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Handling and Management of Chemicals in SMEs

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Abstract: ***A great variety of Small and Medium Enterprises (SMEs) around the world are using chemicals in their daily activities. These can include from the production of chemical products per se, or the use of chemical substances for the delivery of specific services to their customers. In any case, the correct handling, storage, use and management in general of these substances are the only way to eliminate any potential hazards that may arise due to their improper use. These possible hazards can have an impact on the employee, the company itself, the customer and/or even the environment. This paper provides a summary of the most important aspects that any SME, irrelevant to its size, should be taking into consideration and following in their daily practice. Specific information on the REACH and CLP regulations are highlighted, next to the relevant Directives of the European Commission. In addition, there is a thorough summary of the classification of the chemical substances the majority of the company are producing, using or just storing in their premises.***

Keywords: Chemical substances, Health and Safety Management, Chemical Waste Management, Labelling CLP

1. Introduction

The health and safety of employees in dedicated settings for the use and/or management of chemical substances or in any other place operating in a Small and Medium Enterprises' environment with distinct use of chemical products in their everyday business operations, is threatened daily by the immediate and obvious dangers and/or by indirect and long-term effects of the hazardous substances [1]. Addressing these risks, which may sometimes even be life threatening, is crucial and it must be based on a regular schedule of risk assessment. Furthermore, any organization working with potentially hazardous substances should be providing continuous training and education sessions in order to keep the responsibility of its employees stimulated, within a framework of continuous vigilance and control. A dedicated health and safety program can provide a general framework, applicable in each case and lead to appropriate information sources for developing solutions to the possible problems that may arise each time [2].

2. Health and Safety framework

A health and safety framework to safeguard the company and its employees from any chemical hazards, aims to ensure a safe and healthy environment by preventing and addressing the immediate direct and indirect risks that may exist not only in a chemical laboratory, but also in a storage room of canned chemicals for instance in a Micro enterprise environment, by presenting possible ways of dealing with them effectively. It is therefore necessary to create a Health and Safety Guide that will be containing key provisions of the applicable Occupational Safety and Health legislation as well as specific instruction for the Classification, Packaging and Labeling of Dangerous Chemicals and their Mixtures [3]. According to [4] one such health and safety guide it should consider including and address the following variables:

- Buildings and/or laboratory facilities
- Apparatus, instruments, methods
- Circulation of chemicals
- Determining occupational health and control methods suitability of the premises
- Supply of health care materials, installations, instruments and security
- Establish health and safety rules and measures
- Personnel training, "safety technician" inspection and commitment of the management.

The key to the success of an employee in a health and safety program in any SME it is the triptych Training-Inspection-Management as highlighted by [1] The initial and most detrimental step is to train the staff in each business according to the needs underlined by the character of the work, which can be made in many ways, such as supervisory material, written instructions, lectures, seminars, etc. Therefore, the training sessions are followed by the determination of responsibility and acceptance of the personal responsibility of the employees. It is necessary to identify the responsibilities of employers and employees and to define the objectives of each workshop in business. The responsibilities and of both employees and employers, are listed in the Health and Safety Guide of each business operating in the local or international market [5]. As [6] argues the employers are responsible for the following tasks:

- Ensuring a safe and healthy environment by reducing, preventing, avoiding and controlling identified risks in chemical hazards
- The safety and hygiene of their employees
- Continuous training and information on safe in small and medium enterprises, including chemical hazards practices
- Employee health monitoring program

On the other hand, [7] are making a remark of the responsibilities of the employees, such as (i) the compliance with hygiene and safety rules, (ii) protecting the health of themselves and their colleagues, and (iii) not making use of substances and machinery without knowing their function.

In many cases, usually in the production sector, the above rules are not enough, as there must be inspected by the management of the of the production area or by a specific individual employee - the "Safety Technician". The latter controls the application of the various rules, the suitability or preservation of materials and facilities, and, finally, gives

instructions for compliance or improvement of the condition of the laboratory. Consequently, it can be said that businesses environment using chemicals, i.e. dry-cleaners, service areas, paint production companies, any laboratories using hazardous substances etc. should always consider the adoption of a health and safety system as a necessity due to the existence of the many risks involved in their day-to-day delivery of services. The proper design and development of such a system is based on both management and employees, working together and taking responsibility. Each of the Micro enterprises using chemicals should develop a philosophy and a culture towards safe use and management of these substances, while each and every stakeholder should realize that almost any accident can be avoided if there is attention as well as appropriate and valid action by each employee and management. Be working with a culture of prevention, the owner/manager of the Micro firm must ensure proper operation of the health and safety system the company has in place.

3. How to handle and use chemicals safely

The proper handling and use of chemicals, is intended to reduce the risk for employees' work-related accidents. All employees should be aware of both the dangers they are likely to face and the pitfalls of substances that use something that can only be done through proper training [5].Before using any chemical substance, all employees must be well aware of its characteristics, its functions and its proper usage. Safety data sheets are a very good source of information along with substance labels and related literature, in case it is needed for further information. In any case, the employees need to be aware of the following points, as most of these are to be found in the safety instructions given to the company during the purchase of the chemicals products to be used:

- The percentage of chemicals that are dangerous or toxic, the maximum permitted exposure to these substances and the lethal dose of any toxicant
- How the chemical penetrates the human body (ingestion, inhalation, injection, skin contact)
- The type of risk they face (erosion, eruption, inflammation, irritation, toxicity)
- The way the substance affects the human body
- Symptoms appear after employees' exposure in large quantities
- Symptoms appear after repeated exposure to
- Cancer challenge to be developed
- Causing abnormalities during pregnancy
- The physical properties of the substance (solid, liquid, gas, explosive, etc.)
- The chemical compatibility of the substances
- Education and Laboratory Practices
- Standard operating procedures should be developed after the start of each job with a chemical describing all steps to protect the employee and reduce the risk.
- Suggested laboratory practices in small and medium enterprises
- Scanners, which are an effective means of controlling it exposure to hazardous substances. The laboratory supervisor must train staff in the use and operation of the leads to prevent infections and possible accidents.
- Personal protective equipment

3.1 REACH regulation

The majority, if not all, of the above information and/or safety instructions are available on the labels and the packaging of any chemical material that is being sold legally, internationally and is based and follows the international safety standards. A very helpful tool towards the safe use of chemical by any company has been established and implemented by the European Union since June 1st, 2007. This tool goes by the name REACH that stand for the words Registration, Evaluation, Authorization and Restriction of Chemicals. As stated by the European Chemicals Agency (ECHA) REACH does not only apply to all chemical substances from cleaning products and paints to substances used in the production of clothes, electrical appliances and/or furniture and to the heavy industry, but it works towards safeguarding the safety burden in every company, no matter its size. How is this being succeeded? Every Micro firm, SME or large-scale company that is using any kind of chemical substance within the EU is obliged to abide by REACH regulation. By doing so, the companies they have to identify the potential risks and the safe management from the chemicals they are using, to introduce these to ECHA and, in addition to that to forward these practices to the users of these chemical products (www.echa.europa.eu). According to [8] SMEs are provided with a great variety of sources of support to comply with REACH, from national helpdesks in charge for REACH to guidance and assistance offered by ECHA and the EU Commission. However, many smaller firms, usually the Micro enterprises, do not consider themselves as "involved" in the chemical industry due to the low quantities of substances they might be using. As a result, these companies might still be unaware of REACH [9]. As [10] underline, for REACH to be effective, more attention is needed to educate EU companies, and especially smaller companies, i.e. Micro-SMEs, at the most basic level for them to understand why and how they fall into this regulation [11].

3.2 Classification of chemical substances

Chemicals are generally classified into similar categories in terms of the action of substances, either on humans or on the environment. This classification is not necessarily based on a similar chemical structure of these products. Directive 67/548 / EEC on the Classification, Packaging and Labeling of Dangerous Substances [12] and analogous Directive 88/379 / EEC on preparations (mixtures of substances) have laid the foundations for a unified understanding of the risks arising from the use of chemicals.According to the regulations on the labeling of substances and preparations, chemicals having a similar action are classified in the same category (flammable, corrosive, irritant etc.) and are characterized by a special mark of their class. The definitions contained in these texts are simple and general and aim to be rapidly classified [4]. Depending on their physical and chemical properties, chemicals are classified into [7]:

1) Explosives
2) Oxidizing substances
3) Flammable substances

4) Highly flammable substances
5) Toxic substances
6) Harmful substances
7) Corrosive substances
8) Irritants

Based on [3] the above-mentioned are analyzed in the following manner:

- ***Explosives:*** Solid, liquid, viscous or gelatinous substances and preparations which react exothermally and with the simultaneous release of gases, even without the presence of atmospheric oxygen, burst into flame and are susceptible to violent and violent reactions. The use of an explosive should be avoided if it can be replaced with another non-explosive. If explosive substances are to be used at all, this should be done in the smallest possible quantities. Explosive containers should be protected from vibration and high temperatures. When explosive solids are used, any form of impact, even abrasion (e.g. when transporting them with a spatula) should be avoided.
- ***Oxidants:***participate in violent exothermic reactions in the presence of other highly flammable chemicals.
- ***Flammable substances:*** have a flash point of 21 – 55oC. Highly flammable substances: have a flash point of less than or equal to 21°C. Substances and preparations which can be heated and eventually ignited in the air at normal temperature without power or solid state, which can be easily ignited after a brief ignition source that effects and still burning or burning after the ignition source is withdrawn in a liquid state, with a very low flash point or in contact with water or liquid air, they emit extremely flammable gases in dangerous quantities.
- ***Toxic substances:*** can cause serious diseases, even death, if they enter the human body by skin, mouth or breathing.
- ***Highly toxic substances:***substances and preparations which inhaled, swallowed or absorbed through the skin even in minimal quantities cause death or acute or chronic damage to health. Almost all chemicals, depending on their amount and concentration, can have a toxic effect. Therefore, they should only be handled inside a fume hood and avoid contact with any chemical compound. As a rule, all chemicals should be treated as potential poisons unless they are known to be completely harmless compounds. The toxic effects of the compounds are characterized as either "immediate" or "chronic". The most well-known poisons, such as hydrocyanine or chlorine, which have a direct toxic effect, are usually treated with due care. However, chronic toxic effects, the effects of which are visible after repeated exposure to the substance even in small amounts, characterize some compounds. One measure of a compound's risk is the TLV (Threshold Limit Value), measured in ppm / m3 or mg / m3. TLV values give the maximum vapor or dust concentration below which the compound can be classified as low risk.
- ***Harmful substances:*** after they penetrate the human body by the skin or breathing, they can cause limited damage to health.
- ***Corrosive substances:*** substances and preparations, which, in contact with living tissues, can destroy them. These can be further distinguished into (i)*liquid corrosive:* a liquid corrosive will act on the skin slowly or rapidly depending on its concentration and duration of exposure. These substances react directly with the skin and dissolve or remove essential constituents, denaturing its proteins and destroying its cells. Organic, inorganic acids and bases are the most common corrosive liquids. Because liquids often produce vapors, their use must be carried out within the extractor, (ii)*solid corrosives:* they react with the components of the skin when dissolved due to moisture on its surface. Because they are solid, these substances are difficult to remove. Also, because they do not react directly with the skin, they cannot be detected and are likely to cause substantial damage before they are detected, and (iii)*corrosive gases:* Pose the greatest risk to human health because they can damage the lungs and lead to even to death. Their use is compulsory within the hoods and their inhalation is prohibited.
- ***Irritants:*** non-corrosive chemicals that cause inflammation when they come into contact with the skin and mucous membranes.
- ***Carcinogens:*** substances and preparations which, inhaled, ingested or absorbed through the skin, can cause cancer or increase its incidence.
- ***Mutants:*** substances and preparations which, inhaled, ingested or absorbed through the skin, can cause hereditary genetic defects or increase their incidence.
- ***Reproductive toxic substances:*** substances and preparations which, inhaled, ingested or absorbed through the skin, may cause or increase the incidence of non-hereditary offspring phenomena, or adversely affect both reproductive functions.

3.3 CLP regulation

A substance may exhibit multiple properties at the same time, multiple characterizations are possible (e.g. flammable and harmful substances accompanied by the corresponding signals. The mark of each category is a square on an orange background with a pattern depicting or symbolizing the action of the group's chemicals. The mark is accompanied by a Latin letter which in some cases is followed by a pointer or + sign. The signals are the first level of information a worker can derive for the action of a chemical [13].

A simple signal is often not enough to convey all the information that is interesting or even necessary to their user. The variety of risks and measures to address them requires more specialized knowledge. This is achieved by standardized risk phrases and standard precautions or safe use actions. The former provides information on the risks stemming from the use of the substance, while the latter refer to measures that are necessary to avoid harming one's health. The phrases are coded and have a number after the letter R (Risk) or S (Safety). For instance, the phrase R 27 means "very toxic to skin contact", the phrase S 37 means "wear suitable gloves" while mixed phrases are possible in each category that combine the individual. For example, R 36/38 means "irritating to eyes and skin" while S 3/7/9 "keep container closed in cool and well-ventilated area" [4].

Proper labeling of reagent packages, the majority of which are chemicals, aims to inform users of the dangers of chemical reagents and safe handling. The European CLP Regulation (1272/2008) on the Classification, Labeling and Packaging of Chemicals and Mixtures came into force on 20

January 2009 [14-15]. It establishes the European Union's new criteria for classification and labeling, based on the United Nations Global Harmonized System (UNGHS) [16].In accordance with the provisions of the CLP Regulation, from 1 December 2010 all chemicals placed on the market must be classified, labeled and packaged in accordance with the CLP criteria. Respectively for mixtures of chemicals placed on the market this is valid from 1 June 2015. Manufacturers and importers of chemicals or mixtures are responsible for identifying the hazards of the substances and mixtures and for their classification. As stated by the European Chemical Agency (www.echa.europa.eu) the chemical reagent labels should provide clearly the following information:

- The name of the main chemical (s) and their identification numbers (CAS, EINECS)
- The name, address and telephone number of the manufacturer or importer in the EU
- Risk Pictogram (s) (Annex B)
- All hazard statements and up to 6 precautionary statements (H - phrases, Annex C) (P - phrases, Annex D) resulting from the classification of the chemical or mixture
- The quantity contained in the container; and
- Other supplementary information

The labels must be written in English as well as in the local language of the country of distribution of the product (and in any other language the manufacturer wishes). A label of a hazardous reagent/mixture contains the names of the major chemicals responsible for the final hazard classification of the mixture. Generally, as highlighted by [17] labels do not contain chemicals that are less than 0.1% by weight unless classified as carcinogenic, mutagenic or toxic to reproduction.

Note:*The Thirteenth Adaptation to Technical Progress to CLP Regulation ATP amends the CLP by adding ECHA's Risk Assessment Committee's latest opinions from 2017 on harmonized classification of more than a few substances. (See: Annex VI). This update was published in October 2018 in the EU Official Journal and it is going enter into force 20 days after its publication, while the changes are going to be applied from 1 May 2020.*

4. Chemical waste

Each Small and Medium Enterprise (SME) that is using and/or producing any chemical substances should have a specific storage space for hazardous waste. This space will have the necessary signs and labels, it will be outside the main premises, yet it shall be easily accessible. All waste should be stored in special barrels and these should be then separated into containers. In the highly unlikely case that a Micro enterprise is producing radioactive waste, this can never be stored together with other types of chemical waste [1].

Chemical waste, as one would find in a garage/service area for instance, is basically of a special type of hazardous waste, both for the environment and for the humans, and is subject to the legislation concerning waste specifying that they must be inactivated and/or disposed of appropriately. Although such waste coming from Micro companies, and also from the SMEs, is usually found in small quantities, it should be collected in special containers and delivered to specific local centers for disposal. The dedicated containers for the collection of chemical waste are typically classified into different categories to avoid mixing inappropriate chemicals and to exclude any potential hazardous reactions between them. In many cases, prior to the collection of waste, some processing by the personnel of the company that used the dangerous substances is necessary [18]. Furthermore, any containers used in the process of the disposal must be suitable for the storage of waste (e.g. resistant to solvents), as well as well sealed. Containers should be stored in a well-ventilated area to avoid the accumulation of dangerous vapors. Waste should not be stored for more than nine months. After the expiry of the storage period they should be destroyed or disposed of in special places [13].

When a company, irrelevant to whether it is a Micro-SME or a larger SME, is using a large variety of chemical products, it should always be following a pattern to be able to separate its waste. A waste separation program may include [19] the following: (a) Separation of halogens from non-halogenated solvents because halogenated solvents are carcinogenic and more difficult to process and they also produce toxic gases when burned, (b) Exclusion of metals from waste solvents, (c) Keeping acetone and dichloromethane away from other solvents.

Another critical point is that disposal vessels should be kept in good condition to prevent leaks. It is also forbidden to use closed containers with cork or paraffin. If a material is placed in an inappropriate container, it must be removed immediately. The size of the container should be appropriate to the amount of material discharged and the material from which it is made compatible with the waste material, e.g. acids or bases should not be disposed of in cans [20]. Lastly, as emphasized by [13]every waste container in the laboratory should have the necessary identification tag, which should be including:

- The phrase "hazardous waste"
- The name and address of the manufacturer
- The date the container started to be used
- The composition and physical state of the waste
- The hazardous properties of waste
- The name must be specific and not generic, and abbreviations are forbidden

5. Discussion

In conclusion, it is easy to understand that all the above might look very difficult for the most Micro enterprises to follow. Reasons for that are many with the most prominent to be focusing on the size of the company and/or on the actual services that they deliver to the customers. The comment that comes from the personnel of many Micro firms, is more often than not that the amount of chemicals we are using daily is negligible and there is no major risk of an accident. As a result, the priorities of the owner/managers and/or the personnel are further away from regular risk assessment and their priorities are further away from an

organized chemical risk management framework. As [6] argued conventional approaches to support the focus of smaller firms on the chemical risks and on the company's compliance to the regulation are likely to fail. On the contrary, more direct approaches, such as training and education, or even sectoral focused actions might help Micro firms achieve better results in the handling and safe use of chemical substances.

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