

Forum: Environmental Committee (EC)

Issue: Ensuring safe transport of potentially destructive chemicals

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INTRODUCTION

The use of potentially destructive chemicals is very extensive in modern society despite their negative impact on both humans and nature. It is truly utopic to aspire to a world without the use of such chemicals and thus we should take measures to ensure its safe transportation and overall management.

Despite prior efforts, exposure to chemicals is a remaining danger when dealing with destructive chemicals. Depending on the type, duration and concentration, exposure may include inhaling, swallowing or coming in contact with such substances. The outcomes are numerous, from poisoning, vomiting, nausea, headaches, rashes and chemical burns to birth defects, disorders of the lung, kidney or liver and even nervous system disorders.

Luckily, we are capable today to classify potentially hazardous substances as well as list the most common ones being acids, caustic substances, disinfectants, glues, heavy metals- such as mercury, lead, cadmium, aluminum-, paint, pesticides, solvents and petroleum products. Certain safety data sheets or labels that are mostly required or at least should be required, include hazard pictograms, signal words, hazard and precautionary statements as proposed by the Globally Harmonised System of Classification and Labelling of Chemicals (GHS).

It is quite apparent that a variety of issues are faced during transportation of hazardous materials. Apart from certain factors including poor maintenance and lack of competence, the causes of accidents during the transportation of HAZMAT(hazardous materials) depend highly on the transporting route and means. Road accidents are often a result of overturning or overfilling. In terms of rail transportation, derailments and collisions are more common than not.

Decreasing exposure to such chemicals and establishing a chemical management and safety system could be very beneficial. According to Angel Gurría, the OECD(The Organisation for Economic Cooperation and Development) Secretary General "A healthy economy needs a healthy environment". Furthermore, when implementing safe transportation measures, the Sustainable Development Goals (SDGs) are slowly but steadily being accomplished by ensuring good health and well being, providing access to clean water and sanitation, promoting innovation and building resilient infrastructure, as well as reducing cities' environmental impact and achieving sustainable consumption and production.

DEFINITION OF KEY-TERMS

Potentially destructive chemicals

Any chemical, in either gas, liquid or solid form, that has the potential to cause harm is referred to as a potentially destructive chemical.¹

Control of Substances Hazardous to Health (COSHH)

COSHH is a set of regulations put in place to protect workers from ill health when working with specific substances and materials. Breach of COSHH regulations by an employer or employee is a crime, punishable by an unlimited fine.²

Hazardous Materials Transportation Act (HMTA)

The Hazardous Material Transportation Act (HMTA) was published in 1975. Its primary objective is to provide adequate protection against the risks to life and property inherent in the transportation of hazardous material in commerce by improving the regulatory and enforcement authority of the Secretary of Transportation.³

Flammable

Capable of being easily ignited and of burning quickly.⁴

Corrosive

Tending or having the power to corrode: weaken or destroy gradually.⁵

Toxic

Containing or being poisonous material especially when capable of causing death or serious debilitation.⁶

Reactive

Readily responsive to a stimulus.⁷

¹ "Chemical Hazards and Toxic Substances in the Workplace." *Facilities Management*, 12 Sept. 2018, www.facilities.cuimc.columbia.edu/news/chemical-hazards-and-toxic-substances-workplace. Accessed 4 July 2023.

² *British Safety Council*, www.britsafe.org/training-and-learning/find-the-right-course-for-you/informational-resources/what-is-coshh/. Accessed 4 July 2023.

³ *EPA*, <https://archive.epa.gov/emergencies/content/lawsregs/web/html/hmtaover.html>. Accessed 4 July 2023.

⁴ "Flammable." Merriam-Webster.com Dictionary, Merriam-Webster, <https://www.merriam-webster.com/dictionary/flammable>. Accessed 4 July 2023.

⁵ "Corrode." Merriam-Webster.com Dictionary, Merriam-Webster, <https://www.merriam-webster.com/dictionary/corrode>. Accessed 4 July 2023.

⁶ "Toxic." Merriam-Webster.com Dictionary, Merriam-Webster, <https://www.merriam-webster.com/dictionary/toxic>. Accessed 4 July 2023.

⁷ "Reactive." Merriam-Webster.com Dictionary, Merriam-Webster, <https://www.merriam-webster.com/dictionary/reactive>. Accessed 4 July 2023.

BACKGROUND INFORMATION

Potentially Destructive Chemicals and the 29 CFR 1910

The list of potentially destructive chemicals is extremely detailed while their characteristics vary. The most common and hazardous chemicals are flammable, corrosive, toxic and reactive.

The 29 CFR 1910 is a sum of occupational safety and health administration standards. These are numerous while referring to testing, emergency planning, routes, prevention plans, environmental control, regulations, personal protective equipment and material handling amongst others.

Class or Division	1.3	1.4	1.5	1.6	2.1	2.2	2.3 Zone A	2.3 Zone B	3	4.1	4.2	4.3	5.1	5.2	6.1 PGI Zone A	7	8 Liquids
Explosives - 1.3	*	*	*	*	X		X	X	X		X	X	X	X	X		X
Explosives - 1.4	*	*	*	*	O		O	O	O		O				O		O
Very Insensitive Explosives - 1.5	*	*	*	*	X	X	X	X	X	X	X	X	X	X	X	X	X
Extremely Insensitive Explosives - 1.6	*	*	*	*													
Flammable Gases - 2.1	X	O	X				X	O							O	O	
Non-Toxic, Non- Flammable gases - 2.2			X														
Toxic Gas Zone A - 2.3	X	O	X		X				X	X	X	X	X	X			X
Toxic Gas Zone B - 2.3	X	O	X		O				O	O	O	O	O	O			O
Flammable Liquids - 3	X	O	X				X	O							O		X
Flammable Solids - 4.1			X				X	O									X
Spontaneously Combustible Materials - 4.2	X	O	X				X	O									X
Substances which, in contact with water, emit flammable gases - 4.3	X		X				X	O									X
Oxidizers - 5.1	X		X				X	O	O								X
Organic Peroxides - 5.2	X		X				X	O									X
Toxic Liquids PGI Zone A - 6.1	X	O	X		O				X	X	X	X	X	X			X
Radioactive Materials - 7			X		O												
Corrosive Liquids - 8	X	O	X				X	O		O	X	O	O	O			X

Figure 1 Dangerous Goods Segregation Table⁸

It is absolutely necessary to know what types of dangerous goods are being transported each time and their main characteristics. Depending on the size of the load and the class of the chemicals there are certain measures that should be taken. The 29 CFR 1910 standards constitute the first one, while segregation rules, the second main measurement. Some HAZMAT must not be transported together to minimize the risk of mixing chemicals in case of a spill. All materials transported together should be compatible. Thus is it necessary for everyone engaging in the transportation process to be aware of the aforementioned or to have acquired a written analysis of the hazardous goods transported.

Transportation of potentially destructive chemicals

⁸ *Dangerous Goods Segregation Table and Principles*, https://www.chemsafetypro.com/Topics/TDG/Dangerous_goods_segregation_hazardous_chemicals_segregation.html. Accessed 4 July 2023.

The transportation of such chemicals shall be done with great precaution while being in compliance with federal, state, national, local or international regulations, mostly the HMTA. Depending on the type of transportation or the substances, the regulations may vary. Some of the most characteristic are the International Air Transportation Association's (IATA) Dangerous Goods Regulations (ICAO Technical Instructions), the International Maritime Dangerous Goods (IMDG), the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) and the Convention Covering International Carriage by Rail

Different types of transportation and appropriate measures of reducing the risk of accidents

By Road Transport

In order to avoid the possible accidents or exposure to chemicals during their transportation over the road, it is necessary to check the vehicle's condition (tires, valves, wiring, wipers, headlights), to ensure that the vehicle carries fire extinguishers and emergency kits, to properly clear the tanks and to keep track of the different products that have been transported by the same vehicle. The majority of the above as well as other precaution measures are implemented and ensured through pre-existing federal or national laws.

Rail Road Transport

In terms of transporting hazardous chemicals by rail the preventive measures apart from the ones mentioned in the previous section, include labeling all types of cargo, not exceeding weight/size limits, having emergency personnel, preferring routes through unpopulated areas are aligning tanks incase of transporting corrosive chemicals. All the aforementioned are part of safety protocols while they are highlighted in the GHS as well.

By Water Transport

When following marine routes for the transportation of potentially destructive chemicals it is very much needed for every ship to provide ventilation to all cargo, to have a precise navigation system and safety, to be able to perform emergency response plans and to maintain cargo purity through cargo coating so as to handle chemicals of the aforementioned 9 classes. Many nations ensure the implementation of such measures through conventions such as the International Convention for the Prevention of Pollution from Ships (MARPOL).

Placarding Chemicals

In order to achieve the safest storage of potentially destructive chemicals following a placarding system is mandatory. Placarding is a series of signs and labels depicting handling systems, compatibility of substances, safety issues and many other characteristics of the chemicals being transported. The placards must correspond to the hazard class of the materials and follow certain design and placement requirements.

The most widely used signs include the name of the substance, the manufacturer, the chemical code number, any wording or phrasing depicting the danger level such as warning, danger or caution and certain characteristics (toxicity, corrosion etc.). The ones seen in daily life on trucks and rail cars are usually “Flammable Liquid” or “Toxic and Flammable Gas”.

Placards are not only necessary but should be precisely chosen according to the type, transportation system and other requirements. Thus not using or acquiring false placards could result in fines that may even reach 75.000 US dollars due to the possible hazards and accidents. In addition, correct labeling should be paired with proper packaging. Packaging should be based on size and material. Leaks, breaks, melts or bursts shall be avoided at all costs.

Past Accidents

Toxic spill in Debelets (2011)

On July 11th 2011, a truck transporting a hazardous chemical overturned, an event which led to the spill of large amounts of toxic substances in the Bulgarian town of Debelets. Citizens were forced to evacuate their homes due to the toxic gas leak and the high levels of harmful emissions. The specific chemical was Styrene C₈H₈ (also known as Vinyl Benzene), a very flammable colorless oily liquid, dangerous for the human organism that causes nausea if inhaled and evaporates easily leaving a sweet smell behind. The truck overturned due to the driver not being cautious and recklessly polluting the environment.



Figure 2 Toxic spill in Debelets

More specifically, toxic gasses were emitted into the atmosphere which made the conditions not appropriate for any organism to survive, since the material was carcinogenic. Firefighters were forced to keep the area covered in water to eliminate or at least decrease the risk of explosion or fire. The toxic cloud was very dangerous but due to the accident being under constant scrutiny, no further negative effects were noted.

Erika Oil Spill (1999)

On December 12th 1999, an oil tanker, Erika, broke in two near France polluting almost 400 kilometers of coastline and causing great damage to the environment. The tanker was transporting around 31.000 tons of heavy fuel oil. Due to a structural failure and the severe weather conditions during that day, the ship broke in two pieces. The result was an oil spill affecting multiple nautical miles. It is truly an environmental



Figure 3 Erika Oil Spill

tragedy that affected the fish population, tourism and France. About 42.000 sea birds died after being covered in oil. The heavy weather that continued in the following days and the tides brought the oil closer to shore. It was very difficult to contain this pollution. French planes were the ones responsible for tracking and attempting to not allow the spill to drift further into the sea. A significant number of civil parties aided the difficult process of cleanup. Despite the mobilization of response operations, the tide and weather conditions made it very difficult to clean up and track. The damage control was finally done in 2001 after a two year long attempt.

MAJOR COUNTRIES AND ORGANIZATIONS INVOLVED

The Organisation for Economic Cooperation and Development

The OECD as an organization aims for better cooperation in the economic sector. In the words of Angel Gurría “the OECD promotes better integration of environmental concerns into economic and sectorial policies”. Implementing a chemical management system has always been a priority of the OECD. They are working on minimizing and eventually eliminating risks of the use of chemicals and during the process of their transportation. In correspondence to the Globally Harmonised System (GHS) they ensure the safety of humans and nature during transport of potentially destructive chemicals by proposing elements and introducing safety data sheets. Such sheets have been very beneficial in minimizing the risk of mixing chemicals or any other types of reactions during potential accidents. In addition, they help increase the knowledge of anyone participating in the transportation process including workers and drivers. Finally, they identify a hazard description for every dangerous good being transported so as for it to be communicated to users and companies and thus not endanger anyone.

International Air Transport Association (IATA)

The specific association works closely with local governments so as to ensure the safety of aircrafts and personnel during transportation. They offer certain Dangerous Goods Regulations (DGR), which constitute a global reference for transporting any hazardous substances including potentially destructive chemicals. They are amended annually to “stay current” and be able to correspond to all types of hazards. These guidelines have been very successful in avoiding unwanted incidents and educating personnel since companies and individuals rely on them daily. They ensure the safe and efficient transportation of hazardous goods. The DGR are offered in a wide variety of languages making themselves available to anyone and proposing multiple solutions to the leading problems that come with the transportation of destructive chemicals via air.

International Maritime Dangerous Goods (IMDG)

The IMDG code aims to correspond to numerous aspects of maritime safety and danger. It proposes certain provisions with which the transportation of potentially destructive chemicals should comply. It was originally created to enhance safety and caution. The requirements for every and each substance have been developed in great detail with particular reference to incompatible substances. It manages to successfully deal with safety issues and concerns caused by the transportation of HAZMAT. The specific code currently holds a mandatory status under the International Convention for the Safety of Life at Sea (SOLAS), with a few sections being simple recommendations. Thus, the IMDG code sets the basic requirements for all the transport modes and based on its mandatory nature it allows for safe transportation.

FEDERAL MOTOR CARRIER SAFETY ADMINISTRATION (FMCSA)

The FMCSA’s main goal is to improve the safety of motor vehicles. In terms of chemical control when transporting HAZMAT they propose both emergency response plans with certain requirements and some chemical packaging recommendations. Their emergency plan suggests an emergency telephone number being monitored at all times. They ask for shipping papers and labels including emergency response information such as immediate health hazards, handling methods and first aid measures. In addition, they promote the utilization of performance oriented packaging, a packaging construction system based on performance standards as developed by the UN. With the above they have been able to provide immediate aid when needed in terms of accidents.

USA

Air Sea USA offers UN approved packaging for all types of hazardous goods. It allows the usage of a transportation network that provides safety and caution when transporting any dangerous chemicals. They have a huge variety of options to choose from to ensure maximum security and accident prevention.

As effective as the work of Air Sea USA and other organizations is, the accidents that occur during chemical transportation are not limited, in reality their number has increased. A well-known incident is the HAZMAT spill in Massachusetts on April 17th 2020. A truck carrying a total of 10.000 gallons of gasoline and ethyl alcohol. After a crash, the two liquids were mixed together and spilled into a nearby swamp. The cost of everything that was needed for the environment to return to its previous condition was 1.1 million \$. This accident could have been avoided, only if an Electronic Stability Control System was installed to trucks carrying destructive chemicals just like this one. Railroad accidents have a high percentage of chemical-related accidents. CBS news with data from the Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) came to the conclusion that for every hazardous materials incident involving a train, there are 33 HAZMAT incidents involving rigs on US roadways.

Canada

In order to ensure safety and caution during the transportation of potentially destructive chemicals, Canada developed the Transportation of Dangerous Goods (TDG) Program. The above promotes safety standards and regulations since it provides risk-based oversight and gives expert advice on HAZMAT so as to ensure public safety during all types of dangerous goods transportation. The specific program conducts research and analyzes data, while collaborating with multiple other nations so as to establish a worldwide safe transportation system. All the above activities are being yearly inspected by engineers and other specialists. Finally, they offer packaging and handling advice as well as an emergency number for aid provision when and if needed.

Australia

The cornerstones of Australia's HAZMAT transportation system are two: Commonwealth, for transportation by air through the Civil Aviation Safety Authority (CASA) and by sea through the Australian Maritime Safety Authority (AMSA), and the Australian states and territories who are responsible for road and rail transportation. All the above are cooperating to develop an internationally harmonized legislation for Australia's HAZMAT transport. They provide certain regulations for transporting Radioactive Material in cooperation with the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). Australia has fully adopted the GHS with Safe Work Australia being in responsibility for its implementation.

Germany

In Germany, the German Federal Institute for Risk Assessment (BfR) is one of the most powerful tools against HAZMAT accidents during their transport. They suggest safe packaging, propose logistics concepts, traffic guidance, quality control and accident prevention strategies. Many types of dangerous goods are being transported for further processing or to acquire new usages which leads to unnecessary health hazards. The

aforementioned Institute advises the Federal Ministry of Transport, Building and Urban Affairs so as to minimize the danger to health and nature and provide measures for the prevention and handling of chemicals. One of their goals is to protect the marine environment from spills or any other type of accidents that may occur during the transport of potentially destructive chemicals by sea. Finally, they attempt to separate all chemicals to the segregation classes so as to ensure national safety.

TIMELINE OF EVENTS

DATE	DESCRIPTION OF EVENT
11 July 2011	Toxic Spill in Debelets
12 December 1999	Erika Oil SPill
1956	ST/SG/AC.10/1/Rev.21 (First Draft)
2003	ST/SG/AC.10/30/Rev.4(Adoption by UN)
1975	Publication of HMTA
30 September 1961	OECD was founded
19 April 1945	IATA was founded
1965	Adoption of IMDG code
1 January 2000	Establishment of FMCSA

1974	SOLAS Convention
1 January 2005	Establishment of HMSP program
17 April 2020	Massachusetts HAZMAT spill

RELEVANT UN RESOLUTIONS, TREATIES AND EVENTS

ST/SG/AC.10/1/Rev.21 (Vol.I)⁹

The above are the Recommendations on the Transport of Dangerous Goods by the United Nations (UN) which is addressed to governments and organizations. It is an official document regularly amended and updated which functions as an emergency response to transportation accidents involving hazardous chemicals and radioactive materials. The competent authorities should achieve compliance with these regulations and their goals. Some of the most important parts of this document are the case of radioactive materials, the official names of substances and reports of accidents and incidents.

ST/SG/AC.10/30/Rev.4¹⁰

The aforementioned is the Globally Harmonized System of Classification and Labelling of Chemicals (GHS). It is necessary for the comprehension and usage of safety data sheets. The United Nations Economic and Social Council's Sub-Committee of Experts on the Globally Harmonised System of Classification and Labeling of Chemicals (UNSCGHS) is responsible for maintaining the GHS and ensuring its purpose and applications. The specific document recognises multiple types of physical hazards, with health hazards included and different environmental hazards mentioned. Finally it consists of 10 different annexes all connected to potentially destructive chemicals and quite a few to the system of their transportation.

⁹ *Transport of Dangerous Goods - UNECE*, Accessed 29 July 2023.

https://unece.org/fileadmin/DAM/trans/danger/publi/unrec/rev21/ST-SG-AC10-1r21e_Vol1_WEB.pdf

¹⁰ *Globally Harmonized System of Classification and Labelling of ... - UNECE*, Accessed 29 July

2023. https://unece.org/fileadmin/DAM/trans/danger/publi/ghs/ghs_rev04/English/ST-SG-AC10-30-Rev4e.pdf

Rotterdam Convention

The Convention's goals are to encourage collaboration and collaborative efforts among the parties in the worldwide trade of certain dangerous substances in order to safeguard human health and the natural world from potential harm and to contribute to the more sustainable use of those who were hazardous chemicals. This is done by facilitating sharing of knowledge about these chemicals' characteristics, by establishing a national decision-making procedure for their import and export process. The Convention applies to industrial chemicals and pesticides that have been severely limited or outright banned by Parties due to health or environmental concerns and that have been informed by States for participation in the PIC process. Consideration of adding a substance to Annex III of the Convention begins with one complaint from each of the two designated zones. It is also possible to suggest adding formulations of highly dangerous pesticides to Annex III if they represent a risk when used in underdeveloped nations or nations undergoing economic transition. A "decision guidance document" (DGD), providing details about the chemical and the regulatory choices to ban or severely restrict the substance for health or environmental grounds, is distributed to all Parties after a chemical is added to Annex III.

PREVIOUS ATTEMPTS TO SOLVE THE ISSUE

Hazardous Materials Safety Permit (HMSP)

In support of the Federal Motor Carrier Safety Administration (FMCSA) to improve safety when transporting potentially destructive chemicals the HMSP was developed. The specific program requires safety permits depending on the content that is being transported with specific attention given to the case of anhydrous ammonia. All the permits that fall in the above categories often require applications and renewals. The HMSP program has allowed for the safe and cautious transportation of HAZMAT since its establishment. It has greatly decreased the rate of crashes as well as the out of service (OOS) rates for hazmat, vehicles and drivers.

Safety Data Sheet (SDS)

SDSs are a means of hazard communication standards made up by different sections including Identification, Composition, First-Aid Measures, Fire-Fighting Measures, Accidental Release Measures, Handling and Storage, Exposure Control, Physical and Chemical Properties, Stability and Reactivity, Toxicological Information, Ecological Information, Disposal Information, Transport Information, Regulatory Information and Other Information. It proposes a variety of measures concerning the handling and storage of potentially destructive chemicals, personal protection and different considerations concerning transporting and disposing of such substances. The aforementioned have been highly successful in achieving the desired results. They have created a worldwide system of communication to ensure that everyone can be aware about any cargo. Ever since, not only has transportation been facilitated, but information on dangerous goods has become easily accessible.

POSSIBLE SOLUTIONS

Avoid Transporting Hazardous Chemicals With Food

Tanks transporting food shall not be used for transferring any other type of cargo, especially potentially destructive chemicals. Food and Chemicals should be transported in the same cargo or tank. According to the Federal Food, Drug, and Cosmetic Act (FDA), the sanitary transportation of food may adhere to a set of guidelines, including temperature control, adequate refrigeration, management of storage facilities, correct loading and unloading methods, sanitation of equipment, not mixing cargos, inspecting vehicle conditions, achieving high levels of communications, sterilization and minimizing the risk of contamination. The above as important as it is as a recommendation, it is more than necessary to be implemented as a framework, law or regulation so as for its implementation to be insured.

Follow the Dangerous Goods Segregation Rules for Carrying Mixed Classes of Hazardous Chemicals

Dangerous Goods including potentially destructive chemicals should be transported together only if compatible, to minimize danger of mixing chemicals in case of a spill. Certain chemicals should not be transported nor stored together. The rules of good segregation include hazardous materials of the same class being stored together unless a reaction may be caused, strong acids should not be stored with strong alkali, materials of class 4.3 should be away of water-containing solutions, organic peroxides (class 5.2) and highly pyrophoric goods (class 4.2) are reactive, toxic substances (6.1) should be separated from feeds, a few explosives (1.1, 1.2), infectious substances (6.2) and radioactive chemicals (7) are incompatible with any other type of potentially destructive chemical and finally class 9 chemicals are compatible with almost all other hazardous materials. The implementation of the specific measure can be ensured via numerous means such as suggesting penalizing not being in accordance with such segregation rules.

Keep a Record of the Substances Being Carried

Shipping papers and emergency instructions are deemed necessary for safety. A safety data sheet allows for the appropriate precautions to be taken and the manufacturer's instructions to be followed so as to prevent accidents and ensure the proper handling of hazardous situations. Such records could be mandatorily required by all transporting vehicles to contain and companies to keep copies of.

Confirmation of Required Signs and Proper Labeling (Placards and Markings)

Based on the placarding requirements, warning labels as described above shall include all appropriate information for the content of the cargo being transported. A bill of lading accompanied by a list of the main characteristics of potentially destructive chemicals may be imperative when dealing with or avoiding a physical hazard. A possible framework or regulations could be implemented in terms of the consequences in case of failure to comply with labeling requirements.

BIBLIOGRAPHY

Benefits from Implementing a Chemical Management System - OECD, www.oecd.org/chemicalsafety/benefits-from-implementing-a-chemical-management-system.pdf. Accessed 24 June 2023.

“Workplace Safety - Hazardous Substances.” *Better Health Channel*, 20 Nov. 2000, www.betterhealth.vic.gov.au/health/healthyliving/workplace-safety-hazardous-substances.

Software, pTools. “Dangerous Chemicals.” *Health and Safety Authority*, www.hsa.ie/eng/your_industry/fishing/hazards/dangerous_chemicals/. Accessed 24 June 2023.

Minett, Alex. “What Is Coshh? Hazardous Substance Control Explained.” *CHAS*, 12 June 2023, www.chas.co.uk/blog/coshh-hazardous-substance-control-explained/.

Matt Sokol, VP Sales and Marketing. “Storage and Transportation of Hazardous Chemicals.” *Protective Polymer Coatings*, Advanced Polymer Coatings, 15 Sept. 2021, www.adv-polymer.com/blog/hazardous-chemicals#ch1.

“Shipping Hazardous Materials Internationally: Regulations to Follow.” *Air Sea Containers (US)*, 17 Aug. 2022, www.airseadg.com/en-us/learn/shipping-hazardous-materials-internationally.

Dangerous Goods Segregation Table and Principles, www.chemsafetypro.com/Topics/TDG/Dangerous_goods_segregation_hazardous_chemicals_segregation.html.

Labelmaster. “Infographic: Dangerous Goods on Roads and Rails: Placards.” *Labelmaster Blog*, 17 June 2016, blog.labelmaster.com/infographic-dangerous-goods-on-roads-and-rails-placards/.

Chemical, Royal. “How to Transport Hazardous Chemicals: Royal Chemical.” *How to Transport Hazardous Chemicals | Royal Chemical*, Royal Chemical Company, 28 Nov. 2021, www.royalchemical.com/blog/transporting-hazardous-materials.

“Advisory: Guidance on the Application of 49 CFR Section 385.403; Who Must Hold a Safety Permit?” *FMCSA*, www.fmcsa.dot.gov/regulations/hazardous-materials/advisory-guidance-application-49-cfr-section-385403-who-must-hold.

Advisory: Guidance on the Application of 49 CFR Section 385.403; Who ..., www.fmcsa.dot.gov/sites/fmcsa.dot.gov/files/docs/regulations/hazardous-materials/84271/hmsp-advisory-102517final.pdf.

Grills, Doug. “Safety Data Sheets (SDS) for Chemical Products: What Shippers Need to Know.” *3PL Bulk Freight Company*, www.bulkconnection.com/blog/safety-data-sheets-sds-for-chemical-products.

Homepage | Unece, unece.org/fileadmin/DAM/trans/danger/publi/unrec/rev21/ST-SG-AC10-1r21e_Vol1_WEB_track.pdf.

“ECOSOC Bodies Dealing with Chemicals’ Safety.” *UNECE*, unece.org/transport/dangerous-goods/ecosoc-bodies-dealing-chemicals-safety.

Homepage | Unece, unece.org/fileadmin/DAM/trans/danger/publi/ghs/ghs_rev04/English/ST-SG-AC10-30-Rev4e.pdf.

“Department of Labor Logo United Statesdepartment of Labor.” *1910 - Table of Contents | Occupational Safety and Health Administration*, www.osha.gov/laws-regs/regulations/standardnumber/1910/1910TableofContents.

Mitalski, Gayle. “All about Chemical Blending, Packaging and Transportation: Royal Chemical.” *All About Chemical Blending, Packaging and Transportation | Royal Chemical*, Royal Chemical Company, 10 Feb. 2023, www.royalchemical.com/blog/all-about-chemical-blending-packaging-transportation.

<http://m3web.bg>, M3 Web -. “Turkish Company with Hefty Fine over Toxic Spill in Bulgaria.” *Novinite.Com - Sofia News Agency*, www.novinite.com/articles/130259/Turkish+Company+with+Hefty+Fine+over+Toxic+Spill+in+Bulgaria. Accessed 24 June 2023.

AzerTAG.az. “More than 2500 People Evacuated in Northern Bulgaria after Toxic Spill.” *AZERTAC*, 11 July 2011, azertag.az/en/xeber/More_than_2500_people_evacuated_in_northern_Bulgaria_after_toxic_spill-608879.

“Learn from the Past: Erika Oil Spill, Europe’s Environmental Disaster.” *SAFETY4SEA*, 9 Apr. 2021, safety4sea.com/cm-learn-from-the-past-erika-oil-spill-europes-environmental-disaster/.

“IATA Dangerous Goods Regulations (DGR).” *SKYbrary Aviation Safety*, www.skybrary.aero/articles/iata-dangerous-goods-regulations-dgr. Accessed 24 June 2023.

“Air Sea Containers: Hazardous Goods Packaging Specialists.” *Air Sea Containers (US)*, 24 Nov. 2022, www.airseadg.com/en-us/.

“Hazardous Materials Safety Permit Program (HMSP).” *FMCSA*, www.fmcsa.dot.gov/regulations/hazardous-materials/hazardous-materials-safety-permit-program-hmsp. Accessed 24 June 2023.

Allen, Dale. “What Are GHS Safety Data Sheets?” *IACS*, 21 Sept. 2022, www.thechemicalsafetyassociation.org/post/what-are-ghs-safety-data-sheets.

“Hazmat Road Accidents in the U.S. Have More than Doubled in the Past Decade.” *CBS News*, www.cbsnews.com/news/hazardous-materials-trucks/. Accessed 7 July 2023.

“How to Comply with Federal Hazardous Materials Regulations.” *FMCSA*, www.fmcsa.dot.gov/regulations/hazardous-materials/how-comply-federal-hazardous-materials-regulations#err. Accessed 7 July 2023.

Transport Canada. “Transportation of Dangerous Goods in Canada.” *Transport Canada*, 29 June 2023, tc.canada.ca/en/dangerous-goods/transportation-dangerous-goods-canada.

“Transport of Dangerous Goods.” *Department of Infrastructure, Transport, Regional Development, Communications and the Arts*, 14 Apr. 2023, www.infrastructure.gov.au/infrastructure-transport-vehicles/transport-strategy-policy/transport-australia/transport-dangerous-goods.

“Navigation Und Service.” *BfR*, www.bfr.bund.de/en/transport_of_dangerous_goods-6970.html. Accessed 8 July 2023.