plans, depending on the specific needs and characteristics of for example transportation frequency, density of chemical plants. The states offer their annually plan to federal agencies and if the plan complies with the requirements of the grants, the states are eligible to receive the grants. Further background facts on the HMEP Grants Programme can be found in appendix L.

Since 1973 the Emergency Response Guidebook (ERG) has been published every 2 or 3 years. The ERG is primarily a guide to assist first responders in the activities of (1) quickly identifying the specific or generic classification of the involved materials and (2) protecting themselves and the general public during the incident response phase[31]. In 1986, Mexican and Canadian agencies were involved in the production of the ERG, in order to increase economic development and growth between the countries. The ERG consists of three important steps:

1. Identifying the material;
2. Looking up the material's (3-digit) guide number;
3. Look up what to do according to the ERG.

The ERG is quite practical since all steps are divided by coloured pages. Other indications of the practicality are the lists with all relevant telephone numbers and guidelines about potential hazards, public safety and emergency response as well as the statement that one should approach the incident from upwind[32]. There is an increase of publication numbers of the guidebook, since two million copies were published of the 2004 version, whereas in the past the maximum was one million copies. However, because of a lack of financial means not all emergency responders (5 or 6 million people) have this book. Anticipations and solutions were the digitalization of the guidebook and having one copy on fire trucks, which is used by multiple people. The ERG is translated in all kinds of languages and is used across the world, since the UN references are used. The OHMS also sits on a group (the National Fire Protection Agency) ands helps defining

[30] Source: website OHMS: http://hazmat.dot.gov/training/state/hmep/hmep.htm

[31] http://www.fmcsa.dot.gov/safety-security/hazmat/2004-emergency-response-guidebook.htm

[32] 2004 Emergency Response Guidebook 2004

the different levels of training for hazardous materials teams. The training programme is in this way quite formalized and standardized. For training requirements of specialized hazardous materials teams and for low risk areas there are agreements with high risk localities that respond in case of an accident.

In the case of an accident the first responders are the 'locals' (i.e. law enforcement, local fire department and the emergency medical teams). The coordination of a hazardous materials accident depends on the state law, sometimes the fire chief is in charge or the state police. Also state highway officials can be relevant that maybe responds to a hazardous spill by throwing sand on it. The secondary line consists of the more large scale entities, such as the International Association of Fire Commanders, the International Association of Fire Marshalls and state emergency response authorities. If the scale of an accident is enormous the National Response Teams (NRT) are in charge, where military personnel can be called to assist. Important at the site is that the information on the paper of the truck driver is available and completed, which is the responsibility of the employee. The hazardous material should also be communicated very clearly with placards and corresponding codes.

All states have their own protocols, which is often delegated to the local authorities. This again indicates the local responsibility of emergency response. The OHMS has relatively little direct authority on emergency response.

<u>The Risk Management Programme</u>

A fifth crucial programme of the OHMS is risk management. The risk management programme is quite differentiated in e.g. modes, hazardous materials, manufacturers, shippers and carriers. Through multiple risk analyses all sorts of risks are being assessed, identified and consequently being used as data for (re)allocating resources to meet the OHMS goals. This risk management programme consists of multiple programmes which all have different aims.

The first programme is the Hazardous Materials Transporting Security Programme (HMS Programme). This programme is chiefly the result of the attacks of September the 11th 2001. All sorts of parties were involved since 2002 (e.g. National Tank Truck Carriers, the industry and other DOT agencies). The U.S. DOT Research and Special Programs Administration (RSPA) concluded in 2003 that the most significant security risks involve the transportation of certain radioactive materials, certain explosives, materials that are poisonous by inhalation, certain infectious and toxic substances, and bulk shipments of materials such as flammable and compressed gases, flammable liquids, flammable solids, and corrosives. Based on this security risk assessment, the HM–232 final rule requires persons who offer for transportation or transport certain hazardous materials, to develop and implement security plans[33].

Second, the OHMS issued a Risk Management Self-Evaluation Framework on security (see appendix M). Also multiple notices were placed on the OHMS website with information on security measures on e.g. placards, farmers, ranchers and production agricultural operations and toxic inhalation hazards. Certain risks were identified and communicated to the public. This framework is for security as well as for safety assessments. This framework was produced, because parties involved in transporting hazardous materials are subject to extensive federal regulation and without imposing significant new regulatory burdens and costs on the hazardous materials transport community this initiative was a 'voluntary measure'[34]. The philosophy underlying the framework is action informed by analyses. Analyses of risks, costs, benefits, technical feasibility, and other items are necessary within a system as complicated as hazardous materials transport. However, analyses are not the last stop. Analyses provide the information needed for decision-making and planning but do not by themselves reduce risks. Risks are reduced by actions, and therefore action – informed by analyses – is the intention of this risk management programme. Analyses should be driven by the need for information to feed into decision-making about what actions, if any, are appropriate. As all risk management programmes, there are seven pillar principles: commitment, culture, partnership, prioritization, action, continuous improvement and communication (see appendix O).

The third programme is risk comparison, which identifies risks of several phenomena (see appendix P). Not only the risk of fatalities of motor vehicles and fires, but also the risks of hazardous materials transportation are included (which is 4.2 deaths per 100 million hazardous materials shipments).

The risk management process is an important part and indicator of the risk management programme as well[35]. There are some selected hazardous materials transportation risk analyses or risk management information analyses. Four major analyses of these risk analyses have been conducted. These are the relation between commodity flow and the

[33] Part IV Department of Transportation Research and Special Programs Administration 49 CFR Part 107, et al. Hazardous Materials: Enhancing Hazardous Materials Transportation Security; Interim Final Rule, May 5th 2003.

[34] 'Risk Management Framework for Hazardous Materials Transportation', November 2000.

[35] See appendix Q.

transportation of hazardous materials[36], a risk/benefit-cost analysis on the prohibition of hazardous materials in external piping of cargo tank motor vehicles[37], a comparative risk analysis on hazardous materials and non-hazardous materials truck shipment accidents/incidents[38] and an analysis on the process of ports when petitioned to issue a permit for transportation and loading or unloading of commercial explosives through U.S. ports[39]. All these risk analyses have a specific focus and objective.

There is a set of risk management tools that is used for the analyses. There are four important tools:

- The Automated Resource for Chemical Hazard Incident Evaluation (or ARCHIE). It allows the quick prediction of hazard zones surrounding the release of flammable, explosive, or toxic materials.
- CAMEO. The CAMEO system integrates a chemical database and a method to manage the data, an air dispersion model, and a mapping capability.
- ALOHA or Areal Locations of Hazardous Atmospheres, is an atmospheric dispersion model used for evaluating releases of hazardous chemical vapours.
- MARPLOT or Mapping Applications for Response, Planning, and Local Operational Tasks, is the mapping application[40].

CAMEO, ALOHA and MARPLOT are software tools that support the risk analyses programme significantly. Also the risk management programme has a feedback system, which is the same concept as the training feedback system.

The final big programme is the Department-wide Programme Evaluation of the Hazardous Materials Transportation Programs (HMPE). In March, 2000 a 'ONE-DOT team' from the Office of Inspector General, the USCG, the FAA, the FMCSA, the FRA, and the PHMSA completed a DOT-wide evaluation. The programme evaluation had two broad objectives. Objective I was to document current hazardous materials movements. Objective II was to assess the effectiveness of

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[36] 2002 Economic Census *Transportation* 2002 Commodity Flow Survey, US DOT and US DOC., December 2004.

[37] Risk/benefit-cost analysis on the prohibition of hazardous materials in external piping of cargo tank motor vehicles, January 1999.

[38] Comparative Risks of Hazardous Materials and Non-Hazardous Materials Truck Shipment Accidents/Incidents, prepared by Batelle for FMCSA, March 2001.

[39] Inter-modal Explosives Working Group Report, U.S. DOT, February 2003.

[40] Source: http://hazmat.dot.gov/riskmgmt/tools/risk_tools.htm

DOT's overall hazardous materials programme as it affects each step in the hazardous materials transportation process. The team found that DOT's hazardous materials programme works reasonably well, but needs to be improved through DOT-wide strategic planning and programme coordination, more focused delivery, and better data[41]. This report is an important evaluation on the performance of all hazardous materials DOT agencies. Interestingly enough, this thorough evaluative analysis is only conducted once.

The Outreach Programme

Finally, public outreach (awareness) is important[42]. This is crucial for the ‘soft line’ and more sophisticated approach of the enforcement office. The general public is being informed (i.e. educated) by experts or documentation (e.g. brochures, folders, video’s, presentations[43]) on transporting hazardous materials. The behaviour of the public and people that deal with hazardous materials is intended to be changed, again aiming at reducing the risks. Additionally, all sorts of questions about the HMR can be addressed to a small group of experts of the HMR in the OHMS office and they answer all incoming calls. This indicates very well the emphasis on the communicative aspects of the OHMS safety programme.

Concluding remarks

The OHMS utilizes a broad set of programmes to meet their objectives. These programmes have all different ‘sub objectives’ and personnel per programme are highly specialized on their programme. There are ‘hard line‘ programmes (i.e. enforcement and special permits and approvals). A crucial programme that ‘feed’ the orientation of the programmes is the risk management programme. The training and emergency response programmes are major pillars that give operational personnel specific tools which are vital for their daily work. Finally, the outreach programme is a more ‘soft line’ programme that tries to inform and educate the public and relevant people on the risks of hazardous materials. These six programmes are the pillars that the OHMS relies on in its search for (more) safety.

[41] Source: http://hazmat.dot.gov/riskmgmt/hmpe.htm

[42] For an indication of the broad focus on awareness see appendix J.

[43] See appendix AB.

5.5 Highway Programme: Hazardous materials on the highway

In his paragraph the strategic approaches, the safety programmes and measures of the highway programme will be presented as a case for the OHMS safety policy.

The enforcement of the HMR for highway has been under the authority of the Office of Motor Carriers, which was a sub agency under the Federal Highway Administration (FHWA). Under the Motor Carrier Safety Improvement Act of 1999 branched this sub agency of the FHWA and the FMCSA was born in on January 1, 2000, because the U.S. Congress decided that there should be more separated focus on the vehicles, not only on the U.S. infrastructure. However, the tasks have not changed. Mainly for management sake, the enforcement of the HMR per mode has been decentralized (hence the modal agencies). Inter-modal meetings and multimodal seminars yields uniformity among the modes when necessary. When there is an enforcement issue, the FMCSA feeds back to the OHMS in order to evaluate and maybe modify regulatory, training, emergency response programmes. Within the FMCSA a particular part of the personnel is more specialized on hazardous materials. When international regulations are included in the HMR, these are automatically part of the highway enforcement and programmes. The hazardous materials safety highway programme is closely linked with the OHMS hazardous materials safety programme. The FMCSA in essence enforces the HMR, however sometimes there is a good reason to go beyond the scoop of the HMR. A good example is the post-9/11 period, when there was more focus on the security aspects. The most important regulations that are specifically meant for the highway mode can be seen in appendix R.

5.5.1 Strategic approaches: Paradoxes within and between

The mission of the FMCSA is to reduce crashes, injuries, and fatalities involving large trucks and buses[44]. This mission is not the same as the mission of the OHMS and does not include hazardous materials explicitly. Evidently, there is some relation with the OHMS, which is indicated by the HMR parts 385 (Safety Fitness Procedures), part 386 (Rules of Practice for Motor Carrier, Broker, Freight Forwarder, and Hazardous Materials Proceeding), part 390 (General) and part 397 (Transportation of Hazardous Materials; Driving and Parking Rules)[45]. The FMCSA promotes a strategy based on four pillars:

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[44] Source: Website FMCSA: http://www.fmcsa.dot.gov/about/aboutus.htm

[45] Source: Website FMCSA: http://www.fmcsa.dot.gov/rules-regulations/administration/fmcsr/fmcsrguide.asp?section_type=H

- Develop and enforce data-driven regulations that balance motor carrier (truck and bus companies) safety with industry efficiency;
- Harness safety information systems to focus on higher risk carriers in enforcing the safety regulations;
- Target educational messages to carriers, commercial drivers, and the public; and
- Partner with stakeholders including federal, state, and local enforcement agencies, the motor carrier industry, safety groups, and organized labour on efforts to reduce bus and truck-related crashes[46].

On June 2nd in 2003 on a Highway Safety Leadership Forum, Ms. Sandberg stated that: 'FMCSA is a data-driven organization. (…) We base our safety programme decisions on information to ensure the most effective use of our limited resources[47].' This is repeated by Ms. Sandberg on July 15th 2003 by stating: 'we need an unbroken chain of reliable data. We need a quality control programme that is realistic and works at every level from the enforcement officer who collects the information to the people who manage the data and store it, to the people who use it in analyses in support of decision-making[48].' This strategy results in a set of 'key programmes' the FMCSA carries out[49]:

- Border and International Safety
- Commercial Driver's License Program
- COMPASS
- Enterprise Architecture and FMCSA
- Federal Motor Carrier Safety Regulations (FMCSR)
- Hazardous Materials Regulations (HMR)
- Household Goods Program
- Medical Program
- Motor Carrier Safety Assistance Programme (MCSAP)
- Motor Carrier Safety Identification and Information Systems
- New Entrant Safety Assurance Process
- Performance & Registration Information Systems Management (PRISM)

[46] Source: website FMCSA: http://www.fmcsa.dot.gov/about/what-we-do/strategy/strategy.htm

[47] Source: Transcript of speech - Highway Safety Leadership Forum Lexington, KY **June 2, 2003.**

[48] Source: 29th International Forum on Traffic Records & Highway Information Systems
July 15, 2003 Annette M. Sandberg Acting Administrator, Federal Motor Carrier Safety Administration

[49] Source: website FMCSA: http://www.fmcsa.dot.gov/about/what-we-do/keyprograms/keyprograms.htm#program2
See appendix S for the description of all FMCSA programmes.

- Research and Analysis (R&A)
- Safety Education and Outreach

Note that the hazardous materials programme is on of the fourteen key programmes of the FMCSA.

Some quotes[50] of the administrator of the FMCSA John H. Hill March 2007 additionally indicate the priorities of the FMCSA. 'At FMCSA safety is our number one priority and is a daunting challenge. (…) We will increase our effectiveness and efficiency; and we will leverage the talents and resources of our state partners, as well as those of our stakeholders from the trucking and motor coach industries, and the many committed safety advocate organizations through our newly chartered advisory committees, the Motor Carrier Safety Advisory Committee and the Commercial Driver's License Advisory Committee.' Next to the focus on safety and including lower level governments and partners another priority of the FMCSA is '(…) optimizing our organizational structure to increase efficiency and give the American taxpayers the biggest safety increase possible for their investment in FMCSA. (…) FMCSA is also contributing to the DOT-led National Strategy to Reduce Congestion on America's Transportation Network - a national congestion relief initiative.' Next to this there is a significant overlapped set of priorities of the DOT strategic goals. On a higher political level President Bush and the FMCSA committed themselves to 'foster the safest, most secure national transportation system possible, even as they seek to enhance mobility, reduce congestion, and expand the U.S. economy.' Ms. Sandberg on July 2003 also stated that 'next to safety, SAFETEA (The Safe, Accountable, Flexible and Efficient Transportation Equity Act of 2003) will make U.S. transportation safe and secure, and will make our economy more efficient and productive.' A final indication of the priorities of the FMCSA is Ms Sandberg stating that 'while today we're focused primarily on safety, getting the economy moving has always been, and remains, a top priority for the President and his entire team', on March 2004[51].

[50] Source: http://www.fmcsa.dot.gov/about/news/testimony/tst-032907.htm

[51] Source: Annette M. Sandberg Administrator Federal Motor Carrier Safety Administration to the Truckload Carriers Association Annual Convention Waikoloa, Hawaii March 5, 2004.

5.5.2 Safety programmes and measures: Pillars of a sister agency

The FMCSA utilizes several programmes which often are closely related to the programmes of the OHMS. These programmes are the cargo tank safety programme, the risk assessments and analyses programme, the safety permits programme, the hazardous materials security programme, the incident (spill) and reporting programme, the training and education programme, the compliance review programme and the MCA programme.

The Cargo Tank Safety Programme

This programme can be described as a serious focus on several risks related to the transportation of hazardous materials with cargo tanks. After a NTSB report of 1992, recommendations were postulated to improve the safety measures and devices for rollover accidents. In 1998 a report was published for the FMCSA on rollovers and rollover-protection devices. Rollover accidents were often related to a high speed of a cargo tank in a turn[52]. In 2002 and 2004 check reports were published in which the status of all inspections and investigations of those periods in relation to cargo tanks. The 2002 report assessed a neutral and a quite positive safety trend relative to 2001. The 2004 report is more mixed about the findings. These reports and assessments indicate that there is a significant focus on the cargo tanks that transport hazardous materials.

The Risk Assessments and Analyses Programme

The FMCSA conducts risk analyses to assess the risks that are to be reduced to allocate their (scarce) resources. A good indication of such an analysis is the 2003 Hazardous Materials Serious Crash Analysis. This analysis had three aims: (1) to enhance the current methodology for identifying and characterizing serious hazardous material truck crashes in the U.S.; (2) to improve capability to analyze causes and effects of selected serious hazardous materials crashes; and (3) to support the implementation of hazardous materials truck transportation risk reduction strategies for packages, vehicles, and drivers[53]. As already stated in the OHMS risk management programme, the 2001 Batelle report on comparative risks of hazardous materials and non-hazardous materials of truck shipments accident/incidents, are also published for the FMCSA.

[52] The Dynamics of Tank-Vehicle Rollover and the Implications for Rollover-Protection Devices, Prepared by The University of Michigan Transportation Research Institute for FMCSA, US DOT, November 1998.

[53] Source: ‘Hazardous Materials Serious Crash Analysis’, FMCSA, February 2003.

<u>The Safety Permits Programme</u>

On January 1, 2005, the FMCSA began to phase in the Federal Hazardous Materials Safety Permit Programme for intrastate and foreign motor carriers transporting certain types and amounts of hazardous materials. These carriers had to maintain a certain level of safety in their operations and certify they have programs in place as required by the Hazardous Materials Regulations and the hazardous materials permit regulations. The U.S. Congress directed the FMCSA to implement the permit programme to produce safety and security benefits. The FMCSA estimated that the rule prevents seven hazardous materials truck-related crashes per year, saving approximately $3.6 million annually.[54]. Especially explosives, toxicant inhalation, liquefied natural gas and radioactive materials have higher risks, which leads to the requirement of safety permits. The applicant needs to provide the FMCSA with a list of detailed personal information and specific information related to transportation and the hazardous material. Compliance for these hazardous materials is much more stringent. An interesting aspect in this programme is the fact that a small number of U.S. States (called the 'Alliance'[55]) since May 1993 have been working together to hazardous materials registration and permitting by fostering uniformity of hazardous materials transportation through a 'single state process'. This implies that the coalition collects all fees and distributes them as appropriate to the participating states.

<u>Hazardous Materials Security Programme</u>

The OHMS and the FMCSA work closely together in the field of security and hazardous materials transportation. An operational test was introduced by the FMCSA to assess the vulnerabilities and risks of the transportation of hazardous materials[56]. This programme included follow-up requirements and evaluations. Several technologic security measures were introduces (see appendix U). This security approach was totally new, since the legislative and regulatory context was new (security plan requirements: 49 CFR subpart I, and 172, 800). Right after September 11th of 2001, the DOT took the lead on security of hazardous materials but the Department of Homeland Security has gradually took over some tasks making the FMCSA security programme more supportive than before. The FMCSA stimulates companies and organizations that transport significant quantities of hazardous materials to develop an effective security plan. This security plan should involve a security assessment identifying relevant threats and vulnerabilities. Prioritization of risks is of importance to avoid unnecessary security-related

[54] http://www.fmcsa.dot.gov/safety-security/hazmat/hm-brochure.htm

[55] The Alliance consists of the states: Illinois, Ohio, Michigan, Minnesota, Nevada and West Virginia.

[56] For the checklist of the operational testing see appendix T.

expenses. Training and awareness is also important. The security plan is being verified and updated if necessary[57]. A final security measure is the set of outreach brochures and publications in the context and with the purpose of increasing awareness. First, industry outreach with an emphasis on e.g. transporting agricultural and food commodities, driver and company anti-terrorism tips and suspicious letters of packages. Second, there exists enforcement outreach for inspectors with an emphasis on e.g. assessing suspicious elements and characteristics during inspections and identifying and interdicting threats. Third, driver outreach which is mainly aimed at preventing and dealing with a hijacking[58].

<u>Incidents (spills) Reporting and Prevention Programme</u>

The incidents (spills) reporting part of this programme is the operational equivalent of the incident reporting programme of the OHMS. There are regulatory requirements for an incident report. To have a clear indication what these requirements are, see appendix V. When a hazardous material has spilled, a hazardous materials employee, employer or if one is involved in an incident, he or she should notify the DOT by letter or telephone. Under certain criteria telephonic immediate notification is required. Some of these criteria are when: a person is killed or hospitalized, property damage exceeds $50,000, an evacuation of the general public occurs lasting one or more hours, one or more major transportation arteries and facilities are closed or shut down[59].

The prevention part of this programme is based on the 1995 hazardous materials incident guide. This manual states that it presents countermeasures which may be used to reduce the number of hazardous materials incidents. It includes guides and tips to help employees and safety managers formulate strategies appropriate to their company circumstances which will lead to improved hazardous materials safety. The manual is intended to complement the Commercial Vehicle Preventable Accident Manual already in use by DOT safety specialists to assist carrier companies improve their safety performance[60]. The manual consist of six chapters that reflect parts of the transportation process or safety measures: loading/unloading equipment, loading/unloading inspections, incident mitigation by shipper, load/unloading equipment maintenance, routing and scheduling policy and hazardous materials employees training. For instance the chapter on

[57] Source: Guide to Developing. An Effective Security Plan for the Highway Transportation of Hazardous Materials, developed by Batelle and Total Security U.S. for FMCSA, DOT, October 2003.

[58] Source: http://www.fmcsa.dot.gov/safety-security/security/index.asp

[59] Source: http://www.fmcsa.dot.gov/safety-security/hazmat/ihmir.htm

[60] Hazardous Materials Incident Prevention Manual, constituted by several public and private organizations, July 1995

incident mitigation by shipper includes objectives, descriptions and tips for managers with regard to emergency response guidelines. All these aspects are specified for shippers, carriers and receivers.

Training and education

Training, education and awareness are of crucial importance for the FMCSA as well as for the OHMS. Most of the training programme is related to the OHMS training programme. Nevertheless, there are separate (FMCSA) parts of this programme. The Hazardous General Awareness Module consists of nine training volumes and with quite comprehensible tips and pictures[61]. However it is clearly stated that the module is for general information and training purposes only. The module titles can be found in appendix W. For the training and education programme PHMSA has an important relation with the TSI (see paragraph 5.4.3). Similar to the OHMS safety approach, communication is very important, which is indicated by the documents on the FMCSA website on elaborate explanations and clarifications on the HMR, specific for highway.

Field inspectors are also trained (approximately 12.000 officers a year) to recognized hazardous materials, sometimes specialized in cargo tanks. The Commercial Vehicle Safety Alliance (CVSA) has provided more training on how to inspect vehicles, which is a component of the (broader) commercial vehicle safety plan. Grants are issued to the CVSA. Uniform training on the programmatic level (not shippers, carriers and emergency response personnel) to states and the FMCSA field staffs is provided by the National Training Centre.

However, there are some gaps in the training system because of a lack of knowledge of hazardous materials personnel about changes of training requirements or a lack of financial means of companies to ensure sufficient training lead to sub optimal training.

The Compliance Review Programme

The compliance review programme of hazardous materials and shippers is the enforcement equivalent of the OHMS. These are on site reviews of compliance of companies. If there is a significant reason to believe that a certain company is not complying fully or consistently,

[61] Hazardous Materials General Awareness Training Module: English, http://www.fmcsa.dot.gov/safety-security/hazmat/hmawareeng.htm

because of e.g. bad incidents and/or accidents records, this company is being reviewed. Additional criteria are problems with papers, mislabelling or bad packaging which happens with a certain frequency. This results in a national list of non-compliant companies which is revised and updated with new data.

MCA Programme

The final FMCSA programme is a grant programme for the OHMS highway programme, the Motor Carrier Assistance Programme (MCA Programme). If a state meets the requirements of the MCA Programme it is eligible and receives the fund that is to be used for training and emergency response. There are more than half a dozen federal public partners (e.g. Department of Defence, Department of Energy, Department of Justice, the U.S. Nuclear Regulatory Commission, the Environmental Protection Agency, National Aeronautics and Space Administration, the Department of Homeland Security) that are related to the issue of hazardous materials transportation, next to the majority of private companies. The FMCSA works with all equivalent state agencies and departments on hazardous materials programmes on prevention and response. If the shipper is 'government owned', there is less compliance needed since they already are a public organization. If the shipper has a private contract or a public agency is outsourcing the transportation of hazardous materials, they must fully comply.

Concluding remarks

The programmes of the FMCSA are in essence the highway programme of the OHMS. There are some equivalent programmes with the OHMS programmes, namely risk analyses training and education, compliance review and the MCA programme. However, the safety permit programmes of the OHMS and the FMCSA have different meanings and goals. The Cargo Tank Safety and the Incident Spill Reporting Programme are specifically for the highway programme designed. Also the Security Programme is more specified on the highway mode, since they are 'closest at hand'. The OHMS is not a modal agency, making the differentiation and expertise of the modes highly important.

5.6 The operational perspective: The daily reality for shippers, carriers and emergency response personnel

Next to the FMCSA's safety programme, it is of significance to include the perspective and the context of the industry and the operators. These operators are the truck drivers themselves dealing with the hazardous materials almost every day. The companies, carriers work for, are closely involved in the HMR as well as the day to day operations of the hazardous materials transportation. In this paragraph the focus is on what companies do on a day to day basis to reduce the risks of associated with the transportation of hazardous materials.

First of all, it is not a shock that private shippers of hazardous materials behave in the same way all private companies do in order to make profit. Even though this is the case, there is some overlap with a priority on safety. Most companies want their employers to be safe, the communities they drive through and the products they ship to be safe. This is the self-interest of a company. For the most part companies do not have contact with the OHMS or the FMCSA on a daily basis. On the whole contact exist via bigger (umbrella) organizations (often trade organizations) that serves the interest of the highway trucks (e.g. that the National Tank Truck Carriers). Most companies see the OHMS and the FMCSA as the 'DOT', even though they are different agencies.

The data-driven approach of the OHMS has implications for companies, because they are asked for incident data statistics. The L-UL programme is the first time companies are explicitly involved in the decision-making process of the OHMS and the FMCSA (in the DOT hazardous materials transportation safety policy in general). A problem the OHMS as well as the FMCSA face is underreporting. A majority is reported to the employees, but the basic 'problem' is that employers calculate the costs and benefits of the consequence of reporting and then decide whether they can get away with it[62].

The largest companies (a minority) have their own training programme. This way the training module is specified to the specific needs and context of the truck drivers and the hazardous materials (e.g. Schneider National or Trimac). The training module is (and must be) in compliance with the HMR, which implies a focus on all hazardous materials operations (e.g. loading, transporting, unloading, awareness, placarding, emergency response). This is checked

[62] For some factual information on the issue of underreporting, see appendix H.

by field inspectors of the enforcement programmes of the OHMS and the FMCSA. Sometimes an experienced and a new truck driver work together for several weeks in order to teach the new driver for instance the 'driving defensively concept'. This concept is based on the idea that the truck driver should be prepared for the worst things that can happen while driving. The security measures (next to safety) are incorporated by the private companies, in which often terminal managers and dispatchers are included.

Important aspects from the operational perspective are technical safety measures or devices. These are not (yet) included in the regulations, however some companies use them. The FMCSA in 2007 is trying to chart the possibilities and options regarding these measures. There are two 'popular' modern technical safety measures (developed and sold by companies such as Bendix): (1) the Roll-Over Stability Device (ROSD), which depresses the engine when extreme events happen like a sudden brake, and (2) the Lane Departure Warning System (LDWN) which sensors if a truck moves across the road markers, which lead to a signal on which the truck driver can anticipate. Another (potential) safety device is the 'Drive Cam', which is a camera that is able to record the inside and outside of the truck only when suddenly brakes are hit or the wheels are drifting. This device is not (yet) in use by highway trucks that transport hazardous materials, mainly because it is more intended for busses, trains or ambulances, in which the public context is more significant. By this I mean that (especially in the U.S.) this system is of great use in a court when a driver is being sued. However this device can also be of use for training and disciplining and moreover safety purposes for the truck drivers.

For training, simulations are being planned by LEPC's. After they have planned a scenario, a trucking company is involved (the selection is often based on companies they have incident experience with). Even though all possible scenarios are trained in an ideal world, sometimes a truck tire blows up or a trucker falls asleep. One could say that everything is covered in the scenario's that is within 'the span of control'. These LEPS's often also do outreach at terminals. An example of awareness is the initiative (i.e. producing and distributing a brochure) to inform emergency response personnel about the risks of wetlines. Wetlines are product piping located beneath a cargo tank, used for bottom loading of gasoline or other petroleum products. These wetlines are designed to load and unload the material more easily and safely and break off if they are struck by another vehicle.

Companies that operate across the U.S. often have contracts with third parties for emergency response (e.g. the IAFF). When an accident or incident occurs, local emergency authorities, a company representative and the shipper are being connected on one telephone line. This way contact can be made quickly with emergency response personnel.

The people that deal with hazardous materials in their everyday lives do not consider big philosophies of different safety management approaches the OHMS does think about, but are closely linked to all approaches as well as the programmes for the transportation of hazardous materials on the highway.

5.7 High consequence events: A higher threshold

We have seen a large set of safety approaches, programmes and measures of the OHMS and the FMCSA. For the reduction of the risks of high consequence events, there are several of these initiatives of relevance. In essence all approaches, programmes and safety measures are of relevance for high consequence risks. The HMR state that hazardous materials with higher risks and consequences have a higher threshold. Through risk analyses the highest risks are charted and translated in the enforcement, special permits, training and emergency response programmes. So data for risk analyses is vital for preventing high consequence events. There is a differentiation per type and per mode of the highest risks which mainly are roll-overs of cargo tanks, air plan crashes, lithium batteries in airplanes, air packaging. The release of large quantities of chemicals (especially chlorine) on the railroad system is a high risk which is being monitored with a railroad safe and security tracking system for routing of chlorine. There are 27 factors in this system, of which one is the shortening of the time of transit. Also tank cars themselves are being analyzed via e.g. technical assessment on the impact, energy absorption. Risks and consequences of high consequence events are assessed and translated into all programmes into their particular 'language', implying a significantly higher standard.

5.8 Incidents level: Unwelcome events

In this paragraph six cases (incidents) will be described, which consequently will be analyzed and related to the theories in the next chapter. Before I describe the incidents themselves let us take a look at some statistical and background information. There exists a process flow chart, which indicates very well on what moment which contacts should be informed. For this chart, see appendix F. A very important notion to bare in mind before we look at some incidents data is that the definition of 'serious incidents' has been changed from 1993. The new definition used by the PMHSA was introduced in 2002. Initially (1993), a serious incident was defined as 'one resulting in one or more fatalities or major injuries, closure of a major artery or facility, a vehicle crash or derailment, or an evacuation'. The new definition of a serious incident is:

- 'A fatality or major injury caused by the release of a hazardous material;
- The evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire;
- A release or exposure to fire which results in the closure of a major transportation artery;
- The alteration of an aircraft flight plan or operation;
- The release of radioactive materials from Type B packaging;
- The release of over 11.9 gallons or 88.2 pounds of a severe marine pollutant; or
- The release of a bulk quantity (over 119 gallons or 882 pounds) of a hazardous material[63].'

In appendixes Y, Z and AA there are some background statistics which give a good indication on the number of hazardous materials incidents as well as serious incidents, which are related to the high consequence events I focus on. There are some interesting numbers there which will be discussed in the next chapter. When a serious highway incident occurs, the appropriate state prepares an incident report. When this incident is very serious, the FMCSA requires an investigation of the state. This initiates a review of the operation and the practices. If we look at the historic record of the actual transportation of hazardous materials in the U.S. in total, we see no big jumps other than the one in 2000, which is very obscure (see appendix X). This data is an important footnote for the assessment of the OHMS overall effectiveness.

As already stated the incidents reports I used are produced by the NTSB. The NTSB is an independent federal agency charged by the U.S. Congress with investigating every civil aviation accident in the United States and significant accidents in the other modes of transportation - railroad, highway, marine and pipeline- and issuing safety recommendations aimed at preventing future accidents[64]. This implies that the NTSB is not an unfamiliar organization for PHMSA. However, recommendations do not always fit within the budget and ambitions of the OHMS at a particular point in time.

[63] Source: 'Serious Incident Definition', OHMS, October 1, 2000. - http://hazmat.dot.gov/pubs/inc/serious_incident_new_def.pdf

[64] http://www.ntsb.gov/Abt_NTSB/history.htm

Even though not all incidents have been reported equally extensive, the context, safety issues and especially the probable causes are included in the descriptions of the incidents. In all reports, the NTSB have made recommendations for the OHMS and other DOT agencies, other federal authorities, involved companies, emergency response teams and other parties. Since the focus in this research is on the causes and their relation with the programmatic level as such, these recommendations are not included in the incidents level.

Incident 1.

On October 9, 1997, about 12:10 a.m., a 1994 Mack truck tractor pulling a 1994 Fruehauf MC 306 cargo tank semi trailer was heading south on Central Park Avenue in Yonkers, New York. The truck, which was loaded with 8,800 gallons of gasoline, was just going under an overpass of the New York State Thruway (thruway) when it was struck by a southbound 1990 Eagle Premier sedan. The car hit the right side of the cargo tank in the area of the tank's external/loading unloading lines (loading lines), releasing the gasoline they contained. The ensuing fire destroyed both vehicles and the overpass of the thruway; the thruway remained closed for approximately 6 months. The driver of the car was killed; the driver of the truck was not injured. Property damage was estimated at $7 million. At the time of the accident, the weather was clear and dry with no overcast.

In its investigation, the NTSB identified as a safety issue the danger of operating a truck when its cargo tank's loading lines are carrying hazardous materials. The NTSB concluded after the investigation that the car driver would have survived the accident had there not been a fire. Furthermore, the car struck and fractured one or more of the loading lines of the cargo tank, thus releasing up to 28 gallons of gasoline. Third, if the loading lines been empty, the fire would likely not have occurred. Fourth, when the truck driver made his U-turn, he could not have seen the car. Fifth, the truck driver's use of cocaine did not cause or contribute to the accident. Sixth, the car driver's actions were inappropriate and caused the accident. The last conclusion was that transporting hazardous materials in loading lines creates a hazardous condition. The NTSB also assessed three related probable causes for the incident. First of all, the failure of the car to stop for the red light; (2) to reduce his speed or: (3) apply his brakes soon enough to avoid the collision.

But contributing to the severity of the accident was the fire resulting from the release of gasoline that the cargo tank's loading lines were carrying, as permitted by the U.S. DOT[65].

Incident two

About 5:14 a.m., eastern daylight time, on June 29, 1998, at Stock Island, Key West, Florida, a Dion Oil Company (Dion) driver was on top of a straight-truck cargo tank checking the contents of its compartments and preparing to transfer cargo from a semi trailer cargo tank when explosive vapours ignited within the straight-truck cargo tank. The ignition caused an explosion that threw the driver from the top of the truck. The fire and a series of at least three explosions injured the driver and destroyed the straight truck, a tractor, the front of the semi trailer, and a second nearby straight-truck cargo tank. Damage was estimated at more than $185,000.

As a result of its investigation of the accident, the NTSB identified three major safety issues. Firstly, the adequacy of Dion's product-transfer procedures and training was a important issue, Secondly, the adequacy of the FAA (at that time the authorized agency for enforcement of HMR for highway) oversight of motor carriers' procedures and training for loading and unloading hazardous materials. Another safety issue was the adequacy of Florida's oversight of the fire safety of storage tanks. The NTSB determined that the probable cause of the accident was Dion's lack of adequate procedures and driver training, resulting in the driver's pouring a mixture of gasoline and diesel fuel from a plastic bucket into a cargo-tank compartment that contained a mixture of explosive vapours[66].

Incident 3

About 3:30 a.m. on June 4, 1999, a Quality Carriers, Inc., truck driver arrived at the Whitehall Leather Company1 tannery in Whitehall, Michigan, to deliver a load of sodium hydrosulfide solution. The truck driver had never been to the plant before. The shift supervisor expected the hazardous materials to be ferrous sulphate, there was no verification. During the transfer sodium hydrosulphide and ferrous sulphate were mixed (which is a poisonous gas). About 4 a.m., an employee in the basement of the tannery building smelled a pungent odour and lost consciousness. The employee said that after regaining consciousness about 10 minutes later, he made his way out of the tannery to an area adjacent to the south parking lot, where he found

[65] NTSB report, Highway/Hazardous Materials Accidents Summary Report. Collosion of Tractor/Cargo Tank Semitrailer and Passenger Vehicle and Subsequent Fire, New York, October 9, 1997.

[66] NTSB report. Hazardous Materials Accidents Report. Fire and Explosion of Highway Cargo Tanks, Stock Island Key West, Florida, June 29, 1998.

other employees on break. One of these employees called 911. The property Damage has been assessed on a the amount of over $411,000.

The NTSB determined that the probable cause of this accident was the failure of Whitehall Leather Company to have adequate unloading procedures, practices, and management controls in place to ensure the safe delivery of chemicals to storage tanks. Contributing to the accident was the failure of the U.S. DOT to establish, and oversee compliance with, adequate safety requirements for unloading hazardous materials from highway cargo tanks[67].

Incident 4

About 2:15 p.m., central daylight time, on May 1, 2001, a northbound tractor, in combination with a semi trailer that had horizontally mounted cylinders filled with compressed hydrogen, which is a flammable gas, struck a northbound pickup truck that had veered in front of the tractor-semi trailer on U.S. Highway 75, 2 miles south of Ramona, Oklahoma. According to witnesses, the tractor-semi trailer then went out of control and overturned while continuing along the highway. It went off the road to the east and travelled 300 more feet before it stopped. During the process, some of the cylinders, valves, piping, and fittings at the rear of the semi trailer were damaged and released hydrogen. The hydrogen ignited and burned the rear of the semi trailer. In the meantime, the pickup truck had also run off the road. The pickup truck's fuel line ruptured, resulting in the truck being destroyed by fire. As a result of the accident, the truck driver was killed and the driver of the pickup truck was seriously injured. Residents of five homes in the vicinity of the accident were asked to evacuate, and the highway was closed for more than 12 hours. Damage, cleanup, and lost revenues were estimated at $155,000.

The NTSB drew a set of conclusions after the investigation. First, the factors highway conditions, weather, the mechanical condition of the vehicles, and impairment from alcohol and illegal drugs were excluded as causal or contributory to the accident. Second, because the pickup truck driver was unable to recall information about her activities, including her use of medications and sleep in the 96 hours before the accident, the NTSB could not determine with any confidence why her driving was erratic or why she lost control of her vehicle. Third, the truck drivers operation of the tractor-semi trailer did not cause or contribute to the accident. Fourth, because the valves, piping, and fittings at the rear of the semi trailer were not adequately protected and shielded from the impact caused by the rollover of the semi trailer, 8 of the 10 shutoff valves were sheared off,

[67] NTSB Report. Chemical reaction during cargo transfer. Whitehall, Michigan, June 4, 1999.

which resulted in the release and ignition of the hydrogen. Fifth, a cylinder absorbed the initial impact with the roadway or terrain, resulting in the fracture of its front end and the ejection of the cylinder from the semi trailer. Sixth, the hazardous materials regulations do not provide sufficient and clear requirements for protecting cylinders and valves, piping, and fittings of cylinders that are horizontally mounted on semi trailers. Seventh, because horizontally mounted cylinders on semi trailers typically extend beyond the envelope of the bulkheads, the cylinders are exposed and vulnerable to initial impact with the roadway or terrain during rollover accidents and are at increased risk of damage, failure, and ejection. And eighths, although the incomplete or inaccurate information about hydrogen in the ERG was not a factor in this accident, there is the possibility that the lack of information could increase the risk to emergency response personnel. The NTSB determined that the probable cause of the May 1, 2001, collision and subsequent fire involving a tractor-semi trailer and a pickup truck in Ramona, Oklahoma, was the failure, for unknown reasons, of the pickup driver to control her vehicle. Contributing to the severity of the accident were the adequate protection and shielding of the cylinders, valves, piping, and fittings and the inadequate securement of cylinders on the semi trailer[68].

Incident 5

About 11:50 a.m. central daylight time on April 15, 2003, a nonspecification cargo tank used by River Valley Cooperative (River Valley) exclusively for agricultural purposes as a nurse tank split open after being filled with anhydrous ammonia at River Valley's nurse tank filling facility near Calamus, Iowa. About 1,300 gallons of the poisonous and corrosive gas escaped, seriously injuring two nurse tank loaders, one of whom died from his injuries 9 days after the accident. Equipment repair and replacement costs associated with the accident totalled about $3,100.

As a result of their investigation, the NTSB concluded the following. First, the nurse tank was not overpressurized. Second, the unfused area and offset portion of the longitudinal weld significantly weakened the nurse tank shell; misalignment of the shell surfaces and the large angle weld bead increased the operating stresses in the weakened area. Third, a crack initiated from the unfused area of the longitudinal weld in the nurse tank, most likely during the manufacturing proof pressure test, and grew through the tank shell by fatigue until the tank shell failed under normal operating conditions. Fourth, using spot radiography to qualify longitudinal welds in nurse tanks manufactured to transport anhydrous ammonia, a poisonous and corrosive

[68] NTSB Report. Hazardous Materials Accident Report. Release and Ignition of Hydrogen Following Collision of a Tractor-Semitrailer with Horizontally Mounted Cylinders and a Pickup Truck near Ramona, Oklahoma, May 1, 2001

gas, is not a sufficiently reliable method of detecting critical flaws that can result in tank failure. Fifth, periodic nondestructive testing could have detected the weld defect and internal crack in the nurse tank during its service life, and the tank could have been repaired or removed from service before it failed. And sixth, River Valley Cooperative's emergency procedures were ineffective because they did not direct the nurse tank loaders to evacuate the area when an anhydrous ammonia release posed an inhalation hazard. The NTSB in addition concluded that the probable cause of the sudden failure of the nurse tank at the anhydrous ammonia filling facility near Calamus, Iowa, on April 15, 2003, was inadequate welding and insufficient radiographic inspection during the tank's manufacture and lack of periodic testing during its service life[69].

Incident 6

At 7:17 a.m., on August 22, 2003, an Amerigas Corporation (Amerigas) cargo tank semi trailer arrived at the AK Steel Corporation (AK Steel) facility in Middletown, Ohio. The driver pulled the vehicle up to the fill location and helped an AK Steel employee hook up to the fittings for a plant storage tank. According to the driver, about 7:40 a.m., the AK Steel employee began transferring anhydrous ammonia, a poisonous and corrosive gas, from the storage tank to the cargo tank. The driver said that it took about 30 minutes to equalize the pressure between the storage tank and the cargo tank. He said that once the pressure was equalized, the internal pressure in the cargo tank was 130 pounds per square inch gauge (psig). About 8:20 a.m., while the cargo tank was still being loaded, its front head cracked open, releasing vapour. The driver, who had been resting in the tractor, got out and saw the escaping vapour. He said that he activated the emergency shut off device for the cargo tank and that according to the gauges, the cargo tank was a little less than half full, the internal pressure was about 170 psig, and the temperature of the anhydrous ammonia was 80 degrees F. About 100 employees and contract workers were evacuated from the buildings downwind of the cargo tank and moved to safer locations. Five people were treated for inhalation injuries and released. The cost of repairing and replacing damaged equipment was about $25,000.

The NTSB determined that the probable cause of this accident was the failure of AK Steel Corporation to establish and implement loading procedures that would prohibit using a cargo tank manufactured of quenched and tempered steel to transport anhydrous ammonia containing less than 0.2 percent water by weight, resulting in stress-corrosion cracking and tank failure. Contributing to the cause of the accident was Amerigas Corporation's failure to tell its drivers

[69] NTSB Report. Nurse Tank Failure With Release of Hazardous Materials Near Calamus, Iowa, April 15, 2003.

that anhydrous ammonia containing less than 0.2 percent water by weight should not be loaded into cargo tanks manufactured of quenched and tempered steel[70].

5.9 Concluding remarks

In this chapter we have elaborately focused on several contextual aspects of the OHMS and the OHMS safety management approach, programmes and measures. Next to that we have seen how the highway programme is structured. Six major serious incidents have been portrayed and most important, their probable causes. In the final paragraph of this chapter some concluding remarks are made that summarize the empirical data.

The history of the OHMS is quite rich and is linked to most of the policy instruments and the contexts in which it operates. The reason for this lies in the fact that the transportation of hazardous materials and the historic roots of the HMR in the U.S. is over a century old. The major instrument of the OHMS is the set of HMR. The OHMS can issue, renew, modify and termite regulations. This unique authority implies that some programmes are derived from the HMR, especially the enforcement, training and emergency response programme. Additional programmes are of importance, such as the special permits and approvals programme, the risk analyses programme and the outreach programme. New political and organizational leaders have explicated and reemphasized some strategic approaches which were already practiced, but less formalized and structured. Several contexts have to a certain extent impact on the OHMS policy, especially politics, the media and the industry. For the highway programme all these notions are applicable as well, since the FMCSA in essence just enforces and implements the HMR, issued by the OHMS. The hundreds of thousands daily hazardous materials operators (i.e. shippers and carriers) are the main subject of the HMR and all the OHMS and FMCSA programmes and measures. However, some programmes are specifically highway-related, which the OHMS programmes are not. All these daily activities are interestingly managed and evaluated in several ways by a large set of programmes that are often interrelated.

[70] NTSB Report. Cargo tank head fracture, Middletown, Ohio, August 22, 2003.

6. DATA ANALYSIS: A DISCUSSION BETWEEN THEORY AND PRACTICE

This chapter forms the second part of the research, the data analysis. The empirical data will be related to the theoretical indicators to assess to what extent the OHMS's safety management approach corresponds to either the high reliability theory and/or the normal accidents theory (paragraph 6.2). First some general notions are made about the contextual dimensions (paragraph 6.1). Afterwards analyses of the high consequence events (paragraph 6.3), the incidents level (paragraph 6.4), the effectiveness of the OHMS safety management approach (paragraph 6.5) and an interesting analysis of the OHMS programme from a system perspective (paragraph 6.6) will be presented. Finally some concluding remarks will be made.

6.1 Introduction: Sketching contextual notions

Attempts to reduce risks and incidents of hazardous materials transportation are not totally new. The HMR have been the basic pillar in previous last decades. Even though the OHMS has the authority to issue all sorts of regulations, the inclusion of the industry in particular has been an important aspect of the OHMS policy. The political culture and the role of commerce in the U.S. are significantly important to understand why the OHMS often is not very harsh on the industry. This obviously does not mean that the HMR are not enforced strictly, but it is indicative that e.g. a criterion for penalizing non-compliant companies is the financial impact for the company. The complex web of public actors on the federal, state and local level for mainly training and emergency response in a country with four time zones shows that managing a safety programme of this magnitude is quite demanding. The administrative and institutional structure of the entirety of federal, state and local authorities in the U.S. is well represented in several OHMS and FMCSA programmes. The proximity of the political arena to (or even overlap with) the administration, which is a U.S. political system characteristic has quite some implications, especially for the training programme. The internationalization of hazardous materials which is highly linked to the economic globalization in which a level playing-field is important from a political economic perspective, is also important for several OHMS programmes. These contextual notions and implications for the OHMS policy are vital to understand the safety management approach in general and the characteristics of the indicators in particular.

6.2 Analyzing the safety management approach: Realities of duality

Even though the previous chapter has been vital for the sub questions, this paragraph is the core of the analysis from the theoretical perspectives. All major indicators and 'sub indicators' are covered and analyzed to assess the degree of relevance of the high reliability theory and the normal accidents theory regarding the OHMS safety management approach.

6.2.1 Priorities: Managing incompatibilities

The political leaders (i.e. President Bush and the Secretaries of the DOT) have always put emphasis on the importance of a good transportation network in order to have a solid economy and yield economic growth. This is related to employment, mobility and having an infrastructure that enables commerce to flourish. There is a big priority on safety, as well as security after 9/11. The DOT's top priority is said to be safety. To a large extent increasing safety and simultaneously efficient and enabling the U.S. economy to grow can be seen as an ambiguity. The recent emphasis on a set of goals (safety; reduce congestion; global connectivity; environmental stewardship; security, preparedness and response; and organizational excellence) indicates the multiplicity of strategic goals of the DOT. PMHSA and the OHMSA in addition have adopted these set of objectives. Two ambiguities are good examples for the OHMS's programmes. First, enforcing the HMR and requirements for safety is a regulatory activity but the ability of a company to stay in the market should be included in the decision-process process of penalization. Second, after an accident occurs, the reduction of congestion is also a priority of the OHMS, which makes safety not the only objective at that very moment. However, since 2004 new leaders of PHMSA and the OHMS have put explicit emphasis on a set of approaches which aim at safety in a rationalistic way. These approaches (mainly performance based, data-driven, risk-based and enterprise) indicate a major effort to prioritize the resources and allocate them efficiently.

Another complexity is the relation with other modal agencies. On the one hand, the FMCSA, the FRA, the FAA and the USCG enforce the HMR for their specific mode in order to have a better differentiated and specialized programme structure, but at the same time these agencies have a big set of other priorities than hazardous materials. The FMCSA has 14 programmes, of which the hazardous materials programme is only one. Even though the FMCSA has a priority on safety, this is to be reached efficiently and in the context of facilitating economic growth.

The political contexts in which the OHMS operates and the 'service' they offer to the U.S. economy are important notions to understand why the OHMS does not only have safety as a priority, even though it is the biggest priority. From a high reliability perspective, the emphasis has been put on safety by OHMS leaders but at the same time these leaders are subject to and part of a set of broader DOT priorities. Wildavsky's 'richer is safer' argument is quite appropriate for the OHMS, since sub optimal financial means are indicated by the lack of sufficient field personnel for enforcement and training. However, the OHMS has a professional communication leg (of public outreach and awareness) in which a large set of brochures, pamphlets, videos, guidebooks, presentations and other tools and activities. This way the priority on safety is shared out quite well, which is necessary in a country with multiple thousands of people that work (directly or indirectly) with the transportation hazardous materials or emergency response.

The high reliability theory speaks of a culture of reliability, but I would better speak of a culture of safety (as Mairas et al argued) for the OHMS case. This cultural element will be elaborated further in this chapter. However, for emergency response personnel, reliability is more of an issue. A culture of reliability is hard to create from Washington D.C. to an emergency response team in Los Angeles, but the big apparatus of communication however can yield some influence. Mostly organizations that offer training to emergency response personnel have more influence on this. It is quite complicated to assess whether all these parties agree with the goal of the OHMS, but increasing safety is hard to disagree on for federal and state partners (overlap of priority or authority) as well as for most industrial partners (securing the life of their own personnel, their products and for public relations). Normal accidents theorists argue that conflicting and ambiguous priorities of such organizations are inherent to the complexity of the political context in which they work, which is the case for the OHMS and the FMCSA. The importance of the transportation of hazardous materials for economic and political reasons in the U.S. does not seem to be decreasing. The exact cause of violation of safety rules is rather obscure. It is often caused by a lack of knowledge of the HMR or hazardous materials in general, but I have not found a satisfying rationale. An important indication for the ambiguity and complexity of goals and priorities is the fact that there is significant underreporting of accidents and incidents. There are two major reasons for this: (1) because the local or state authorities have already dealt with it, so there is no further communication with the OHMS; and (2) for juridical reasons companies often do not give all information, because they are either fearful for follow up enforcement actions or they are aware of the fact that employees can sue the company for neglecting the application of sufficient and reliable safety measures. A typical example is that the OHMS always wants companies to go beyond the HMR, but companies often only (if they do so at all) comply with the minimum requirements.

Interesting is the fact that indicators of both theoretical approaches are relevant, but for the prioritization of safety (and to a lesser extent reliability), the complexity and ambiguity of the OHMS context is evidently more in line with the normal accidents theory. Nevertheless, the communication dimension is more indicative for the high reliability theory even though the effectiveness of this communication, especially for the ´prevention leg' (i.e. shippers and carriers), is still a difficulty.

6.2.2 Redundancy: Sincere intentions, complex outcomes

The HMR are very elaborative on all transportation systems (i.e. modes) and included are regulations for all parts of the system, from packaging requirements to the requirements for training emergency response personnel. I have found that there is overlap of safety measures on the programmatic and the operational level. On the programmatic level, the programmes enforcement, training, emergency response, special permits and approvals, risk analyses and public outreach have all their specific goals and focus. This is the case for the OHMS as well as for the FMCSA separately. All programmes have a certain objective and focus and there is no significant overlap or duplication. However, between the OHMS and the FMCSA programmes there is a certain redundancy on the programmatic level. Most important, there is overlap between the enforcement programmes. Next to the fact that this leads to miscommunication and misunderstanding of companies, it has consequences for the budgets of the OHMS enforcement and the FMCSA (and modal) enforcement. The cause of this problem is mainly the lack of a (two-way) data sharing system in which all enforcement lists and data of all modes are shared with the OHMS. With this system an OHMS inspector (or a modal inspector for that matter) can avoid inspecting a company twice (from a company perspective DOT inspects twice) without knowing it. There is a lack of standardization in training and knowledge of the inspectors as well as the quality of the enforcement actions. The certification however, is the same for both enforcement programmes.

The same (interagency) miscommunication I detected in the outreach programmes of the OHMS and the modal agencies. There is a lack of standardization and harmonization of public outreach and awareness programmes which has implications for the level of knowledge of hazardous materials personnel and (again) also for the budgets of the agencies, since the budgets are quantity performance based and since safety is difficult to quantify, this is a major difficulty.

Inter-modal and multimodal sessions are efforts that straighten this miscommunication and territorial complexity.

On the more operational level, for the prevention leg there is little redundancy possible, since truck drivers are driving individually, there is no direct redundancy of personnel possible. There is no need for double training modules, but a frequent training is required. The possible relations between technical safety measures like the ROSD, the RWLN and the Drive Cam are highly unlikely, since they have all different goals and focus at the different parts of the truck in the transportation process. There are voices that have stressed the increase of risks because these safety measures are introduced. However, since these technological safety measures are quite recent, it is difficult to say anything about the effectiveness and the (probable) increase of risks of their combination. For the response leg, there is a Command Control System Process, which has strict protocols and a separation of tasks. If there is an accident in a low risk area, there are agreements with other localities that can take over the emergency response. In practice however, there are some complications on the communicational dimension. We have seen that different emergency response teams use different frequencies. Additionally, states have their own jurisdiction on who should be in charge during an emergency response process. The coordination per state is mostly carries out by only fire chiefs or the state police. Even though there are larger scale emergency communities, this can still result in miscommunication on the scene during an emergency response process.

From a high reliability perspective, there is little intentional redundancy on the programmatic and the operational level. The reason is mainly that a lot of programmes are discussed, agreed on and formalized and consequently fulfil their specific role within the overall safety programme. But from a normal accidents perspective and in practice, these intentions do not always work out the way they should. There are quite some complexities on the programmatic and the operational level, which may decrease the clarity of communication on the emergency response level.

6.2.3 Decentralization, culture and training: Acknowledging strengths and weaknesses

Since the indicators level of decentralization, high reliability culture and training are linked I will discuss them in this analysis in one paragraph. After separate analyses, there will be made some remarks on the interaction of the three indicators.

6.2.3.1 Decentralization

To understand the decentralization element of the OHMS policy more clearly, I have differentiated the indications in prevention and response. For the prevention leg the characteristic of transporting hazardous materials, especially on the highway, is of great importance. Since carriers are mostly the only person that transport hazardous materials (sometimes two persons in rural areas), the decentralized character of 'the system as such' is a fact. There are also thousands of shippers and companies across the U.S. that form the 'headquarters' of the carriers, which also indicate an actual decentralization. For prevention, the OHMS to a large extent has less formal ties with lower authorities. The carriers and shippers in particular are the first responsible people and the nearest to the preventive piece of the OHMS programmes. For the response leg and in addition to this, local authorities, tribes and all U.S. states are fundamental. The institutional and administrative structure of the U.S. in general is of importance in to understand why there is a large extent of decentralization of authority. The federal level only is of relevance if an issue at hand 'overscales' the state authority. This is the case for hazardous materials transportation because there are generic regulations that apply to all shippers and carriers across the U.S. The HMEP Grants Programme and the LEPC's are two important entities that also try to provide decentralized bodies with tools that help them create programmes which allow them to respond as appropriate as possible according to their specific needs. Volunteer fire-fighters, fire chiefs, paid fire-fighters, police officers and emergency medical personnel are authorities that are closest to the scene. These local entities are increasingly included in the designing process of OHMS programmes.

From the normal accidents approach the decentralization is needed for a quick response, which is a huge advantage for the OHMS. At the same time from a normal accidents perspective, the decentralization of the shippers and carriers is a disadvantage since it makes communication and outreach (next to other reasons) rather complicated. The complexity of the normal accidents theory of decentralization, is the need for conformity (i.e. mainly the HMR and their spirit) versus the need for intentional differentiation and fragmentation (e.g. through the Grants Programme and involving LEPC's and local authorities for emergency response). The most important way the OHMS tries to deal with this paradox is the enterprise approach. This way there can be centralization and decentralization of decision-making at the same time for prevention and response. Both centralization and decentralization is needed, which is represented best in the normal accidents theory. However, the effectiveness of the voluntary basis of the approach is not yet clear.

6.2.3.2 Culture

First of all, the U.S. highway system is highly complex and involves all sorts of public and private actors on different levels of authority from a public management perspective. This is the major problem the OHMS faces in promoting a high reliability culture. Second and related to this is the fact that as a result of this diversity there is no 'one organization', which makes any 'organizational culture' rather impossible. I have learned that the OHMS and the FMCSA have a well-built communication programme, which aims at public outreach and awareness (which is something else than training). Through these programmes, both the OHMS and the FMCSA (in a different way), try to create a certain level of awareness on the operational level. The private companies are mainly contacted pro-actively through brochures and seminars and less pro-active through the OHMS website and all sorts of communicative tools. This is mainly for prevention, and to a lesser extent for emergency response. Another very important notion in this context is the training programme (which will be discussed later). The learning programme includes all sorts of information that can lead to a 'mental setting'. And since training requirements are standardized by the HMR, one can argue that there is some sort of cultural element. So if there is an emphasis on culture on the prevention side, which is hard to asses, it is derived from the outreach, awareness and the training programme. Interesting is the fact that initiatives as 'driving defensively' that increase the awareness of the carrier in the transportation process can be incompatible with U.S. democratic-individualistic values from a normal accidents perspective.

For prevention also some big companies have their own training module and have a weekly informal gathering that (implicitly) creates a bond with the other carriers, but they still operate individually. For emergency response, there are also awareness and outreach programmes. For instance the LEPC's visits to local emergency response authorities who inform them on hazardous materials. Private companies and non-profit organizations that offer emergency response modules have their own approach on culture. Most big organizations that train emergency response personnel have this cultural element in their programme. An indicative example of the emphasis on culture of the IAFF is by cultivating friendship and fellowship among emergency response personnel and promoting harmonious relations between fire-fighters and their employers[71], which are two of the eleven strategic missions of the IAFF. Interesting is also that during the emergency response process, sometimes there is a peak on the most dangerous moment and afterwards this diminishes.

[71] Source: http://www.iaff.org/about/history/whoweare.htm

This culture of reliability is to some extent present, but again I would suggest that it is better to speak of a culture of safety, since there is such a big ramification of authorities, entities and people (especially on the prevention leg). Both theoretical approaches are to some extent relevant for the OHMS highway case, since there is a certain emphasis on culture, which is mainly the result of training, outreach and awareness. At the same time, from a normal accidents perspective, a constant high level of awareness and preparedness can be quite hard for carriers and emergency response personnel. It is also possible that this is perhaps a characteristic of the U.S. work ethic, but whether there is a causal relation with the incompatibility of U.S. values is obscure and is something I am not able to articulate.

6.2.3.3 Training

The training programme of the OHMS and the FMCSA are (historically) very important and included in the HMR. There is a set of requirements that all hazardous materials personnel should have. For the prevention leg this is the responsibility of the employee. For instance, all personnel should be trained every 90 days. The response leg is more important for this indicator. Though the HMEP Grants Programme, states and local authorities can train 'their' emergency response personnel, additional technical assistance is offered by the OHMS. The OHMS also funds some organizations that train emergency response personnel. Evidently there are requirements for states and these organizations. The OHMS tries to make these financial flows more transparent (e.g. by accountability). Simulations are often planned by the LEPC's that first decide which simulations are necessary and afterwards often include companies that have had an incident history in that area. A complexity and unintentional 'difficulty' is that there are no serious incidents frequently. Evidently financial means are to be spent efficiently, which often means paying attention to the record and characteristics of prior incidents, but can also lead to biased programme.

From a high reliability approach the OHMS does quite well, since there is a big emphasis on continuous training and via the LEPC's simulations are carried out as well. There are some difficulties on the dimension of finance and transparency, but the OHMS is putting effort in this field. From a normal accidents perspective, there are some factors that can not be trained on, mainly human errors. A major reason is that the HMR are the maximum for most companies (for financial purposes) but often the minimum for OHMS. The notions of the normal accidents theory on practicing on problems caused by safety and (to a lesser extent) political restrains might sound obvious but are aspects I did not found. In fact, the accident with the ethanol (Baltimore in 2007) is a highly politicized issue, but maybe exactly the reasons for more training and simulations for fire-fighters and emergency personnel. So again both approaches are relevant for the OHMS case, with a slight emphasis on the high reliability approach.

6.2.3.4 The indicators for the operational level

The training programme, public outreach and awareness are the main programmes of the OHMS and (to a lesser extent) the FMCSA that try to create and maintain a level of uniformity on the operational level. At the same time too much centralization is not beneficial since the U.S. has multiple states and regions with different characteristics regarding transporting hazardous materials. This paradox is to be solved by a strong culture which is valuable since in practice it leads to a culture of safety, not a culture of reliability. This culture helps to keep safety an important aspect, which is more important for the OHMS than reliability regarding the differences across the U.S. and the ramification of authorities and entities. We have also seen that the normal accidents approach does explain partly decentralization, culture and to a larger extent training. The normal accidents theory also explains partly the degree of decentralization, the difficulties with a high strong (safety) culture and training. At the operational level there is no explicit dominant approach for the explanation or understanding of the OHMS management approach. Both offer a great deal of insights and equally appropriate.

6.2.4 Organizational learning: A sub optimal teachers

The OHMS most importantly learns through data. First, this can be data that is used for risk analyses to assess the significant risks and consequently give feedback to the programmes. Second, data is also used to assess prior incidents. An example is the root cause analysis that provides feedback to the OHMS programmes. A third important learning tool is the safety integrity approach which focuses on the hazardous materials transportation system in an integral way. Fourth, the investigations and inspections of the enforcement personnel can be of great importance. Fifth, findings of the enforcement reports are often feed backed to other OHMS offices which can (or can not) lead to a modification of their programmes. Sixth, external and independent investigations of the e.g. NTSB or the CSB are also great learning tools, since they produce thorough analyses of incidents and afterwards produce recommendations for all involved agencies. Seventh, the feedback provided by meetings with industrial partners and feedback of the training and enforcement programme is a learning tool as well. Eight, the OHMS is able to receive feedback from emergency response communities about training and other emergency response-related aspects. Ninth and very significant is the feedback the OHMS receives from the modal agencies. The FMCSA has some of learning tools the OHMS utilizes as well. The FMCSA also conduct their own risk analyses, from prior incidents, from external investigations, from enforcement field managers, meetings and feedback of lower-level private and public organizations. This data and lessons are also feed backed to the OHMS. Important facilitators for these lessons are the (digitalized) data sharing system and the enterprise approach. The data sharing system is a way to communicate all sorts of incident data and lessons that can be shared with the emergency response community and evenly important with all OHMS offices and the modal partners. This is not yet optimalized and institutionalized, since not all data is harmonized in terms of e.g. quality and sort of data. Technologic improvements and progressions allow this data sharing system to be increasingly important. A noteworthy footnote is that this implies that if (or when) all data and data systems are harmonized. Even more, data analysts are needed in all agencies and authorities. Related to this data sharing is the notion of the enterprise approach which allows the OHMS to include all sorts of companies, agencies and authorities in the data collection process, which should results in an integral and complete data system.

As already stated, a major obstacle in this context is the high level of underreporting of accidents and incidents. This is a great restriction for the OHMS and their ambition to learn from prior accidents and incidents. Related complications are the legislative and financial reasons for companies to not give a extensive report of accidents and incidents. Avoiding sues and enforcement actions are rationales of companies to only give information that is formally required. Another complication is the fact that sometimes state and local authorities already finalized the process of an incident report, while the OHMS is not informed.

The fact that the OHMS puts major emphasis on learning through risk analyses is parallel to the high reliability theory. These analyses are not only conducted by the OHMS, but also analyses of external organizations. Learning through trial and error can also be observed in the OHMS programme as a learning process. The feedback of risk analyses, enforcement programme, modal partners, industrial partners and local authorities can result in the issuance a new regulation. When a certain (new) risk with a significant consequence is addressed by various internal and external entities or actors, an outcome can be an incentive to modify or add elements of the programmes of the OHMS (and the FMCSA). A good example is the L-UL programme, which is defined as a problem by the OHMS, the FMCSA and a large set of industrial partners. However, I have not found notable simulations or imaginations of trials and error that could lead to organizational learning (i.e. for the OHMS). The simulations of accidents planned by the LEPC's can be seen as a learning process of local authorities, which are mainly part of the training programme of emergency response communities. In fact, since these simulations are often based on prior incidents it is questionable whether it would prepare them for other sorts of accidents in the future. This complexity is exactly what the normal accidents theory is arguing.

More important is the fact that underreporting, legislative and financial-economic realities and sub optimal communication with lower-level authorities lead to a sub optimal learning process. This 'feedback-gap' is not argued explicitly by Sagan's theory (he stated faulty reporting instead of underreporting), but in the OHMS case this is a great example of a learning restriction. The degree of faulty reporting was too complex to assess and had huge practical restrains. The normal accidents argument that causes of incidents often are unclear is perfectly indicated by the root cause analysis. This is an analysis that explicitly is designed because of the fact that the root causes often are obscure. The additional argument of the normal accidents theory that the OHMS political leaders have reasons to argue that most incidents are operational errors, is quite complex to assess as well. This is indicated by the fact that a majority of the serious incidents were identified as 'human errors' (till 2004). On the other hand, since 2005 this number dropped immensely and the root cause analysis can be indicative of the fact that this argument is irrelevant for the OHMS case. The final cause of learning restrictions, as stated by the normal accidents theory, is the presence of organizational secrecy. I have not found indications of secrecy between federal and lower-level authorities as such. Nevertheless there is quite some miscommunication between the OHMS and modal agencies (e.g. the enforcement programme) and a lack of optimal communication with other public organizations. However, a major form explicit of secrecy is the privacy issue of companies, which allows them to provide no more information than is requested by the OHMS. This is caused by the fact that there are incomplete insights in crucial data from the industry.

6.3 High consequence events: More emphasis, less clarity

The OHMS has a set of instruments (most important are the HMR) that reduce the risks of hazardous materials transportation. For high consequence events, there are some specific programmes and measures. First of all, the risks with high consequences are assessed through risk analyses. Since these risks enjoy the highest priority, the resources of the OHMS and the FMCSA are allocated efficiently by emphasizing on these particular risks. Some hazardous materials have significant risks and have high consequences if an accident occurs, like certain radioactive materials, certain explosives and materials that are poisonous by inhalation. Also through risk analyses some programmes are created like the L-UL programme, the roll-over programme, air plane crash, lithium batteries in airplanes, air packaging and releases of large quantities of chemicals (i.e. chlorine). Third, the companies that are often non compliant or have a bad (incidents) record form also a higher risk which can lead to higher consequences. Through priority lists of the enforcement programmes of the OHMS and the FMCSA, these companies are being monitored for enforcement purposes. Fourth and related to the two prior notes is the fact that the HMR inherently hold a higher threshold to risks that have a higher consequence. This is also reflected in the training requirements. Dealing with high consequence hazardous materials (e.g. explosives, toxicant inhalation, Liquefied natural gas, radioactive materials) requires a special permit. The FMCSA has a permit programme for these high consequence hazardous materials. On the more operational level, there are some technological measures, which are not required in the HMR, but add to the prevention and reduction of the number of high consequence events.

According to the high reliability theory, the OHMS puts a high priority on the reduction of high consequence events, because of political goals and the allocation of the OHMS resources. Redundancy of programmes and measures are not explicitly found. Decentralization is not different from the main OHMS policy since the private and public entities are not significantly different. The decision-making process as such is the same for all hazardous materials and the HMR and other programmes may vary per risk and their high consequence. Unfortunately I was not able to assess a culture of reliability or safety when a high consequence event occurred. Also for training of carriers, I have not found a significant different focus for high consequence events other than the required training as stated in the HMR and more focus on radioactive materials and ethanol. Organizational learning is not different from the 'regular' OHMS learning process.

So mostly priority, and to a lesser extent training, are indicators from the high reliability perspective that differ from the high reliability perspective on the programmatic level in general. This implies that priority from the normal accidents approach is quite different for high consequence events than for the overall OHMS policy. I have not found difference between enforcement actions related to high consequence events and low consequence events. Decentralization is also not significantly different, since this is to a large extent an institutional or structural element (largely unmanageable by the OHMS), which is not really related to high consequence events. The cultural indicator from a normal accidents perspective for high consequence events is (also) not assessed in its real life form. However, it is not unimaginable that during a high consequence event, there is a higher concentration level which can be linked to a high reliability or safety culture. This can therefore result (arguing from a normal accidents perspective) in an even larger degree of incompatibility with U.S. democratic-individualistic values. The training indicator for high consequence events is even more appropriate for high consequence events since these events are rather rare which makes training for them hard since clear patterns are obscure. Learning is to a large extent the same for the 'generic' programme from a normal accidents perspective. However, the nature and relative rarity of high consequence events have led to even more learning restrictions. Since most companies in addition are quite restrictive in providing crucial data and (which also holds for training), clear patterns are rather obscure for high consequence events. The chance that a high consequence event stays unnoticed for the OHMS, is very small which is different for lower consequence events.

There are some differences between the OHMS programme for high consequence events and the generic policy. Significantly different are the priority and training from the high reliability view and only priority from the normal accidents perspective. Interesting is that some other indicators are even more parallel to the normal accidents theory than for the generic OHMS policy (i.e. culture and learning).

6.4 The incidents level: When theories have moderate meaning

In this paragraph the six serious incidents will be being assessed by the indicators of Sagan's theory. First and most important, one might argue that since part of the causes of the incidents 2, 3, 4, 5 and 6 were a lack of proper procedures or training, there were not sufficient compliance reviews carried out by the enforcement programme (of the OHMS and the FMCSA). Second, sine insufficient training was a cause of incidents 2 and 6, one can also state that the OHMS and the FMCSA were not strict enough in reviewing the (quality of the) the training modules of the related companies. Third, there are some technical causes that have led to serious incidents, namely in incidents 1 and 4. These technical causes can be related to the lack of thorough risk analyses of the OHMS and the FMCSA. If the risks of wet lines and cylinders was assessed and addressed in an earlier stage, there might have been more emphasis on these technical aspects via outreach, training or regulations, which could have led to more attention to it and consequently a lower risk. Incidents 1 and 4 indicate external factors or causes (i.e. driver of other vehicles) as well. These factors in both cases have been the major reason for the incidents, which signifies a level of uncontrollability of factors, by the carrier, the shipper, the OHMS and the FMCSA. 'Other drivers' are an indication of Perrow's notion of interactive complexity. These crashes are unwanted effects, even though they are familiar. This also indicates tight-coupling of the transportation system, these events happen very quickly, making it almost impossible for the carriers to anticipate. These notions of the system approach of the normal accidents perspective leads to system incidents (hence incidents 1 and 4).

Indications that correspond with the argumentations of the high reliability theory are in essence not relevant, since the high reliability theorists argue that via their rationalistic management approach serious accidents or incidents are fairly impossible. Even though there is a high level of decentralization of decision-making, a certain level of a safety culture and a level of training and learning, serious incidents did occur. The normal accident approach has also a meagre explanation for the incidents. Even tough assessing a clear causal relation is rather obscure, the lack of proper enforcement of the OHMS and (or) the FMCSA may have been caused by the fact that the OHMS and especially the FMCSA have multiple priorities and have (perhaps consequently) few field enforcement personnel, as we have seen. There is no reason to think that overlap of duplication of safety measures has been an important reason for causing one of the incidents. The need for centralization of decision-making had no impact on the incidents as well. In fact, decentralization seems to be the clue, since carriers are the nearest persons to the accident, which makes this argument of the normal accidents theorists irrelevant for the OHMS case on the incidents level. Even though the carrier of the first incident had used drugs, this was no cause to the incident, making the cultural element (culture of safety in the case of the carriers) of the normal accidents theory quite irrelevant as well. The notion that for some accidents or events simply can not be trained, we have observed in the (unplanned) crashes of incidents 1 and 4. The normal accident approach argues that some training elements are too dangerous to practice. One might say that if 2 out of 6 (33%) serious incidents are caused by another vehicle, so there should be an extensive training module on this. Even though driving defensively is practiced, practicing a real life near accident to exercise on the driver abilities might be just too unsafe. As already stated, a lack of in-depth risk analyses can be related to the fact that unsecured wet lines and cylinders could cause severe consequences. The restrictive way of drawing conclusions from the incidents causes by the NTSB, is an indication of the argument of the normal accidents perspective that often unclear causes constrain organizational learning.

This paragraph interestingly leads to the conclusion that the analysis of the incidents level (even though both theories are highly relevant and useful to assess the OHMS programme) is less useful to help us understand the serious incidents with their rationales than for the programmatic level. Since one has to be vigilant with drawing causal relations (as the NTSB does as well), especially with a preset set of indicators, assessing serious incidents are highly complex. It is perhaps better to make use of the set of the OHMS and FMCSA programmes and measures in an assessment of serious incidents instead of Sagan's indicators, to draw more honest and perhaps causal relations.

6.5 Effectiveness: A set of (sub) optimalities

Appendixes Y, Z and AA indicate that there are quite some accidents and (serious) incidents on the highway mode. Relatively speaking it is quite low because of the high quantity of transportation of hazardous materials by highway in the U.S. From a high reliability perspective, looking at these numbers (especially appendix AA), one might conclude that there are quite some serious incidents (i.e. over one serious incident a day). From a normal accidents perspective, this is not a surprise; since there are several unavoidable constrains to reduce these numbers. Even though causal relations are rather obscure to draw, the indicators and arguments of the normal accidents theory on a more abstract level can help us explain the serious incidents. Another interesting notion is the fact that the number of serious incidents on the highway programme has been relatively constant in the last decade and at the same time there have been no decrease of the transportation of hazardous materials in commerce in the U.S., in fact a slight increase has been registered. This can be due the fact that no significant or positive changes of programmes or approaches occurred in that period. The number of registrations of hazardous materials across the U.S. has also been relatively stable, with a minor increase. One might argue that the more hazardous materials are being transported, the more serious incidents are likely to occurs from a statistical perspective. However, clear cut relations are difficult to assess and highly incomprehensible, making the assessment of the OHMS effectiveness on high consequent events highly obscure.

There are three major constrains to assess the effectiveness in a more in-depth and qualitative manner. First, the complexity and obscurity of serious incidents make it almost impossible to relate this to the theoretical approaches directly. Second, the OHMS programmes are to a large extent related and complementary, which make the relation of serious incidents with OHMS (and the FMCSA) programmes and measures also rather incomprehensible. Third, the dimensions of complexity and time are also of great importance. For instance the emphasis on a more data-driven and enterprise approach by recent new political and organizational leaders, leading to specific programmes are not the direct cause for a probable reduction of serious incidents. More general, the cause of any particular OHMS programme or FMCSA initiative is not the direct reason for an increase or decrease of risks and incidents. It is the combination of all programmes, safety measures together (e.g. enforcement, training, awareness, risk analyses, data sharing, workshops) that might have had some impact on the outcome of the OHMS policy. Even if this outcome is a reduction of serious incidents, the causal relation between the incident causes and the programmes or measures, are also obscure. Especially since it takes some time for a new programme to have impact and at the same time other programmes have their effect in the 'system'. Even though these complexities make the effectiveness assessment difficult, the importance of prioritization on safety, enforcement, training and risk analyses are a result of the analyses at the incidents level, which imply that an investment in those areas can lead to more effectiveness of serious incidents on the highway.

The theoretical approaches have helped us understand the OHMS policy on different levels and in several areas, which is a substantial part of this research. Even though the effectiveness of the OHMS policy is perhaps an 'over-complexity' to assess, the insights of the hybrid analysis have helped us understand what the strengths and weaknesses and their causes are of the OHMS policy. From the perspective of Sagan's hybrid theory the OHMS is quite effective, since the decision-making process is decentralized via state and local authorities (e.g. LEPC's). The training programme is quite professionalized and institutionalized, which makes the OHMS programme more effective. The learning programme is to some extent professionalized, especially through the risk analyses. However, there is no significant level of redundancy of inspections or other safety measures other than the enforcement programme focusing on all actors of the transportation process and their own level of responsibility. Also emergency response personnel do not overlap (even though there is some miscommunication) and there is no pro-active outreach towards managers of shippers, carriers and emergency response teams to invest in a culture of reliability though e.g. informal meetings or 'team-building days'.

Sub optimalities of the OHMS effectiveness from a normal accidents perspective are more obvious, since this approach only perceives and argues in terms of sub optimalities. The fact that the OHMS has a broad set of strategic goals next to safety can obviously lead to sub optimality. The fact that the organization(s) the OHMS works for and with have multiple, conflicting and other priorities, making the effectiveness of the OHMS less optimal. To a small extent, the fact that carriers and emergency response personnel should have a 'high safety mentality' the entire working time, can lead to sub optimal effectiveness as well from a normal accidents perspective. Training and learning of the OHMS from this perspective are also not increasing the overall effectiveness, because of the lack of sufficient and quality data. All these sub optimal effectiveness elements from a normal accidents view lead to a more pessimistic assessment, especially since these sub optimalties are inherent to the 'system' and might lead to more incidents. Again, this correlation is rather obscure and is not a clear result of my findings.

6.6 The system approach: Additional informative insights

A very interesting aspect of the normal accidents theory is the system approach of Perrow. I have found that the system approach can be very useful to understand the complexity of the OHMS and its environment in a different way than the hybrid theory of Sagan.

The OHMS programme can be seen as a system, with all kinds of internal sub systems (i.e. offices and modal agencies as units). The OHMS in addition has external sub systems, namely industrial partners or the industry in general, federal, state and local authorities. All sub systems and units have their own objectives and sets of priorities, which are highly formalized, institutionalized and have their own authorities making the system (all sub systems together) rather rigid. A good example of this is the fact that enforcement used to only enforce the HMR, but recently OHMS leaders have involved the industry to talk and discuss about common objectives and goals. On the basis of this mutual interest, relations and partners are created. Another example is the involvement of companies of the FMCSA in the design of a guidebook for a security plan after 9/11. Initially the plan was to make a security model and provide it to companies that should comply, which can be quite a burden for companies. So by including these actors, industrial partners have now trusted the FMCSA and are partners also in other areas. This (enterprise) approach makes the system as a whole more flexible because partnerships and relations are being created more easily, but there are dozens of entities in the 'U.S. hazardous materials transportation world' which make the system less clear and lucid. A third great example is the L-UL programme, which involves several entities not only for the sake of the L-UL programme but also for the sake of data sharing and building trust for future partnerships. Interesting is that almost all actors in the L-UL programme argued that the OHMS should take the lead in creating a framework for the industry for L-UL measures. Also internally, inter-modal and multimodal sessions integrate the units of the OHMS as a sub system, which makes the uniformity of all hazardous materials agencies within DOT more complete. However, since this approach is quite recent, it takes time for other external entities to get used to this approach.

The transportation system as the sub system, as well as the socio-technical (e.g. wet lines) and socio-technological (e.g. the ROSD, the LDWN or the Cam Drive) sub systems are to be included in the system approach. Interestingly, all sub systems interact to a certain extent. When a new technology is designed it has implications for the carriers via a camera, making the responsibility of the shippers perhaps increase or leading to higher risks exactly because of the safety measure.

Perrow explicitly speaks of the terms interactive complexity and tight-coupling as elements that can lead to incidents or complication. A federal hazardous materials programme has been present for approximately a century, making it a 'mature' programme, however not all interactions between all subsystems and units are clear. The causes of future incidents will show to what extent this approach has been successful. The dynamics and fast pace of the market, industry and the development of technology also have severe influence on the risks of transporting hazardous materials risks and consequently on the programmes. The OHMS decision-making processes and administrative structures are designed to respond in the same quickness, making the OHMS respond to new external dynamics (hence the focus on foam and roll-over devices).

6.7 Concluding remarks

In this chapter I have analyzed the contextual elements, the programmatic and incidents level, the effectiveness of the OHMS and finally looked at the OHMS programme from a system perspective. The contextual notions (especially the political, institutional and societal contexts) are of great importance to understand the environment in which the OHMS operates. Moreover, these contexts define to a large extent the priorities of OHMS and the way they operate. On the programmatic level we have seen that some indicators have more in common with the high reliability approach, whereas others have more parallels with the normal accidents theory. On the whole, all elements are relevant from both theoretical perspectives. The incidents level has shown that some relations can be made with the OHMS programmes and measures, but to link them to the indicators of Sagan's hybrid theory is less satisfactory. On the effectiveness of the OHMS, no in-depth analysis is really possible because of loose relations. Any (forced) attempt would do harm to the purity of academic reasoning in social scientific research. The future will show us how and if the new explicit approaches (introduced by the OHMS top) increase the effectiveness of the OHMS. Finally and maybe most interestingly are the system characteristics of the OHMS programme and its environment. It shows a totally different site of the institutional configuration of the 'hazardous materials transportation sector', which helps us understand the strengths and weaknesses of introducing or modifying approaches and programmes.

7. CONCLUSIONS: RATIONALITY IN COMPLEXITY

Most U.S. citizens probably do not think of the complexity of institutional sub systems and the feedback loops of enforcement programmes to the special permits and approvals programme when buying hairspray. Exactly these important insights of the federal U.S. hazardous materials transportation programme are sketched in this chapter. Important and interesting conclusions that I have drawn from the analyses are presented.

First, the importance of the history and other contextual notions need to be stressed. The OHMS programme is quite mature, which makes major changes in policy programmes or approaches rather complex. On the other hand, some examples of including public and private entities are signs of a new orientation of the OHMS. The dynamics of the (international) hazardous materials market and the industry are new challenges for the OHMS. Second and related to this, the political and administrative structure of the U.S. is a given fact, which the OHMS can not change by regulations. This implies that other and more sophisticated and nuanced methods are utilized, such as public outreach, awareness and again the enterprise approach which enables the OHMS to make decisions with decentralized and lower-level partners, while still operate as a centralized agency. Third, the U.S. political and economic (historic) context makes the industry a very important part of society and no public authority, especially no federal agency should impose lots of stringent regulations on the industry with the economic gravitas of hazardous materials. The OHMS also here utilized subtle methods and approaches by having some ‘flexibility’ in the programmes, especially enforcement. The fact that communication is such an important portion of the OHMS’s toolkit is because harsh instruments are not very desirable by the industry and the political leaders and therefore not pragmatic.

The OHMS utilizes a very diverse set of methods and programmes to reduce the risks associated with the transportation of hazardous materials. The most important pillar is the authority to issue, enforce and modify regulations. Most programmes are derived from these regulations. Relatively recent, new political and organizational leaders have put more emphasis on certain rationalistic approaches which help the OHMS to prioritize and assess the most significant risks. At the same time methods have been introduced that are less rationalistic, but on a subtle manner involve industry and public entities to deal with the political sensitivity as described above. With the new approaches data should be collected and processed more professionalized, institutionalized and harmonized, which I have not concluded. Training and emergency response have been important programmes as well, but the OHMS now reaches out the training and the emergency response community more pro-active. The programmes, specifically for the highway mode, are enforced by the FMCSA. Furthermore, the new approaches have been adopted by the FMCSA which have made partnerships with public and private organizations. The FMCSA also aims at specific programmes for the highway programmes.

I have concluded that theoretical approaches of Sagan are both to a high extent useful to understand the safety management approach of the OHMS on the programmatic level. Priorities of the OHMS are multiple, conflicting and part of a larger DOT set of objectives. Furthermore the FMCSA has a dozen other programmes (non-hazardous materials) which make the indicator of priority correspond quite significantly with the normal accidents perspective. However, the emphasis on data management, in order to have a more efficient and effective way of reducing risks, indicates a clear-cut ambition and priority on safety, making it also partly compatible with the high reliability theory to a lesser extent. The argument of redundancy is quire complicated in the OHMS case, since there is some overlap of e.g. the enforcement programmes of the OHMS and the FMCSA, but this is often unintentional. Most important is the notion that it is caused by miscommunications which consequently has rather large budgetary consequences. Also miscommunication on the emergency response level is sometimes a difficulty, which is unintended and makes the argument of redundancy less relevant but the insights of this theoretical indicators have helped me find these complications, which can be seen as an added value. The notion of decentralization is very interesting, since there is a 'natural' form of decentralization of authority in the U.S. which the hazardous materials programme is able to use in their advantage. At the same time this now and then leads to 'over-fragmentation' which makes the web of actors difficult to comprehend and manage. This makes the high reliability as well as the normal accidents theory relevant in this context. Tight-coupling on the operational level is not the crux on the programmatic level, but the institutional complexity of centralization which is dealt with by applying the enterprise approach is a creative anticipation of the OHMS. Culture is the fourth indicator which is also supported by both theoretical approaches, but on this indicator I have not been able to conduct a real-world in-depth analysis on the culture of reliability or safety of the carriers as well as the emergency response personnel. Both theories define this as an organizational culture, but the very character of the U.S. hazardous materials transportation world is that it is greatly fragmented and there is not one organization. I have concluded that there might be some sort of safety culture among the carriers. A high reliability culture is promoted by training organizations, but the normal accidents approach also leads to a more pessimistic conclusion since there are some examples of operators of hazardous materials that are not optimally concentrated and focused on safety all the time. However, to relate this to the incompatibility with American values is something I have not concluded. Training is another important programme of the OHMS (for carriers, shippers and emergency response personnel). At the same time there are quite some restrictions the OHMS faces, but these are somewhat less dominant than the OHMS training goals making the high reliability theory just a little more relevant for this indicator. The final indicator is organizational learning which is very interesting. The OHMS has a lot of parallels with the high reliability theory but even more with the normal accidents theory, indicating the complexity the OHMS faces especially with collecting data. System characteristics are the main reasons for this complexity, which maybe is a margin the OHMS should accept, given the nature of the system. However, again attempts as the enterprise approach form a good alternative to address and anticipate to these learning gaps. So slightly more dominant is the normal accidents theory, but the high reliability theory is also extremely appropriate for the OHMS case. The fact that for all indicators both theories were significantly relevant indicates that both theories are needed to have a comprehensive understanding of the rationality and the complexity simultaneously. For organizational science this implies that by utilizing multiple theoretical lenses (in this case even opposite lenses), a much better and inclusive understanding can be reached.

On high consequence events (incidents level in general) I have concluded that most incidents have some relation to the lack of proper enforcement or learning. Moreover, there are some interactive complexities and tight-coupling aspects of the transportation system, which have led to serious incidents. Some incidents could be prevented if enforcement actions were carried out more properly. The 'system accidents' (of Perrow's rationale) became 'system incidents' because wet lines and cylinders were not properly protected, which may be due to a lack of risk analyses. However the causes of the serious incidents are not always clear (as the normal accidents theory pessimistically suggests), especially not when relating them to the indicators of Sagan's hybrid theory. Interactive complexity and tight-coupling within the highway transportation system can lead to serious incidents, which makes these theoretical notions to a larger extent relevant for the incidents level. At the programmatic level there are indications of interactive complexity as well. The relations between incidents, which are economically and politically contextualized, and safety programmes are very much incomprehensible and unpredictable. Tight-coupling is less relevant on the programmatic level, since (the pace of) the process of decision-making is not the same as tight-coupling of the highway transportation system. Furthermore, most programmes are not directly linked to one another, even though there are quite some links. The system is more loosely coupled, in the terms of Perrow.

The effectiveness of the OHMS is a highly complex assessment, since the causal relations are very obscure. Next to an assessment of the quantitative data, little can be said on the effectiveness of the OHMS safety management approach. Especially since there are so many sub systems that interact that causality is very hard to assess. This indicates interactive complexity of sub systems. I have concluded that there are not always unwanted and unexpected sequences in the system due to the complexity, but it makes the assessment of causality rather complex. The instrumentality of causality is often the cornerstone of the OHMS safety management approach. This indicates the high rationalistic ambitions of the OHMS, especially in a complexity of sub systems and contexts. This paradox can be 'detached' by acknowledging and accepting the complexity and manage from rationality and complexity perspectives. The objectives of the OHMS do not have strict quantitative numbers, next to the ambition of five percent reduction of serious incidents per year. However, in practice this is not the case. One might even argue that there is a margin that can not be reduced since there are all sorts of restrictions and complexities in the overall system resulting in sub optimalities for the effectiveness of the OHMS.

A final conclusion I have drawn is the importance of the risk society to contextualize the OHMS case. The *very reason d'être* of the OHMS can be derived from Beck's notions on the political implications of the cultural mindset of a society. The media and the politics are of vital importance for OHMS leaders and often also for the margins of the programmes. However and interestingly, the role of the industry in the U.S. is of such significance that one might argue that the risk society has a limit. Also the U.S. 'culture of suing' is a restriction of the basic notions and implications of the risk society. In fact, suing a company for negligence while a carrier made an avoidable error can be seen as a reaction to the risk society since it is a cultural answer to the fact that we (including the OHMS) do not have everything in control. Related to these notions is underreporting, which is also an aspect that is a U.S. system characteristic giving the 'U.S. risk society' a slightly different meaning. This conclusion makes the traditional theory of risk society partly obsolete since there are several specific contexts and realities (charted by nuanced and in-depth assessments) that add to the understanding of the evolvement of the U.S. risk society.

8. REFLECTIONS AND RECOMMENDATIONS: EMBARCING COMPLEXITY TO EVOLVE

The OHMS is a highly professionalized and grown-up programme with a lot of expertise and experience. However, after the analysis there can be made some recommendations that might improve the OHMS programme on certain aspects keeping in mind the system as a whole. In appendix AC, a separate report (I produced for the OHMS) on the OHMS approaches can make the set of recommendations more comprehensive. First there are some methodological recommendations I would like to address.

There are three recommendations for future research on the OHMS policy in a methodological sense. First, the assessment of the culture of carriers of hazardous materials and the U.S. hazardous materials emergency response community should be more extensive. Unfortunately, I was not able to assess this culture via questionnaires. Future researchers should assess this cultural element, which can make the overall analysis even more complete. Second, more serious incidents documents should be used in order to have more data to draw conclusions from. Even though I have used (all) six NTSB serious incidents reports of the last decade, analyzing 15 years or more may lead to a discovery of more and less obscure patterns in the analysis. The OHMS programme should then evidently be analyzed even more in an even more historic context. These patterns may result in a more conclusive narrative on the OHMS effectiveness. Third, in future research all modes should be analyzed, making a cross-modal comparison possible which can result in new and interesting insights.

There are some recommendations for the OHMS I would like to address that have resulted from the conclusions of the data analysis I conducted. First, even though the OHMS is surrounded with agencies and organizations that have other priorities, safety should be the only priority of the OHMS. Albeit safety is the number one priority of the OHMS, there are some economic-related priorities as well. Second, there should be better communication and agreements between the OHMS and the modal agencies, especially on the enforcement programme. Third, the OHMS leaders should invest more in a culture of safety via managers of shippers and carriers. This leads to a more pro-active attitude of the operational personnel. Moreover, the OHMS should assess whether all hazardous materials training modules invest in a culture of reliability and safety. There should be invested in informal team-building days to have the advantage of the high reliability perspective and do not have the disadvantage of the normal accident perspective on culture. Fourth, training for operational human errors is a great restriction, especially since there is a lack of professional feedback on incident data. Since human errors are a major root cause for incidents, the incidents data system needs to be improved and related to the training programme. Fifth, the learning process of the OHMS suffers from a feedback gap of sufficient, quality and harmonized incident data. By approaching the industry and state and local authorities with a plan that is constituted by jurists, economists and engineers, there are options to have a better and more transparent data sharing system for the OHMS, the modal agencies, lower-level authorities and companies.

The more recent priorities of the OHMS to operate from a more data-driven, risk-based and enterprise approach also need to be fostered and institutionalized. These approaches are very much intertwined but the basis is the enterprise approach. By including all sorts of public and private organizations that are key partners networks can be created (e.g. industry network, training network, emergency response network) which have their own sub networks per mode. By institutionalizing these networks, trust and partnership becomes a routine, which can lead to a more open communication on data sharing. This data sharing is important for the bulk of decisions the OHMS makes across all its offices (hence the data-driven and risk-based approach). Simultaneously a highly digitalized data sharing system needs to be created, which enables data sharing within and between the networks as well as with the OHMS and the modal agencies (see appendix AC, figure A). This requires some investments but it has a major advantage for the transparency of the data sharing and reinforces the relation with the networks. Perhaps most important is the fact that the institutionalization of the networks can facilitate all sorts of programmes, projects and (urgent) initiatives in the future. In addition to this notion is sharing best practices of these approaches with other countries, which could prevent the OHMS from re-inventing the wheel. By adopting these recommendations the consistency of the OHMS programme can be strengthened and simultaneously enables the OHMS to be more adaptive to institutional and programmatic dynamics.

BIBLIOGRAPHY

Literature

- Beck, U. (1992) *Risk Society*. Sage, London.
- Bendor, J.B. (1985) *Parallel Systems: Redundancy in Government*. University California Press, Berkeley.
- Birkland, T.A. (2001) *An Introduction to the Policy Process. Theories, Concepts, and Models of Public Policy Making.* ME Sharpe Publishers, New York.
- Dempsey, P.S. (1988) *The Social and Economic Consequences of Deregulation. A Decade Later, and the Band played on.*
- Ewald, F. (1987) *L'État Providence*. Grasser & Fasquelle, Paris.
- Franklin, J. (ed.) (1998) *The Politics of Risk Society*. Polity Press, Cambridge.
- Gerring, J. (2007) *Case study Research. Principles and Practices.* Cambridge University Press, Cambridge.
- Gomm, R., Hammersley, M., Foster, P. (eds) (2000) *Case Study Method. Key Issues, Key Texts*. Sage Publications, London.
- Hansson, S.O. and Peterson, M. (2000) 'Philosophy of Risk Newsletter', Vol 1 No. 1, May 24th.
- Hansson, S.O. (2002) 'Philosophical Perspectives on Risk', conference Research in Ethics and Engineering, Delft University of Technology, April 25th.
- Hirschhorn, L. (1985) 'On Technological Catastrophe', *Science* 228, May 17th.
- Hoppe, R. and Peterse, Aat (1993) *Handling Frozen Fire. Political Culture and Risk Management*. Westview Press, Boulder.
- Kahneman, D., Slovic, P. And Tversky, A. (eds.) (1982) *Judgment under Uncertainty: Heuristics and Biases*. Camebridge University Press, New York.
- Katz, J. (1977) 'Cover-Up and Collective Integrity: On the Natural Antagonisms of Authority Internal and External to Organizations', *Social Problems*¸ 25 (1).
- Kleinderfer, P.R. and Kunreuther, H.C. (ed.) (1987) *Insuring and Managing Hazardous Risks: From Seveso to Bhopal and Beyond*. Springer-Verlag, Berlin.
- Levitt, R. E. (1975) *The Effect on Top Management on Safety in Construction*, doctoral dissertation, Department of Civil Engineering, Stanford University.

- March, J. G. (1981) 'Decisions in Organizations and Theories of Choice', in Van der Ven, A. H. and Joyce, W. F. (eds.) *Perspectives on Organization Design and Behaviour*, JohnWiley, New York.
- March, J.G. and Olsen, J.P. (1986) 'Garbage Can Models of Decision Making in Organizations', in March, J.G. and Weissinger-Baylon, R. (eds.) *Ambiguity and Command: Organizational Perspectives on Military Decision Making.* Pitman, Marshfield.
- March, J.G. (1988) *Decisions and Organizations*. Basil Blackwell, Oxford.
- March, J.M. (1994) *A Primer on Decision Making. How Decision Happen*. The Free Press, New York.
- Marais,K. Dulac, N and Leveson, N. (2004) *Beyond Normal Accidents and High Reliability Organizations: The Need for an Alternative Approach to Safety in Complex Systems*. MIT.
- Marone, J. G. and Woodhouse, E. J. (1986) *Adverting Catastrophe: Strategies for Regulating Risky Technologies*. University of California Press, Berkely.
- Marone, J.G. and Woodhouse, E.J. (1989) *The Demise of Nuclear Energy*. Yale University Press, New Haven.
- Mythen, G. (2004) *Ulrich Beck. A Critical Introduction to the Risk Society*. Pluto Press, London.
- Nisbett, R., Ross, L. (1980) *Human Inference: Strategies and Shortcomings of Social Judgments*. Prentice-Hall, Englewood Cliffs.
- Perrow, C. (1977) 'Three Types of Effectiveness Studies', in Goodman, P.S., Pennings, J. M. and Associates, *New Perspectives on Organizational Effectiveness*. Josey Bass, San Franssisco.
- Perrow, C. (1983) 'The Organizational Context of Human Factors Engineering', *Administrative Science Quarterly*, 28 (4).
- Perrow, C. (1984) *Normal Accidents. Living with High-Risk Technologies*. Basic Books Publishers, New York.
- Perrow, C. (1992) 'Accidents in High Risk Systems', *Technology Studies*, 1 (1).
- La Porte, T.R. and Consolini, P. (1991) 'Working in Practice But Not in Theory: Theoretical Challenges of High-Reliability Organizations', *Journals of Public Administration Research and Theory*, 1, 19-47.
- La Porte, T. R. and Rochlin, G. (1994) 'A Rejoinder to Perrow', *Journal of Contingencies and Crisis Management*, 2 (4).
- La Porte, T. R. (1996) 'High Reliability Organizations: Unlikely, Demanding, and At Risk', *Journal of Contingencies and Crisis Management*, 63 (4).

- Reason, J. (1990) *Human error*. Cambridge University Press, Cambridge.
- Roberts, K. H. (1990a) 'Managing High Reliability Organizations', *California Management Review*, 32(4), pp. 101-114.
- Roberts, K. H. (1990b). 'Some Characteristics of One Type of High Reliability Organization', *Organizational Science*, 1(2), pp. 160-176.
- Robson, C. (2002) *Real World Research A Resource for Social Scientists and Practitioners-Researchers*. Blackwell Publishing, Malden.
- Rochlin, G. I. (1991) 'Iran Airflight 655 and the USS Vinceness: Complex, Large-Scale Military Systems and the Failure of Control', in La Porte, T. R. (ed.) *Social Reponses to Large Technical Systems: Control or Anticipation*, NATO ASI Series, Kluwer Academic Publishers.
- Rochlin, G. I., La Porte, T.R. and Roberts, K.H. (1987) 'The Self-Designing High Reliability Organizations', *Naval War College Review*, Autumn.
- Sagan, S.D. (1993) *The Limits of Safety. Organizational, Accidents, and Nuclear Weapons.* Princeton University Press, New Jersey.
- Scott, W.R. (1987) *Organizations: Rational, Natural and Open Systems*. Prentice-Hall, Enlgewood Cliffs.
- Shrivastava, P. (1987) *Bhopal: Anatomy of a Crisis.* Ballinger, Cambridge.
- Simon, H. (1957) 'A Behavioral Model of Rational Choice', in *Models of Man, Social and Rational: Mathematical Essays on Rational Human Behavior in a Social Setting*, Wiley, New York.
- Simon, H. (1990) 'A mechanism for social selection and successful altruism', *Science* 250 (4988): 1665-1668.
- Starbuck, W.H. and Milliken, F.J. (1988) 'Challenger: Fine-Tuning the Odds until Something Breaks', *Journal of Management Studies*. 25 (4).
- Steinbruner, J.D. (1974) *The Cybernetic Theory of Decision*. Princeton University Press, Princeton.
- Tamuz, M. (1988) 'Monitoring Dangers in the Air: Studies in Ambiguity and Information'. Doctoral Dissertation, Department of Sociology, Stanford University.

  Tasca, L. (1990) *The Social Construction of Human Error,* doctoral dissertation, Department of Sociology, State University of New York at Stony Brook.
- Teisman, G.R. (2005) *Publiek Management op de Grens van Chaos en Orde. Over Leidinggeven en Organiseren in Complexiteit*. Sdu Uitgevers, Den Haag.

- Weick, K. E. (1987) 'Organizational Culture as a Source of High Reliability', *California Management Review*, 29(2), pp. 112-127.
- Weick, K.E. and Roberts, K.H. (1993) 'Collective Minds in Organizations: Heedful Interrelating on Flight Decks', *Administrative Science Quarterly*, 38(3), pp. 357-381.
- Weick, K.E., Sutcliffe, K. and Obstfeld, D. (1991) 'Organizing for High Reliability', *Research in Organizational Behaviour, 21, pp. 81-123.*
- *Wildavsky, A.* (1988) *Searching for Safety. Transaction Publishers, New Brunswick.*
- Woodhouse, E.J. (1988) 'Sophisticated Trial and Error in Decision Making about Risk', in Kraft, M.E. and Vig, N.J. (eds.), *Technology and Politics*. Duke University Press, Durham.

Documents

- '29th International Forum on Traffic Records & Highway Information Systems July 15', 2003 Annette M. Sandberg Acting Administrator. Department of Transportation, Federal Motor Carrier Safety Administration.
- 'A National Risk Assessment for Selected Hazardous Materials in Transportation'. Argonne National Laboratory, University of Chicago, 2000.
- 'An Overview of the Hazardous Materials Transportation Law (Federal Hazmat Law)'. Department of Transportation, Research and Special Programs Administration, 1997.
- 'A summary Evaluation of Risk Associated with Bulk Loading/Unloading of Hazmat'. Department of Transportation, Office of Hazardous Materials Safety, 2007.
- 'Bilingual Hazardous Materials General Awareness Training' (Volume I-IX). Department of Transportation, Federal Motor Carrier Safety Administration.
- 'Comparative Risks of Hazardous Materials and Non-Hazardous Materials Truck Shipment Accidents/Incidents'. Batelle, 2001.
- 'Cooperative Research for Hazardous Materials Transportation Defining the Need, Converging on Solutions'. Transportation Research Board of the National Academies, 2005.
- 'Department of Transportation Strategic Plan 2003-2008. Safer Simpler, Smarter Transportation Solutions'. Department of Transportation, 2003.
- 'Department of Transportation Strategic Plan. New Ideas for a Nation on the Move, Fiscal Years 2006-2011. Department of Transportation, 2006.
- 'Departmentwide Program Evaluation of the Hazardous Materials Transportation Program'. Department of Transportation 2002.

- 'Economic Census Transportation 2002 Commodity Flow Survey'. Department of Commerce and Department of Transportation, 2004.
- 'Emergency Response Guidebook 2004. A Guidebook for first Responders during Initial Phase of a Dangerous Goods/Hazardous Materials Incident'. Developed jointly by Transport Canada (TC), the U.S. Department of Transportation (DOT), the Secretariat of Transport and Communications of Mexico (SCT) and with the collaboration of CIQUIME (Centro de Información Química para Emergencias) of Argentina, 2004.
- 'Enhancing Security of Hazardous Materials Shipments Against Acts of Terrorism or Sabotage Using RSPA's Risk Management Self-Evaluation Framework'. Department of Transportation, 2002.
- 'Estimating the Extent of Under-reporting of Hazmat Incidents'. Department of Transportation, Office of Hazardous Materials Safety, 2007.
- 'Federal Hazardous Materials Transportation Law'. Department of Transportation, Research and Special Programs Administration, 2002.
- 'Final Report: Dynamics of Tank Vehicle Roll-Overs'. Department of Transportation, Federal Motor Carrier Safety Administration, 1998.
- 'FMCSA Talking Points'. Department of Transportation, Federal Motor Carrier Safety Administration.
- 'FY 2006 – FY 2011 Information Resources Management Plan'. U.S. Department of Transportation Office of the Chief Information Officer, 2006.
- 'Guide to Developing an Effective Security Plan for the Highway Transportation of Hazardous Materials'. Batelle and TotalSecurity.US, 2003.
- 'Hazardous Materials Accident Brief. Cargo Tank head Fracture, Middletown, Ohio August 22, 2003. National Transportation Safety Board, 2004.
- 'Hazardous Materials Accident Brief. Chemical reaction during cargo transfer Whitehall, Michigan June 4 1999'. National Transportation Safety Board, 2000.
- 'Hazardous Materials Accident Report. Dire and Explosion of Highway Cargo Tanks, Stock Island Key West, Florida June 29, 1998'. National Transportation Safety Board, 1999.
- 'Hazardous Materials Accident Report. Nurse Tank Failure with Release of Hazardous Materials near Calamus, Iowa April 15, 2003'. National Transportation Safety Board, 2004.

- 'Hazardous Materials Accident Report. Release and Ignition of Hydrogen Following Collision of a Tractor-Semitrailer with Horizontally Mounted Cylinders and a Pickup Truck near Ramona, Oklahoma May 1, 2001. National Transportation Safety Board, 2002.
- 'Hazardous Materials Awareness Study Guide'. Fire & Rescue Training Institute, University of Kansas, 2004.
- 'Highway/Hazardous Materials Accident Summary Report. Collision of Tractor/Cargo Tank Semitrailer and Passenger Vehicle and Subsequent Fire, Yonkers, New York October 9, 1997. National Transportation Safety Board, 1998.
- 'Hazardous Materials Emergency Preparedness Grants Program: Assessment of the alignment between local activities and program goals'. Prepared by: Economic and Industry Analysis Division John A. Volpe National Transportation Systems Center United States Department of Transportation Cambridge, Massachusetts, 2005.
- 'Hazardous Materials Highlights. Department of Transportation, Federal Motor Carrier Safety Administration, 2001.
- 'Hazardous Materials Risk Assessment'. Department of Transportation, Federal Motor Carrier Safety Administration, 2001.
- 'Hazardous Materials Serious Crash Analysis'. Department of Transportation, Federal Motor Carrier Safety Administration, 2003.
- 'Hazardous Materials Transportation Incident Data for Root Cause Analysis'. Department of Transportation, Office of Hazardous Materials Safety, 2006.
- 'Hazmat Safety & Security Field Operational Test, Final Report'. Batelle, 2004.
- 'Highway Safety Leadership Forum Lexington' (transcript). KY June 2, 2003.
- 'Hijacking Brochure'. Department of Transportation, Federal Motor Carrier Safety Administration
- 'How to Comply with Federal Hazardous Materials Regulations'. Department of Transportation, Federal Motor Carrier Safety Administration.
- 'Intermodal Explosives Working Group Report'. Department of Transportation, 2003.
- 'Interstate HM Incident Reporting Compliance'. Department of Transportation, Federal Motor Carrier Safety Administration.
- 'Hazardous Materials Shipper Check Report 2000'. Department of Transportation, Federal Motor Carrier Safety Administration, 2000.
- 'Hazardous Materials Shipper Check Report 2001'. Department of Transportation, Federal Motor Carrier Safety Administration, 2001.

- 'Hazardous Materials Shipper Check Report 2002'. Department of Transportation, Federal Motor Carrier Safety Administration, 2002.
- 'HM Incident Prevention Manual'. Department of Transportation, Federal Motor Carrier Safety Administration, 1995.
- 'How to use the Hazardous Materials Regulations. CFR 49 Parts 100 to 185'. Pipeline and Hazardous Materials Safety Administration.
- 'Law Enforcement Alert - Security Assessment for Enforcement'. Department of Transportation, Federal Motor Carrier Safety Administration.
- 'Performance and Accountability Report FY 2006'. Department of Transportation, 2006.
- 'Prohibiting Hazardous Material in External Piping of MC 306/DOT 406 Cargo Tank Motor Vehicles. Preliminary Assessment'. Department of Transportation, 1999.
- 'Recommended Practice for Responding to Hazardous Materials Incidents'. National Fire Protection Association, 1997.
- 'Recommended Practice for Responding to Hazardous Materials Incidents'. National Fire Protection Association, 2002.
- 'Report on FMCSA's Security Sensitivity Visits to the House and Senate Committees on Appropriations'. Department of Transportation, Federal Motor Carrier Safety Administration, 2002.
- 'Report to Congress on the Hazardous Material Emergency Preparedness (HMEP) Grants Program'. Department of Transportation, 1998.
- 'Risk Based Decision Making in the Hazardous Materials Safety Program. Department of Transportation, Research and Special Programs Administration, 1998.
- 'Risk Management Framework for Hazardous Materials Transportation'. ICF Consulting, 2000.
- 'Safety Performance Data'. Department of Transportation, Office of Hazardous Materials Safety.
- 'Safety Study Protecting Excavation Public Safety through Damage Prevention'. National Transportation Safety Board, 1997.
- 'Serious Incident Definition'. Department of Transportation, Office of Hazardous Materials Safety, 2000.
- 'Standard for Competencies for EMS Personnel Responding to Hazardous Materials Incidents'. National Fire Protection Association, 1997.
- 'Standard for Competencies for EMS Personnel Responding to Hazardous Materials Incidents'. National Fire Protection Association, 2002.

- 'Standard for Professional Competence of Responders to Hazardous Materials Incidents'. National Fire Protection Association, 1997.
- 'Tank Check Report 2002'. Department of Transportation, Federal Motor Carrier Safety Administration, 2002.
- 'Tank Check Report 2004'. Department of Transportation, Federal Motor Carrier Safety Administration, 2004.
- 'Task 2 Report - Evaluate Current System'. ICF Consulting, 2000.
- 'The Role of Hazardous Material Placards In Transportation Safety and Security'. Prepared by U.S. Department of Transportation Research and Special Programs Administration Office of Hazardous Materials Safety and John A. Volpe National Transportation Systems Centre, 2003.
- 'Three Case Studies for the Risk Management Framework for Hazardous Materials Transportation'. ICF Consulting, 2000.
- 'Transportation Research, Development and Technology Strategic Plan 2006-2010'. U.S. Department of Transportation Research and Innovative Technology Administration, 2006.
- 'Uniformity of State Hazardous Materials Permitting and Registration'. Department of Transportation, Federal Motor Carrier Safety Administration.
- 'U.S. Department of Transportation Biennial Report on Hazardous Materials Transportation Calendar Years 1996-1997'. U.S. Department of Transportation, 1999.
- 'We are all Safer. NTSB-Inspired Improvements in Transportation Safety'. National Transportation Safety Board (2nd ed.), 1998.

Websites

- Chemical Safety and Hazard Investigation Board
  www.chemsafety.gov [June, July 2007]
- Department of Transportation
  www.dot.gov [April, May, June, July 2007]
- Federal Aviation Administration
  www.faa.gov [June, July 2007]
- Federal Motor Carrier Safety Administration
  www.fmcsa.dot.gov [June, July 2007]
- Federal Railroad Administration

www.fra.dot.gov [June, July 2007]

- Governmental Printing Office
  ww.gpoaccess.gov [June, July 2007]
- International Association of Fire Chiefs
  www.iafc.org [June, July 2007]
- International Fire Marshals Associations
  www.ifma.org [June, July 2007]
- Office of Hazardous Materials Safety
  hazmat.dot.gov [April, May, June, July 2007]
- Pipeline Hazardous Materials Safety Administration
  www.phmsa.dot.gov [April, May, June, July 2007]
- United States Coast Guard
  www.uscg.mil [June, July 2007]
- National Response Team
  www.nrt.org [June, July 2007]
- National Transportation Safety Board
  www.ntsb.gov [June, July 2007]
- Transportation Safety Institute
  www.tsi.dot.gov [June, July 2007]

A Quest for Safety

An Analysis on the Safety Management Approach of the
United States Office of Hazardous Materials Safety

Appendix

Erasmus University Rotterdam
International Public Management and Policy
Shivant Jhagroe - 280055

Prof. dr. ing. G.R. Teisman
Dr. F.A.A. Boons

Contents

Note

This is the addendum of the 'A Quest for Safety' thesis. The aim of this supplement is to provide more background information about mainly the strategies, programmes and measures of the OHMS and the FMCSA, with the thought to have this separate appendix next to the thesis while reading it. This way it is more convenient to read the thesis with the background information at hand.

Appendix A. Hazardous Materials Classes

- **Class 1 - Explosives**
    - Division 1.1 Explosives with a mass explosion hazard
    - Division 1.2 Explosives with a projection hazard
    - Division 1.3 Explosives with predominantly a fire hazard
    - Division 1.4 Explosives with no significant blast hazard
    - Division 1.5 Very insensitive explosives with a mass explosion hazard
    - Division 1.6 Extremely insensitive articles

- **Class 2 - Gases**
    - Division 2.1 Flammable gases
    - Division 2.2 Non-flammable, non-toxic* gases
    - Division 2.3 Toxic* gases

- **Class 3 - Flammable liquids (and Combustible liquids** [U.S.]**)**

- **Class 4 - Flammable solids; Spontaneously combustible materials; and Dangerous when wet materials/Water-reactive substances**
    - Division 4.1 Flammable solids
    - Division 4.2 Spontaneously combustible materials
    - Division 4.3 Water-reactive substances/Dangerous when wet materials

- **Class 5 - Oxidizing substances and Organic peroxides**
    - Division 5.1 Oxidizing substances
    - Division 5.2 Organic peroxides

- **Class 6 - Toxic* substances and Infectious substances**
    - Division 6.1 Toxic*substances
    - Division 6.2 Infectious substances
- **Class 7 - Radioactive materials**

- **Class 8 - Corrosive substances**

- **Class 9 - Miscellaneous hazardous materials/Products, Substances or Organisms**

* The words ‘poison’ or ‘poisonous’ are synonymous with the word ‘toxic’.

Source: Emergency Response Guide 2004.

Appendix B. Overview methodology

Main indicators for high reliability theory and normal accidents theory

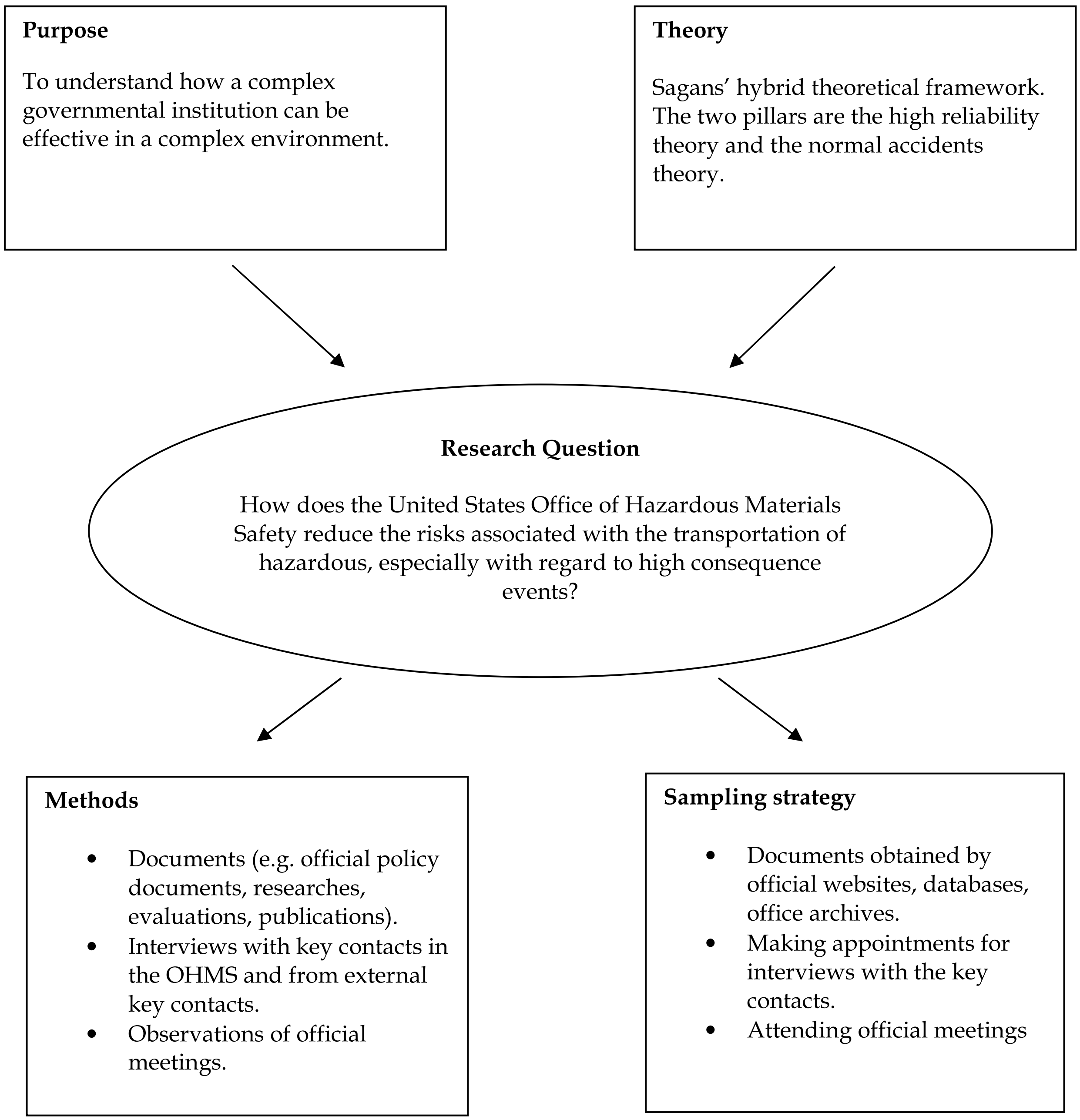
1. Priority of leaders and organization
2. Redundancy of safety measures
3. Decentralization of decision-making
4. Culture of reliability
5. Continuous operations, training and simulations
6. Organizational learning

1. How does the OHMS reduce the risks associated with the transportation of hazardous materials, especially with regard to high consequence events? *(Programmatic level)*
2. How and why did serious highway hazardous materials incidents occur? *(Incidents level)*

Appendix C. Interviewees

Bob Richard	Deputy Associate Administrator, Office of Hazardous Materials Safety. Department of Transportation.
Dave Sargent	Director, Office of Hazardous Materials Initiatives and Training. Department of Transportation.
Delmer Billings	Director, Office of Hazardous Materials Special Permits and Approvals. Department of Transportation.
Douglas Reeves	Supervisor General Engineer, Office of Hazardous Materials Technology. Department of Transportation.
James Simmons	Chief Hazardous Materials Division. Office of Enforcement and Compliance, Federal Motor Carrier Safety Administration. Department of Transportation.
Ryan Posten	Director, Office of Hazardous Materials Enforcement. Department of Transportation.
Salvatore Caccavale	Director Environmental Health and Safety. Superior Bulk Logistics, Inc.
Stacey Gerard	Assistant Administrator Chief Safety Officer. Pipeline and Hazardous Materials Safety Administration. Department of Transportation

Appendix D. Overview Research Design



Based on Robson (2005: 82).

Appendix E. The Hazardous Materials Regulations

- **105**: Hazardous Materials Programme Definitions and General Procedures
- **106**: Rulemaking Procedures
- **107**: Hazardous Materials Programme Procedures
- **110**: Hazardous Materials Public Sector Training and Planning Grants
- **130**: Oil Spill Prevention and Response Plans
- **171**: General Information, Regulations and Definitions
- **172** Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information and Training Requirements
- **173**: Shippers General Requirements for Shipments and Packagings.
- **174**: Carriage by Rail
- **176**: Carriage by Aircraft
- **177**: Carriage by Public Highway
- **178**: Specifications for Packagings
- **179**: Specifications for Tank Cars
- **180**: Continuing Qualification and Maintenance of Packagings

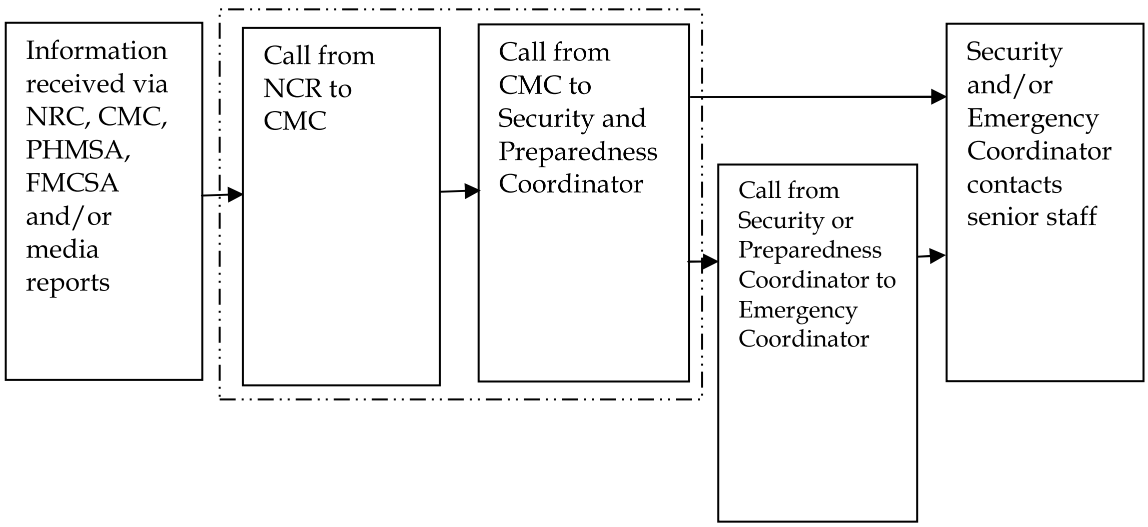
Part 172 – Hazardous Materials table, special provisions, hazardous materials communications, emergency response information and training requirements.

- **Subpart A:** General
- **Subpart B:** Table of Hazardous Materials and Special Provisions
  Subpart C: Shipping Papers
- **Subpart D:** Marking
- **Subpart E:** Labeling
- **Subpart F:** Placarding
- **Subpart G:** Emergency Response Information
- **Subpart H:** Training
- **Subpart I:** Security Plans

Source: www.myregs.com/dotrspa

Appendix F. Information Flow Chart

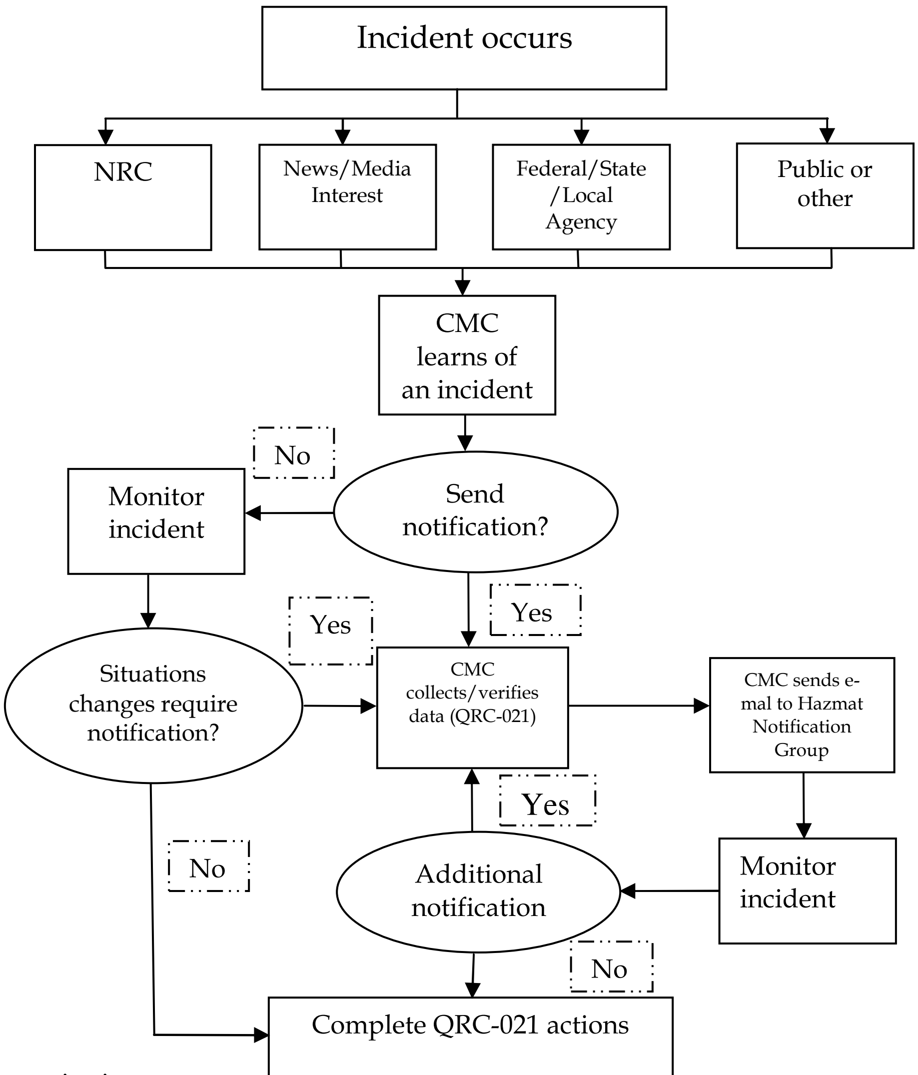
Information Flow chart of monitoring accidents and incidents



Source: 'Hazardous Materials Safety Monitoring Accidents & Incidents', an OHMS document 2007.

Appendix G. CMC Process Flow Chart

CMC Process Flow Chart



Notification criteria:
- Serious incident;
- National media interest;
- Politically sensitive issues.

QRC = Quick Response Card

Email content:
- Narrative summary of incident (QRC-021 data);
- Impact on transportation system;
- Sources of information.

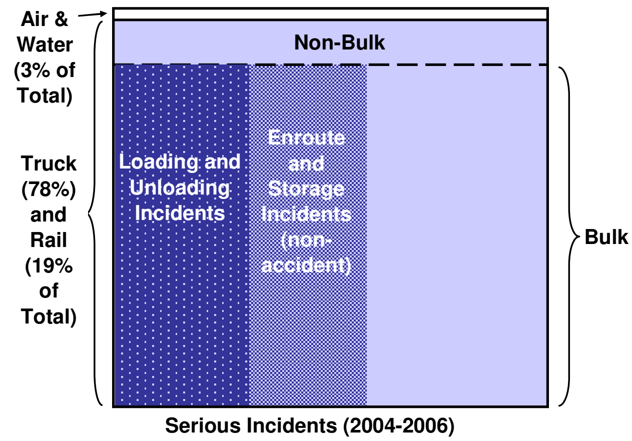
Source: 'Hazardous Materials Safety Monitoring Accidents & Incidents', an OHMS document 2007.

Appendix H. L-UL programme

Bulk L-UL operations in the trucking and rail modes represent *from a third to half of the overall risk* (probability) of serious incidents in hazardous materials transportation.

- *Trucking and rail* account for about 72% of all hazardous materials ton-miles (2002 CFS, excluding pipeline), 89% of all incidents, and 97% of serious incidents—our primary measure of programme performance.

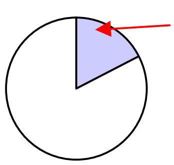
- *Bulk commodities* dominate the *serious safety incidents* involving hazardous materials by truck and rail —and account for 9 out of 10 high consequence events by most measures.



Loading and unloading of bulk hazardous materials account for 27% of serious incidents directly, and might be a factor for up to 24% more of the total. Many causes of en-route and storage incidents strongly suggest a loading issue—causes like *overfilled; improper preparation for transportation; or loose closure, component or device;* the linkages for other causes are unclear. The OHMS considered all en-route or storage incidents not involving an accident or derailment as the upper limit on L-UL related causes.

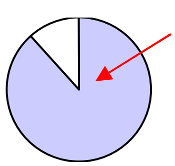
For Trucking and Rail modes:

Bulk hazmat accounts for …	**Loading/unloading accounts for …**



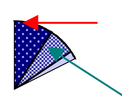
17% of reported incidents

Any incident meeting the reporting criteria.



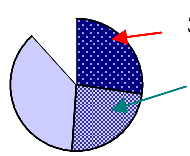
88% of serious incidents

Incidents involving death, major injury, fire, explosion, evacuation, or several other defined outcomes.



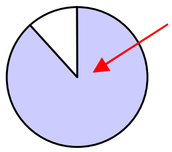
Over half of bulk hazmat incidents,

and may be a factor in up to 40% of bulk en-route and storage incidents (not including accidents or derailments).



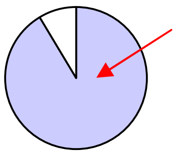
31% of serious incidents (bulk)

and may be a factor in up to 27% of these serious incidents en-route or in storage.



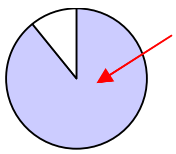
88% of fatal incidents

and all incidents with multiple fatalities.



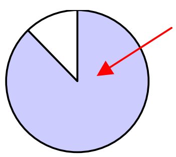
91% of major injuries

requiring hospitalization – about 64 per year on average.



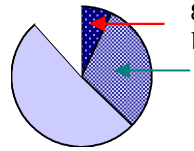
89% of evacuations (# people)

about 17,000 people/year, and 76% of the number of separate evacuations.



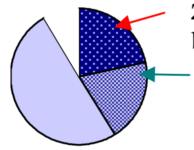
88% of the reported dollar damage from incidents

about $80M per year average.



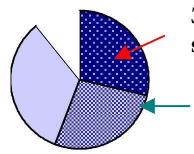
8% of fatal incidents involving bulk

and may be a factor in up to 34% of fatal incidents involving bulk en-route or in storage.



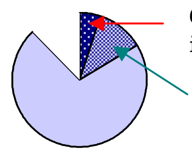
24% of major injuries involving bulk

And may be a factor in up to 21% of major injuries involving bulk en-route or in storage.



32% of people evacuated for serious bulk incidents

And may be a factor in up to 31% of people evacuated for bulk incidents en-route or in storage.



6% of the dollar damage from bulk incidents

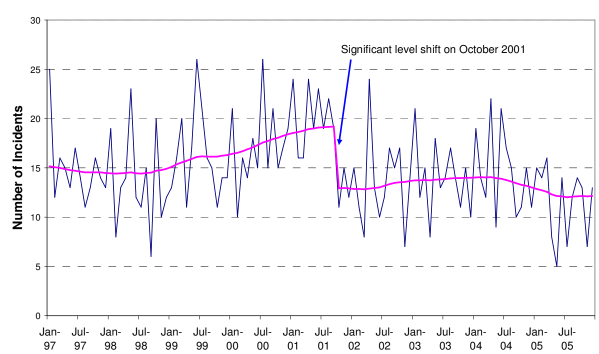
And may be a factor in up to 13% of dollar damage from bulk incidents en-route or in storage.

Source: DOT/PHMSA Incident Data (2004-2006) from HMIS, as of Jan. 9, 2007

The trend over time shows little real change over the past decade, implying a need to look for new solutions.

- For bulk L-UL, the number of serious incidents at the end of 2005 is lower than 1997-2000, but all of the decline occurred in one step right after 9/11/01. This indicates a structural shift in hazardous materials transportation at that point, rather than a programmatic effect.

Serious Incidents: Bulk Hazmat - Loading and Unloading
Original data (1997-2005) with Trend



- The trend since 9/11 is essentially flat through the end of 2005.

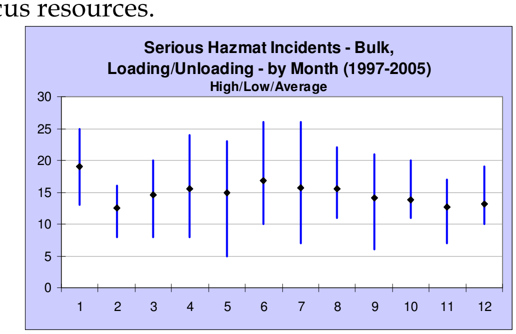
Bulk L-UL operations also might present an *opportunity* for reducing risk that is disproportionately greater than the risk itself, since there is by definition a high volume of product per shipment. Any broad intervention at the point of shipment affects substantially more volume than an intervention for a packaged shipment.

Patterns in the incident data suggest several factors that might be useful in targeting interventions.

- *Causes*: The top 10 identified causes account for almost 80% of the total number of bulk L-UL incidents in 2005. Many causes of en-route and storage incidents point to a loading issue—causes like *overfilled; over-pressurized; improper preparation for transportation; inadequate blocking and bracing; or loose closure, component or device*. Cause information provides one of the best sources for identifying solutions.

- *Geographic distribution*: The top 10 states account for about 60% of the total serious incidents for bulk hazardous materials. Solutions are sometimes targeted, especially during a pilot phase; geographic patterns can help focus resources.

- *Seasonal pattern*: The month of January is historically higher than other months of the year. That's the only month that shows a statistically significant difference. Seasonal patterns can help point to important factors beyond the identified causes of an incident. More analysis might illuminate other seasonal factors.



Data sources, limitations, and methodology:

Data are from the Hazardous Materials Information System, as of Jan. 9, 2007. Data in HMIS are incidents meeting published reporting criteria for hazardous materials incidents. Each record in the data base was counted as an incident, although this might appear to inflate the number of 'incidents' to a small degree since there are separate records for each commodity released. Incident numbers in this analysis are limited to truck and rail, except where indicated otherwise. Truck and rail together account for 89% of the total number of incidents, and 97% of serious incidents.

Serious incidents are a subset of all reported incidents; these are the focus of DOT's principal performance measure for hazardous materials safety. Serious incidents include any unintentional release resulting in death, major injury, closure of a major transportation artery, alteration of an aircraft flight plan, release of radioactive material from a Type B package, suspected release of certain infectious substances, or release of a bulk quantity of hazardous material.

Source: 'A Summary Evaluation of Risk Associated with Bulk Loading/Unloading of Hazmat'. Office of Hazardous Materials Safety, March 2007.

Appendix I. Underreporting

Estimates of Under-reporting for Hazmat Incidents
(2004-2006 HMIS Data)

	Top 44 Carriers	All other Carriers	Total
Total # reported incidents:	**47,108**	**4,419**	**51,527**
Percent of total:	91.4%	8.6%	100.0%
# reported serious incidents:	**578**	**1,020**	**1,598**
Percent of total:	36.2%	63.8%	100.0%
# reported fatal incidents:	**4**	**39**	**43**
Percent of total:	9.3%	90.7%	100.0%
Ratio of SI's to Total:	0.0123	0.2308	0.0310
Ratio of Total to SI's:	81.5	4.3	32.2
Ratio of FI's to Total:	0.000085	0.008826	0.000835
Ratio of Total to FI's:	11,777	113	1,198
Total incidents extrapolated from 44-carrier SI's:	**47,108**	**83,132**	**130,240**
Under-reporting (assuming SI/Total ratio):	-	78,713	78,713
Est. percent of reports missing:	0.0%	94.7%	60.4%
Total incidents extrapolated from 44-carrier FI's:	**47,108**	**459,303**	**506,411**
Under-reporting (assuming FI/Total ratio):	-	454,884	454,884
Est. percent of reports missing:	0.0%	99.0%	89.8%

SI's = Serious Incidents

FI's = Fatal Incidents

Source: 'Report on underreporting', Office of Hazardous Materials Safety, 2007.

Appendix J. Awareness publications and reports

- **Hazardous Materials Information and Brochures**
  - How to Handle Radioactive Materials
  - Guide for Preparing Shipping Papers
  - Wetlines Awareness for Emergency Responders
  - Hazardous Materials Safety Brochure
  - Hazmat Transportation Safety Institute (TSI) Training Brochure
  - Hazmat CD-ROM Training Modules Brochure
  - Hazmat CD-ROM Training Modules
  - Intrastate Commerce (HM-200) Publications
    - Transporting Agricultural Products Safely (
    - Complying with the October 1, 1998 Intrastate Commerce Requirements (HM-200)
    - What Are Materials of Trade, and What Regulations Apply?
  - Hazmat Publications and Videos Online Ordering
  - Commercial Suppliers

    - 2004 Emergency Response Guidebook
    - DOT Chart 12 (Marking, Labeling, and Placarding Guides)
  - Hazmat Identification System Improvements (HM206)
    - Fumigant Marking Requirement
  - In Support of Small Business
  - Compliance Assistance Guide: Cargo Tank
  - Guidelines For Selecting Preferred Highway Routes For Controlled Ram Shipments
  - Hazmat Safety News March 2003 (HMEP)
  - Hazmat Safety News February 2003 (Harmonization with International Regulations)
  - What To Do/Know When Transporting Hazmat Internationally
  - Is your COMAT Safe To Fly brochure
  - Kid Zone: How To Stay Safe At Home
  - Guide for Brokers, Forwarding Agents, etc.

- **Safety Alerts**

    - Safety Alert (May 2006)
        - Manufacture, Marking, and Sale of Untested Compressed Gas Cylinders
    - Safety Alert (April 2006)
        - Responding to Incidents Involving Ethanol and Gasoline Fuel Mixtures
    - Cargo Tank Safety Advisory Notice
    - Safety Alert (March 2003)
        - Don't Ship a PSA, PBE, or EEBD (Contains a Chemical Oxygen Generator) without a DOT Approval
    - Safety Alert (January 2002)
        - Hazmat Transportation Security on Highest Alert during Olympics and Super Bowl
    - Safety Alert (October 2001)
        - Hazmat Transportation Community Urged to Increase Safety Measures
    - Safety Alert (September 2001)
        - Hazmat Transportation Community Urged to Increase Safety Measures
    - Safety Alert (April 2001)
        - This document provides information on requalification of acetylene cylinders.
    - Safety Alert (January 1998)
        - This document provides an overview of the regulations pertaining to oxygen generators. It also includes some COMAT questions and answers.
    - Safety Alert (January 1998)
        - PBE/Oxygen Generators (January 1998)
    - Safety Alert (February 1997)
        - This document contains summaries of PHMSA rulemakings. Visit our Rulemakings page to view or print the summarized documents.

- **Other Hazardous Materials Reports**

    - Identification of Factors for Selecting Modes and Routes for Shipping High-Level Radioactive Waste and Spent Nuclear Fuel
    - Federal Hazardous Materials Transportation Law

    - An Overview of the Federal Hazmat Transportation Law
- Hazardous Materials Shipments
- Reports: Hazardous Materials Incidents Cost Estimates
    - Total Reported Hazardous Materials Incidents
    - July 27, 1994 White Plains, NY Propane Truck Incident
    - March 25, 2004 Bridgeport, CT Tanker Truck Incident
- Compressed Gas Cylinders
    - Information on DOT Specification 3AL Cylinders
    - Advisory: Cylinders - Overfilling Prevention Device (OPD)
- Biennial Report on Hazardous Materials Transportation -- This is a report sent by the President to Congress which discusses DOT's hazardous materials transportation accomplishments, projections for future years, violations, penalties assessed, and safety record.
    - 1996 - 1997 Biennial Report
        - Full Version
        - Report without charts and graphs from Chapter 10 "Safety Performance Data"
    - 1994 - 1995 Biennial Report
- Report on Penalty Actions
    - Download Penalty Actions Reports by Mode/Year
- Guidance for Conducting Hazardous Materials Flow Surveys
- The Dynamics of Tank-Vehicle Rollover and the Implications for Rollover-Protection Devices (UMTRI-98-53)
- A complete copy of the final rule published under Docket HM-200 can be obtained here
- A complete copy of the final rule published under Docket HM-206 can be obtained here.
- Placard Report: The Role of Hazardous Materials Placards In Transportation Safety and Security

Source: http://hazmat.dot.gov/pubs/pubs.htm#other

Appendix K. Training requirements

U.S. Department of Transportation (USDOT) regulations require initial and recurrent training of all employees who perform work functions covered by the Hazardous Materials Regulations (HMR; 49 CFR Parts 171-180). Any employee whose work directly affects hazardous materials transportation safety is required to have training. The Office of Hazardous Materials Safety has prepared training modules that meet the requirements for General Awareness Training as prescribed in Title 49 CFR, Part 172, Subpart H.

All hazardous materials employers[1] are required (by law 49 U.S.C. § 5107) to train, test and maintain training records for all hazardous materials employees. These training areas include safe packaging, loading, unloading, handling, storing and transporting of hazardous material and emergency preparedness for responding to an incident involving the transportation of hazardous materials. This leads to a certification which is also required and the employer must develop and retain records of current training (inclusive of preceding three years) for each hazardous materials employee (during the period of employment and 90 days thereafter). Relevant training received from a previous employer or other source may be used to satisfy the requirements, provided a current record of training is obtained from the previous employer or source. A training record must include:

- Hazardous materials employee's name;
- Completion date of most recent training;
- Training Materials (Copy, description, or location);
- Name and address of hazardous materials trainer; and
- Certification that the hazardous materials employee has been trained and tested.

A hazardous materials training must include

- General awareness/familiarization;
- Function-specific, training;

[1] Means a person who uses one or more of its employees in connection with: transporting hazmat in commerce; causing hazmat to be transported or shipped in commerce; or representing, marking, certifying, selling, offering, reconditioning, testing, repairing, or modifying packagings as qualified for use in the transportation of hazmat. (The term "hazmat employer" also includes any department, agency, or instrumentality of the United States, a State, a political subdivision of a State, or an Indian tribe engaged in offering or transporting hazmat in commerce.) Source: website hazmat - http://hazmat.dot.gov/training/trainreq.htm

- Safety;
- Security awareness;
- In-depth security training, if a security plan is required; and
- Driver training (for each hazardous materials employee who will operate a motor vehicle).

Also new employee, or an employee who changes job functions, may perform hazardous materials job functions before completing training, provided. The employee does so under the direct supervision of a properly trained and knowledgeable hazardous materials employee and the hazardous materials training is completed within 90 days of employment or change in job function.

There are several conferences and workshops offered by the OHMS throughout a year. Two-day seminars and one-day workshops are free and result in a certification of the attendees. On the OHMS website workshops are provided as self-paced instructional products with a PowerPoint presentation and instructor and student manuals.

Source: www.myregs.com/dotrspa

Appendix L. The HMEP Grants Program

Hazardous materials Emergency Preparedness (HMEP) Grants Programme Fact Sheet

Programme progress

- Cumulative survey results indicate, thus far, HMEP grantees have accomplished 8,616 commodity flow and hazard analyses, created or updated 50,982 plans, conducted 11,722 exercises, and helped an average of 1,713 LEPCs each year.
- Since the beginning of the programme approximately $125 million has been awarded in HMEP grants.
- Over 2,102,000 responders and others have been trained in part thus far with HMEP grant funds.
- HMEP Curriculum guidelines are distributed to over 24,000 grantees, LEPCs/State Emergency Response Commissions and local fire departments on a request basis (telephone (301) 447-1009 for a copy). Grantees will use these guidelines to qualify courses for the list of courses mandated by Congress. Assistance is being provided to grantees in using the guidelines to qualify their courses.
- The next edition of the HMEP Curriculum guidelines is under development, and will include: complete new responder training requirements fully consistent with the new NFPA 472; new hospital first receiver training requirements consistent with new JCAHO requirements; new incident command system (ICS) training guidelines consistent with and cross walking NIMS, FIRESCOPE and the National Wildfire Coordinating Group, the Fire Service Incident Management System Consortium, OSHA, and NFPA requirements; and new Training Programme Management guidelines providing guidance on curriculum design, on risk-based training planning needed for implementation of new NFPA 472 training, on delivery management and record keeping, and on emerging instructor certification and responder certification systems and procedures
- The HMEP grant program's role in providing hazardous materials planning and training support was commended by local responders during the Tamaroa, Illinois incident on February 9, 2003, the I-95 tanker accident which took 5 lives on January 13, 2004, and the San Antonio collision, derailment and chlorine spill on June 28, 2004, where 2 were killed and twenty injured.

- The HMEP grant programme is actively involved in the NFPA 472 change process through technical assistance sessions and national response team training committee meetings
- The International Association of Firefighters has trained, thus far, approximately 1,800 fire service instructors using HMEP grant funds. Graduate instructors train approximately 47 students each year, making hazardous materials training available to more fire-fighters at an increased number of locations.

Background

- The HMEP grant programme evolved from a proposal developed by DOT, FEMA, EPA, DOL/OSHA, and DOE. It was presented to Congress during the legislative process to reauthorize the HMTA of 1974. Federal Hazardous Material Transportation Law (FHMTL) creates an appropriate role for the federal government to provide financial, technical assistance, national direction, and guidance to enhance state and local hazardous materials emergency planning and training.
- In August, 2005, President Bush signed the 'Hazardous Materials Transportation Safety and Security Reauthorization Act of 2005', more than doubling the HMEP grants programme and providing for a new Hazardous Materials Instructor Training grant.
- The HMEP grant programme is carefully crafted to build upon existing programs and relationships. It increases the emphasis on transportation in ongoing efforts. The HMEP grant programme was designed to support the framework and working relationships established within the National Response System and the Emergency Planning and Community Right-To-Know Act (EPCRA) of 1986 (Title III).

Planning Grants

- FHMTL authorizes $5 million in annual planning grants to sates, territories and native American tribes -- with a required 75% pass-through of funds to LEPCs.
- These planning grants are to be used for: 1) developing, improving, and implementing emergency plans under Title III; 2) conducting commodity flow studies; and 3) determining the need for regional hazardous material response.

Training Grants

- FHMTL authorizes $7.8 million in annual training grants to states, territories and Native American Tribes -- with 75% of the funding used to provide training to local responders, including volunteers.
- Training grants are to be used for training public sector employees to respond safely and efficiently to accidents and incidents involving the transportation of hazardous materials.

Curriculum Guidelines Developments

- Using curriculum guidelines prepared by a National consensus author team process, states will qualify courses they use for hazardous materials training.
- The list of courses mandated by Congress will consist of state qualified courses. In this way, a national list of courses will be generated in full partnership with the states.
- Assistance is being given to states in using the qualification mechanism contained in the curriculum guidelines.

Coordination

- The Training and Curriculum subcommittee of the National Response Team's Preparedness Committee, co-chaired by DOT and FEMA USFA, provides coordination for the HMEP grant programme at the federal level.
- Assistance is supplied to grantees by DOT staff insuring accomplishment of objectives and proper expenditure of funds.

Source: http://hazmat.dot.gov/training/state/hmep/hmepfact.htm

Appendix M. Risk Management Self-Evaluating Framework (security)

When selecting security risk control points, the following areas require special attention:

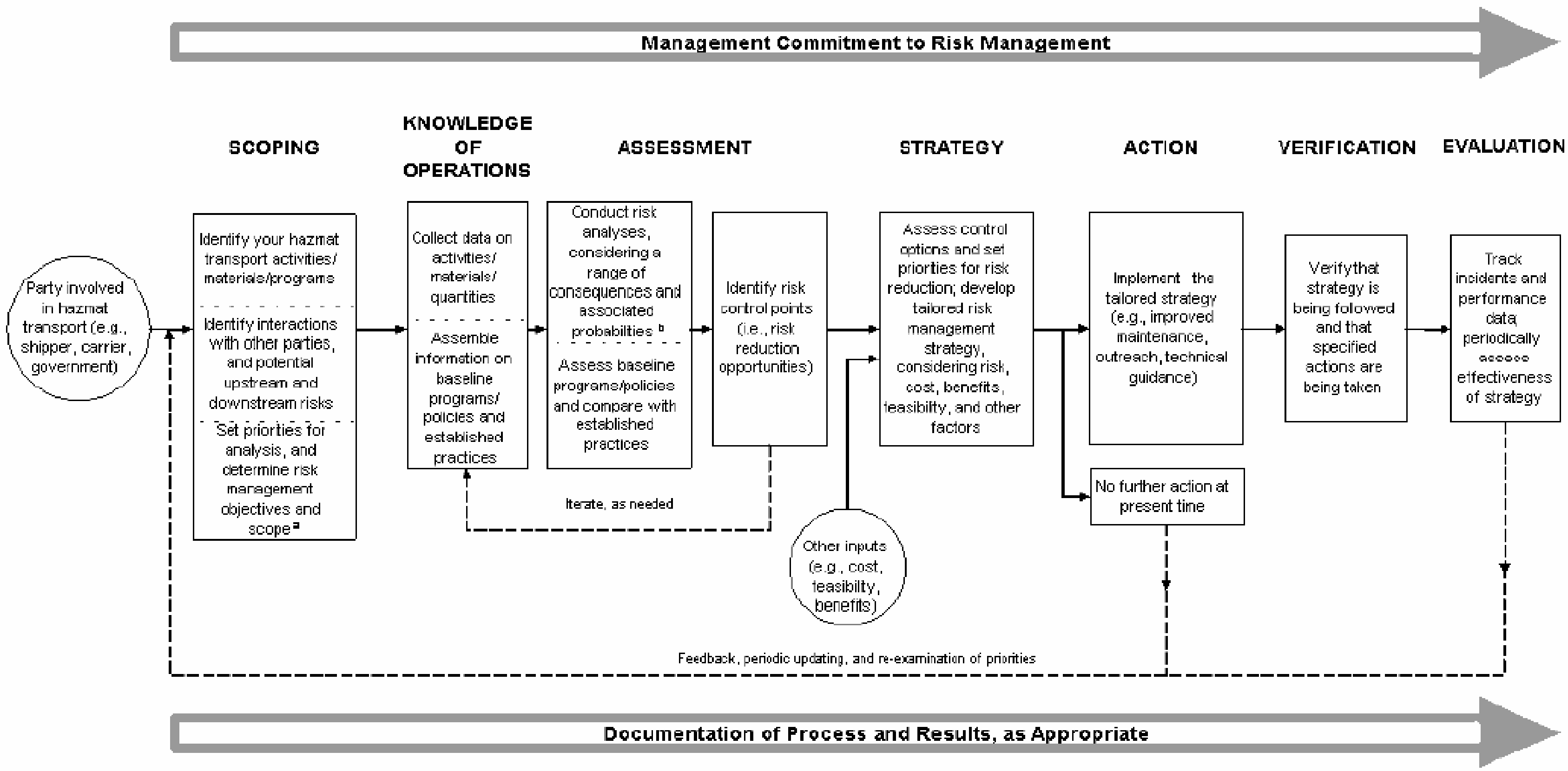
- P*ersonnel backgrounds* (e.g., employment history and verification of citizenship or immigration status);
- *Hazardous materials and package control* (e.g., adequate lighting, locks, and security systems);
- *En route security* (e.g., avoidance of tunnels, high population centres);
- *Technical innovations* (e.g., appropriate access control systems, use of satellite tracking and surveillance systems);
- *Management prerogatives* (e.g., fingerprinting applicants during employment process);
- *Communications* (e.g., use of cell phones to reach all key personnel as well as risk communications for public and immediate reporting of suspicious activity or thefts to appropriate authorities);
- *Emergency Response* (e.g., adequacy of training and resources for response to terrorist type incidents); and
- *Readjustment based upon current conditions* (e.g., heightened security after initial terrorist attacks or in accordance with threat levels that may have been established by appropriate authorities).

This framework is the same as for the safety model.

Source: Enhancing Security of Hazardous Materials Shipments Against Acts of Terrorism or Sabotage Using RSPA's Risk Management Self-Evaluation Framework (RMSEF) January 2002. DOT.

Appendix N. Risk Management Framework

Exhibit 2
A Generic, Stepwise Approach to Risk Management for Hazardous Materials Transportation



Source: 'Risk Management Framework for Hazardous Materials Transportation. Office of Hazardous Materials Safety, November 2000.

Appendix O. Risk Management Principles

Fundamental Risk Management Principles for Hazardous Materials Transportation

Commitment – There must be a tangible, visible commitment – including resources – from management and the work force to reduce risks. Risk management should be everyone's job. Provide incentives to reinforce the commitment. *Be accountable.*

Culture – Promote a proactive "risk reduction culture" in day-to-day operations. Ask risk questions when making decisions and performing operations. Incorporate risk considerations into basic management systems, such as record keeping, quality control, performance evaluation, and training. *Think risk reduction.*

Partnership – The most effective risk management is built on interaction among all the parties involved in a hazardous materials transport chain (e.g., shipper, package manufacturer, carrier, consignee). Don't try to manage risks in a vacuum. *Team up to manage risk effectively.*

Prioritization – Because there typically are numerous risks to address and various ways to reduce them, and because resources – both private and public sector – for managing risks are limited, priorities must be set. Establish priorities, based on analysis, to address the worst risks first. *Articulate your risk reduction priorities.*

Action – Risk is reduced by concrete actions specific to your hazardous materials transport operations. Actions are selected based on risks, costs, and benefits, factoring in such realistic considerations as technical feasibility, budgets, competition, regulatory burden, and legal constraints. Action is the heart of effective risk management; planning and analysis, while necessary, do not reduce risk. Actions do. *Adopt a bias for action.*

Continuous improvement – All risks associated with hazardous materials transportation cannot be totally eliminated. Through commitment, self-evaluation, and the flexibility to change, improvements in risk management results and efficiency should be sought continuously. *Adapt to get better.*

Communication – All parties who have a role in risk management – including company management, employees, consignees, suppliers, emergency responders – need to know their role and be aware of relevant risk information (e.g., nature and level of risk, risk control points). Appropriate documentation and dissemination of risk analyses and risk reduction strategies can facilitate communications. *Share risk knowledge.*

Source: The U.S. DOT's Strategic Plan 2003-2008.

Appendix P. Risk comparison

A Comparison of risk
Accidental Deaths - United States - 1999-2003

Type	5 Yr. Average	General Population[b] Risk Per Year	Risk Based on Exposure or Other Measures
Motor Vehicle[5]	36,676	1 out of 7,700	1.3 deaths per 100 million vehicle miles [c,d]
Poisoning [9]	15,206	1 out of 18,700	
Work Related [7]	5,800	1 out of 49,000	4.3 deaths per 100,000 workers
Large Trucks [5]	5,150	1 out of 55,000	2.5 deaths per 100 million vehicle miles
Pedestrian [5]	4,846	1 out of 58,000	
Drowning [9]	3,409	1 out of 83,500	
Fires [9]	3,312	1 out of 86,000	
Motorcycles [5]	3,112	1 out of 91,500	31.3 deaths per 100 million vehicle miles
Railroads [3]	931	1 out of 306,000	1.3 deaths per million train miles
Firearms [9]	779	1 out of 366,000	
Recreational Boating [8]	714	1 out of 399,000	5.6 deaths per 100,000 registered boats
Bicycles [5]	695	1 out of 410,000	
Electric Current [10]	410	1 out of 695,000	
Air Carriers [2]	138[a]	1 out of 2,067,000	1.9 deaths per 100 million aircraft miles
Flood [4]	58	1 out of 4,928,000	
Tornado [4]	57	1 out of 5,015,000	
Lightning [4]	47	1 out of 6,061,000	
HAZMAT Transportation [1]	12	1 out of 23,350,000	4.2 deaths per 100 million shipments

1) Hazardous Materials Incident Data, Department of Transportation, Pipeline and Hazardous Materials Safety Administration.

2) *National Transportation Statistics*, Department of Transportation's Bureau of Transportation Statistics. Air carrier data was calculated for all air carriers operating under either 14 CFR 121 or 14 CFR 135. Data used in this comparison was from air carriers operating under 14 CFR 121, which includes large aircraft, and under 14 CFR 135, which includes aircraft with less than 10 seats. Passenger and cargo aircraft are included in both categories.

3) *National Transportation Statistics*, Department of Transportation's Bureau of Transportation Statistics. Railroad fatality statistics include railroad only fatalities and grade crossing fatalities. Mileage data used was for Railroad System Safety and Property Damage Data.
4) *U.S. Natural Hazard Statistics*, National Weather Service. The National Weather Service is a programme of the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA).
5) *Traffic Safety Facts 2004*, Department of Transportation's National Highway Traffic Safety Administration. Motor vehicle fatalities are limited to occupant fatalities and exclude related fatalities to pedestrians, bicyclists, and others. On average, including fatalities to other than motor vehicle occupants in motor vehicle accidents would add approximately 5,500 fatalities to the motor vehicle fatality total. Large trucks are defined as having a gross vehicle weight greater than 10,000 pounds. Truck related fatalities are also counted in the overall motor vehicle category. FHWA-RD-89-013, *Present Practices of Highway Transportation of Highway Material*, Harwood and Russell, indicates about 5% of truck accidents reported to the FHWA involved trucks carrying hazardous materials. Applying this percentage to overall hazardous materials transportation yields a risk of about 260 fatalities related to general truck transportation risk apart from risks related to the particular hazards of the materials themselves.
6) Fatality data obtained from the *Census of Fatal and Occupational Injuries*, Department of Labor's Bureau of Labor Statistics (2003 and 1999-2002). Workforce data obtained from the *Current Population Survey*, Department of Labor's Bureau of Labor Statistics. Workforce risk calculated using the total employed civilian work force.
7) *Boating Statistics – 2003*, United States Coat Guard.
8) *WISQARS (Web-based Injury Statistics Query and Reporting System) Injury Mortality Reports 1999 - 2003*, Department of Health and Human Services' Centers for Disease Control and Prevention. Only unintentional fatalities were used in this report. Fire data was limited to fire/flame fatalities and excluded fatalities due to contact with hot objects/substances.
9) *Injury Facts*, National Safety Council. 2004, 2005/2006, and 2007 editions used to compile data.

   a. Other than the persons aboard the aircraft who were killed, fatalities resulting from the September 11 terrorist acts are excluded.

   b. An average of approximately 285,000,000 over the period was used in computations.

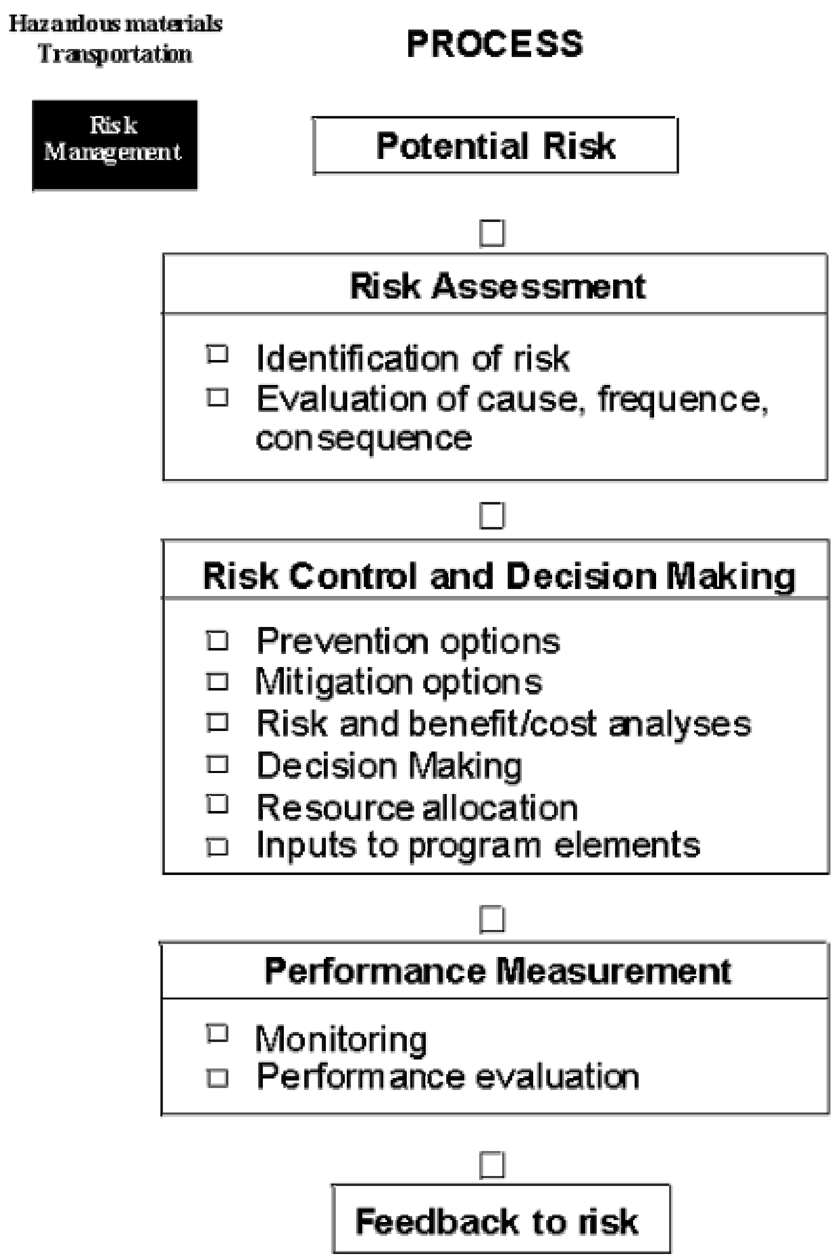
   c. Deaths per passenger mile should also be considered as a basic risk measure when comparing risks amongst various modes of transportation. Since the average number of passengers in an aircraft far exceeds the average number of passengers in a motor vehicle, the passenger mile risk of air carrier transportation is significantly less than that of motor vehicle transportation.

d. The fatality rate in currently about 1.3 fatalities per 100,000,000 vehicle miles in 1999-2003, or about 1 fatality per 77,000,000 miles. Another way of looking at this is that if a person drove about 770,000 miles in their lifetime (15,500 miles per year for 50 years), there is about 1 in 100 chance that person will die as a result of an automobile accident during their lifetime.

Source: http://hazmat.dot.gov/riskmgmt/riskcompare.htm

Appendix Q. Risk management process

Risk Management Process



Source: http://hazmat.dot.gov/riskmgmt/risk_process.htm

Appendix R. Hazardous materials regulations (highway)

Part 177 – Carriage by public highway

Subpart A: General Information and Regulations
Subpart B: Loading and Unloading
Subpart C: Segregation and Separation Chart of Hazardous Materials
Subpart D: Vehicles and Shipments in Transit; Accidents
Subpart E: Regulations Applying to Hazardous Material on Motor Vehicles Carrying Passengers for Hire

Part 179 – Specifications for tank cars

Subpart A: Introduction, Approvals and Reports
Subpart B: General Design Requirements
Subpart C: Specifications for Pressure Tank Car Tanks
Subpart D: Specifications for Non-Pressure Tank Car Tanks
Subpart E: Specifications for Multi-Unit Tank Car Tanks
Subpart F: Specification for Cryogenic Liquid Tank Car Tanks and Seamless Steel Tanks

Source: www.myregs.com/dotrspa

Appendix S. Key programmes of the FMCSA

Border and International Safety

FMCSA supports the development of compatible motor carrier safety requirements and procedures throughout North America. FMCSA works closely with the governments of Canada and Mexico to ensure that these countries' motor carriers, drivers, and vehicles operating in the U.S. meet the same safety standards as U.S. carriers.

Commercial Driver's License Programme

FMCSA develops, monitors, and ensures compliance with the commercial driver licensing standards for drivers, carriers, and states.

COMPASS

COMPASS is a multi-year effort to modernize FMCSA's Safety Systems by integrating new information technologies with improved FMCSA business processes.

Enterprise Architecture and FMCSA

Just as builders would not undertake the construction of a house or an office building without a well-documented architectural blueprint, so too an agency should not undertake the development of information technology (IT) systems without a detailed, documented plan, or 'blueprint'. For FMCSA, that blueprint is called Enterprise Architecture

Federal Motor Carrier Safety Regulations (FMCSR)

FMCSA develops, maintains, and enforces federal regulations that promote carrier safety, industry productivity, and new technologies. FMCSR establishes safe operating requirements for commercial vehicle drivers, carriers, vehicles, and vehicle equipment.

Hazardous Materials Regulations (HMR)

FMCSA enforces HMR, which are designed to ensure the safe and secure transportation of hazardous materials. These rules address the classification of hazardous materials, proper packaging, employee training, hazard communication, and operational requirements.

Household Goods Programme

FMCSA regulates interstate household goods movers and requires them to register with the agency. FMCSA has developed a Web site, www.ProtectYourMove.gov, to assist consumers moving across state lines. We also have a toll-free hotline (1-888-368-7238) and Web site, nccdb.fmcsa.dot.gov, for consumer complaints on interstate movers.

Medical Programme

The mission of the FMCSA Medical Programme is to promote the safety of America's roadways through the publication and implementation of medical regulations, policies and standards that ensure commercial motor vehicle drivers engaged in interstate commerce are physically qualified to do so.

Motor Carrier Safety Assistance Programme (MCSAP)

A federal grant programme that provides states with financial assistance to hire staff and implement strategies to enforce FMCSRs and HMR. MCSAP funds are used to conduct roadside inspections and review motor carriers' compliance with FMCSR and HMR. MCSAP funds promote detection and correction of commercial motor vehicle safety defects, commercial vehicle driver deficiencies, and unsafe motor carrier practices before they become contributing factors to crashes and hazardous materials incidents.

Motor Carrier Safety Identification and Information Systems

FMCSA provides safety data, state and national crash statistics, current analysis results, and detailed motor carrier safety performance data to industry and the public. This data allows federal and state enforcement officials to target inspections and investigations on higher risk carriers, vehicles, and drivers.

New Entrant Safety Assurance Process

FMCSA ensures that new entrant motor carriers (carriers applying for a new U.S. DOT number) are knowledgeable about applicable federal motor carrier safety and hazardous materials regulations. There is an 18-month monitoring period for new applicants, which requires the carrier to pass a safety audit and maintain safe operations to receive permanent U.S. DOT registration. New entrant motor carriers that fail to maintain adequate basic safety management controls may have their temporary U.S. DOT registration revoked.

Performance & Registration Information Systems Management (PRISM)

A federal-state partnership that makes safe performance a requirement for obtaining and keeping commercial vehicle registration. PRISM links federal motor carrier safety records with the state's vehicle registration system. The U.S. DOT number of the carrier responsible for safety is identified at the vehicle level allowing the state to determine a carrier's safety fitness before issuing license plates. Safety performance is continuously monitored, and carriers prohibited by FMCSA from operating in interstate commerce may have their ability to register vehicles denied. PRISM plays a key role in FMCSA's effort to remove high-risk carriers from our highways.

Research and Analysis (R&A)

R&A work is aimed at gaining fundamental and applied knowledge in order to develop new methods and technologies to enhance truck and bus safety and security.

Safety Education and Outreach

FMCSA implements educational strategies to increase motor carrier compliance with the safety regulations and reduce the likelihood of a commercial vehicle crash. Messages are aimed at all highway users including passenger car drivers, truck drivers, pedestrians, and bicyclists.

Source: www.fmcsa.dot.gov

Appendix T. Operational testing FMCSA on Security

1. Pick up of HM from shipper

1.1. HM driver identification and verification by the shipper

1.2. HM cargo verification by the driver, dispatcher, and receiver

1.3. HM driver identification and verification by the vehicle

1.4. HM driver identification and verification by the dispatcher

1.5. HM cargo tampering alert to the driver and the dispatcher

1.6. Remote cargo locking and unlocking by the dispatcher

2. En-route transportation of HM

2.1. HM driver identification and verification by dispatcher

2.2. HM driver identification and verification by roadside safety enforcement officers

2.3. HM cargo location tracking by the dispatcher

2.4. HM cargo route adherence by the dispatcher and roadside safety enforcement officers, as required, based on the quantity and type of HM being transported

2.5. Untethered trailer notification and tracking by the dispatcher

2.6. HM cargo tampering alert to the driver and the dispatcher

2.7. Remote cargo locking and unlocking by the dispatcher

2.8. Real-time emergency alert message notification by the driver to the dispatcher

2.9. Real-time emergency alert message notification by the vehicle after the vehicle is involved in a crash

2.10. Real-time emergency alert message notification by the vehicle to the dispatcher if vehicle senses an unauthorized driver

2.11. Real-time emergency alert message notification by the dispatcher to local and state law enforcement officials and emergency responders

2.12. Remote HM vehicle disabling by the driver

2.13. Remote HM vehicle disabling by the dispatcher

2.14. HM driver identification and verification by the vehicle if the vehicle is motionless for 10 minutes

3. Delivery of HM to receiver

3.1 Remote cargo locking and unlocking by the dispatcher

3.2 HM driver identification and verification by the receiver

3.3 HM cargo verification by the receiver

3.4 Receiver confirmation of received cargo to the driver and dispatcher

3.5 Auditable log of all shipments to be kept by the motor carrier

Source: www.fmcsa.dot.gov/safety-security/hazmat/fot/sowsot.htm

Appendix U. Technologic security measures FMCSA

Technology Components by Scenario		
Scenario	**Description**	**Technology Components**
1	Bulk Fuel Delivery	Wireless Satellite Communication Global Login In-Dash Panic Button Wireless Panic Button Digital Phone Terrestrial Communication On-Board Computer
2	LTL High Hazard	Wireless Satellite Communication Global Login In-Dash Panic Button Wireless Panic Button Terrestrial Communications
3	Bulk Other	Wireless Satellite Communications Biometric Authentication In-Dash Panic Button Wireless Panic Button Electronic Supply Chain Manifest
4	Truckload Explosives	Wireless Satellite Communication Biometric Authentication In-Dash Panic Button Wireless Panic Button Electronic Supply Chain Manifest On-Board Computer Wireless Electronic Cargo Seal Geo-Fencing Untethered Trailer Tracking

Source: www.fmcsa.dot.gov/safety-security/hazmat/fot/Exec-Ops-Concepts.asp

Appendix V. Incident report requirements

171.15 Immediate notice of certain hazardous materials incidents.

(a) General. As soon as practical but no later than 12 hours after the occurrence of any incident described in paragraph (b) of this section, each person in physical possession of the hazardous material must provide notice by telephone to the National Response Center (NRC) on 800-424-8802 (toll free) or 202-267-2675 (toll call). Notice involving an infectious substance (etiologic agent) may be given to the Director, Centers for Disease Control and Prevention, U.S. Public Health Service, Atlanta, Ga., 800-232-0124 (toll free), in place of notice to the NRC. Each notice must include the following information:

(1) Name of reporter;

(2) Name and address of person represented by reporter;

(3) Phone number where reporter can be contacted;

(4) Date, time, and location of incident;

(5) The extent of injury, if any;

(6) Class or division, proper shipping name, and quantity of hazardous materials involved, if such information is available; and

(7) Type of incident and nature of hazardous material involvement and whether a continuing danger to life exists at the scene.

(b) Reportable Incident. A telephone report is required whenever any of the following occurs during the course of transportation in commerce (including loading, unloading, and temporary storage):

(1) As a direct result of a hazardous material -

i. A person is killed;
ii. A person receives an injury requiring admittance to a hospital;
iii. The general public is evacuated for one hour or more;
iv. A major transportation artery or facility is closed or shut down for one hour or more; or
v. The operation flight pattern or routine of an aircraft is altered;

(2) Fire, breakage, spillage, or suspected radioactive contamination occurs involving a radioactive material (see also § 176.48 of this subchapter);

(3) Fire, breakage, spillage, or suspected contamination occurs involving an infectious substance other than a diagnostic specimen or regulated medical waste;

(4) A release of a marine pollutant occurs in a quantity exceeding 450 L (119 gallons) for a liquid or 400 kg (882 pounds) for a solid; or

(5) A situation exists of such a nature (e.g., a continuing danger to life exists at the scene of the incident) that, in the judgment of the person in possession of the hazardous material, it should be reported to the NRC even though it does not meet the criteria of paragraph (b) (1), (2), (3) or (4) of this section.
(c) Written report. Each person making a report under this section must also make the report required by § 171.16 of this Subpart.

Note to § 171.15: Under 40 CFR 302.6, EPA requires persons in charge of facilities (including transport vehicles, vessels, and aircraft) to report any release of a hazardous substance in a quantity equal to or greater than its reportable quantity, as soon as that person has knowledge of the release, to DOT's National Response Center at (toll free) 800 424 8802 or (toll) 202 267 2675.

171.16 Detailed hazardous materials incident reports.
(a) General. Each person in physical possession of a hazardous material at the time that any of the following incidents occurs during transportation (including loading, unloading, and temporary storage) must submit a Hazardous Materials Incident Report on DOT Form F 5800.1 (01-2004) within 30 days of discovery of the incident:
(1) Any of the circumstances set forth in § 171.15(b);
(2) An unintentional release of a hazardous material or the discharge of any quantity of hazardous waste;
(3) A specification cargo tank with a capacity of 1,000 gallons or greater containing any hazardous material suffers structural damage to the lading retention system or damage that requires repair to a system intended to protect the lading retention system, even if there is no release of hazardous material; or
(4) An undeclared hazardous material is discovered.
(b) Providing and retaining copies of the report. Each person reporting under this section must--
(1) Submit a written Hazardous Materials Incident Report to the Information Systems Manager, DHM-63, Pipeline and Hazardous Materials Safety Administration, Department of Transportation, Washington, DC 20590 0001, or an electronic Hazardous Material Incident Report to the Information System Manager, DHM-63, Pipeline and Hazardous Materials Safety Administration, Department of Transportation, Washington, DC 20590-0001 at http://hazmat.dot.gov;
(2) For an incident involving transportation by aircraft, submit a written or electronic copy of the

Hazardous Materials Incident Report to the FAA Security Field Office nearest the location of the incident; and

(3) Retain a written or electronic copy of the Hazardous Materials Incident Report for a period of two years at the reporting person's principal place of business. If the written or electronic Hazardous Materials Incident Report is maintained at other than the reporting person's principal place of business, the report must be made available at the reporting person's principal place of business within 24 hours of a request for the report by an authorized representative or special agent of the Department of Transportation.

(c) Updating the incident report. A Hazardous Materials Incident Report must be updated within one year of the date of occurrence of the incident whenever:

(1) A death results from injury caused by a hazardous material;

(2) There was a misidentification of the hazardous material or packaging information on a prior incident report;

(3) Damage, loss or related cost that was not known when the initial incident report was filed becomes known; or

(4) Damage, loss, or related cost changes by $25,000 or more, or 10% of the prior total estimate, whichever is greater.

(d) Exceptions. Unless a telephone report is required under the provisions of § 171.15 of this part, the requirements of paragraphs (a), (b), and (c) of this section do not apply to the following incidents:

(1) A release of a minimal amount of material from--

i. a vent, for materials for which venting is authorized;
ii. the routine operation of a seal, pump, compressor, or valve; or
iii. connection or disconnection of loading or unloading lines, provided that the release does not result in property damage.

(2) An unintentional release of hazardous material when:

i. The material is properly classed as--
   (A) ORM-D; or
   (B) a Packing Group III material in Class or Division 3, 4, 5, 6.1, 8, or 9;
ii. Each packaging has a capacity of less than 20 liters (5.2 gallons) for liquids or less than 30 kg (66 pounds) for solids;
iii. The total aggregate release is less than 20 liters (5.2 gallons) for liquids or less than 30 kg (66 pounds) for solids; and
iv. The material is not--
   (A) offered for transportation or transported by aircraft,

(B) a hazardous waste, or

(C) an undeclared hazardous material.

(3) An undeclared hazardous material discovered in an air passenger's checked or carry-on baggage during the airport screening process. (For discrepancy reporting by carriers, see § 175.31 of this subchapter.)

Source: hazmat.dot.gov/enforce/spills/spills.htm

Appendix W. Hazardous Materials General Awareness Training

Volume 1. - Understanding and Using the Code of Federal Regulations, Title 49

Volume 2. - Shipping Papers

Volume 3. - Marking and Labelling

Volume 4. - Placarding

Volume 5. - Hazardous Materials Training

Volume 6. - Preformed Oriented Packaging

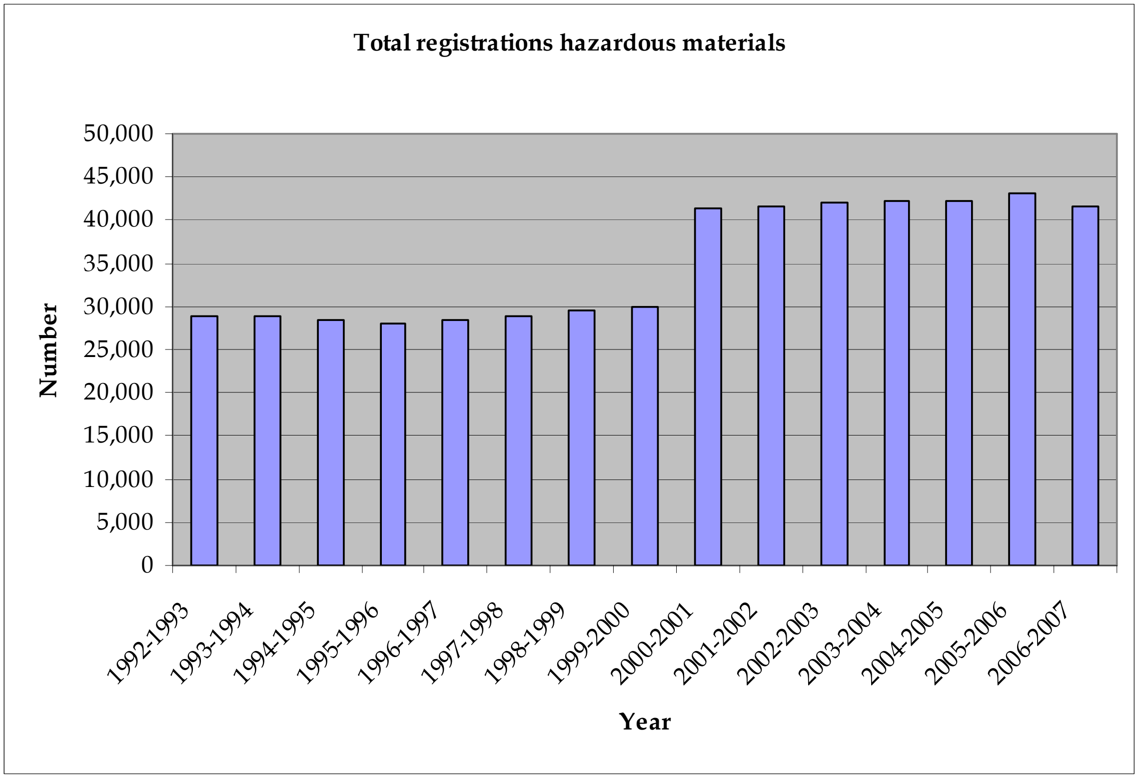
Volume 7. - Carriage by Highway

Volume 8. - Bulk Packaging and Cargo Tanks

Volume 9. - Driving and Parking Rules

Source: www.fmcsa.dot.gov/safety-security/security/index.asp

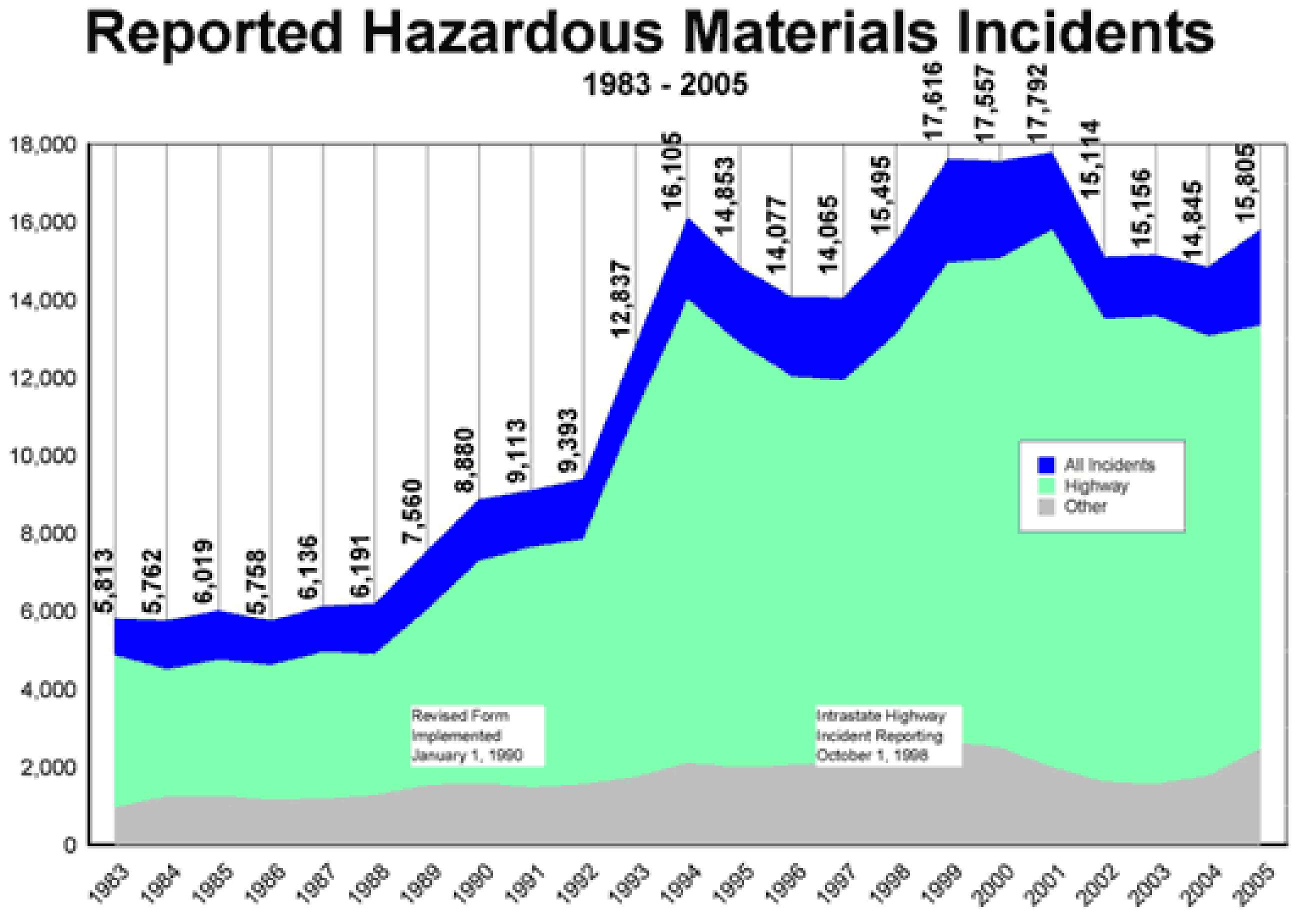
Appendix X. Transporting Hazardous Materials in the U.S.



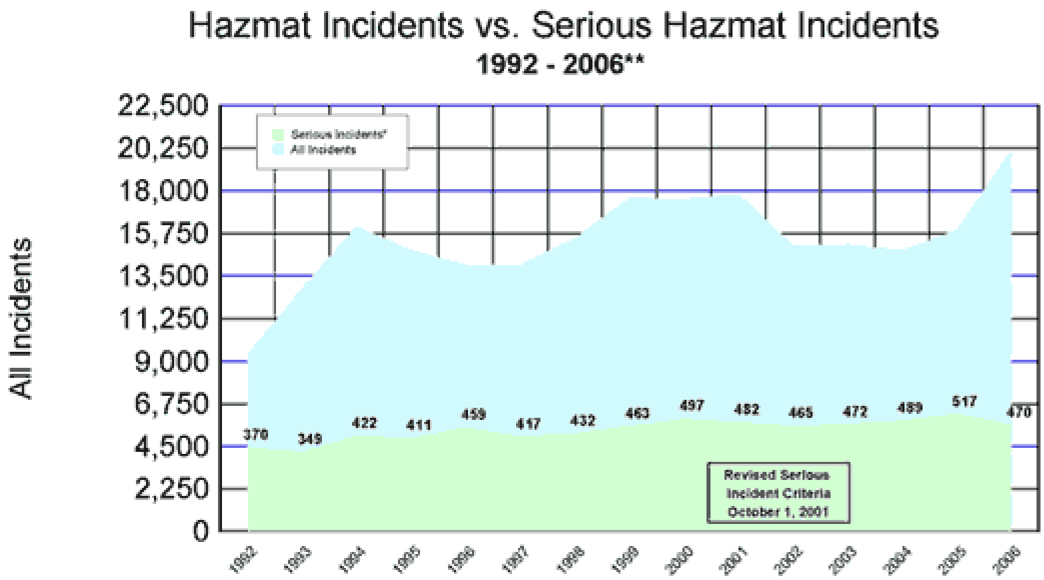
Note that these are numbers based on registrations. However, there is no clear insight on the actual numbers. Sometimes multiple year contracts are not included the following year. The big jump of 200-2001 is very obscure and there is not (yet) a clear cut explanation. Perhaps since the communications between the OHMS and the modes are not optimal on registration numbers.

Source: Hazardous Materials Information System, U.S. Department of Transportation. Data as of 07/17/2007

Appendix Y. Hazardous materials incidents



Source: http://hazmat.dot.gov/enforce/spills/spills.htm



The PHMSA revised the definition of a serious incident in 2002. This report uses both definitions:

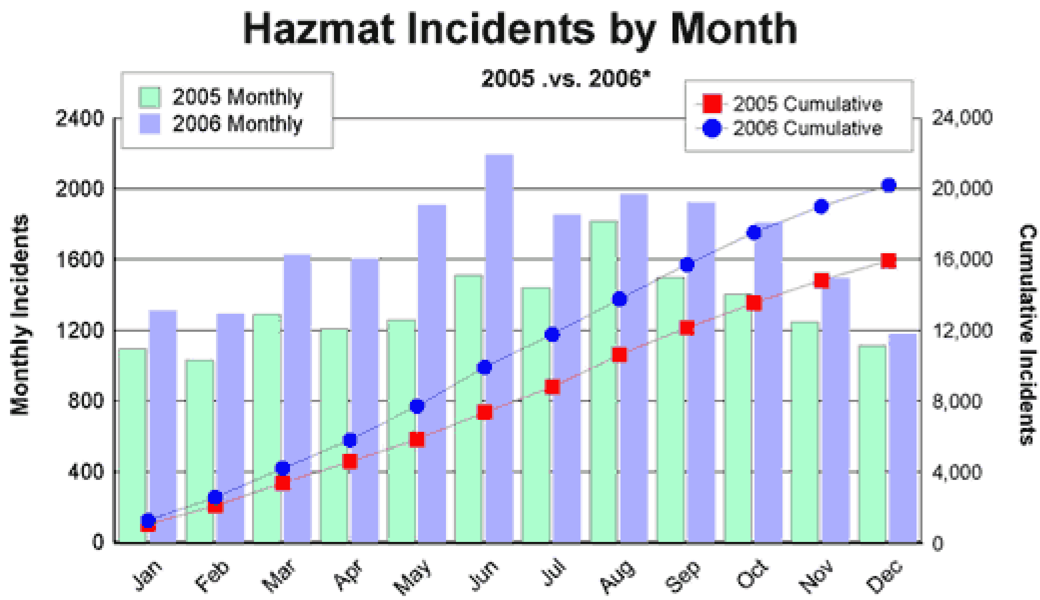
The previous definition:

- a fatality or major injury caused by the release of a hazardous material;
- closure of a major transportation artery;
- the evacuation of 6 or more persons due to the presence of a hazardous material;
- a vehicle accident or derailment resulting in the release of a hazardous material.

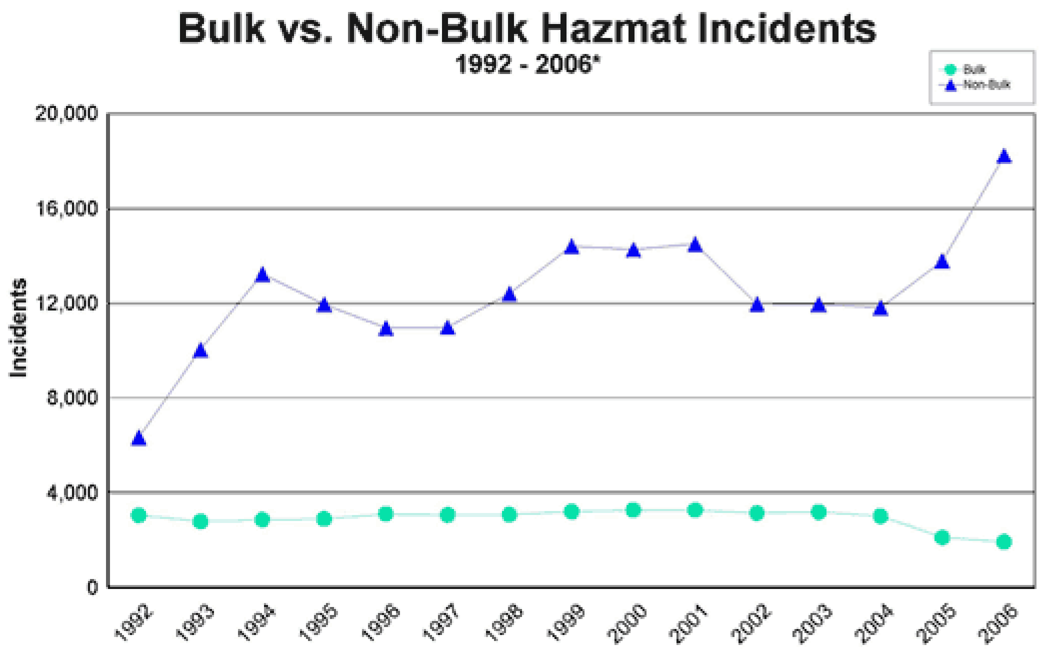
The definition used since 2002:

- a fatality or major injury caused by the release of a hazardous material;
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire;
- the alteration of an aircraft flight plan or operation;
- a vehicle accident or derailment resulting in the release of a hazardous material;
- the release of radioactive materials from Type B packaging;
- the release of over 11.9 gallons or 88.2 pounds of a severe marine pollutant; or
- the release of a bulk quantity (over 119 gallons or 882 pounds) of a hazardous material.

Source: Hazardous Materials Information System, U.S. Department of Transportation. Data as of 3/6/2007.



Source: Hazardous Materials Information System, U.S. Department of Transportation. Data as of 3/6/2007.



Source: Hazardous Materials Information System, U.S. Department of Transportation. Data as of 3/6/2007. Note: Bulk packages are defined as those with maximum capacity greater than 450L (119 gallons).

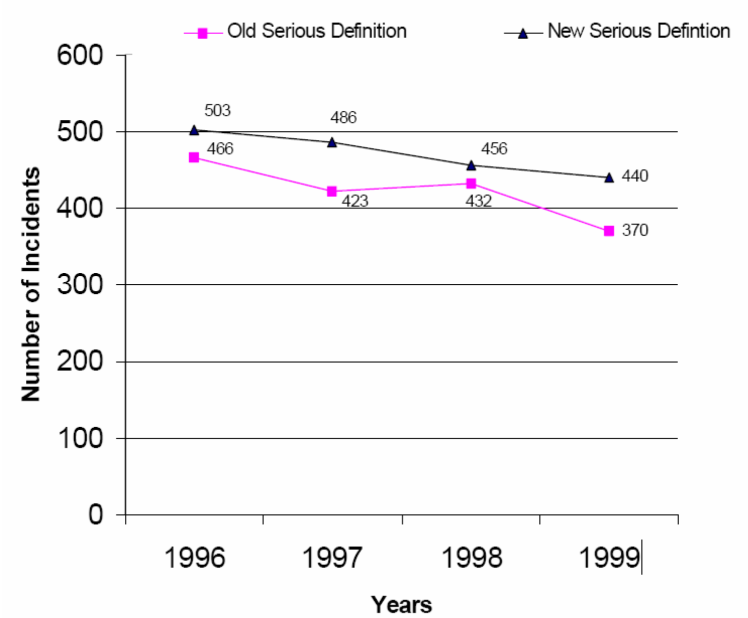
Appendix Z. Incidents and Definitions

Number of incidents per year meeting the definitions for serious and significant incidents. Data current as of June 26, 2000. Data does not include hazardous material in bulk packaging in an accident with no release that would be included in the significant category if damage was sustained to the hazardous materials container or if a crash or derailment was involved.

Year	Old Serious Incidents	New Significant Incidents	New Serious Incidents
1990	402	777	525
1991	405	738	460
1992	376	711	456
1993	358	707	428
1994	427	745	437
1995	408	714	420
1996	466	797	503
1997	423	773	486
1998	432	770	456
1999	370	898	440
Total	4,067	7,630	4,611

Source: Serious Incident Definition, OHMS, October 1, 2000. - http://hazmat.dot.gov/pubs/inc/serious_incident_new_def.pdf

Comparison of Old and New Definitions of 'Serious Incidents'



Source: Serious Incident Definition, OHMS, October 1, 2000. - http://hazmat.dot.gov/pubs/inc/serious_incident_new_def.pdf

Appendix AA. Statistical data serious incidents

Incidents By Mode and Incident Year

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Air	13	25	18	35	37	15	13	6	19	17	198
Highway	397	356	447	449	488	377	399	400	418	389	4,120
Rail	61	72	68	83	63	71	58	82	84	75	717
Water	1	4	0	2	1	3	2	4	2	1	20
Total	**472**	**457**	**533**	**569**	**589**	**466**	**472**	**492**	**523**	**482**	**5,055**

Fatalities By Mode and Incident Year

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Air	0	0	0	0	0	0	0	0	0	0	0
Highway	12	13	9	16	9	9	15	13	24	6	126
Rail	0	0	0	0	3	1	0	3	10	0	17
Water	0	0	0	0	0	0	0	0	0	0	0
Total	**12**	**13**	**9**	**16**	**12**	**10**	**15**	**16**	**34**	**6**	**143**

Injuries By Mode and Incident Year

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Air	1	4	3	0	6	0	0	3	53	2	72
Highway	59	45	84	45	24	25	33	56	99	66	536
Rail	7	9	4	57	23	3	2	75	664	13	857
Water	0	2	0	0	0	0	0	0	0	0	2
Total	**67**	**60**	**91**	**102**	**53**	**28**	**35**	**134**	**816**	**81**	**1,467**

Damages By Mode and Incident Year

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Air	2,651	22,429	7,405	53,931	27,529	60,000	1,715	15,100	12,575	576,035	779,370
Highway	16,606,743	19,802,331	24,036,634	40,725,377	33,775,708	35,701,954	35,986,419	35,388,574	33,320,573	47,755,370	323,099,683
Rail	7,209,187	13,318,623	29,765,038	25,330,431	18,496,249	7,226,964	3,028,260	12,671,796	13,836,689	6,983,793	137,867,030
Water	13,000	980,221	0	226,460	22,242	13,383	116,000	1,596,922	69,500	31,030	3,068,758
Total	**23,831,581**	**34,123,604**	**53,809,077**	**66,336,199**	**52,321,728**	**43,002,301**	**39,132,394**	**49,672,392**	**47,239,337**	**55,346,228**	**464,814,841**

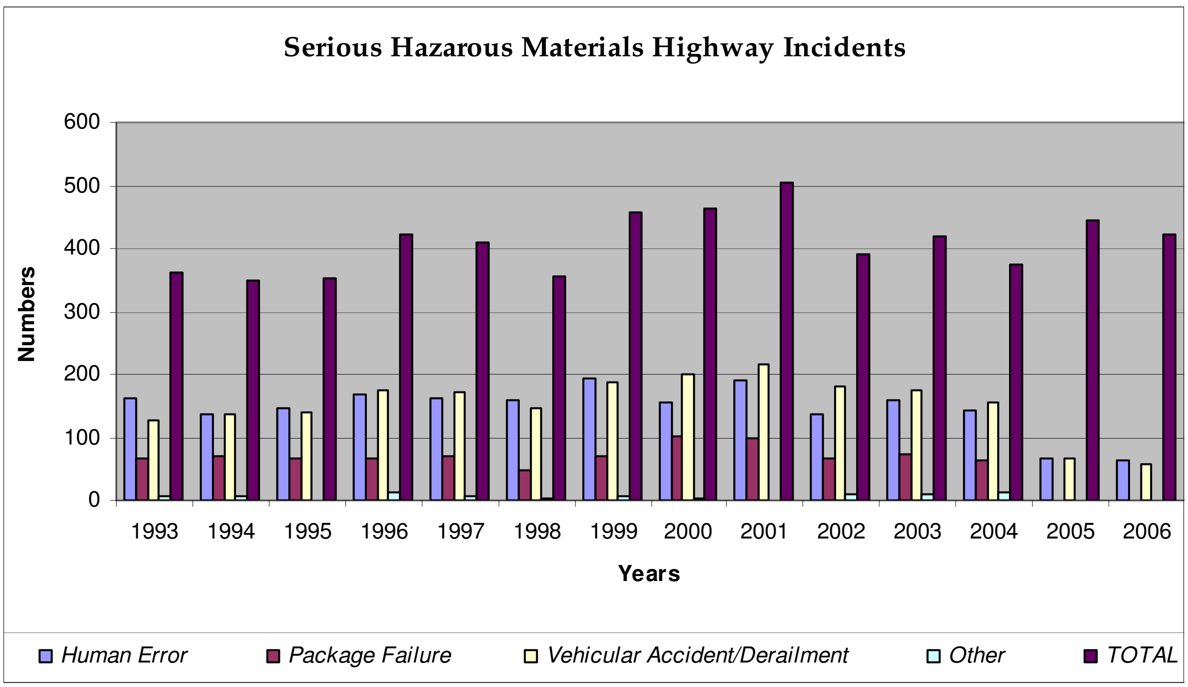
Source: http://hazmat.dot.gov/pubs/inc/data/10yearfrm.htm

Undeclared incidents

Incidents By Mode and Incident Year

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Air	359	493	547	460	370	204	190	249	734	693	4,299
Highway	130	125	162	32	11	16	27	42	590	571	1,706
Rail	2	0	0	0	0	0	0	0	16	11	29
Water	0	0	0	0	0	0	0	0	54	58	112
Total	**491**	**618**	**709**	**492**	**381**	**220**	**217**	**291**	**1,394**	**1,333**	**6,146**

Source: http://hazmat.dot.gov/pubs/inc/data/10yearfrm.htm



Note that 2005 and 2006 do not have 'package failure' and 'other' as causes, because the categorization of causes of serious incidents were changed and differentiated (from 3 major categories to over two dozens) from 2005.

Serious hazardous materials highway incidents and probable causes 2005

Cause	2005
Abrasion	3
Broken Component or Device	9
Conveyer or Material Handling Equipment Mishap	5
Corrosion - Exterior	1
Corrosion - Interior	4
Defective Component or Device	17
Deterioration or Aging	10
Dropped	6
Fire, Temperature, or Heat	10
Forklift Accident	4
Freezing	2
Human Error	67
Impact with Sharp or Protruding Object (e.g., nails)	13
Improper Preparation for Transportation	7
Inadequate Accident Damage Protection	1
Inadequate Blocking and Bracing	5
Inadequate Preparation for Transportation	1
Inadequate Procedures	1
Loose Closure, Component, or Device	3
Misaligned Material, Component, or Device	1
Missing Component or Device	1
Overfilled	15
Over-pressurized	4
Rollover Accident	105
Too Much Weight on Package	1
Valve Open	2
Vehicular Crash or Accident Damage	66
Water Damage	1
Cause Not Reported	78
TOTAL	443

Source: http://hazmat.dot.gov/pubs/inc/data/10yearfrm.htm

Serious hazardous materials highway incidents and probable causes 2005

Cause	**2006**
Abrasion	4
Broken Component or Device	10
Commodity Self-Ignition	1
Commodity Polymerization	1
Corrosion - Exterior	1
Corrosion - Interior	1
Defective Component or Device	14
Derailment	1
Deterioration or Aging	9
Dropped	7
Fire, Temperature, or Heat	7
Forklift Accident	15
Freezing	1
Human Error	64
Impact with Sharp or Protruding Object (e.g., nails)	5
Improper Preparation for Transportation	8
Inadequate Blocking and Bracing	9
Inadequate Maintenance	2
Inadequate Preparation for Transportation	5
Inadequate Procedures	3
Inadequate Training	1
Incompatible Product	2
Incorrectly Sized Component or Device	1
Loose Closure, Component, or Device	9
Misaligned Material, Component, or Device	2
Missing Component or Device	3
Overfilled	7
Over-pressurized	4
Rollover Accident	89
Threads Worn or Cross Threaded	2
Valve Open 4	4
Vehicular Crash or Accident Damage	58
Cause Not Reported	72
TOTAL	422

Source: http://hazmat.dot.gov/pubs/inc/data/10yearfrm.htm

Appendix AB. Outreach documentation

Brochures and folders indicating the emphasis on communication (i.e. outreach).

Appendix AC. The Report for the OHMS

Fostering the new Office of Hazardous Materials Safety Approaches

Reflections and suggestions

- July 19th 2007 -

Introduction

The Pipeline and Hazardous Materials Safety Administration's Office of Hazardous Materials Safety (OHMS) has been focusing on the reduction of risks associated with the transportation of hazardous materials for many years, however for the last year there has been a renewed focus on the approach used to address how the agency assesses the risk, uses data and interacts with stakeholders. This renewed focus has been implemented by the most recent political and organizational leaders. These approaches are being characterized as the data driven, risk based enterprise government approaches. They are not necessarily new, but are now being promoted more explicitly, and a reemphasized safety culture is being instilled in the staff and through partnerships with stakeholder organizations.

This report aims at the strengths, weaknesses and opportunities and effectiveness of these approaches. The performance based approach, data-driven approach, the enterprise approach and the risk-based approach will be discussed. One project that focuses on releases of hazardous materials during loading and unloading (i.e. The Loading and Unloading (L-UL) initiative) will also be analyzed and serves as a case to describe and assess the application of these approaches. In addition, the new L-UL programme will be assessed through two theoretical lenses and serves as a case for a hybrid (organizational) theory (Sagan, 1993). First it is important to note that these three indicative approaches of a new management style and the L-UL programme are very much intertwined and interrelated. Background information is obtained from documents analyses, interviews and observations.

The performance based approach

The hazardous materials safety programme has a history of prescriptive regulations. A gradual development towards performance based regulations is perhaps the biggest shift in the OHMS management philosophy. The regulations traditionally prescribe the shippers and carriers often to adhere to strict protocols or rules. The aim of the performance based approach is to let the regulations be less encumbered for the industry by requiring that hazardous materials should be transported *safely* from point A to point B. However, penalties or fines for non-compliance are higher for performance based than for prescriptive based regulations. Basic requirements (often less technical) of prescriptive regulations often have the spirit of: (1) performance requirements; (2) standards for performance; (3) compliance (e.g. documentation); and (4) enforcement implications (penalties). The performance based approach enables the OHMS programmes and the regulations to be more flexible, whereas detailed prescriptions can make the OHMS overall programme rather rigid.

The data driven approach

The DOT's hazardous materials transportation programme has always used data to form the basis of analyses and basically all decisions, be it enforcement, regulatory, outreach, policy or programme priorities. The importance and utilization of data is not new. The collection, storage and distribution however has been emphasized in an attempt to professionalize the data management of the OHMS. It is important to note that the industry has a specific role in the context of data collection and sharing. Under the U.S. Hazardous Materials Regulations companies are required to report incidents. The data used to drive the OHMS safety programme relies on the effective and accurate reporting of incidents. Not all companies report incidents and sometimes the reports are incomplete or lacking vital data needed for root cause analysis based on a number of factors including fear of reprisal, litigation factors or simply ignorance of the reporting requirements. There are also some economic and juridical issues that withhold companies from sharing specific crucial data which is important for the learning process of the OHMS. A great example is the root cause analysis. This analysis aims at identifying and assessing available incident data and interviewing shippers and carriers to ascertain their knowledge and responsibilities of incident reporting. The incident data that is obtained from shippers and carriers can be used as feedback to evaluate and modify emphases of existing programmes. A result of this incident data analysis can also imply the beginning of a new programme (e.g. L-UL programme). Since underreporting is a significant concern for the OHMS, including these actors is of the essence. This data management approach includes the professionalization of collecting, harmonizing, storing and sharing data.

- The OHMS is a major (if not the most important) player in the web of public actors that regulate the hazardous materials transportation industry, which is indicated by the fact that the OHMS is authorized to issue and enforce regulations. The management of data that is important for risk analyses, other learning tools and the prioritization of resources. This rationalistic approach implies the accumulation of all relevant data into one major system, which can be redistributed to other agencies. An advantage of this database is to allow many experts to analyze the data and draw their own conclusions. OHMS is in the process of formalizing its data management team and enhancing the availability and ease of evaluating the data by its own staff and stakeholders. The belief is that the more people review the data the better the assessments of the risk and how to address the risk will become.

- A transparent and highly digitalized data sharing system (i.e. Oracle Business Tools) will reinforce this approach. From this database, which included not only incident data but also data on specified risks per mode, hazardous materials, packaging as well as inter-modal transportation system, all relevant hazardous materials personnel should be able to utilize and find e.g. incident patterns, highest risks or highest consequences to act accordingly related to their programme and taking the whole system into account. This implies that systemic thinking should be promoted and improved among all appropriate personnel. For enforcement personnel, this may mean that patterns of non-compliance are of importance for the prioritization of resources. For training offices, this may imply that patterns of feedback can be used to focus outreach efforts and the development and distribution of training materials.

- Collecting the data should be as integral as possible. From rational system approach, the subsystems of the training (e.g. NTI, HMST's, IAFF), emergency response (e.g. state police, local fire departments, LEPC's), enforcement communities as well as other public entities that have relevant data are to be included in the data sharing system. The industry can also be seen as a sub system (via trade associations) but juridical and financial restraints may result in sub optimal sharing. However, the inclusion of the industry is also of great importance so that they can validate trends and implement self-corrective actions. Per community (or sub system) this data is also to be centralized, but at the same time managed and shared as rationalistic as possible. There are several data systems per sub system, which are to be 'upscaled' to the 'OHMS level.' An inherent advantage is the fact that these sub systems can have their own specific data sharing system which enables them to learn from each other and communicate best practices. When a major incident or lesson is learned from the emergency response or the training community, this can be shared throughout the particular community and if relevant shared with the other sub systems.

- Obviously data managers (and maybe technical assistants) per sub system are to be appointed that communicate back to the OHMS and other sub system if significant changes or lessons are learned and changes in programmes are introduced (i.e. HMR).

- The storage and (re)distribution of the OHMS data system needs to be highly digitalized for efficiency sake. This consequently requires sufficient training of all OHMS personnel that work with this data (system). All system participants (OHMS personnel and sub system personnel if needed) are to be notified if new data is introduced. For the sake of structure (and organizationally) this can be introduced best weekly or monthly.

- Communication of the data with modal partners is very important. Moreover, specific data per mode is to be communicated by the (OHMS hazardous materials) data manager of the OHMS and the data managers of the modes, which should also be inter-modally based for the sake of synergy and good communication (see appendix A).

- This highly rationalized system should be able to operate as efficiently as possible and also monitored by data system specialists. The accumulation of data can be problematic if there are no sufficient resources to manage this, so Human Resource Management related to the data sharing system as well as sufficient financial means is crucial and need to be budgeted.

- Communities or sub systems have their own rationales, interests and priorities, which make data sharing quite complicated. For instance local or state authorities are decoupled with the OHMS system or do not have the budget or resources for this data sharing system or the rationale of companies to not provide all available data. This may lead to a form of bounded rationality. To deal with this,
    i. Common goals and grounds need to be established. The problem definition must be built on a consensus view, which can be reached by using incident statistics and focusing on the benefits of data sharing between the government and the industry and must be transparent (e.g. employee safety and product safety leads to better PR, transparency breeds self-corrective actions and more confident and trusting employees and better economic results). Juridical and economic/financial reasons for sub optimal data sharing then need to be reduced. This is a system characteristic, but through (informal) meetings with key partners and stakeholders, this can be reduced.
    ii. Before approaching the partners, an 'approach plan' should be prepared by jurists, economists and engineers in order to have a solid, reliable and convincing narrative.

- The enterprise approach is very important since the system characteristics of hazardous materials transport is a complex system involving numerous stakeholder groups and individuals. The appropriate management approaches result in investing in key contacts and stakeholders and the process of data sharing in order to have a healthy data sharing system, which is highly linked to the enterprise approach. Recent examples (cases or themes) were network management can be beneficial are 'using foam for ethanol' and 'incident traffic management'.

- A final thought is the sharing of best practices with other countries. Serious incidents or even crucial incident data of equivalent federal agencies of e.g. Mexico, Canada and EU-countries can give new insights to tackle existing problems of data sharing in general or even causes of incidents. Evidently the internal contexts of foreign countries need to be translated to the U.S. context in order to assess whether a lesson can be learned in the first place.

The enterprise approach

Also the enterprise approach in its recent form is a result of emphasising more on the inclusion of public and private partners in the decision-making process (and data sharing). This approach is based on the idea that including the entities that deal with regulations on other levels (mainly operational) is beneficial on the long-term since a certain consensus is needed for a particular decision and to avoid unwanted side effects and spill-over effects. This leads to more acceptation and compliance of a certain decision. Network management is of crucial importance here as well.

- First, all relevant actors should be charted on the federal, state and local level of the public sector and also all hazardous materials organizations in commerce. There should be a differentiation of relevant actors depending on a decision or topic. If a decision is to be made that only impacts the training community, the 'training network' should be 'activated' and meetings are to be planned with this network. Since there are quite some spill-over effects in most hazardous materials decisions, often all networks are to be included. After charting the most relevant actors per network, a network and representatives of constituencies (e.g. NTTC, AAR, IME) are to be assessed on their representation of the entire network (or sub system). For instance, not all small hazardous materials truck companies might be included in the 'industry network'. Relating the (or a) registration list(s) of all private hazardous materials companies to this network (and/or via trade associations) can assess the ratio of the 'network involvement'. If there is a significant gap in the network (e.g. 5%), registration can be made stricter (or more feasible) by using key contacts in the industry network.

- Second, the assessment whether certain networks are to be included in the decision-making process is crucial. After a thorough scrutiny of the spill-over and long-term effects on the networks (in e.g. economic or organizational sense) this can be determined. The L-UL programme is a great example since there are quite some spill-over effects on e.g. the industry network, the training network, the emergency response network in economic and organizational sense.

- Third, within the networks there might be different 'network types' in the eye of the OHMS which might manifest itself in dynamic networks. Some networks are ad-hoc, some more structural and depending on the assessment of the impact of a decision, also this needs to be bared in mind in order not to have insufficient or irrelevant actors involved and neither to have an overstretch. Other networks may include the large scale emergency response entities such as the NRT, which are perhaps not the same as the 'small scale' network of the local emergency response teams. With structural networks structural meetings are recommended. All structural networks can for instance meet once a (or two) month(s) and discuss important ongoing or urgent issues (agenda is to be set by the OHMS since it is the 'manager' of the networks). This makes issue-based meetings less relevant by including the topics in the agenda.

- Fourth, this additionally creates a long-term relation with the networks, which is also of crucial importance for future decisions, programmes, projects or urgent situations. This network management approach can institutionalize the enterprise philosophy in a practical way without a producing a big burden on the networks themselves. This institutionalization process is not settled overnight so the OHMS leaders need to invest in this network building which in the future can function as a structure for quick and efficient communication. This way a balance can be found between a pure rationalistic approach of including all sorts of actors and organizations formally and a more complex approach in which all actors and organizations have their own priorities next to safety. Evidently existing networks and contacts can be 'utilized' for extension and further institutionalization. The key term is 'institutional adaptiveness' which encompasses the idea of a flexible organization which acknowledge that it should operate as an 'organism' and be open with its environment and intelligently adapt to its environment depending on the context, specific situations, needs or goals it has.

- In some EU-countries the inclusion of the industry and other lower-level authorities has a rich history (e.g. the Netherlands and Scandinavian countries) before making formal decisions. A learning tool might be to assess major lessons and breakthroughs of foreign equivalent agencies and translate them into the U.S. context, if relevant and valuable.

Risk-based approach

A major complexity the OHMS faces is the high ambitions and the lack of sufficient resources. The risk-based approach is a way to (re)allocate the OHMS resources (i.e. personnel and financial) in order to invest in the reduction or minimalization of risks with high consequences.

		Consequences of risk	
		High	Low
Probability of risk	High	A	B
	Low	C	D

- The quadrants with the most emphasis are A and C, however B and D are also of importance. Via risk analyses of transportation systems, packaging and other technical assessments risks that are associated with the transportation of hazardous materials are charted. The 'event tree' is a great example, which charts all probable risks when a certain scenario occurs, resulting in an assessment of all sorts of scenarios with the related risks.

- Second, compliance reviews of the enforcement programme can assess risks. The field enforcement managers or field enforcement personnel should be able to have one list of non or low compliance companies of all the agencies. Also this data system needs to be managed properly which enables all users to select e.g. a priority list per mode and an overall list. Related to this list all inspections, investigations and other enforcement actions of the OHMS and the modes need to be shared efficiently as well. After an enforcement action of a field inspector, the priority list needs to be updated immediately and a file of the action (per company) should be produced separately. This way miscommunication of enforcement actions can be avoided, which have been the case in the past. Evidently this data sharing system also is most practical if it is highly digitalized and user-friendly.

The digitalized risk analyses systems ARCHIE, CAMEO, ALOHA and MARPLOT are existing tools to assess certain risks but have separate focuses on the hazardous materials transportation system. The Safety Integrity approach is a more integral system approach that aims at assessing all transportation sub systems, units and parts to assess the risks per part. This provides the OHMS an integral approach prioritize the highest risks (with the highest consequences). Even though it may sound interesting to integrate the technical risk analyses and the day-to-day enforcement risk data base, there is no rationale to suggest that integration could be an added value for the prioritization of risks. However, the incidents data (for root cause analysis) can be translated into a risk list which can support the existing technical risk analyses. Moreover, all relevant risk data from the data system (see data-driven approach) can be included for a less fragmented risk analysis programme.

Thus, an integration of the technical risk analyses into one system analysis next to the enforcement risk data system should enable the OHMS to assess and prioritize risks per mode, packaging and hazardous material more efficient and effective. Also best practices can be shared with foreign partners depending on whether the approaches they use and contexts they operate in.

L-UL Programme

The L-UL programme is a recent initiative in which through a profound risk analysis the problem of accidents and incidents during loading and unloading of bulk hazardous materials has been acknowledged. This programme is a case in which the performance based, data-driven, enterprise and risk-based approach are combined. The risk analysis illuminates the problem for the OHMS. This can be supported by incident data, non compliance data and other lessons from the past. The performance based approach is indicated by the acknowledgement and wish of stakeholders that the OHMS should produce a 'framework' which incorporates all valuable suggestions to solve this issue, instead of strict regulations. The data-driven approach is relevant and indicated by the fact that data is used for decisions. More important is the fact that underreporting of crucial (incident) data from companies is required. The enterprise approach makes it possible for the OHMS to address the problem, possible suggestions and ask input from the industry. The risk-based approach evidently is the allocation of resources of the OHMS to invest in the L-UL programme via e.g. enforcement and training. The workshop of June 14th 2007 with industrial partners and other relevant organizations was an indication of the enterprise approach in which the problem was addressed to the broader hazardous materials transportation community. Further institutionalization of the L-UL can be attained through the utilization of the (training and industry) networks (that also already exist). The enterprise approach is the first step of institutionalizing networks that (1) facilitate problem addressing; (2) brainstorming on possible and feasible solutions and (3) making agreements with the networks (separate and/or holistically).

1. After the acknowledgement of the networks (which should be to a degree the OHMS is content with) of the problem as such, the sharing of crucial data of the training, emergency response, state and local authorities and especially the industry network should be aimed on. Again, by constituting a plan maximization of data sharing can be assessed. The industry and other organizations have acknowledged the L-UL problem and stated that the OHMS should take the 'lead' by constituting a framework that includes a set of practical guidelines. This is the indication of the engagement of the networks that should be utilized fully.
2. All networks should give input on their thoughts of the guidelines. By having just some major representatives or key contacts per network the communication can be facilitated efficiently and effectively. The OHMS should be the 'process manager' and 'network manager' at all times and include all networks during the process of constituting the L-UL framework.

3. Consequently agreements are to be made with the networks on data sharing, complying with the set of guidelines, responsibilities. Since the enterprise approach of the L-UL programme is an example of a complex system approach, it is rather difficult to have strict protocols and rules on responsibilities and compliance. By making and maintaining 'healthy' contacts with key players of the networks by the OHMS leaders, trust and reliability can be fostered. However, if there is a consensus of the networks that strict regulations should be imposed, the OHMS obviously should take this in consideration.

So the L-UL programme can be described as a case of all approaches together that can reduce the risks and consequences of accidents of loading and unloading of hazardous materials on rail and highway. More important from a public management perspective is the possibility to construct and institutionalize networks that can facilitate all sorts of hazardous materials issues in the future and have an optimal and integral approach to come to solutions that are determined flexible. The OHMS, the regulations and all its public and private partners are rather formalized and institutionalized. However the (international) market and technology constantly change and are highly dynamic. Evidently from the moment that a set of guidelines is agreed on and operational agreements are made, monitoring and annual or biannual evaluations should be carried out to asses the effectiveness of the programme. Also for the L-UL programme lessons from foreign equivalent agencies can be highly relevant, by using and developing existing foreign networks.

<u>L-UL and safety management</u>

The L-UL programme is also a good case to assess the way in which the programme can be structured best organizationally from a more theoretical perspective (Sagan, 1993). This theory is hybrid and has two views on safety management. There are basically six organizational elements that are of crucial importance to be effective from a high reliability perspective. From a normal accidents perspective these elements are rather ineffective and can have counterproductive effects.

	High reliable theory	**Normal accidents theory**
Premises	*Accidents can be prevented through good organizational design and management.*	*Accidents are inevitable in complex and tightly coupled systems.*
1.Objectives	Safety is the priority and the organizational objective.	Safety is one of a number competing objectives.

2. Redundancy	Redundancy enhances safety: duplication and overlap can make 'a reliable system out of unreliable parts'.	Redundancy often causes accidents: it increases interactive complexity and opaqueness and encourages risk-taking.
3. (De)centralization	Decentralized decision-making is needed to permit prompt and flexible field-level responses to surprises.	Organizational contradiction: decentralization is needed for complexity, but centralization is needed for tight coupled systems.
4. Culture	A 'culture of reliability' will enhance safety by encouraging uniform and appropriate responses.	A military model of intense discipline, socialization and isolation is incompatible with democratic values.
5. Continuity	Continuous operations, training and simulations can create and maintain high reliability operations.	Organizations cannot train for unimagined, highly dangerous or politically unpalatable operations.
6. Learning	Trial and error learning from accidents can be effective and can be supplemented by anticipation and simulations.	Denial of responsibility, faulty reporting and reconstruction of history cripples learning efforts.

Source: (Sagan, 1993: 46)

1. The objective of the OHMS in the L-UL programme is quite obvious: safety. However, the priority of other networks and organizations of the system (that constitute the 'hazardous materials organization' on a more operational level) have other perspectives. The OHMS should focus only on safety and address the problem of (serious) incidents and the consequences for the industry, to have a common ground to work from. On the more operational level the OHMS should assess the system of rail and highway transportation of loading and unloading and duplicate of e.g. inspection of hazardous materials packages, papers, labelling, spills, etc. within the 'transportation chain'.
2. There is no risk of interactive complexity (unfamiliar or unwanted effects) *if* there are agreements with all networks (e.g. included in training requirements, shippers, carriers, dispatchers). Moreover when future scenario's of the international hazardous materials market and the development of technology is assessed periodically.
3. The level of decentralization in the U.S. hazardous materials transportation community is rather high since states, locals, shippers and carriers have operational space to assess and anticipate to local situations. However, in the L-UL programme a certain level of

uniformity of guidelines is of essence, which also can be consolidated in the agreements with the networks. A high level of uniformity can exists within a decentralized structure, making tight-coupling rather irrelevant, moreover since sub systems and units of the transportation system operate separately (loading, shipping, unloading). For this uniformity the OHMS in combination with the networks that are relevant and have added value, an assessment should be made to uniform guidelines per e.g. mode, packaging, hazardous materials for the L-UL programme.

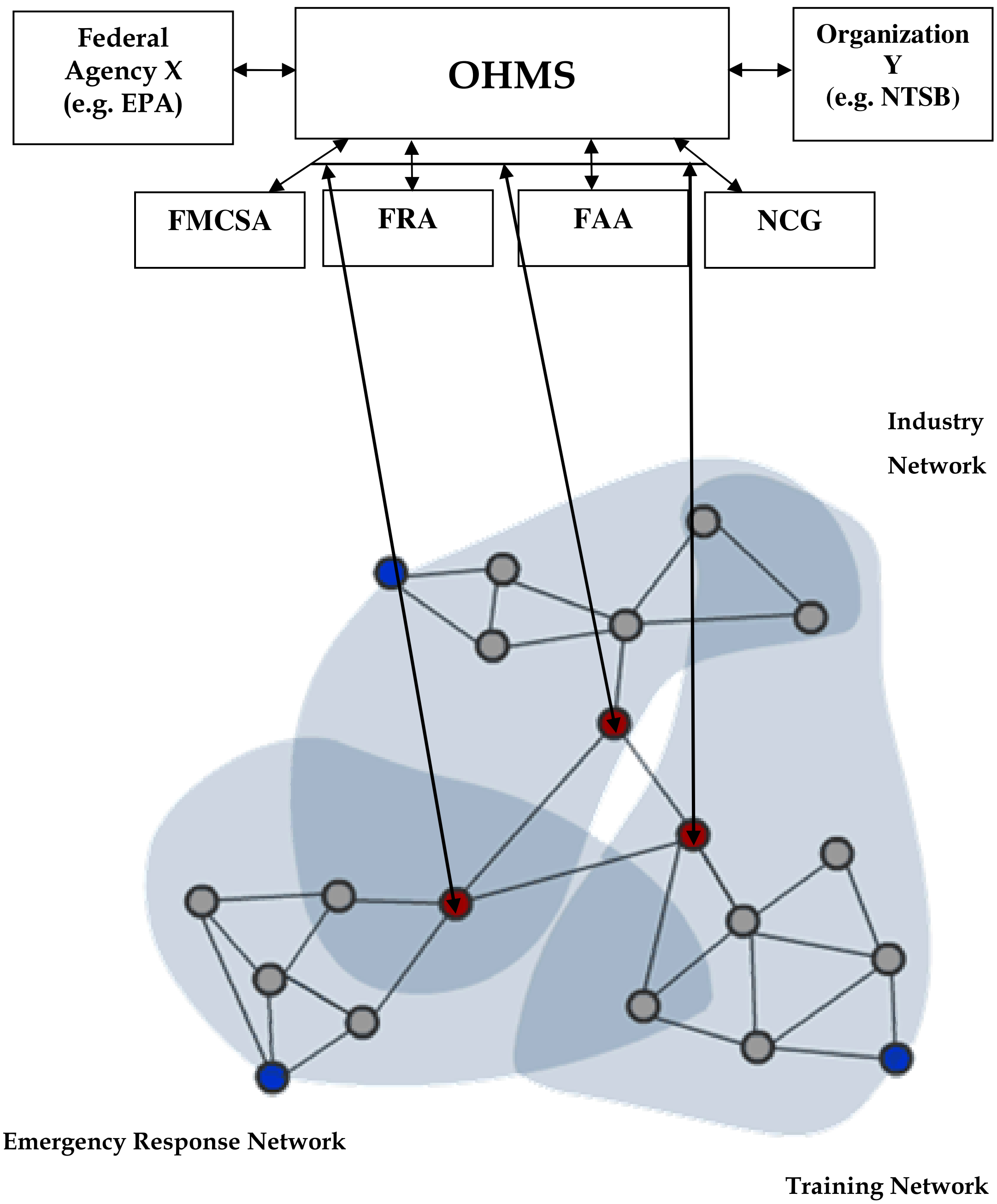
4. This culture of reliability should be promoted via brochures and other communicative tools that give a practical overview of the guidelines (per mode, packaging, etc.) emphasising on safety. A culture of safety is more relevant and important that a culture of reliability in a highly decentralized institutional and administrative structure in the U.S. context and considering conflicting interests of industry and federal agencies. The argument of the normal accidents perspective of the incompatibility with individualistic-democratic values. However this can be disentangled by advising managers of carriers and shippers operational personnel should have sufficient breaks or have informal meetings or days for team-building.
5. Training personnel involved in L-UL operations should be also specified in e.g. seminars on L-UL trainings only that aim at the process of L-UL and all specific responsibilities and training skills. This constant monitored training module should be developed by the OHMS and the training network (maybe including the industry network). The argument of training restrictions because of unimagined events can be invalidated by having a structured feedback system of all L-UL related networks (see data sharing system above) and having profound transportation system analyses. Highly dangerous and political unpalatable arguments are not significantly relevant for the L-UL programme. The experience of the emergency response community or network can be utilized for data sharing and lessons throughout the whole hazardous materials community (including all networks and sub networks).
6. The final argument is learning, which is crucial for feedback to the L-UL programme. OHMS has declared themselves a ‘learning organization’ and management is instilling the concept into the staff culture. Risk analyses of the OHMS, other agencies and other organizations can be used, also prior incidents are highly important. Again, data sharing and transparency is a keystone for learning. The feedback mechanisms of the networks also should be utilized via the institutionalized contacts that are being built. Simulations of L-UL issues and problems also can be lessons on the operational level, which can be advised to e.g. the LEPC’s. The juridical and economic/financial rationales of companies

to restrain from all data sharing can be dealt with via an approach plan as already discussed. And international lessons also can be learned. After assessing whether L-UL issues and/or programmes exist in foreign countries, there is maybe no need to re-invent the wheel. An L-UL evaluation needs to be conducted after 1 or 2 years, to assess the effectiveness of the programme.

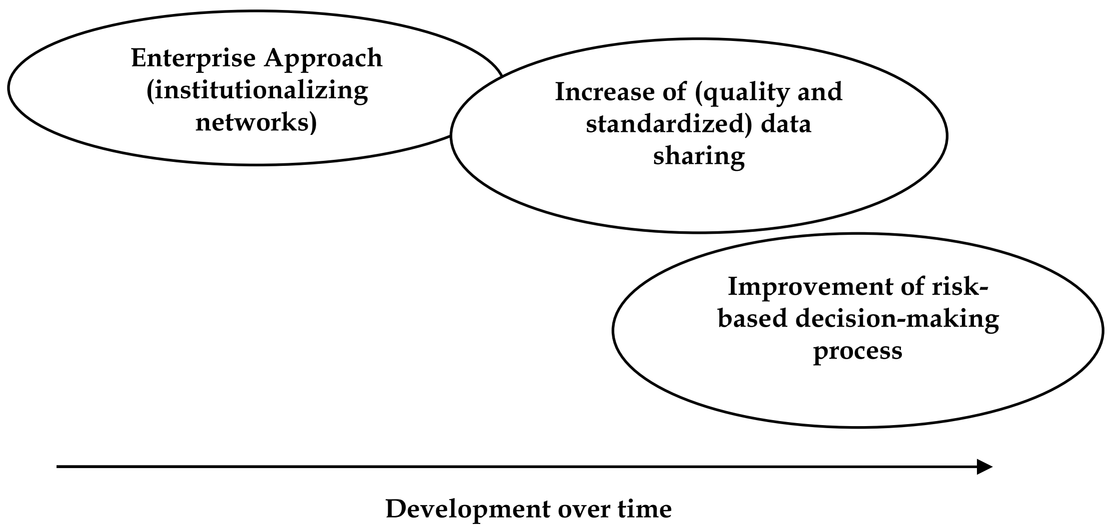
Conclusions

- The relatively new ambitions and approaches of the OHMS indicate a more explicit drive to include stakeholders that may have been previously excluded or overlooked and lead to a more rationalized system of analyses and prioritization. However, the OHMS is part of highly complex environment with dozens of relevant actors so this task requires vigilance and a persistent approach over time.
- By institutionalizing networks (even more) data sharing agreements can be made more easily and data quality can be enhanced. Consequently this set of data can be utilized for risk analyses (see appendix B).
- Internally, this implies (minor) human resource shifts and new learning modules that reinforce the new approaches.
- Institutional adaptiveness of the OHMS is a strategic notion that can be very effective toward reaching enhanced safety and efficiency goals via rationalized programmes.
- International lessons or best practices can add to this strategy.
- Via a combination of network management, process management and data management (that are highly related to the OHMS programmes) organizational goals can be reached more efficiently and effectively.
- Additionally through an ongoing investment in network institutionalization, future programmes or projects can also be carried out more efficiently and effectively.
- By emphasising on the new approaches via key stakeholders within the networks (as well as within the DOT) a more inclusive and integral form of hazardous materials safety management can be designed rationally, acknowledging the institutional complexity simultaneously.

Appendix A. Example of an integral data sharing system



Appendix B. A strategy for synergy



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