Importance of GHS in Seafarers Education

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Abstract. Global harmonized system (GHS), relating to hazard chemicals, is a process of making regulations among countries uniform to the extent possible so as to benefit an industry to export its product to several countries with one communication system.

On one side, the system is helpful to develop communication as labeling and material safety data sheets, and on the other side is helpful for personal in the industry (including manufacturer, chemical carrier, Ports, Terminals, Ships, laboratories) to properly handle chemicals with covering all safety rules.

Such international guidelines are believed to be the most reliable information so that USERS of hazard chemicals is confident enough in handling, storage, segregation, disposal and using.

The current article has two goals. Firstly, is to extend the awareness and understanding the main principles of GHS system, their guidelines, and how the hazard chemicals are being classified, communicated as labels, symbols, pictograms, hazardous / precautionary statements and material safety data sheets. Secondly, is to establish the importance of implementing of GHS in curricular of bachelor students of maritime specialization, significance of increasing their awareness, knowledge and understanding in hazardous communication and understanding of hazard identification and risk management of different cargos, which is the part of ISM code and MSC 286(86) requirements.

Keywords: *Global harmonizing system (GHS), Chemical Hazardous classification, communication, labeling, symbols /pictograms, Safety Data Sheets (SDS)*

1. Introduction

The Globally Harmonized System of Classification and Labeling Chemicals (GHS) is a single worldwide system for classifying and communicating the hazardous properties of industrial and consumer chemicals. GHS sits alongside the UN 'Transport of Dangerous Goods' system.

The UN brought together experts from different countries to create the GHS with the aim to have, worldwide, the same:

- criteria for classifying chemicals according to their health, environmental and physical hazards;
- hazard communication requirements for labelling and safety data sheets.

Compared to pre-GHS hazard communication, GHS offers better protection to workers and users and facilitates international chemical trade.

Before the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) was created and implemented, there were many different regulations on hazard classification in use in different countries, resulting in multiple standards, classifications and labels for the same hazard. The fact that Chemicals directly or indirectly affect our lives and are essential to our food, our health, our lifestyle; the fact that the widespread use of chemicals has resulting in the development of sector-specific regulations (transport, production, workplace, agriculture, trade, and consumer products); and the fact that Chemicals and related products are specific to Goals 9 & 17 (Industry, Innovation, & Infrastructure, and Partnerships for the Goals) respectively, and implicated in practically all of the other Sustainable Development Goals (SDGs); the cost of the much needed compliance with multiple systems of classification and labeling is significant. Having readily available information on the hazardous properties of chemicals, and recommended control measures, allows the production, transport, use and disposal of chemicals to be managed safely. Thus, human health and the environment are protected. A worldwide standard accepted as an alternative to local and regional systems presents an opportunity to reduce cost and improve compliance.

In pre-GHS era, users may see different label warnings or safety data sheet information for the same chemical, which can cause confusion. In addition to that, most of countries have their own hazard classification and labelling regulations in pre-GHS era. Those regulations vary significantly and compliance with them is very costly and time-consuming.

The GHS aims to ensure that information on the hazardous properties of chemicals is available throughout the world in order to enhance the protection of human health and the environment during the handling, transport and use of chemicals. GHS also provides the basis for harmonizing regulations on chemicals at national, regional and worldwide level. This is important for facilitating trade. At a more basic level, GHS also aims to provide a structure for countries that do not yet have a classification and labelling system.

The GHS is referred to as the 'Purple Book' reflecting the purple binding of the published version of GHS. This is in keeping with the Transport of Dangerous Goods system.

Fig. 1. - 'Purple Book' (UN GHS Purple Book) [1]

The GHS is not a formal treaty, but instead is a non-legally binding international agreement. Therefore countries (or trading blocs) must create local or national legislation to implement the GHS.

Many countries already have regulatory systems in place for chemical classification and hazard communication. These systems may be similar in content and approach, but their differences are significant enough to require multiple classifications, labels, and safety data sheets (SDS) for the same product. Regulatory authorities in countries adopting the GHS will take the agreed criteria and provisions, and implement them through their own regulatory process and procedures. The GHS document provides countries with the regulatory building blocks with which to develop or modify existing national programs that address classification of hazards and transmittal of information about those hazards and associated protective measures.

The United Nations goal was broad international adoption, and as of 2017, GHS has been adopted to varying degrees in nearly all major countries.

As a voluntary international system, the GHS is not legally binding in any country. Therefore, countries adopting GHS have to issue their own regulations or standards to implement GHS criteria and provisions. Two examples are:

- The EU CLP REGULATION (EC) No 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures;
- OSHA's Hazard Communication Standard (HCS) 2012 in the United States;

Fig. 2. GHS implementation - world map [2].

Globally Harmonized System of Classification and Labelling of Chemicals (GHS)

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- : Countries/regions that have already implemented GHS.
- : Countries/regions where GHS is voluntary.
- : Countries/regions that are in the process of implementing GHS.
- : Countries/regions where GHS is not implemented or not available.

2. Methodology

The study was accomplished using traditional scientific methods such as mind mapping, deduction, induction, envisioning, system thinking and complexity thinking. These methods were selected considering the aim and research objectives as well as literature availability. The study begins to unpack a web of complex and entangled ideas around GHS system. Mind mapping, a visualization of information and associations between its components, was primarily used at the initial stage of the research, which was identifying and collecting state to the art information and regulations. Obtained outcomes were developed into research objectives and consequently shaped the content of learning course which to be developed for ungraduated students. Whilst an extensive list of literature on hazardous materials exists, the research faced a lack of literature relating to GHS system in maritime education and training contexts, except the main regulations requirements.

3. Scope of UN GHS and Applicable Industry Sectors

Prior to the development of the GHS system, the communication systems of hazardous substances used in different countries differed from each other in terms of both marking and data in

the safety sheets. There was no unified approach, which was the barrier in timely data processing and approval of system internationally.

The GHS covers all hazardous chemicals and Sectors that may adopt GHS include:

Transport	• The UN Recommendations on the Transport of Dangerous Goods - Model Regulations takes precedence;
	• GHS parts expected to be adopted:
	  ○ GHS hazard classification criteria;
	  ○ GHS hazard pictogram;

Workplace	• Some authorities may not have jurisdictions over environmental hazards.
	• GHS parts expected to be adopted:
	  ○ GHS hazard classification criteria;
	  ○ GHS label elements;
	  ○ GHS safety data sheet;

Consumer	• Labels may include the core elements of GHS labels subject to some sector-specific considerations(i.e., instructions for use, expiration date);
	• Risk-based labelling may be applied.
	• GHS parts expected to be adopted:
	  ○ GHS hazard classification criteria;
	  ○ GHS label elements;

Pesticides	• Pesticide labels may include the core elements of GHS labels subject to some sector-specific considerations(i.e., instruction for use, crops, expiration date);
	• GHS parts expected to be adopted:
	  ○ GHS hazard classification criteria;
	  ○ GHS label elements;
	  ○ GHS safety data sheets required in workplace

Some countries have adopted GHS in all 4 sectors while other countries have only adopted GHS in 1 or 2 sectors.

3.1. GHS Hazard Class, Hazard Category and Hazard Pictogram

GHS describes the nature and severity of a chemical hazard by hazard calss and hazard category. GHS also assigns standard pictograms representing different types of hazards.

- **Hazard class**: the nature of a chemical hazard, i.e., flammable liquids, carcinogen.
- **Hazard category**: the division of criteria within each hazard class. For example, flammable liquids have 4 categories among which flammable liquids category 1 represents the most severe hazard.
- **Hazard pictogram**: 9 pictograms conveying different types of health, physical and environmental hazards.

The picture below shows the type of chemical hazards each GHS pictogram represents.

Fig 3. GHS pictograms [3]

There are 29 hazard classes in the latest version of UN GHS (UN GHS Rev. 8). A chemical meeting the criteria for any hazard class below will be regarded as a hazardous chemical [5].

Physical Hazards(17 classes)	Health Hazards(10 classes)	Environmental Hazards (2 classes)
• Explosives • Flammable Gases • Aerosols • Oxidizing Gases • Gases Under Pressure • Flammable Liquids • Flammable Solids • Self-Reactive Substances • Pyrophoric Liquids • Pyrophoric Solids • Self-Heating Substances	• Acute Toxicity (Oral/Dermal/Inhalation) • Skin Corrosion/Irritation • Serious Eye Damage/Eye Irritation • Respiratory or Skin Sensitization • Germ Cell Mutagenicity • Carcinogenicity • Reproductive Toxicology • Target Organ Systemic Toxicity - Single Exposure	• Hazardous to Aquatic Environment (Acute/Chronic) • Hazardous to the Ozone Layer

• Substances which, in contact with water emit flammable gases • Oxidizing Liquids • Oxidizing Solids • Organic Peroxides • Corrosive to Metals • Desensitized explosives [Added in GHS Rev.6]	• Target Organ Systemic Toxicity - Repeated Exposure • Aspiration Toxicity	

It shall be noted that the GHS allows individual countries or regions to choose which hazard classes or hazard categories to implement to meet their domestic needs. For example, EU has not adopted flammable liquids category 4. The United States has not adopted Hazardous to the Ozone Layer yet. This is often called **GHS Building Blocks** approach.

3.2. GHS Classification and Labelling Elements

GHS classification is a process to determine the hazard class and category of a chemical (substance or mixture) in accordance with GHS hazard classification criteria.

The picture below is an example of GHS classification criteria for flammable liquids. A liquid with a flash point between 23 and 60 Celsius degrees will be classified as flammable liquid category 3. A liquid with a flash point above 95 Celsius degrees does not meet GHS classification criteria and will not be regarded as a hazardous chemical,

Category	Criteria
1	Flash Point $< 23°C$ Initial Boiling Point $\leq 35°C$
2	Flash Point $< 23°C$ Initial Boiling Point $> 35°C$
3	Flash Point $\geq 23°C$ Initial Boiling Point $\leq 60°C$
4	Flash Point $> 60°C$ Initial Boiling Point $\leq 95°C$

Once a chemical has been classified according to GHS classification criteria, you can easily find assigned signal word, pictogram, hazard statements and precautionary statements that need to be included on labels and in SDSs. The data are unified in one catalogue [4].

For example, a liquid with a flash point between 23 and 60 Celsius degrees will be classified as flammable liquid category 3. By checking the page 316 of above document, you can easily find out the core labelling elements for this liquid:

- Signal word: Warning;
- Pictogram: Flame;

- Hazard statement: H226 flammable liquid and vapour;
- Precautionary statement: P210, P233, P280, P303+P361+P353, P370+P378, P403+P235, P501

The labeling rules of GHS system has the following core elements, which includes:

- **Product identifier**: Chemical identities of a substance or hazardous ingredients in a mixture;
- **Supplier identification**: The name, address and telephone number of a supplier;
- **Signal word:** Danger or Warning;
- **Hazard pictogram:** conveying different types of chemical hazards;
- **Hazard statement:** standardized and assigned phrases that describe the hazard(s) as determined by hazard classification;
- **Precautionary statement:** standardized phrases that describe measures to minimize or prevent adverse effects;

An example of a GHS label for a chemical can be found below:

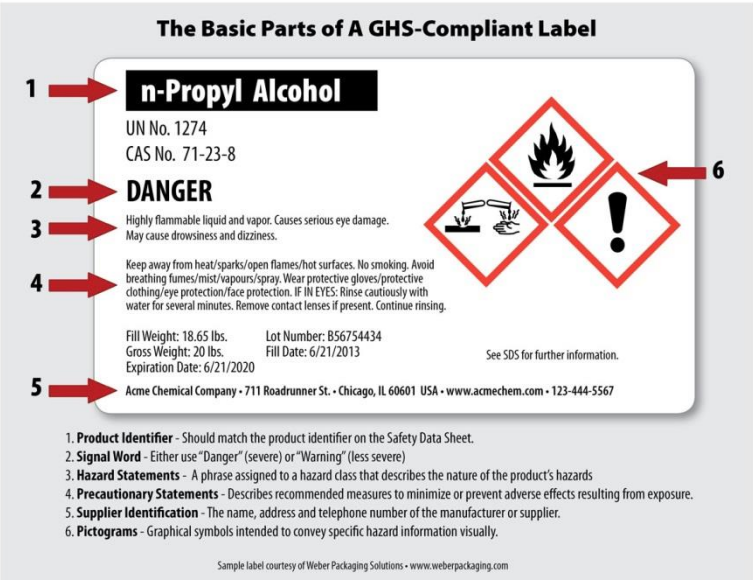

Fig 4. GHS label [4,5]

GHS also established the minimum concentration limits of hazardous substances. GHS cut-off value or GHS concentration limit is the minimum concentration for a hazardous substance to trigger the classification of a mixture containing it. They are mainly expressed as % thresholds and are primarily used for mixture classification under GHS.

Example of cut-off value/concentration limit for hazard class skin corrosion/irritation. If a mixture contains a hazardous ingredient that has been classified as skin corrosive category 1, the mixture itself will also be classified as skin corrosive category 1 if the concentration of ingredient exceeds 5%.

3.3. Safety Data Sheet (SDS)

Safety Data Sheet (SDS), also called as Material Safety Data Sheet (MSDS) in pre-GHS era, is a very important document to inform its audience of the hazards of a substance or mixture and provide advice on safety precautions.

GHS has harmonized the format and content of Safety Data Sheets. There are 16 sections in standard GHS SDSs (as shown below). GHS has also set the minimum info required for each section.

- Section 1 Identification of the substance or mixture and of the supplier;
- Section 2 Hazard identification;
- Section 3 Composition/information on ingredients;
- Section 4 First-aid measures;
- Section 5 Fire-fighting measures;
- Section 6 Accidental release measures;
- Section 7 Handling and storage;
- Section 8 Exposure controls/personal protection;
- Section 9 Physical and chemical properties;
- Section 10 Stability and reactivity;
- Section 11 Toxicological information;
- Section 12 Ecological information;
- Section 13 Disposal consideration;
- Section 14 Transportation information;
- Section 15 Regulatory information;
- Section 16 Other information.

Please be noted that:

- An SDS usually needs to be prepared in the language of its destination country;
- Some countries may have set additional requirements on some sections of SDSs (for example, information disclosure in section 3, occupational exposure limits in section 8, regulatory info in section 15) [5].

4. GHS SDS in Maritime Industry

A ship has to carry different types of cargo which includes oil cargo, chemical cargo, and cargo in gaseous form. These types of goods are hazardous for marine environment as well as for the health of seafarer. Apart from carrying cargo, the ship carries different types of chemicals and solutions which are used for several marine operations. A Material Safety Data Sheet is provided for such cargo and also for chemicals carried onboard which are used for maintenance purpose.

Effective 1 January 2011, SOLAS requires that each ship must be provided with Material Safety Data Sheets (MSDS) for oil cargoes (MARPOL Annex I cargoes) and for oil fuel (bunkers) as defined in MARPOL - Resolution MSC.239(83) – Adoption of Amendments to SOLAS (new Regulation VI/5-1) [6]. The MSDS have to be provided prior to loading such oil as cargo in bulk or as oil fuel. Additionally, the IMO has recommended a format and content for the MSDS (IMO Resolution MSC.286(86)) [7].

Therefore, after 1 January 2011, parties to SOLAS can be expected to verify that ships have the required MSDS.

OCIMF VIQ 7 – Chapter 5.46 reads: ‘Ships carrying MARPOL Annex I cargoes, as defined in Appendix I to Annex I of the Protocol of 1978 relating to the International Convention for the Prevention of Pollution from Ships, 1973, and marine fuel oils shall be provided with a material safety data sheet prior to the loading of such cargoes. (SOLAS 2007 Amendments VI 5-1)’ ‘On ships carrying MARPOL Annex II cargoes, Prior to loading, the shipper should provide both to the Master and the Company, as defined in the ISM Code, a Material Safety Data Sheet (MSDS), formatted in accordance with resolution MSC.286(86), for cargoes containing benzene. (IBC Appendix 8 Annex) [8].

Appendix 1 of the Resolution MSC.286(86) is the recommendation for MSDS/SDS for marine use suitable to meet the particular needs of the marine industry containing safety, handling, and

environmental information to be supplied to a ship to the loading of MARPOL Annex I Type Oil as cargo in bulk and bunkering of oil fuel [8].

Goods present on board ship that can be hazardous to the ship and its crew are:

- Different hazardous goods like fuel oil, lube oil, chemicals, LNG, LPG etc.
- Cargo carried in containers under IMDG code.
- Fuel oil and lube oil carried as a bunker are also hazardous in nature and can harm humans and environment
- For maintenance and operational purpose, different kinds of chemicals are used onboard which can be hazardous. They are mostly used as cleaning agents, for water treatments, for dosing in fuels and as an additive in sanitation systems [9].

SDS is carried onboard for ensuring the safety of marine environment and seafarers, provides useful and accessible information on the product carried on board, either as a cargo or for operational purposes, for all individual hazardous material carried on board along with proper personal protective equipments (PPE) so that in the time of emergency, appropriate procedures and swift response can be achieved in that situation.

5. GHS implementation in curriculum

Curriculums for undergraduate students in the field of Maritime Studies contains learning course “Quality assurance and Risk Management onboard ship” aims to provide students with a general knowledge on quality management applicable in the context of shipping covers training in the requirements of the International Security Management Code (ISM code), the principles of development of the management system, documentation of the processes and activities based on hazards identification, risk assessments and management, handling and management of hazardous chemicals for cargo of the high risk activities.

Study of the GHS Material Safety Data Sheets (MSDS / SDS) document provided in the learning course allows the student to get complete information about a specific cargo or substance, in particular to understand the following information:

- the physical and chemical properties like the three main points such as flash, boiling and melting points

- the nature of the substance indicating its toxicity
- effects on health
- first aid that needs to be administered in case of adverse contact
- possible reactions
- methods of storage
- methods of disposal
- protective equipment to be used by people that come in contact with the material
- spill-handling procedures

6. Conclusion

Providing thorough comprehensive and explanatory information to Maritime students about the Globally Harmonized System (GHS) is a vital task that will serve to raise their personal safety awareness and educate future qualified, highly competent seafarers.

Mastering the GHS system for students of Maritime specialties will develop their skills of leadership in the GHS system and provide them the relevant knowledge for safely performance the duties assigned to the future employment. During the teaching process the student will equipped with the appropriate knowledge, understanding, skills and competences in handling the hazardous goods and:

- Understand the dangers of the system when working with hazardous substances / cargo;
- Be able to correctly understand and use the warning signs, symbols and phrases reflected in the classifier;
- Correctly use the information of SDS;
- Promptly and efficiently search for necessary information on cargo transportation, storage, first aid, firefighting, physical and chemical properties;
- Understand and evaluate the Impact of potential hazards on health, environment, physical hazards, etc.;
- Be able to correctly understand information and, based on its processing, identifying hazards related to substances and mixtures , as well as risk identifications and management issues.

All above-mentioned, will eventually give the undergraduate students the appropriate level

of awareness, increase safely performance of duties in the work environment, develop habitual awareness, which is a prerequisite for the development of a safety culture.

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