

**“A STUDY ON THE IMPORTANCE OF HANDLING HAZARDOUS  
MATERIALS IN SUPPLY CHAIN MANAGEMENT”**

*A project report submitted to  
The Indian Maritime University, Chennai Campus in Partial fulfilment of the  
requirements for the award of the Degree of MBA in Port and Shipping Management*

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**INDIAN MARITIME UNIVERSITY**

(A Central University, Government of India)

**MAY 2023**

## DECLARATION

The project work titled “**A STUDY ON THE IMPORTANCE OF HANDLING HAZARDOUS MATERIALS IN SUPPLY CHAIN MANAGEMENT**” has been carried out under the direction of **Dr. M. Sekar** in partial fulfilment of the requirements for the award of degree of Master of Business Administration in Port and Shipping Management to be submitted to the School of Maritime Management, Indian Maritime University, Chennai Campus

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Place: Chennai



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## CERTIFICATE

This is to certify that the report titled “**A STUDY ON THE IMPORTANCE OF HANDLING HAZARDOUS MATERIALS IN SUPPLY CHAIN MANAGEMENT**” submitted to the School of Maritime Management, Indian Maritime University, Chennai Campus, by KUMAR SHASHANK, (Registration Number: 2103304012) in partial fulfilment of the requirements for the award of degree of Master of Business Administration in Port and Shipping Management is a record of project work done under my supervision.

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## **ACKNOWLEDGEMENT**

I would like to express my immense gratitude to the distinguished individuals and organization who have offered their invaluable support and contribution while completing this project study.

I express my sincere thanks to **Dr. M. Sekar**, Associate Professor, Indian Maritime University, Chennai campus for his guidance and encouragement in carrying out this project report.

I also extend my gratitude to **Dr. B. Swaminathan**, HOD School of Maritime Management and eminent professor for their invaluable support and words of wisdom.

I would like to extend my appreciation to the staff of organization and my colleagues who gave freely and generously of their time and expertise.

The valuable input and review from the above-mentioned individuals made the preparation for this project study possible.

## EXECUTIVE SUMMARY

Dangerous goods, shortly DG, are substances which pose risk to health, safety, property or the environment when transported. Some dangerous goods that pose risks are called hazardous materials (HAZMAT) even if they are not transported. At Global Hazmat, there are many businesses in numerous industries that deal with hazardous materials on a daily basis. The main aim of this study was to understand the role of safety measures taken while handling Hazardous material and on various procedures and case studies related to Hazardous material. Hazardous materials come under chemical regulations. Hazmat teams are specially trained staff to treat dangerous items, including radioactive, flammable, explosive, corrosive, oxidizing, asphyxiating, bio hazardous, poisonous, pathogenic or allergenic materials. Most of the Accidents happened in warehouses due to the non-compliance safety measures. The mitigation of hazardous material risks can include the application of safety precautions during transport, usage, storage and disposal. Findings of the study indicate that by law, most countries have control over movement of hazardous materials, and they are subject to a variety of international treaties. Also, different countries can use different class types for the same product. People who handle hazardous items are required to wear protective gear and metropolitan fire services often have a specially equipped response team to handle injuries and spills. It is seen from the case studies that many accidents are caused due to the noncompliance of safety measures. Laws and regulations on the use and handling of hazardous materials can vary depending on the material behaviour and status.

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## **CHAPTER- 1**

### **INTRODUCTION**

The practise of supply chain management entails organising, carrying out, and overseeing supply chain operations as efficiently as is practical. Supply chain management deals with the transportation and storage of raw materials, stocks for ongoing projects, and finished goods from the site of production to the point of consumption. In order to meet customer needs, logistics is the science and art of controlling and regulating the flow of information, people, and other resources like energy between the point of origin, the point of packing, and the point of consumption. This process integrates information, transportation, inventory, warehousing, material handling, and packaging. Some compounds can be dangerous to transport, endangering people's health, safety, property, and the environment. The term "dangerous goods" (DG) refers to these products. Certain materials and products that travel by train, ship, air, or roadway are categorised as hazardous products because they are combustible, explosive, toxic, or harmful to people or the environment. In order to ensure safe storage, handling, and disposal of hazardous goods, federal regulatory agencies require makers and distributors to acknowledge the physical, health, and environmental concerns of their products in a variety of ways. Various tools, including as posters, labels, marketing materials, and MSDS (Material Safety Data Sheets), are used to disseminate this information. Many goods used in logistics are hazardous. Individuals are not need to be aware of the gravity. Due of the potential for exposure to cause serious physical harm, chronic sickness, or even death, these laws and regulations place a specific emphasis on disclosing the dangers associated with such goods. The environment and property may potentially be harmed or killed. All employees must be aware of and respect the risks associated with these Products. These dangers to health, safety, and property are present throughout all functional areas. In order to satisfy customer demands, logistics is the science and art of managing and directing the flow of information, people, and other resources between the site of origin and packaging and the place of consumption. Information, transportation, stock, warehousing, and material handling are all integrated in this process. Planning, executing, and managing supply chain operations as effectively as feasible is the process of supply chain management. The movement and storage of raw materials, inventories for work-in-progress, and finished commodities from the point of origin to the point of consumption are all covered by supply chain management. Hazardous commodities shipping is a difficult task. When it comes to how products are handled in airports, ports, and on United Nations vessels, there are several considerations to

make. Regarding the transfer of hazardous materials, the Committee of Experts has published rules. These rules are adopted by the regulatory body in charge of overseeing the various modes of transportation. Each dangerous material has a specific UN identification number. The rule is based on a system of categorization that places substances or items in one of nine classes. Class 1 is the least harmful, while class 9 is the most dangerous.

## **1.1 SIGNIFICANCE OF SUPPLYCHAIN MANAGEMENT**

Every organisation, no matter how big or little, needs supply chain management (SCM). SCM is the dynamic management of materials storage to increase customer satisfaction and achieve a competitive advantage. Along with stock management and tracking finished goods from their point of manufacture to their final destination, SCM also takes care of the development and storage of the raw materials needed to make an item.

Today's supply chain management comprises the critical planning of beginning to end business cycles to recognise market and financial worth as well as offering a company an advantage over their rivals.

A business's supply chain management has a significant impact. Simple SCM can directly improve customer service. To comfort both the manufacturers and the merchants, the appropriate thing and the appropriate amount should be communicated in the ideal approach. Customers must have the choice to know where to go in order to get the necessary goods. Customers must have higher expectations for customer service.

In the event that products are not distributed as planned, supply chain management of an organisation must assure customers that they will receive their orders as soon as possible. SCM also has a significant impact on an organization's primary issue. An effective supply chain management executive can improve the efficiency of manufacturing facilities, distribution centres, and transportation equipment. Because customers may purchase their goods and they are delivered in a timely manner, income is obviously increased.

**This trade notice outlines the various guidelines and procedures that handling agents must adhere to when handling dangerous products or hazardous cargo at DDPA. The following are the specifics: -**

The Deendayal Port Authority has made clear a number of hazardous goods and handling guidelines for both liquid and dry international maritime hazardous cargo, as well as a number of standard operating procedures for handling liquid hazardous cargo at DDPA.

The rules, guidelines, and other requirements of the DDPA for managing dangerous commodities must be followed by all DDPA stakeholders.

It is expressly stated in the DDAP standards that oil importing businesses should employ a safety surveyor, particularly when handling cargo like LPG and ammonia. To determine the level of danger, a safety surveyor will thoroughly examine the loading and will continuously watch how the hazardous cargo is being loaded and discharged.

Oil firms are required to routinely check the integrity of their pipeline covers inside the port. To keep the pipeline in top condition, they must make sure it is damage-free and do routine checks and inspections. They need to appropriately paint the pipeline to keep it in good condition. The businesses are required to provide a safety report on the pipelines to the traffic manager and deputy conservator of the DDPA.

The MSIHC rules 1989, which were passed under the 1986 Environmental Protection Act, compel the oil corporations to adhere to all relevant and necessary standards. It is necessary to conduct internal and external safety audits. The port should receive this report. Oil companies are in charge of adhering to SOPs and OCPs. The port's various authorities will perform a thorough inspection of various port facilities to ensure maximum safety at all levels.

Providing alerts and advises in the event of any hazardous acts or unsafe situations found during a cargo handling operation or terminal inspection is another duty of the safety officer. Oil businesses who are concerned should make an effort to fix any issues and challenges and keep a safe operating environment by following the port's requirements. The standards also address a number of dock worker welfare, health, and safety issues when handling cargo.

The cargo handling company or terminal operator can obtain landing clearance by supplying the necessary documentation. International Maritime Dangerous Goods Liquid Cargo must be loaded or discharged 48 hours before it arrives at DDPA, and this information must be given to the handling agent.

They will not be responsible for any delays brought on by incomplete paperwork, carelessness on the part of the handling agency, or other circumstances.

The DDPA regulations also cover many matters to guarantee security while terminal operators, stevedores, and container handlers load and unload dangerous containers. An experienced operator who has a lot of lifting equipment and lifting appliance experience must perform the loading and unloading tasks. A competent person who is knowledgeable about the relevant legal guidelines and safety requirements for handling hazardous containers must supervise this loading and unloading. The in-charge safety officer, assistant fire safety officer, etc. must proclaim the prayer. The Safety Officer and Traffic Department officers are in charge of conducting routine

inspections and reporting any unsafe behaviour or circumstance that deviates from the typical safety requirements at the Port. They must take any infraction seriously and take the necessary action if they notice it in any way.

The dangerous products handling regulations of the DDPA provide that the stevedore is completely in charge of ensuring the security of any personnel used by stevedores for loading and unloading operations. Port Deendayal.

Container handling agents, stevedores, and terminal operators are required under the DDPA to immediately report any noncompliance or unsafe conditions at the port to the officer in charge of the affected area or the Safety Officer. Additionally, the hazardous materials nodal officer will be informed of this.

## **1.2 OBJECTIVES OF THE STUDY**

- To analyse the challenges in handling of HAZMAT.
- To study the modern trends in hazardous material handling and its impacts.
- To analyse the challenges in handling of HAZMAT.
- To suggest findings for the above study.

## **1.3 SCOPE OF STUDY**

This study was conducted to know about the safety measures in movement of the hazardous materials and innovative techniques in this area. This research plays a sequent role in gathering information's about the internal and external work procedures and helps in attaining employee feedback and satisfaction

## **1.4 RESEARCH METHODOLOGY**

Research methodology is the science of how research is done scientifically. It's a way to systematically and logically solving a problem and helps us to understand the process and product of the research. To accomplish the above said objective the important information is being taken by utilizing both the primary and secondary data. This study uses extensive secondary data from public domain to analyse the Handling of Hazardous Cargo, safety measures implemented by companies and carry out a comparative analysis. The data has been collected from research papers, public reports, journals, company websites, reference books, newspaper articles and Industry magazines. Some information collected has been pictorially represented. The data so called is interpreted and analysed with reference to the project title.

## **1.5 LIMITATION OF THE STUDY**

The study had mainly done on the basis of the secondary data as well as primary data available in the reports, journals and company websites. Rather than giving a wide picture on the hazardous cargo the study is restricted only to the safety measures in movement of the hazardous materials with in the logistics companies.

- Some of the respondents in the questionnaire didn't respond accurately
- Lack of time
- The data collected like Questionaries is limited.

Personal visit to the firm and personal interaction with the workers was not feasible.

## **CHAPTER-2**

### **LITERATURE REVIEW**

#### **2.1 Managing Hazardous Materials in Supply Chains**

This article provides an overview of best practices for managing hazardous materials in supply chains. It discusses the importance of proper handling, storage, and transportation of hazardous materials, as well as the associated regulatory requirements. The study emphasizes the need for effective risk assessment, training programs, and communication among supply chain partners. The authors stress the need for effective risk assessment strategies to identify potential hazards and develop appropriate mitigation measures. They emphasize that risk assessment should encompass not only the immediate handling and storage stages but also the entire supply chain, including transportation and disposal. It emphasizes the importance of educating employees on proper procedures, safety protocols, and emergency response plans. Well-trained personnel are better equipped to handle hazardous materials, reducing the risk of accidents and minimizing potential damages. Communication and collaboration among supply chain partners are also identified as key factors in effective hazardous material management. The authors argue that establishing clear lines of communication and information sharing channels between suppliers, manufacturers, distributors, and regulatory authorities is essential. Timely and accurate information exchange enhances coordination, facilitates compliance with regulatory requirements, and enables efficient response to emergencies. (Johnson, 2018)

#### **2.2 The Economic Impact of Mishandling Hazardous Materials in Supply Chains**

This research examines the economic implications of mishandling hazardous materials in supply chains. It explores the costs associated with accidents, spills, and regulatory non-compliance. The study highlights the importance of implementing risk mitigation strategies and investing in appropriate handling equipment to minimize financial losses and reputational damage. The review highlights the significant financial consequences that can arise from accidents, spills, and regulatory non-compliance related to hazardous materials.

The authors emphasize that mishandling hazardous materials can lead to costly incidents, including property damage, clean-up expenses, fines, legal liabilities, and negative impacts on a company's reputation. They argue that the potential economic losses resulting from mishandling hazardous materials extend beyond immediate direct costs, such as clean-up and legal fees, to

include indirect costs such as business interruption, supply chain disruptions, and loss of customer trust. (Brown, 2017)

### **2.3 Technological Innovations for Safe Handling of Hazardous Materials in Supply Chains**

This review paper investigates technological innovations that enhance the safe handling of hazardous materials in supply chains. It explores the application of advanced tracking systems, sensor technologies, and automation to improve visibility, traceability, and real-time monitoring. The study emphasizes the potential of these innovations to mitigate risks and enhance supply chain resilience. The importance of advanced tracking systems in monitoring and tracing the movement of hazardous materials throughout the supply chain. These systems utilize technologies such as GPS, RFID, and barcoding to provide accurate and real-time information on the location, condition, and handling of hazardous materials. Improved visibility enables supply chain managers to proactively identify potential risks, monitor compliance with handling protocols, and promptly respond to incidents or emergencies.

Sensor technologies also play a significant role in ensuring safe handling practices. The review highlights the use of sensors to monitor critical parameters such as temperature, pressure, humidity, and leakage. By integrating sensors into packaging, containers, and transportation vehicles, supply chain stakeholders can detect anomalies or deviations from safe operating conditions, enabling timely interventions and preventive actions. Automated systems, such as robotic handling equipment and intelligent material handling systems, reduce reliance on manual labour and minimize the exposure of workers to hazardous substances. These technologies improve efficiency, accuracy, and safety by reducing human error and fatigue-related risks. (Clark, 2020)

### **2.4 Environmental Sustainability in Hazardous Materials Management**

This focuses on the environmental sustainability aspects of managing hazardous materials in supply chains. It discusses the importance of reducing the environmental impact through waste minimization, recycling, and proper disposal practices.

Recycling and resource recovery play a crucial role in sustainable hazardous material management. The authors discuss the importance of implementing recycling programs for hazardous materials, where feasible. Proper segregation, collection, and treatment of hazardous waste allow for the recovery of valuable resources and reduce the reliance on raw materials. The

review also emphasizes the need to consider the life cycle impacts of recycled materials to ensure overall environmental sustainability. The authors address the proper disposal of hazardous materials as a key aspect of environmental sustainability. They highlight the importance of complying with relevant regulations and industry standards to ensure safe and responsible disposal practices. Proper treatment, containment, and disposal methods mitigate the risks of environmental contamination and potential harm to human health. The review also discusses the role of green logistics and sustainable packaging in hazardous material management. It emphasizes the need for efficient transportation routes, optimized packaging designs, and the use of environmentally friendly materials. By minimizing transportation distances, optimizing packaging dimensions, and reducing material waste, supply chains can reduce their environmental footprint and improve sustainability. Also explore the concept of extended producer responsibility (EPR) as a means to promote environmental sustainability in hazardous material management. EPR places responsibility on producers for the entire life cycle of their products, including the safe and sustainable handling of hazardous materials. The review discusses the benefits of implementing EPR programs, such as encouraging eco-design, product take-back initiatives, and the establishment of producer-funded recycling systems. (Martinez, 2019)

## **2.5 Legal and Regulatory Frameworks for Handling Hazardous Materials in Supply Chains**

This article examines the legal and regulatory frameworks governing the handling of hazardous materials in supply chains. It discusses the role of international conventions, national legislation, and industry standards in ensuring compliance and minimizing risks. The study emphasizes the need for companies to stay updated on regulatory requirements and maintain ethical practices. These conventions establish guidelines and obligations for the proper handling, transportation, and disposal of hazardous waste. The review emphasizes the significance of adhering to these conventions to prevent illegal dumping, environmental contamination, and adverse health effects. National legislation plays a crucial role in enforcing and implementing legal frameworks for hazardous material management. The importance of national laws and regulations that govern the classification, labelling, storage, transportation, and disposal of hazardous materials. Compliance with these legal requirements ensures the protection of human health, safety, and the environment. The review underscores the need for supply chain managers to stay updated on the evolving regulatory landscape and maintain robust compliance practices. It addresses the role of

industry standards and certifications in hazardous material management. They highlight the significance of certifications such as ISO 14001 (Environmental Management Systems) and OHSAS 18001 (Occupational Health and Safety) in guiding organizations to adopt best practices for handling hazardous materials. The review emphasizes that adhering to these industry standards not only ensures legal compliance but also enhances risk management, stakeholder trust, and corporate reputation. (Turner, 2019)

## **2.6 The Role of Training and Education in Handling Hazardous Materials in Supply Chains**

This research focuses on the importance of training and education programs for handling hazardous materials in supply chains. It discusses the benefits of raising awareness among employees, suppliers, and other stakeholders about proper handling procedures, safety protocols, and emergency response plans. The study underscores the importance of training programs in equipping employees with the necessary knowledge and skills to handle hazardous materials safely. They emphasize the need for comprehensive training that covers proper handling procedures, storage requirements, emergency response protocols, and the use of personal protective equipment. Well-trained employees are better prepared to identify hazards, prevent accidents, and respond effectively in hazardous situations. They argue that training programs should involve multiple stakeholders, including suppliers, manufacturers, distributors, and regulatory authorities. By fostering communication, cooperation, and shared understanding, cross-functional training enhances coordination and promotes a holistic approach to hazardous material management. (Peterson, 2016)

## **2.7 Mitigating Supply Chain Disruptions Caused by Hazardous Material Incidents**

This article examines the role of third-party logistics providers (3PLs) in handling hazardous materials within supply chains. It discusses the benefits and challenges of outsourcing hazardous material management to specialized 3PLs. The study highlights the importance of selecting reliable and experienced 3PL partners and establishing clear communication channels to ensure compliance and safety. Third-party logistics providers are companies that offer outsourced logistics services, including transportation, warehousing, and distribution, to other businesses. When it comes to hazardous materials, 3PLs play a crucial role in ensuring their safe and compliant handling throughout the supply chain. (Roberts, 2017)

# CHAPTER 3

## DANGEROUS CARGO

### 3.1 CLASSIFICATION OF DANGEROUS GOODS

Class 1 Explosives

Class 2 Gases (flammable, non-flammable, non-toxic and toxic gases)

Class 3 Flammable liquids

Class 4 Flammable solids

Class 5 Oxidising substances, Organic peroxides 13

Class 6 Toxic and infectious substances

Class 7 Radioactive material

Class 8 Corrosives

Class 9 Miscellaneous dangerous goods

#### Hazardous Material Placards

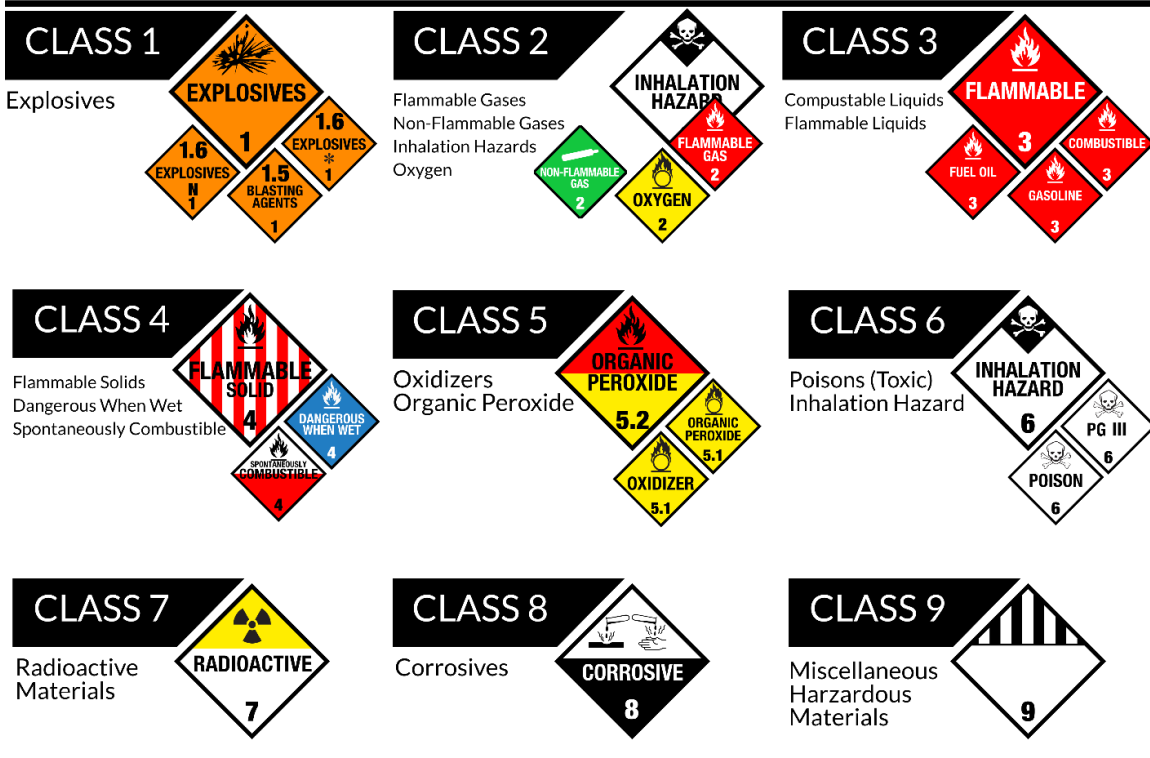


Figure 1 :Classification of Dangerous Goods

## **Class 1 – Explosives**

Explosives are substances or items that, as a result of a chemical reaction, have the ability to detonate or conflagrate swiftly.

DGI has experience dealing with explosives and other Class 1 risky products. DGI can satisfy all client requirements for explosives logistics, including packing, packaging, compliance, goods forwarding, and training.

By causing chemical reactions at pressures, temperatures, and speeds that can cause catastrophic destruction by force and/or other harmful amounts of heat, light, sound, gas, or smoke, explosives are able to produce gases.

### **Sub-Divisions**

**Division 1.1:** Substances and articles which have a mass explosion hazard

**Division 1.2:** Substances and articles which have a projection hazard but not a mass explosion hazard

**Division 1.3:** Substances and articles which have a fire hazard and either a minor blast hazard or a minor projection hazard or both but not a mass explosion hazard

**Division 1.4:** Substances and articles which present no significant hazard; only a small hazard in the event of ignition or initiation during transport with any effects largely confined to the package

**Division 1.5:** Very insensitive substances which have a mass explosion hazard

**Division 1.6:** Extremely insensitive articles which do not have a mass explosion hazard

### **Commonly Transported Explosives**

Ammunition/cartridges, Fireworks/pyrotechnics, Flares, Blasting caps / detonators, Fuse, Primers, Explosive charges (blasting, demolition etc), Detonating cord, Air bag inflators, Igniters, Rockets, TNT / TNT compositions, RDX / RDX compositions, PETN / PETN compositions.

## **Class 2 – Gases**

Gases are defined as substances and items containing those chemicals that have a vapour pressure of 300 kPa or more at 50 °C or that are completely gaseous at 20 °C and standard air pressure under the dangerous products regulations. This class includes things charged with a gas, compressed gases, liquefied gases, dissolved gases, cooled liquefied gases, mixtures of one or more gases with one or more vapours of other substances, and aerosols. DGI specialises in managing petrol and deals with Class 2 Dangerous Goods. DGI can accommodate all client

requirements for the logistics of gases, including packing, packaging, compliance, products forwarding, and training.

### **Reason for Regulation**

Gases are capable of posing serious hazards due to their flammability, potential as asphyxiants, ability to oxidize and/or their toxicity or corrosiveness to humans.

### **Sub-Divisions**

**Division 2.1:** Flammable gases

**Division 2.2:** Non-flammable, non-toxic gases

**Division 2.3:** Toxic gases

### **Commonly Transported Gases**

Aerosols, Compressed air, Hydrocarbon gas-powered devices, Fire extinguishers, Gas cartridges, Fertilizer ammoniating solution, Insecticide gases, Refrigerant gases, Lighters, Acetylene / Oxyacetylene, Carbon dioxide, Helium / helium compounds, Hydrogen / hydrogen compounds, Oxygen / oxygen compounds, Nitrogen / nitrogen compounds, Natural gas, Oil gas, Petroleum gases, Butane, Propane, Ethane, Methane, Dimethyl ether, Propene / propylene, Ethylene.

### **Class 3 - Flammable Liquids**

Flammable liquids are defined by dangerous goods regulations as liquids, mixtures of liquids, or liquids containing solids in solution or suspension that emit flammable vapour (have a flash point) at temperatures no higher than 60–65°C, liquids offered for transport at temperatures at or above their flash point, or substances transported at elevated temperatures in a liquid state that emit flammable vapour at or below the maximum transp

DGI has experience working with class 3 risky commodities, such as flammable liquids. DGI can satisfy all client requirements for flammable liquid logistics, including packing, packaging, compliance, goods forwarding, and training.

### **Reason for Regulation**

Flammable liquids are capable of posing serious hazards due to their volatility, combustibility and potential in causing or propagating severe conflagrations.

## **Sub-Divisions**

There are no subdivisions within Class 3, Flammable Liquids.

## **Commonly Transported Flammable Liquids**

Acetone / acetone oils, Adhesives, Paints / lacquers / varnishes, Alcohols, Perfumery products, Gasoline / Petrol, Diesel fuel, Aviation fuel, Liquid bio-fuels, Coal tar / coal tar distillates, Petroleum crude oil, Petroleum distillates, Gas oil, Shale oil, Heating oil, Kerosene, Resins, Tars, Turpentine, Carbamate insecticides, Organochlorine pesticides, Organophosphorus pesticides, Copper based pesticides, Esters, Ethers, Ethanol, Benzene, Butanol's, Chloropropene's, Diethyl ether, Isobutanes, Isopropyl, Methanol, Octanes.

## **Class 4 – Flammable Solids; Spontaneous Combustibles; ‘Dangerous When Wet’ Materials**

Flammable solids are substances that quickly catch fire, can ignite a fire by friction while being carried, are likely to undergo a significantly exothermic reaction on their own, or are solid desensitised explosives. The list also includes substances that spontaneously heat up under normal transport conditions, heat up when in contact with air, or both, as well as substances that produce flammable gases or become spontaneously combustible when in contact with water.

DGI has extensive experience working with class 4 risky commodities, such as flammable liquids. DGI is able to take care of all client requirements for the logistics of flammable solids, including packing, packaging, compliance, products forwarding, and training.

## **Reason for Regulation**

Flammable solids are capable of posing serious hazards due to their volatility, combustibility and potential in causing or propagating severe conflagrations.

## **Sub-Divisions**

**Division 4.1:** Flammable solids

**Division 4.2:** Substances liable to spontaneous combustion

**Division 4.3:** Substances which, in contact with water, emit flammable gases

## **Commonly Transported Flammable Solids; Spontaneous Combustibles; ‘Dangerous When Wet’ Materials**

Alkali metals, Metal powders, Aluminium phosphide, Sodium batteries, Sodium cells, Firelighters, Matches, Calcium carbide, Camphor, Carbon, Activated carbon, Celluloid, Cerium, Copra, Seed cake, Oily cotton waste, Desensitized explosives, Oily fabrics, Oily fibres, Ferrocium, Iron oxide (spent, Iron sponge/direct-reduced iron (spent) , Metaldehyde, Naphthalene, Nitrocellulose, Phosphorus, Sulphur.

## **Class 5 - Oxidizers; Organic Peroxides**

Oxidizers are defined as compounds that can initiate or support combustion, typically by generating oxygen as a by-product of a redox chemical reaction. An organic peroxide is a compound whose chemical structure substitutes organic radicals for one or both of the hydrogen atoms.

Organic peroxides and oxidising agents, which are regarded as dangerous commodities, are handled expertly by DGI. DGI can take care of all of the client's logistical requirements for oxidising agents and organic peroxides, including packing, packaging, compliance, goods forwarding, and training.

### **Reason for Regulation**

Even though they may not be combustible in and of themselves, oxidizers can produce oxygen and in doing so, induce or aid in the burning of other substances. Organic peroxides can release heat while undergoing exothermic autocatalytic breakdown because they are thermally unstable. Additionally, organic peroxides may burn quickly, be sensitive to touch or friction, react violently with other compounds, or harm eyes. They may also decompose explosively.

### **Sub-Divisions**

**Division 5.1:** Oxidizing substances

**Division 5.1:** Organic peroxides

## **Commonly Transported Oxidizers; Organic Peroxides**

Chemical oxygen generators, Ammonium nitrate fertilizers, Chlorates, Nitrates, Nitrites, Perchlorates, Permanganates, Persulphates, Aluminium nitrate, Ammonium dichromate, Ammonium nitrate, Ammonium persulphate, Calcium hypochlorite, Calcium nitrate, Calcium

peroxide, Hydrogen peroxide, Magnesium peroxide, Lead nitrate, Lithium hypochlorite, Potassium chlorate, Potassium nitrate, Potassium chlorate, Potassium perchlorate, Potassium permanganate, Sodium nitrate, Sodium persulphate.

## **Class 6 - Toxic Substances; Infectious Substances**

When swallowed, inhaled, or in contact with the skin, toxic chemicals have the potential to kill, badly harm, or impair people. Any substance that is suspected of containing pathogens or is known to do so is considered to be infectious. According to regulations governing dangerous products, pathogens are classified as microorganisms that can cause disease in humans or animals, such as bacteria, viruses, rickettsia, parasites, and fungi.

DGI handles Class 6 dangerous commodities with expertise, including infectious compounds and hazardous chemicals. DGI can take care of all of the client's logistical requirements for oxidising agents and organic peroxides, including packing, packaging, compliance, goods forwarding, and training.

### **Reason for Regulation**

Toxic and infectious substances can pose significant risks to human and animal health upon contact.

### **Sub-Divisions**

**Division 6.1:** Toxic substances

**Division 6.2:** Infectious substances

### **Commonly Transported Toxic Substances; Infectious Substances**

Medical/Biomedical waste, Clinical waste, Biological cultures / samples / specimens, Medical cultures / samples / specimens, Tear gas substances, Motor fuel anti-knock mixture, Dyes, Carbamate pesticides, Alkaloids, Allyls, Acids, Arsenates, Arsenates, Cyanides, Thiols/mercaptans, Cresols, Barium compounds, Arsenics / arsenic compounds, Beryllium/beryllium compounds, Lead compounds, Mercury compounds, Nicotine / nicotine compounds, Selenium compounds, Antimony, Ammonium metavanadate, Adiponitrile, Chloroform, Dichloromethane, Hexachlorophene, Phenol, Resorcinol.

## **Class 7 - Radioactive Material**

Any substance that contains radionuclides and whose overall activity and activity concentration exceed prescribed limitations is defined as radioactive material under the dangerous products regulation. A radionuclide is an atom that is susceptible to radioactive decay because its nucleus is unstable.

DGI is experienced in handling radioactive material and other Class 7 Dangerous Goods. DGI is able to take care of all client requirements for the logistics of radioactive material, including packing, packaging, compliance, products forwarding, and training.

### **Reason for Regulation**

Whilst undergoing radioactive decay radionuclides emit ionizing radiation, which presents potentially severe risks to human health.

### **Sub-Divisions**

There are no subdivisions within Class 7, Radioactive Material.

### **Commonly Transported Radioactive Material**

Radioactive ores, medical isotopes, Yellowcake, Density gauges, Mixed fission products, Surface contaminated objects, Caesium radionuclides / isotopes, Iridium radionuclides / isotopes, Americium radionuclides / isotopes, Plutonium radionuclides / isotopes, Radium radionuclides / isotopes, Thorium radionuclides / isotopes, Uranium radionuclides / isotopes, Depleted uranium / depleted uranium products, Uranium hexafluoride, Enriched Uranium.

## **Class 8 – Corrosives**

Corrosives are substances that break down or chemically disintegrate other materials when they come into touch with them.

DGI handles risky items in Class 8 expertly, including corrosives. DGI is capable of handling all client requirements for the logistics of corrosives, including packing, packaging, compliance, products forwarding, and training.

### **Reason for Regulation**

Corrosives cause severe damage when in contact with living tissue or, in the case of leakage, damage or destroy surrounding materials.

### **Sub-Divisions**

There are no subdivisions within Class 8, Corrosives.

### **Commonly Transported Corrosives**

Acids/acid solutions, Batteries, Battery fluid, Fuel cell cartridges, Dyes, Fire extinguisher charges, Formaldehyde, Flux, Paints, Alkylphenols, Amines, Polyamines, Sulphides, Polysulphides, Chlorides, Chlorosilanes, Bromine, Cyclohexylamine, Phenol / carbolic acid, Hydrofluoric acid, Hydrochloric acid, Sulfuric acid, Nitric acid, Sludge acid, Hydrogen fluoride, Iodine, Morpholine.

### **Class 9 - Miscellaneous Dangerous Goods**

Chemicals and other things that present a risk or danger during shipment and are not covered by other classifications are examples of other risky products. This category includes goods and chemicals that are environmentally dangerous, must be transported at high temperatures, contain genetically modified organisms and microbes, are magnetised, or are subject to aviation regulations.

Class 9 Dangerous commodities, which includes a variety of dangerous commodities, are managed expertly by DGI. DGI can accommodate all client requirements for the logistics of diverse dangerous items, including packing, packaging, compliance, goods forwarding, and training.

### **Reason for Regulation**

Miscellaneous dangerous goods present a wide array of potential hazards to human health and safety, infrastructure and/ or their means of transport.

### **Sub-Divisions**

There are no subdivisions within Class 9, Miscellaneous Dangerous Goods.

### **Commonly Transported Miscellaneous Dangerous Goods**

Dry ice / cardice / solid carbon dioxide, Expandable polymeric beads / polystyrene beads, Ammonium nitrate fertilizers, Blue asbestos / crocidolite, Lithium ion batteries, Lithium metal batteries, Battery powered equipment, Battery powered vehicles, Fuel cell engines, Internal combustion engines, Vehicles, Magnetized material, Dangerous goods in apparatus, Dangerous

goods in machinery, Genetically modified organisms, Genetically modified micro-organisms, Chemical kits, First aid kits, Lifesaving appliances, Air bag modules, Seatbelt pretensioners, Plastics moulding compound, Castor bean plant products, Polychlorinated biphenyls, Polychlorinated terphenyls, Dibromo difluoromethane, Benzaldehyde.

### **3.2 IMDG CODE GUIDELINES AND REGULATIONS**

International Maritime Dangerous products, or IMDG, is a code that specifies regulations and best practises for the secure transportation of dangerous products by water in order to safeguard the crew of the ship and avoid environmental damage. The International Maritime Organisation (IMO) is responsible for maintaining and updating the IMDG Code.

The IMDG code also specifies stowage and segregation processes, standards for marine pollutants, regulations for the transportation of hazardous materials by sea, and specifications for shipboard safety and marine environment preservation. Implementing the IMDG code is necessary without needlessly obstructing the transportation of dangerous commodities in accordance with the provisions of the International Convention for the Safety of Life at Sea (SOLAS) and the International Convention for the Prevention of Pollution from Ships (MARPOL).

The IMDG Code provides guidelines and requirements for the transport of hazardous materials as follow:

- Categorize the dangerous goods into groups based on the hazardous level the present during transportation.
- Packing and storage requirements of dangerous goods during transportation.
- Provides identification marks and hazard warning signs of dangerous goods during transportation.
- Necessary documents and data sheets that need to be available during transportation.
- Ensuring proper separation of any dangerous goods that may dangerously react together during transportation.
- Guidelines of the storage location of dangerous goods on board the ship during transportation.

Emergency response guidelines for fire or spillage involving dangerous goods on board the ship.

### **3.3 SOLAS CONVENTION**

Most people agree that the SOLAS Convention, in all of its iterations, is the most significant international treaty pertaining to the security of merchant ships. Following the Titanic disaster, the first version was adopted in 1914; the second in 1929; the third in 1948; and the fourth in 1960. The tacit acceptance mechanism is present in the 1974 edition and states that an amendment shall become effective on a specific date unless objections to the amendment are received from a predetermined number of Parties prior to that date.

As a result, the 1974 Convention has been updated and amended on numerous occasions. The Convention in force today is sometimes referred to as SOLAS, 1974, as amended. Technical provisions

The SOLAS Convention's primary goal is to lay down minimum requirements for the design, furnishing, and management of ships that are compatible with their safety. The Convention specifies a number of certificates that can be used as evidence that ships flying the flag of a flag state have complied with its standards. If there are strong reasons to suspect that a ship and its equipment do not substantially comply with the requirements of the Convention, control provisions also permit Contracting Governments to inspect the ship. This process is known as port State control. The present SOLAS Convention is composed of Articles outlining general responsibilities, the amendment process, and other topics, followed by an Annex with 14 Chapters.

#### **Chapter I - General Provisions**

Includes rules governing the inspection of various ship types and the issuance of certificates certifying that the ship complies with the Convention's standards. The Chapter also contains guidelines for the management of ships in ports owned or controlled by other Contracting Governments.

#### **Chapter II-1 - Construction - Subdivision and stability, machinery and electrical installations**

In order to ensure that the ship will remain afloat and stable in the event that the ship's hull experiences damage, passenger ships must be divided into watertight compartments. Along with stability standards for both passenger and freight ships, specifications are also made for watertight integrity standards and bilge pumping practises for passenger ships. Depending on the length of the ship and the sort of service it is doing, the maximum allowable distance between

two adjacent bulkheads—the yardstick by which the degree of subdivision is determined—varies. The highest level of subdivision is used on passenger ships.

The requirements for mechanical and electrical systems are created to ensure that, in an emergency, the services needed for the safety of the ship, its passengers, and crew will continue to operate.

The development of "goal-based standards" for oil tankers and bulk carriers in 2010 mandated that new ships be constructed for a certain design life, as well as to be safe and environmentally friendly, in intact and specified damage scenarios, throughout their lifespan. The rule states that ships must be sturdy, stable, and watertight to lessen the risk of losing the ship or causing environmental damage to the ocean due to structural failure, including collapse that results in flooding or loss of watertight integrity.

### **Chapter II-2 - Fire protection, fire detection and fire extinction**

Incorporates stringent fire safety standards for all ships along with special protections for tankers, cargo ships, and passenger ships.

They include the following rules: dividing the ship into main and vertical zones by thermal and structural boundaries; separating the accommodations from the rest of the ship by thermal and structural boundaries; prohibiting the use of combustible materials; spotting any fire in the zone of origin; containing and extinguishing any fire in the space of origin; safeguarding the means of escape or of access for firefighting purposes; and readily available fire extinguishers.

### **Chapter III - Life-saving appliances and arrangements**

The Chapter provides requirements for life-saving devices and arrangements, including the kinds of lifeboats, rescue boats, and life jackets that should be used on different types of ships. Regulation 34 makes the International Life-Saving Appliance (LSA) Code mandatory and states that all life-saving devices and arrangements must comply with the relevant LSA Code standards. The LSA Code outlines certain technical specifications for LSAs.

### **Chapter IV – Radiocommunications**

This chapter also discusses the Global Maritime Distress and Safety System (GMDSS). All passenger ships and all cargo ships with a gross tonnage of 300 or more are required to carry equipment like satellite emergency position indicating radio beacons (EPIRBs) and search and rescue transponders (SARTs) for the location of the ship or survival craft in order to increase the likelihood of a successful rescue after an accident.

Chapter IV regulations cover both ship requirements for carrying radiocommunications equipment and government promises to provide radiocommunication services. The Chapter has a direct relationship to the Radio Regulations of the International Telecommunication Union.

### **Chapter V - Safety of navigation**

Chapter V lays out general operating criteria that apply to all ships on all journeys as well as specific navigation safety services that Contracting Governments should provide. In contrast, only certain classes of ships that are travelling internationally are covered by the entire Convention.

Among the subjects covered are the maintenance of ships' meteorological services, ice patrol services, ship routing, and search and rescue services.

The Contracting Governments are also required to ensure that all ships are suitably and effectively manned from a safety standpoint, and this Chapter provides extensive responsibilities for masters to respond to distress calls from people in need.

### **Chapter VI - Carriage of Cargoes**

Except for liquids and gases in bulk, which "may necessitate special precautions due to their particular hazards to ships or persons on board," all types of cargo are covered under this chapter. The regulations outline the storage and security requirements for commodities and freight units (such containers). Grain-carrying cargo ships shall adhere to the International Grain Code in line with the Chapter.

### **Chapter VII - Carriage of dangerous goods**

The regulations are contained in three parts:

Part A - Carriage of dangerous goods in packaged form - includes provisions for the classification, packing, marking, labelling and placarding, documentation and stowage of dangerous goods. Contracting Governments are required to issue instructions at the national level and the Chapter makes mandatory the International Maritime Dangerous Goods (IMDG) Code, developed by IMO, which is constantly updated to accommodate new dangerous goods and to supplement or revise existing provisions.

Part A-1 - Carriage of dangerous goods in solid form in bulk - covers the documentation, stowage and segregation requirements for these goods and requires reporting of incidents involving such goods.

Part B - covers Construction and equipment of ships carrying dangerous liquid chemicals in bulk and requires chemical tankers to comply with the International Bulk Chemical Code (IBC Code).

Part C - covers Construction and equipment of ships carrying liquefied gases in bulk and gas carriers to comply with the requirements of the International Gas Carrier Code (IGC Code).

Part D - includes special requirements for the carriage of packaged irradiated nuclear fuel, plutonium and high-level radioactive wastes on board ships and requires ships carrying such products to comply with the International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes on Board Ships (INF Code).

The chapter requires carriage of dangerous goods to be in compliance with the relevant provisions of the International Maritime Dangerous Goods Code (IMDG Code).

### **Chapter VIII - Nuclear ships**

Describes the essential requirements for nuclear-powered ships and shows particular concern for radiation dangers. The Code of Safety for Nuclear Merchant Ships, which the IMO Assembly adopted in 1981, is referenced in this passage.

### **Chapter IX - Management for the Safe Operation of Ships**

The Chapter makes mandatory the International Safety Management (ISM) Code, which requires that the shipowner or any other person who has acquired control of the ship (the "Company") implement a safety management system.

### **Chapter X - Safety measures for high-speed craft**

The Chapter makes mandatory the International Code of Safety for High-Speed Craft (HSC Code).

### **Chapter XI-1 - Special measures to enhance maritime safety**

Increased surveys, ship identification numbers, authorization of recognised bodies (charged with performing surveys and inspections on Administration behaviours), and port State control on operational requirements are all defined in this chapter. Chapter XI-2 - Special measures to enhance maritime security

In this chapter's Regulation XI-2/3, the International Ship and Port Facilities Security Code (ISPS Code) is codified. Part A of the Code outlines obligations that must be met, while Part B provides guidance on how to do so. Regulation XI-2/8 confirms that it is the Master's duty to exercise

professional discretion in making decisions that would protect the security of the ship. The article states that neither the Company nor the charterer or any other party may prohibit him in this regard.

According to Regulation XI-2/5, all ships must have a ship security alarm system. Regulation XI-2/6, which among other things requires that Contracting Governments guarantee the conclusion of port facility security assessments and the development, execution, and evaluation of port facility security plans in accordance with the ISPS Code, among other things, outlines the requirements for port facilities. Other regulations in this chapter cover information disclosure to the IMO, management of ships while they are in port (including tactics like detention, operations delays, movement restrictions inside the port, or expulsion of a ship from port), and the specific accountability of Companies.

### **Chapter XII - Additional safety measures for bulk carriers**

The Chapter includes structural requirements for bulk carriers over 150 metres in length.

### **Chapter XIII - Verification of compliance**

Makes mandatory from 1 January 2016 the IMO Member State Audit Scheme.

### **Chapter XIV - Safety measures for ships operating in polar waters**

The chapter makes mandatory, from 1 January 2017, the Introduction and part I-A of the International Code for Ships Operating in Polar Waters (the Polar Code)

## **3.4 GLOBAL REGULATIONS**

The United Nations developed the UN Guidance on the Transport of Dangerous products Model legislation (TDG Model Regulations) as a directive to harmonise the creation of national and international legislation governing the various modes of transport for dangerous products (air, road, and sea). The majority of dangerous goods regulations, including the IMDG Code, the IATA, and various national legislation, are formed on the basis of this Model Regulation.

### **3.4.1 Dangerous Goods Regulations (DGR)**

We can prepare, manage, or approve shipments of hazardous items by air with the help of the IATA Dangerous items Regulations (DGR), which is a reliable source. It may be forbidden or restricted to transport some hazardous goods by air because they pose a threat to the safety of an

aircraft or the passengers inside. The sole Standard that airlines accept is the IATA DGR handbook, which serves as the industry standard for the air transportation of hazardous commodities. The information provided in the content is current and ensures that hazardous products are transported by air safely. This guidebook is the result of close collaboration between ICAO, local governments, and airline member representatives and IATA. The adoption of the DGR may be advantageous to all parties engaged in the air transportation of dangerous products, including airlines, freight forwarders, ground handlers, manufacturers, and shippers. Cargo and passenger acceptance staff should confirm the contents of any item of cargo or baggage where there are suspicions that it may contain dangerous goods from shippers and passengers. The goal of DGR is to prevent undeclared dangerous goods from being loaded on an aircraft and passengers from taking those dangerous goods on board that they are not permitted to have in their baggage. The 1960 IMO SOLAS (Safety for Life at Sea) Convention led to the 1965 adoption of the International Maritime Dangerous Goods or IMDG Code. To avoid harm to people or damage to ships and their cargoes, the IMDG Code regulates the transportation of dangerous products by water. The main reason that carrying marine contaminants is regulated is to protect the marine ecosystem. The IMDG Code's objective is to increase the safety of transporting hazardous commodities while permitting their unrestricted free movement. The IMDG Code describes all of the hazardous goods that can be transported by ship and includes solid, liquid, and gaseous materials. The suggested or containment techniques for explosive, flammable, oxidising, and radioactive chemicals are also provided. The package and all other relevant product information are supplied. The code will undergo revisions every two years in the future to allow for technological advancements.

### **3.4.2 HAZMAT**

Hazardous materials, also known as compounds that pose a moderate risk to property, human health, or the environment, are referred to as HAZMAT. Chemicals that are hazardous, fuels, nuclear waste, and biological, chemical, and radiological agents are only a few examples of HAZMATs. HAZMATs, which include dust, fumes, gas, vapour, nebula, and smoke, may be emitted as liquids, solids, gases, or a combination of all three. HAZMAT spills have harmed buildings, homes, properties, and the environment while also resulting in injuries, fatalities, and difficulties with human or animal health. It is reasonable to assume that one cannot consistently encounter such severe HAZMAT effects. The truth is that many products include hazardous materials. Chemicals are routinely produced and utilised in houses, and they are delivered everyday via highways, railways, waterways, and pipelines. HAZMAT is regulated to promote

their safe handling, storage, transportation, and disposal to help prevent HAZMAT incidents. Numerous accidents and natural disasters result in thousands of incidents each year where HAZMATs are released into the environment. Spills in coastal seas not only have the potential to harm people and the environment, but they can also significantly impede marine transportation with far-reaching economic effects. HAZMAT accidents, which include both inland and coastal spills, are frequently handled by first responders including firefighters and local law police.

#### **3.4.3 Globally Harmonized System of Classification and Labelling of Chemicals (GHS)**

The Globally Harmonised Chemicals categorization and Labelling System (GHS), which is run by the United Nations, was created to replace the numerous hazardous substance categorization and labelling systems that are currently in use all over the world. Standardised hazard check standards, widely used warning pictograms, and harmonised safety data sheets are some of the GHS's key components. These features give consumers of hazardous items a range of information. As a supplement to the UN Numbered system of controlled hazardous material transport, the system is used. The UN Secretariat is in charge of overseeing implementation. The goal of GHS is to create a single, worldwide standardised system for handling chemical classification, labelling, and safety data sheets. In order to improve the protection of human health and the environment throughout the handling, transport, and use of these chemicals, it strives to ensure that information on physical risks and toxicity from chemicals is available.

#### **3.4.4 International Carriage of Dangerous Goods by Rail (RID)**

New regulations for the international rail transportation of dangerous goods (RID) were established. The most recent regulation takes effect on January 1, 2019. New packing guidelines, updated classification codes, and testing of certain gas cylinders are all part of the most recent law. The goal was to keep people and property safe while using the rails. The 2019 edition is meant to take the place of the 2017 version. But until June 30, 2019, a transitional period permits the RID 2017's rules to be applied. RID describes the international rail transportation of hazardous materials among the RID Contracting States that are now located in Europe, Asia, and North Africa.

## **3.5 HUMAN FACTOR AS THE MAIN OPERATIONAL RISK IN DANGEROUS**

### **3.5.1 GOODS TRANSPORTATION**

One of the most important considerations when organising the safe handling and transportation of dangerous goods is risk management. By using a semi-quantitative risk assessment method to examine risks, it is possible to narrowly concentrate on operational risks that are caused by the actions of various parties involved in the transportation of dangerous goods. When handling and shipping dangerous goods, there are several actions that are regarded as events but may not actually result in mishaps. It is challenging to adhere to both legal requirements and suggested safety measures while transporting packed dangerous goods (DG) by road in order to avoid mishaps when using chemicals that are detrimental to people, property, and the environment. There are many distinct risks that can happen when handling and transporting dangerous goods because there are so many different parties involved. The significance of the human aspect has been overstated; thus, this study explores how to analyse various hazards associated with particular participants in the chain of transportation for dangerous commodities. The human component has a significant impact on maintaining safety in the transportation of dangerous goods, this paper's conclusion states. The number of operational risks associated with dangerous goods from various parties and a thorough assessment of operational risks support the idea that human component is one of the primary reasons why incidents become accidents. The chain of parties involved in the transportation of dangerous goods, the recurring nature of operational hazards at those parties, and the potential consequences of an incident all contribute to accidents.

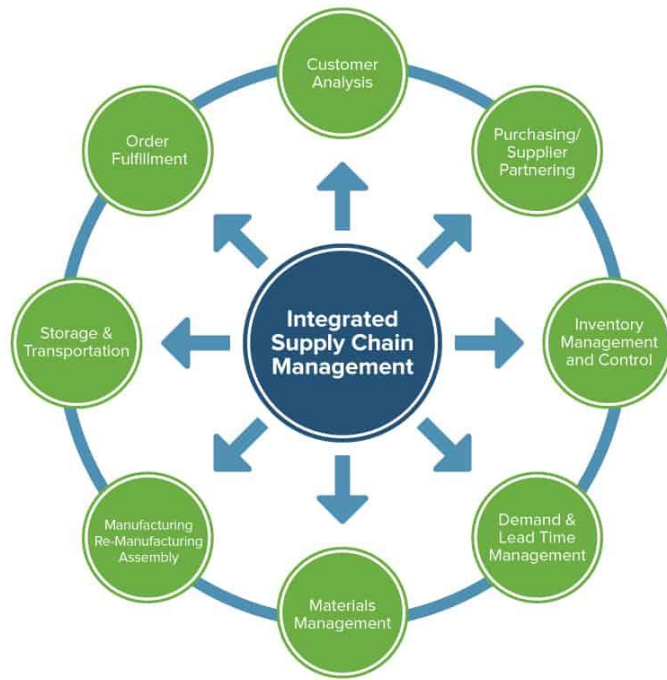
### **3.5.2 FIRE SAFETY MEASURES IN WAREHOUSES**

The steps taken by warehouses to prevent fires are covered in the paper. Due to the volume of stored products, losses from fires in warehouses can be very substantial. In addition to the destruction of the goods, warehouse fires pose a risk to the employees who work there, particularly those who end up in the path of a rapidly growing blaze. This essay first explained and listed the different types of fire sources, such as fuel (which stands for the burning substance, such as paper or petrol), oxygen (which is present in the air and is necessary for combustion), and energy (which raises the fuel temperature to the point at which fire ignition occurs). Analysis was done on the variables that impact fire ignition, fire spread, and fire extinguishing. In order to improve the degree of fire safety and health at work in warehouses, fire protection measures were finally provided. This study makes several recommendations for fire protection, the first of which

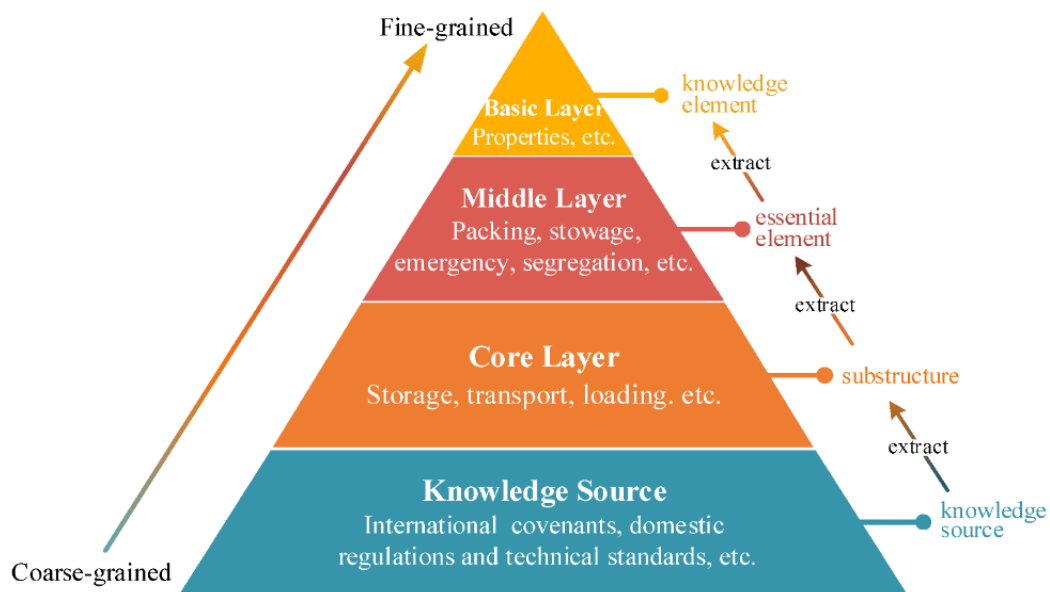
is to take into account the building materials utilised in warehouses. The best materials for this purpose are concrete and steel wrapped in plaster or fibrous silicate panels due to their high levels of heat resistance. The use of large, heavy oak beams as a second measure is recommended due to their structural stability and slower rate of combustion than uncoated steel construction. Additionally, it covers automatic extinguishing system, automatic fire detection system, and warehouse ventilation system in order to give 24-hour fire detection capability. Therefore, the paper's conclusion is that fire breakouts can seriously harm the reputation of the warehouse management. Future business plans could be jeopardised, which could jeopardise recovery. Due to this, warehouses are extremely vulnerable to fire danger, necessitating the application of special safety measures in order to ensure optimum safety inside the warehouse.

### **3.6 CONSTRUCTION OF KNOWLEDGE GRAPHS FOR MARITIME DANGEROUS GOODS**

International shipping involves a substantial portion of dangerous goods, and both the government and businesses place a high priority on transit safety. Dangerous items come in a vast range, and the expertise required is extensive and sophisticated. The safe transportation of dangerous commodities depends significantly on the organisation and management of this knowledge. This study built the knowledge graph of maritime hazardous goods (KGMDG), a new technology comprising knowledge organisation, management, and service, and introduced the knowledge graph technology into the field of maritime dangerous goods (MDG). The knowledge graph of marine dangerous goods (KGMDG) recognises the relationships between knowledge of MDGs and quickly presents the knowledge hierarchy of the sector. A knowledge graph presents knowledge more visually and delivers improved retrieval efficiency and quality compared to standard knowledge management systems. A fresh approach to knowledge management and mining for marine dangerous goods (MDG) is offered by the knowledge graph of maritime dangerous goods (KGMDG). Promoting the exchange, diffusion, and use of knowledge is crucial. This article's conclusion indicates that there are still many areas of knowledge that are uncertain, including how to better communicate this knowledge and make it easier for computers to understand.



**Figure 2: Supply Chain Management**



**Figure 3: Knowledge Structure of MDG**

## CHAPTER 4

### HAZARDOUS CARGO HANDLING PROCEDURES

#### **4.1 STANDARD OPERATING PROCEDURE FOR HANDLING LIQUID HAZARDOUS CARGO AT DEENDAYAL PORT AUTHORITY**

**4.1.1 Definitions.** In these SOP unless the context otherwise requires,

- i. "Container" means an article of transport equipment specially designed and constructed for the purpose of transport of dangerous goods by one or more modes of transport. Note Containers used for the carriage of dangerous or hazardous cargo shall be of adequate strength to resist the possible stress imposed by the conditions of the services in which they are deployed and they shall be properly and regularly maintained.
- ii. "Closed container" means a container which can be laden only through one or more doors in the side or end walls.
- iii. "Open top container" means a container with the bottom side and walls, but no roof.
- iv. "Tank container" means container especially built for transport and distributing liquids and gases in bulk.
- v. "Platform container" means a type of loadable platform having the same overall external length and width as the base of series containers and equipped with top and bottom corner fittings located, as on these containers, so that some of the same securing and lifting devices may be used
- vi. "Container space" means a space occupied by one container equivalent to one Twenty-Foot Equivalent Unit.; Note. One Twenty-Foot Equivalent Unit measures 6.1 metres x 2.4 metres x 2.4 metres and thin distance may be occupied by a neutral container or containers (vii) Deputy conservator" means the person appointed as such by MOS to be the Head of Marine Department.
- vii. "Container parking yard" means the yard in which the containers are stacked.
- viii. "Container handling equipment's" means equipment's used for safe handling of containers including Transfer Cranes, Top Lift Trucks, Fork Lift Trucks or any other equipment fitted with special device for lifting containers.
- ix. "Container ship" means a ship in which the containers are loaded either below the deck or above deck and shall also include container-oriented ships handling cargo in

break bulk form; (xi) Dangerous cargo shed means a specially constructed shed used for keeping dangerous or hazardous cargo.

- x. "International Maritime Dangerous Goods Code means the International Maritime Dangerous Goods code adopted, by International Maritime Organization and as amended from time to time;
- xi. Loading and unloading" refer to the placing of a container aboard the ship and to its removal there from;
- xii. "Packages" refer to receptacles for dangerous goods and receptacles containing dangerous or hazardous cargo.
- xiii. "Packing and unpacking refer to the placing of package containing dangerous or hazardous cargo into a container and their removal there from.
- xiv. "Port" means the Deendayal Port Authority.
- xv. "Stuffing and de stuffing" mean filling up the container with cargo and removal of cargo from the container.
- xvi. Transport tractor-trailer" means a combination of transport tractor with trailer coupled together permanently or temporarily designed primarily for the transportation of goods by road.
- xvii. "Agent" means a person /persons/company/terminal handling cargo container at Deendayal Port Authority.

All other words and expressions used herein not defined, are defined in the Major Port Trusts Act, 1963 (38 of 1963) or the Indian Ports Act, 1908 (15 of 1908) shall have the meanings respectively assigned to them in those Acts.

#### **4.1.2. Dangerous or Hazardous Cargo**

The term "dangerous or hazardous cargo" refers to everything that is classified as a dangerous good under the International Maritime Dangerous Goods (IMDG) regulations established by the International Maritime Organisation. Handling dangerous goods in any other way than in accordance with the IMDG Code is prohibited by international law. The SOLAS & IMDG Code also requires the publication of instructions on emergency response procedures and medical first aid relevant to events involving dangerous goods in line with the standards specified by the Organisation. All parties (including shippers, stevedores, transport operators, etc.) must strictly adhere to the requirements of the IMDG Code for the safe preparation, storage, handling, and shipment of dangerous goods in order to ensure that there are no incidents when dealing with dangerous goods on board ships and in ports.

#### **4.1.3 General acceptability of ships carrying dangerous or hazardous containers into port**

1. All dangerous or hazardous cargo entering the Port area must be classified, packaged, labelled and marked in accordance with the International Maritime Dangerous Goods Code and be declared by the ship or shipper accordingly and the container shall also be marked as such and shall be accompanied by a packing certificate issued by the operating company indicating the contents.
2. No ship carrying containers containing dangerous or hazardous cargo on board shall enter the port unless the containers are stowed and so documented according to the applicable provisions of the International Maritime Dangerous Goods code.

#### **4.1.4 Restriction on entry of ships carrying certain classes and quantities of dangerous or hazardous cargo**

- i. Ships carrying explosives (IMDG Class 1) and Radio-active substance dangerous or hazardous cargo. (IMDG Class 7) Including Ammonium Nitrate is not permitted at Deendayal Port Authority.
- ii. No cylinder containing gases compressed, liquefied or dissolved under pressure shall be permitted to be brought inside the port unless such cylinders are permitted for import or export by the Chief Controller of Explosives.
- iii. Dangerous goods in tank containers of the following class and type of commodity shall be limited aboard any ship to such quantity as may be notified by the port authorities, namely  
Class 2-Liquefied, Inflammable or Poisonous Gases  
Class 3.1 - Inflammable Liquid's e.g., Carbon Disulphide; Class 4.2-Spontaneously Combustible Liquids e.g., Aluminium Alkyls;  
Class 6 Tetra-methyl Lead (Fuel Additives);  
Class 6.1 Poisonous (Toxic) substances;  
Class 6.2 Infectious substances;  
Class 8-Corrosives;  
Class 9- Miscellaneous dangerous substances;
- iv. Operations at DPA are 24x7 i.e., 365 days of night navigation and cargo operations
- v. The Deputy Conservator or officer responsible for the safety of the port or any authorized representative specially nominated by him for the dangerous or hazardous cargo in the port shall be the sole authority to give permission for landing or loading dangerous or hazardous cargo in containers in the consultation with Traffic Department
- vi. The limitation of the quantity of the hazardous cargo is advised by Traffic Department

#### **4.1.5 Advance Notification. (Annexure-1)**

1. The Master or the ship owner or agent must inform the Deputy Conservator through Traffic Department at least (48) forty-eight hours prior to arrival of the ship of the dangerous or hazardous goods/the containers/liquid aboard the ship and those to be discharged at the port.
2. The intention to land or load dangerous or hazardous cargo shall be given by the steamer agents or consignees to the Deputy Conservator after the recommendation of Traffic Department for seeking the permission at least 48 hrs prior in advance and such application shall include a complete list of all substances with their true chemical name and International Maritime Dangerous Goods code number, shall furnish complete details including their full technical names, quantities, mode of packaging, IMDG code classification, UN No and such other relevant data.
3. An application for issue of permits for inflammable liquids including petroleum as defined in clause (a) of section 2 of the Petroleum Act, 1934 (30 of 1934), shall contain the information in respect of flash points of such liquids and whether such liquids are miscible with water or not.
4. In addition to the documents as specified in this SOP, the Deputy Conservator, Traffic Manager, FCASO, Deputy Secretary, Container Terminal in-charge shall be provided with the information regarding transit cargo of dangerous or hazardous goods containers carried by each ship.
5. In the case of export, the intention to export, dangerous or hazardous cargoes through containers/liquid cargo shall be advised to the Traffic Manager prior to their delivery to the berth at least (48) forty-eight hours in advance and permission obtained from the Deputy Conservator.
6. In the case of cargo in transit, the same prohibitions and restrictions as applicable in respect of dangerous or hazardous cargo for loading or unloading shall be applicable.

#### **4.1.6 Stacking of dangerous or hazardous cargo containers**

The Container Terminal in-charge ensure the stacking dangerous or hazardous cargo containers in either of the following:

- i. Stack the containers separately in a specially designated area which has been constructed for storage of dangerous or hazardous cargo and provided with firefighting arrangements;  
or

- ii. Stack the containers in the parking yard itself by providing proper segregation as per International Maritime Dangerous Goods Code.

#### **4.1.7. Identification, packing, marking, labelling or placarding and certification**

In order to comply with the relevant IMDG Code provisions or, alternatively, the pertinent national or international requirements applicable to the relevant mode of transport, hazardous handlers must ensure that any dangerous cargo entering their premises has been properly certified or declared by the cargo interests and is properly identified, packed, marked, labelled, or displayed.

#### **4.1.8 Container brought in for customs examination in port by road or Rail.**

**On-Roll Off Barges.** - This facility is not available at Deendayal Port Authority.

1. Stuffing / de stuffing of cargo on board of the vessel in to/from container is not allowed.
2. Stuffing / de stuffing of IMDG hazardous / dangerous container cargo in Deendayal Port Authority premises is not allowed / not permitted.

#### **4.1.9 Precautions to be taken by persons handling dangerous or hazardous cargo**

- 1) The following firefighting provisions shall be made in the designated areas where dangerous or hazardous cargo containers are kept, namely:
  - a) The provision of all firefighting equipment as required by national or international regulations is properly maintained and fully operational condition;
  - b) The provision of clear information as to emergency routines to be followed and a regular practice of such routines;
  - c) Good liaison between the container yard and the fire station so that the fire service shall be readily available at all times;
  - d) Good housekeeping and cleanliness shall be ensured since patches of oil mixed with the sawdust are potential sources of ignition and heaps of rubbish can be readily ignited, and piles of dunnage can assist in the rapid spread of the fire;
  - e) Proper care shall be taken to minimize sources of ignition such as smoking, unprotected or ill maintained electrical installations or other equipment's;
  - f) Clear access to fire appliances within the premises shall be maintained and its route kept clear at all times to enable emergency vehicles to reach the area.

- g) There shall be a separate dyke facility provided to place for any leaking containers and the size of the dyke to be such that it can contain double the volume of the cargo in the container. Also, pump shall be made available to reload the leaked chemical to the tanks/containers.
- 2) The following necessary arrangements of equipment shall be provided in the designated areas by the agency operating the dangerous or hazardous containers are kept, namely;
  - i. Adequate and proper breathing apparatus shall be provided and personnel trained in its use should be available so as to render immediate assistance to personnel affected by noxious fumes;
  - ii. protective clothing, comprising rubber boots and gloves and apron together with oilskins shall be available for use in dealing with spilt material; and
- 3) Adequate lighting arrangements shall be made and –
  - i. Wherever dangerous goods are handled or when other goods handled adjacent to dangerous goods, adequate and flameproof lighting shall be provided; and
  - ii. It shall be remembered that labels may appear to change colour in artificial light.
- 4) The adequate precautions to be taken to prevent the short circuit of insulation. The insulation and earthing system are inspected and tested at appropriate intervals to ensure their effectiveness. Any other metallic connections between the Berth and the Ship are protected or arranged so as to ensure there is no possibility of incentive sparking where a flammable atmosphere may be present. Terminal in charge handling dangerous goods must ensure the required segregation and environmental condition are maintained at all the time as determined through reference to the IMDG Code or the UN Model Regulation as appropriate. This includes dangerous goods being transported through a Port area. The Material safety data sheet for each substance or product provides more detailed information on the condition for handling.

#### **4.1.10 Operational Procedure**

The terminal manager is responsible for developing and putting into place operational procedures as needed for the handling or storage of hazardous materials. A safety management system that enables the detection, appraisal, and management of hazards associated with the handling of dangerous items must include these steps. The safe transit of hazardous cargoes and related activities in port regions must also take into account best international practises, particularly IMO recommendations.

#### **4.1.11 Emergency procedures**

The appropriate emergency arrangements (plans and procedures) are made, brought to the attention of all concerned and ensure their training is appropriate and commensurate with their responsibilities. These arrangements should include:

- i. The provision of appropriate emergency response alarm operating points;
- ii. Procedures for notification of an incident or emergency to the appropriate emergency response services within and the Port premises;
- iii. Procedures for notification to the Port authority of an incident or emergency to the users both on land and water;
- iv. The provision of emergency equipment appropriate to the hazards of the dangerous cargoes to be handled;
- v. The formation of a local emergency response team to co-ordinate action. in the case of major emergency and to deal with any day-to-day untoward incidents such as a minor leak or spillage of dangerous cargoes;
- vi. Co-ordinated arrangements for the release of a ship in case of an emergency; and arrangements to ensure adequate access/egress at all times. An emergency response procedure for the Ships carrying the dangerous goods (EMS Guide), Medical First Aid Guide for use in Accident involving dangerous Goods (MFAG) and the emergency and fire plan of the ship. The information at the berth should include the emergency procedure on the berth fire and emergency arrangements on the berth and the telephone number of the fire service, ambulance, CISF, local police and authorities to be informed in case of any incident concerning dangerous cargo.

#### **4.1.12 Compatibility**

The container handling agency or terminal operator shall make sure that dangerous liquid bulk cargoes are handled and stored in a way that eliminates the possibility of a hazardous interaction with other cargoes or products.

#### **4.1.13 Protective Area**

The container handling agency or the terminal operator must ensure that the hazardous container storage area is protected by the required barriers in order to avoid any negative incident from happening as a result of the movement of other transportation vehicles.

#### **4.1.14 Site Access**

Due to the risk, only people with legitimate intentions should be allowed access to any places used for the handling or transportation of hazardous materials. The access control system must include the following capabilities: a method for determining the amount of access that will be authorised for each; a method for keeping track of everyone present at once; and a method for issuing visitors with restricted access passes or prohibiting unaccompanied entry.

#### **4.1.15 Training**

Instruction in familiarity and general knowledge. Each person should receive training specific to his or her job in order to handle and transport hazardous materials safely. Participants in the training programme should get aware with the general hazards connected to the relevant risky commodities as well as the appropriate legal requirements. The many types of dangerous cargoes, the marking, labelling, and packing rules, as well as the specifications for compatibility and segregation, should all be included in this instruction. Additionally, it ought to go through the purpose and information contained in the shipping paperwork as well as the readily available emergency reaction supplies.

### **4.2 PROCEDURE OF TRANSPORTATION OF CARGO**

#### **4.2.1 PRE-HAZARDOUS APPROVAL**

The process begins when the customer requests authorization from the shipping company to convey hazardous cargo. The majority of lines feature unique models for applications involving dangerous commodities. Each field on the relevant template page must be filled out by the consumer before sending it to the shipping firm. It is essential for the shipping line to confirm that the hazardous goods are accepted at the transshipment or ports where the vessel calls because some ports do not permit vessels carrying high risk commodities like Class 1 or Class 7 to access their ports or enter without taking safety precautions. Once all relevant actions have been done and confirmation has been acquired from all necessary parties, the shipping line can only authorise a risky booking. The client can only get the booking and empty container release after that. The shipping line will validate that all of the information supplied by the shipper is accurate (the shipping lines would use the IMDG Code to do this). Currently, the vast majority of shipping lines run a specific dangerous desk or dangerous cargo centre. After the accuracy of the client's information has been confirmed, the DG Desk will search for hazardous cargo space on the vessel assigned to deliver this cargo. The number and kind of hazardous commodities that can be

transported on a ship are normally limited. This might vary from ship to ship, queue to queue, port to port, and depending on the cargo that is currently on board. If it can be determined that there is enough space on the ship in cooperation with the operating desk to hold the particular type of hazardous cargo and that this cargo is allowed to pass through the various ports that it may call, the hazardous desk will give the export desk/client the all-clear that the hazardous cargo is acceptable.

#### **4.2.2. POST-HAZARDOUS APPROVAL**

After being built in line with the hazardous standards, the container will be transported as usual to the container terminal during the stack time. All harmful goods entering particular ports might need to have the necessary paperwork. The port shall decide if this container meets the definition of a dangerous container and shall move such container to the authorised dangerous stacking place inside the port area. Always affix the Required Hazardous Labels to the container's four sides. Without labels, any risky container entering the port needs permission from both the port and the ship. Prior to the container being put into the ship, the shipping line must receive the customer's completed risky packing declaration. This completes the information regarding the hazardous cargo that is being transported. Because misrepresenting dangerous commodities can have serious repercussions for the lives of numerous individuals in the port, ship, and carriers who oversee this container throughout their route from Point A to Point B, the shipper must be cautious and patient when filling up. If there was a discrepancy in the cargo details between the time of application and the time of packing, it is the shipper's responsibility to ensure that the shipping line is notified right away. Before the ship arrives for loading, risky approvals might be reapplied. If not, it must wait until the following ship.

#### **4.2.3 POST LOADING**

The Dangerous packing declaration is typically only present in one copy aboard the ship. The shipping line also supplies a separate dangerous cargo manifest describing all of the dangerous cargo that is onboard, and each dangerous cargo on board will have its own dangerous packing declaration. It's crucial to recognise the differences between stowage and segregation because they serve various goals. Only if the shipping line, port, and carrier have all the necessary information can this be done effectively. To make sure that the cargo is well-protected during transit and to decide what to do if an event occurs on board, the line must have a thorough understanding of the cargo and how it is packed. This sort of action might be possible depending on the materials used.

## **4.3 COMPANYS HANDLING HAZARDOUS GOODS**

### **4.3.1 KUEHNE+NAGEL INTERNATIONAL**

Kuehne + Nagel International is a global transport and logistics company based in Switzerland. It was founded in 1890, in Germany, by August Kuhne and Friedrich Nagel. It provides sea freight and airfreight forwarding, contract logistics, and overland businesses to ensure the safe and compliant handling of dangerous goods, Kuehne + Nagel use robust processes, clear instructions, training, and monitoring. This guarantees that Kuehne + Nagel workers have the skills and knowledge necessary to carry out their tasks in a secure and professional manner, in line with all applicable laws. A network of experts spread across all of the company's worldwide business units upholds the global Hazardous products criteria. All types of hazardous items can pose a risk during storage and transportation, which is why the recommendations strive to eliminate or significantly reduce that risk.

### **4.3.2 APL LOGISTICS LIMITED**

APL Logistics Ltd is a wholly owned subsidiary of Kintetsu World Express, Inc. (KWE), a Japan-based freight forwarding and transportation company. As a global supply chain specialist, APL Logistics does business in more than 60 countries. Headquartered in Singapore, APL Logistics has locations across the globe. In 1980, in response to the increasing importance of Asian imports, U.S.-based container transportation and shipping company APL has created American Consolidation Services (ACS) to meet the needs of importers seeking assistance in managing the flow of their Asian goods. APL Logistics specialized in Transportation of Hazardous goods which many other forwarders cannot manage. APL team of specialized professionals who have worked for established airlines and shipping lines within the dangerous goods freight industry. To handling of dangerous cargo requires a very professional approach, which requires experienced employees. APL Logistics has trained and skilled staff to handle this shipping. There are several companies in India that are producers, as well as importers and exporters for chemicals and other hazardous equipment and APL gives more importance to handling these risky shipments.

### **4.3.3 FEDEX**

FedEx Corporation is an American multinational delivery services company incorporated October 2, 1997. The company is known for its overnight delivery service and pioneering a program that can monitor shipments and provide real-time alert on package position, a feature

that most other carrier companies have now introduced. FedEx is also one of the top contractors of the US government. In January 2000, FDX Corporation changed its name to FedEx Corporation and re-branded all of its subsidiaries FedEx Express is a world leader in the shipment of Hazardous goods and has specialists on staff to assist with dangerous goods questions. Dangerous goods transport must be tendered to FedEx Express in compliance with existing International Air Transport Association (IATA) legislation for air transport and the FedEx Express Terms and Conditions. It is necessary regardless of the routing, and whether the shipment ends up physically moving by air, land or a combination of these.

#### **4.4 HANDLING OF DANGEROUS GOODS**

Dangerous goods are substances that pose a direct risk to persons, property, and the environment. These substances may be radioactive, poisonous, explosive, flammable, oxidising, or corrosive. You must handle hazardous items carefully and in a way that reduces the hazards they can present to your workplace since they pose a variety of risks to people, property, and the environment. Chemical Producers now package their hazardous goods in increasingly larger packages as a result of the higher use of hazardous items in the last century. Hazardous commodities like acids and combustible liquids are frequently seen today in containers as large as 205L drums and 1000L Intermediate Bulk Containers. If these bulky products aren't handled properly, it could seriously harm both people and property.

- **SAFETY DATA SHEETS**

To ensure that everyone on the job is aware of the particular risks related with the hazardous substances that they are deal, it is very necessary to have a copy of the safety data sheets for each Hazardous substance. Safety data sheets are documents that outline the specific reactivity, fire, health and environmental dangers related with a particular substance. The safety data sheet will also outline the basic storage and handling requirements for the particular substance. Before a dangerous substance is dispensed or used, the safety data sheet for the substance must be consulted to ensure that the dangerous substance is managed in the safest manner.

- **FORK LIFTS**

A forklift (also called lift truck) is a powered industrial truck used to lift and move materials over short distances. If the company procures their Hazardous goods in 1000L intermediate bulk containers (IBC's), a forklift must be used to lift these IBC 's in and out of chemical storage

containers. 205L drums have a rounded shape and are much more difficult to handle. Forklift attachments must be used when moving these drums in and out of chemical storage containers.

- **PERSONAL PROTECTIVE EQUIPMENT**

Personal protective equipment (like gloves, Respiratory Equipment) is another form of protection that can be used to protect people and properties from the risks Hazardous goods. The use of personal protective equipment when dispensing and handling toxic and corrosive substances is particularly important. Toxic substances are substances which damage human health when they enter the body. The means by which harmful substances come into the body are called exposure paths. There are 3 principal routes of exposure. They are Ingestion, Skin contact, Inhalation. Among these three inhalations is the most common type. To minimize the risk of exposure to toxic substances, it is necessary to use the appropriate personal protective equipment such as respiratory equipment and gloves while handling and dispensing toxic Substance.

## **4.5 SAFETY MEASURES REQUIRED IN WAREHOUSE**

### **4.5.1 SAFE LIFTING TECHNIQUES**

If a load needs to be transported, first choose the best method for moving it. Check the route to make sure there are no obstructions in the path and make sure there is enough place for loading at the destination if lifting is the most appropriate option. Always use safe lifting techniques, and make sure the load doesn't obstruct the lifter's vision. Utilise all material handling equipment with caution, adhere to the recommended operating methods, push wherever you can instead of pull, and lean in the direction you are moving. Additionally, never use a forklift or any other motorised machinery without authorization or training.



**Figure 6: Safe Lifting Symbol**

#### **4.5.2 LABELING HAZARDOUS ZONES**

Storage areas for hazardous equipment should be clearly marked, and secure walkways should be highlighted with the proper signs. Using tape or white and black lines painted on the floor of the designated area is the best technique to mark unsafe areas. This enables employees to be aware of potentially hazardous situations and can help to stop occurrences that could result in serious injury.



**Figure 7: Hazardous Zones**

#### **4.5.3 USE OF SAFETY EQUIPMENT**

A vital piece of equipment in the warehouse are forklifts or hydraulic dollies, which are used to lift goods that are too heavy. When required, appropriate eye protection and hard hats should also be worn. Employees should be aware of emergency exits, and they shouldn't ever obstruct the sprinklers that were put into the roof. Installation of safety devices aims to lower workplace injuries. Getting started with its utilisation could take some effort, but it is time well spent.

## 4.6 CASE STUDY ON BEIRUT EXPLOSION 2020

On August 4, 2020, a significant chemical explosion took place in the port of Beirut, Lebanon. 2,750 tonnes of ammonium nitrate (AN) were set ablaze by an unattended warehouse fire, resulting in one of the deadliest explosions in recent memory. In an instant, the blast's supersonic pressure and heat wave killed 220 people, instantly injured over 6,500 more, and severely damaged the region's crowded residential and business districts. This review is one of the in-depth studies that examines the effects of the Beirut explosion on human health and the environment in great detail. It also examines earlier AN incident and offers practical advice and tactics to enhance chemical safety controls, boost emergency readiness, and lessen the long-term clinical impacts of explosion and toxic gas exposure. Government officials and policymakers can use these suggested concrete actions as a springboard to develop frameworks, pass laws, and put chemical safety procedures into place to ensure the secure storage of hazardous materials. They can also use them to reorganise the healthcare system's disaster preparedness in order to enhance emergency preparedness in the event of future major disasters and advance population safety. Future clinical efforts should include a thorough evaluation of the physical harm that blast victims have experienced, as well as systemic mitigation and potential treatment of late blast consequences that affect individuals, communities, and the region as a whole.



**Figure 9: Beirut Port**

#### **4.7 CASE STUDY ON SRILANKA SHIP FIRE 2021**

Sri Lanka is staring at a catastrophe for the environment. The MV X-Press Pearl containerer caught fire on May 20 while it was docked about 9 nautical miles northwest of Colombo. The Singapore-flagged ship has 1,486 compartments loaded with 25 tonnes of nitric acid and other synthetic compounds used as raw ingredients for plastic packaging. In addition, the ship's tanks were holding around 300 tonnes of fuel. After seething for a fortnight, the fire has been doused. An endeavour by rescue specialists to tow the ship into more profound waters to contain the harm to the coastline bombed when the vessel started sinking on June 2. “An environmental emergency of this nature causes significant damage to the planet by the release of hazardous substances into the ecosystem,” UN Resident Coordinator in Sri Lanka Hanaa Singer-Hamdy said in a statement. In turn, this puts the lives and livelihoods of the people living in coastal areas in danger. Huge quantities of microplastic granules have contaminated the well-known seashores of the South Asian nation in Negombo, a popular tourist destination, preventing fishing and inciting feelings of environmental harm. According to media sources, since the ship caught fire on May 20, more than 50 turtles and 18 dolphins have been found dead throughout the island.



**Figure 10: Sir Lanka Ship Fire**

## **4.8 PROBLEMS AND SOLUTIONS OF HANDLING HAZARDOUS MATERIALS**

### **Problems**

- For managing the each and every work efficiently at the Port qualified, skills human resource is required. Shortage of qualified human resource is a problem faced by the port.
- Lack of proper knowledge on handling hazardous goods is a major problem faced by the Ports.
- Lack of essential tools and equipment's required for hazardous goods handling at port.
- Certain Times unexpected contingencies also results in problem at Port.
- The biggest problem faced by Indian ports are shortage of efficient and skilled manpower.
- The biggest problem faced by Indian ports are shortage of efficient and skilled manpower.
- Since there is huge increasing port related operations and cargo transfer increasing need for qualified and skill manpower.
- Lack of knowledge on handling of various port equipment and tools is a Major issue. This results in waste of resources as well as incidents and accidents.
- Most of the time good handling related hazards takes place due to not using proper equipment and safety measure.
- Every good having certain standard procedure of handling. That has to be followed Strictly

### **Solutions**

- Effectively planning human resource and preparing them for the various functions of port.
- Making sure that all the personals who are in charge of hazardous goods handling are having the proper knowledge of various procedures and standards. For this conducting timely mock drills and examinations are essential.
- Keeping ready the essential tools and equipment's that are required for handling different type of hazardous goods.
- Having proper planning and action plans for addressing unexpected contingencies at port.
- Consider potential hazards and plan ahead. Have arrangements and procedures in place to handle emergency circumstances that may arise from hazmat spills or exposure. This means making sure employees understand emergency procedures, including evacuation, clean up or what to do in case of fire. Make sure emergency equipment such as eye wash and shower stations are accessible, kept clean and are tested routinely. Train employees

on first aid skills and how to respond to co-workers who may be injured or experience chemical exposure.

- Employees handling hazardous materials should always read the labels to understand what they working with and have the safety data sheet accessible prior to using any materials in order to understand how to handle a spill or exposure to that chemical.

## 4.9 DATA ANALYSIS AND INTERPRETATION

### 4.9.1 Commodity-wise growth of cargo traffic at Major Ports

Table 4.1 Commodity-wise growth in Tonnes (2019-2022)

Commodities	January, 2020		January, 2021		(April-January,2019-20)		(April-January,2020-21)	
	Cargo handled	% Share	Cargo handled	% Share	Cargo handled	% Share	Cargo handled	% Share
POL Crude	12773	20.7	14218	22.1	125489	21.4	111095	20.5
POL Products	5895	9.6	4833	7.5	57167	9.8	44112	8.1
LPG or LNG	1095	1.7	1306	2	10944	1.9	12134	2.2
Edible Oil	864	1.4	918	1.4	9896	1.7	8549	1.6
FRM-Liquid	506	0.8	562	0.9	5099	0.9	5262	1
Thermal Coal	7173	11.6	6166	9.6	66458	11.3	56158	10.4
Coking Coal	2965	4.8	3919	6.1	33334	5.7	29796	5.5
Other Coal	3153	5.1	3235	5	21865	3.7	19570	3.6
Fertilizer	857	1.4	955	1.5	8464	1.4	8970	1.7

Commodities	March, 2021		March, 2022		(April-March,2020-21)		(April-March,2021-22)	
	Cargo handled	% Share	Cargo handled	% Share	Cargo handled	% Share	Cargo handled	% Share
POL Crude	13804	20	14337	20.4	136369	20.3	144617	20.1
POL Products	5599	8.1	5741	8.2	54066	8	61034	8.5
LPG or LNG	1292	1.9	1185	1.7	14666	2.2	15702	2.2
Edible Oil	809	1.2	792	1.1	9952	1.5	11184	1.6
FRM-Liquid	389	0.6	419	0.6	6132	0.9	6347	0.9
Thermal Coal	7336	10.6	9867	14.1	71307	10.6	86868	12.5
Coking Coal	4204	6.1	2554	3.6	37272	5.5	34119	4.7
Other Coal	1436	2.1	4261	6.1	23313	3.5	24349	3.4
Fertilizer	314	0.5	635	0.9	10343	1.5	7278	1

Source: Ministry of Port Shipping and Waterway

## **CHAPTER 5**

### **FINDINGD, SUGGESTION AND CONCLUION**

#### **5.1 FINDINGS**

- Proper handling of hazardous materials is crucial in supply chain management to ensure the safety of workers, consumers, and the environment.
- Inadequate handling of hazardous materials can lead to accidents, injuries, and even fatalities, posing significant risks to human health and the environment.
- Effective handling of hazardous materials requires comprehensive training programs for employees involved in supply chain management, including proper handling techniques, storage procedures, and emergency response protocols.
- Compliance with relevant regulations and standards is essential in managing hazardous materials throughout the supply chain. This includes understanding legal requirements, obtaining necessary permits and certifications, and maintaining accurate documentation.
- Implementing advanced technologies and systems, such as real-time tracking, monitoring, and sensor-based solutions, can enhance the management of hazardous materials in the supply chain. These technologies provide increased visibility, traceability, and control over the movement and condition of hazardous materials.
- Collaboration and communication among supply chain stakeholders, including manufacturers, suppliers, distributors, and regulatory authorities, are critical for effective handling of hazardous materials. Clear communication channels and shared responsibility help ensure that proper protocols are followed at each stage of the supply chain.
- Risk assessment and mitigation strategies play a vital role in handling hazardous materials. Conducting regular risk assessments helps identify potential hazards and vulnerabilities in the supply chain, enabling proactive measures to minimize risks.

- Environmental sustainability should be a key consideration when handling hazardous materials. Promoting the use of eco-friendly alternatives, reducing waste generation, and adopting proper disposal and recycling practices can contribute to a greener supply chain and mitigate the environmental impact of hazardous materials.
- Continuous improvement and periodic evaluation of hazardous material handling processes are necessary to adapt to changing regulations, technologies, and best practices. Regular audits and performance monitoring help identify areas for improvement and ensure ongoing compliance and effectiveness in managing hazardous materials.

## **5.2 SUGGESTION**

- Emphasize the need for comprehensive training programs: Highlight the importance of implementing thorough training programs for employees involved in handling hazardous materials. Discuss the specific topics that should be covered, such as proper handling techniques, safety protocols, emergency response procedures, and regulatory compliance.
- Explore technological solutions: Investigate and discuss the potential role of advanced technologies in improving the handling of hazardous materials in the supply chain. Consider technologies such as real-time tracking systems, sensor-based monitoring, and data analytics to enhance visibility, traceability, and control over hazardous materials throughout the supply chain.
- Discuss regulatory compliance: Provide a detailed overview of the relevant regulations and standards governing the handling of hazardous materials in supply chain management. Discuss the implications of non-compliance and suggest strategies for ensuring adherence to these regulations.
- Address environmental sustainability: Emphasize the importance of environmental sustainability in the handling of hazardous materials. Discuss the benefits of using eco-friendly alternatives, waste reduction strategies, and proper disposal and recycling practices. Highlight how integrating sustainability measures into supply chain management can contribute to a greener and more responsible approach.

- Promote collaboration and communication: Emphasize the significance of collaboration and communication among supply chain stakeholders in handling hazardous materials effectively. Discuss the importance of establishing clear communication channels, sharing information, and fostering a culture of shared responsibility to ensure compliance and safety throughout the supply chain.
- Encourage continuous improvement: Advocate for a culture of continuous improvement in handling hazardous materials. Discuss the need for regular audits, performance monitoring, and evaluation of processes to identify areas for enhancement. Encourage the adoption of industry best practices and the integration of feedback and lessons learned into future operations.

### **5.3 CONCLUSION**

- Effective handling of hazardous materials is of paramount importance in supply chain management to ensure the safety of workers, consumers, and the environment. Inadequate handling can lead to severe consequences, including accidents, injuries, environmental damage, and reputational harm.
- Proper training programs for employees involved in handling hazardous materials are essential. These programs should cover techniques, safety protocols, emergency response procedures, and regulatory compliance to ensure competent and responsible handling throughout the supply chain.
- The integration of advanced technologies, such as real-time tracking systems and sensor-based monitoring, enhances visibility, traceability, and control over hazardous materials, promoting better management practices and reducing risks.
- Compliance with regulations and standards is crucial. Organizations must stay updated with relevant laws, obtain necessary permits and certifications, and maintain accurate documentation to ensure legal compliance and accountability.
- Collaboration and communication among supply chain stakeholders play a critical role in handling hazardous materials effectively. Clear communication channels, shared responsibility, and collaboration with regulatory authorities foster a culture of safety and compliance.

- Environmental sustainability should be prioritized. Promoting eco-friendly alternatives, waste reduction strategies, and proper disposal and recycling practices mitigate the environmental impact of hazardous materials, contributing to a greener and more sustainable supply chain.
  
- Continuous improvement is necessary to adapt to changing regulations, technologies, and best practices. Regular risk assessments, performance monitoring, and audits help identify areas for improvement and ensure ongoing compliance and effectiveness in handling hazardous materials.

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