

**Report
On
Identification and Analysis of Hazardous and Risky Works in
Polyurethane Foam Industries of Nepal**



**Submitted to:
Occupational Safety and Health Centre (OSHC)
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EXECUTIVE SUMMARY

Occupational Safety and Health (OSH) is a discipline with a broad scope involving many specialized fields. In its broadest sense, it should aim at: the promotion and maintenance of the highest degree of physical, mental and social well-being of employees; the prevention among employees of adverse effects on health caused by their working conditions; the protection of employees in their employment from risks resulting from factors adverse to health; the placing and maintenance of employees in an occupational environment adapted to physical and mental needs; and the adaptation of work to humans.

There are unlimited numbers of hazards that can be found in almost any workplace. Polyurethane Foam Industries are the chemical based industries. In Nepal it is small scale industries where OSH management system is very poor in condition. Workers were exposed with hazardous chemicals while handling and processing

The objective of study is to prepare a report on the Identification and Analysis of hazardous and risky works in Polyurethane Foam Industries of Nepal. During the study PU foam industries were visited and conducted the monitoring of most prevalent hazards. Formal data of registered and operated PU Foam industries are not available. Many source claims that 10 PU foam industries are in operation which employ more than 100 direct employees. These industries are located in Kathmandu Valley and Terai region of Nepal. For the study, five PU Foam industries were visited which are located in Kathmandu, Lalitpur and Rupandehi districts. Total 67 workers including 16 women are working in those five industries.

Silicone, Amine, Stannous Octate, Filler, Colour, Polyol, Toluene Diisocyanate, Methylene Chloride and Water are the raw materials and chemicals used in PU foam Industries. Chemical Preparation, Mixing, Foaming, Drying and shaping/sizing are the major process steps for PU foam industries.

Polyurethane foam (PUF) is used as a cushioning material. It's virtually everywhere we turn: in mattresses, seating, and protective panels in vehicles and aircraft; in residential and commercial upholstered furniture; in pillows, apparel padding, air and fluid filtration, office/desk seating, medical braces and restraints; and beneath the carpeting in our homes. Polyurethane Foam industries is a chemical based industries where polymerization of chemicals takes place. Most of the Nepalese Foam industries are using Toluene Diisocyanate (TDI) and Polyol as prime chemicals. TDI is considered as a very hazardous chemical. During the polymerization toxic gases are released where workers get exposed.

Working conditions in the majority of visited polyurethane foams are not satisfactory. Working environment was hazardous and a risk to the health of the workers. It was found unmanaged industries as compared to other industries of Nepal. During the study it was not found any fatal occupational accidents and occupational diseases suffered by workers. The workers are exposed to hazardous chemicals like Toluene Diisocyanate (TDI) and Methylene Chloride.

TDI is a toxic and a very potent sensitizing agent that can enter the body through inhalation, by skin contact or through ingestion. TDI can cause central nervous system

damage but the major risk is the risk of sensitizing of the respiratory system. If once sensitized you shall only be exposed to very few molecules of TDI to react. In worst case the allergic reaction to TDI can be fatal. Methylene Chloride is a toxic chemical that is very fast evaporating. Methylene Chloride can enter the body through inhalation, by absorption through skin and from ingestion. Methylene Chloride causes damage to the central nervous system and is a carcinogen.

Labour Act 2074 and Labour Regulation 2075 are having the all provisions related to safety and health of employees. Compliance of these laws will help industries to protect their workers safety and health and it also enhance their productivity. The study seen toxic gases of TDI and Methylene chloride are major safety and health problem in PU foam industries. Effective local exhaust ventilation and proper gas filter mask will enhance the safety and health of the workers.

LIST OF ABBREVIATION

ACGIH	:	Association Advancing Occupational and Environmental Health
CO ₂	:	Carbon Dioxide
dBA	:	A-weighted Decibels
FPF	:	Flexible polyurethane foam
GDP	:	Gross Domestic Product
HIRA	:	Hazard Identification and Risk Assessment
IEE	:	Initial Environmental Examination
ILO	:	International Labour Organization
ISIC	:	International Standard Industrial Classification
ISO	:	International Organization for Standardization
KW	:	Killo Watt
MDA	:	Methylenedianiline
MDI	:	Methylene Diphenylisocyanate
Mg/m ³	:	Milligram per Cubic Meter
MOE	:	Margin of Exposure
MSD	:	Musculoskeletal Disorders
MSDS	:	Material Safety Data Sheet
NIOSH	:	National Institute for Occupational Safety and Health
NLFS	:	Nepal Labour Force Survey
OSH	:	Occupational safety and health
OSHA	:	Occupational Safety and Health Administration
OSHC	:	Occupational Safety and Health Center
PELs	:	Permissible Exposure Limit
PFA	:	Polyurethane Foam Association
PPE's	:	Personal Protective Equipments
PU	:	Polyurethane Foam
RELs	:	Recommended Exposure Limit
SDS	:	Safety Data Sheet
SMRs	:	Standardized mortality Ratios
TDA	:	Touline diamine
TDI	:	Touline diisocyanate
TLV	:	Threshold Limit Value
US	:	United States
WDI	:	World Development Indicator

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Chapter – 1

Introduction

1.1 Background

Occupational Safety and Health (OSH) is a discipline with a broad scope involving many specialized fields. In its broadest sense, it should aim at: the promotion and maintenance of the highest degree of physical, mental and social well-being of employees; the prevention among employees of adverse effects on health caused by their working conditions; the protection of employees in their employment from risks resulting from factors averse to health; the placing and maintenance of employees in an occupational environment adapted to physical and mental needs; and the adaptation of work to humans.

Poor OSH condition in industries is reduced the productivity of the employees and increased the risk of accident and diseases. Improvement in OSH practice requires the collaboration and participation of both employer and employees in safety and health program. It is prime to maintain the better OSH condition for the better future of employees and industry and also compliance the national law related to OSH.

Only few Polyurethane (PU) Foam Industries are operated in Nepal. Most of the Polyurethane Foam industries are small scale in Nepal. They produce the flexible polyurethane foam (FPF) using as a cushioning material. It's virtually everywhere we turn: in mattresses, seating, and protective panels in vehicles and aircraft; in residential and commercial upholstered furniture; in pillows, apparel padding, air and fluid filtration, office/desk seating, medical braces and restraints; and beneath the carpeting in our homes. It comfortably restrains, supports, and relieves pressure for wheelchair users; allows prostheses to breathe; and provides a medium for collection and absorption in hospitals, laboratories, and testing instruments.

Formal data of registered and operated PU Foam industries are not available. Many source claims that 10 PU foam industries are in operation which employ the more than 100 direct employees. These industries are located in Kathmandu Valley and Terai region of Nepal.

Polyurethane Foam industries is a chemical based industries where polymerization of chemicals taking place. Most of the Nepalese Foam industries are using Toluene Diisocyanate (TDI) and Polyol as a prime chemicals. TDI considered as a very hazardous chemicals. During the polymerization toxic gases is released where workers get exposed. Nepalese Perspectives on Manufacturing

1.2 Occupational Hazards

There are unlimited numbers of hazards that can be found in almost any workplace. There are obvious unsafe working conditions, such as unguarded machinery, slippery floors or inadequate fire precautions, but there are also a number of categories of insidious hazards (that is, those hazards that are dangerous but which may not be obvious) including:

- physical hazards, such as noise, vibration, illumination, radiation, electricity and extreme temperatures;

- chemical hazards, arising from liquids, solids, dusts, fumes, vapours and gases;
- biological hazards, such as bacteria, viruses, infectious waste and infestations;
- psychological hazards resulting from stress and strain;
- physiological and Mechanical hazards associated with the non-application of ergonomic principles, for example badly designed machinery, mechanical devices and tools used by workers, improper seating and workstation design, or poorly designed work practices.

Most of the workers in Nepal exposed a combination of these hazards at work. For example, it is not difficult to imagine a workplace where one exposed to chemicals, unguarded and noisy machines, hot temperatures, slippery floors, etc. all at the same time.

1.3 Occupational Safety and Health in Nepal

Occupational Safety and Health (OSH) is a cross-disciplinary area concerned with protecting the safety, health and welfare of people engaged in work or employment. The goal of all occupational safety and health programs is directed in fostering a safe work environment. OSH determines vulnerabilities and provides mitigating and adoptive measures to overcome any work related adversities. It analyses problems through surveillance in determining hazards, conditions of work, and exposure of workers.

The tools of OSH assess the health of workers and takes measures to reduce vulnerability of hazards and risk which can cause health impairment. It also dictates on preventive and control measures to prevent unnecessary exposure during normal operating conditions. It also includes emergency preparedness and continues on in case of possible accidents and emergencies. OSH strengthens health education, health promotion, and promotion of work ability through disseminating Information on identified workplace health hazards.

The concept of OSH in Nepal is in its initial stage. The notion of OSH in Nepal has not been able to educate about its principle and ideologies at all level. The OSH sector in Nepal has three major identified sectors,

- government,
- the industries/ employers and
- the work force/labor unions.

The government of Nepal has enforced concepts of OSH through its Labor Act 2074; it is well covered the almost issues of OSH. Nepal has already endorsed 9 conventions passed by ILO but has not yet ratified convention No. 155 which solely bears OSH obligations. The industries bearing obligation to providing safe working conditions by practicing OSH have an easy exit mechanism.

The major façade to installing concept of OSH in Nepal lies in inability of concerned stakeholders to grasp the utility and importance of occupational health services. The major impediments in enforcing effective OSH practices in Nepal are as follows:

- Need of separate laws on OSH
- Fully implementation of Labour Act 2074 and Labour Regulation 2075
- Compliance of Noise and Illumination level standard
- Isolation and overlooking of OSH issues by formal and informal sectors
- Necessity to build the capacity of State, employers and workers on OSH Needs

Any practice needs a valid and justifiable legal support for its effective enforcement and implementation. Nepal has yet to ratify various international declarations and protocols under OSH chiefly ILO convention 155. Absence of firm legal grounds, acts and policies have always produced mayhem, so is the case of OSH in Nepal. There is an immediate need for enacting OSH specific legal tools. The other strategic needs are as follows:

- Effective legal tools and their enforcements
- Formation of apex government body specifically for OSH
- Dialogue, interactions and brainstorming sessions for policy formulation and necessary amendments
- Training, capacity building and skill transfer
- Detailed studies and publications on OSH in Nepal

National data of occupational accident and diseases is not properly available. Due to lack of database and information regarding occupational accident and diseases actual cause and effects cannot explain. In the all related law, rules, regulation treated the all industries through single eye either they are hazardous and risky in nature or not. So, no any special criteria developed to define the industries hazardous or others.

Internationally recognized some occupational diseases also may found in Nepal but lacks of proper research and confirmation not easy to say in this sector. But in the context of occupational accident some news and information can be got from news media and concern agencies and based on this, we can say that particular sector is an accident prone industrial sector.

Ministry of Labour, Employment and Social Security, Department of Labour and Occupational Safety and Occupational Safety and Health Center are the responsible agencies of the government with regards to OSH in Nepal. However, promotional as well as enforcement aspects are found to be very weak in Nepal.

1.4 Objective of Study

The main objective of study is to prepare a report on the Identification and Analysis of hazardous and risky works in Polyurethane Foam Industries of Nepal. The specific objectives of the study were as:

- To identify the hazards in PU foam industries.

- To analyze the risk associated with these hazards.
- To determine appropriate methods to eliminate or minimized these hazards.

1.5 Scope of the Works

The scope of the work was as follows:

1. Collection of related report and literatures, standards and publications from concerned organization / agencies.
2. Visit five Polyurethane Foam Industries to collect primary data of physical, chemical and mechanical Hazards. Samples data should be collected from workplace of Polyurethane Foam Industries of Kathmandu Valley, Parsa, Bara and Rupandehi District by using monitoring equipment's.
3. Collection of all available secondary information and data.
4. Analyze the primary and secondary data
5. Preparation of draft report with recommendations (how to eliminate these hazards or if not possible to eliminate these hazards how to minimize these hazards and submission to Occupational Safety and Health Center (OSHC) for comments and feedback.
6. Incorporation of relevant comments, suggestion and feedback given by OSHC meeting and finalize the report.

1.6 Méthodology

The methodologies adopted for the preparation of the report areas follow:

- The report is based on the primary and secondary information.
- International norms and expert opinion is considered for the studies.
- Books, publications, reports, literature and internet sites will be used for the description of the sector and Nepalese context.
- Primary data were collected by site visit and measurement with equipment's.
 - Dust: Exposure of dust was monitored by using Personal Sampler. Cyclone based filter holder and pre weighted glass fiber filter used. Duration of sampling and flow rate were recorded. After monitoring samples safely transported to laboratory. Gravimetric Methods used for the determination of dust in mg/m^3 .
 - Noise: Noise Level was monitored with the help of automatic Noise Data Logger. The data logger calibrated before taking measurement by using of master calibrator made by Bruel and Kjaer.
 - Light: Light Level was measured with the help of Lux Meter and correction factor applied as per the source of light.
 - Mechanical: by walkthrough and checklist survey.
- Prepared and submitted the draft report to the OSHC for comments and feedback.
- The comments and suggestions from OSHC were studied and relevant comments and suggestions incorporated to finalize the report.

Chapter - 2

Literature Review

Polyurethane Foam industries is a chemical based industries where polymerization of chemicals taking place. Most of the Nepalese Foam industries are using Toulene Diisocyanate (TDI) and Polyol as a prime chemicals. TDI considered as a very hazardous chemicals. During the polymerization toxic gases is released where workers get exposed. National and international literature reviewed and presented below:

2.1 Health Risk in PU Foam Industry

Methylene diphenylisocyanate (MDI) and toluene diisocyanate (TDI) are widely used in industry to produce polyurethane foam products. Small amounts of methylenedianiline (MDA) and toluene diamine (TDA) are released during MDI and TDI polymerization and may be present in newly finished polyurethane foam parts. MDA and TDA concentrations in foam decline exponentially within several hours of demolding. MDA and the 2,4-isomer of TDA are known animal carcinogens and, in addition, have significant non-carcinogenic health effects. Our goal was to determine whether worker exposure to MDA or TDA in freshly produced polyurethane foams was associated with unacceptable health risks. Sampling and analysis of the fresh foam indicated that MDA and TDA concentrations varied considerably among products, but concentrations in all materials evaluated declined rapidly over time. We found that, under a worst-case exposure scenario, cancer risks from TDA exposure were approximately 5×10^{-6} , whereas cancer risks from MDA exposure resulted in a tumorigenic margin of exposure (MOE) of 85 000. Non-cancer chronic hazard indices were well below 1.0. Therefore, the potential cancer and non-cancer health risks from MDA or TDA exposure to newly manufactured foam parts appear to fall well within acceptable health risk criteria.

More than 12 million Americans, or 9 percent of the workforce, are employed directly in manufacturing. According to the Bureau of Economic Analysis, manufacturers in the United States perform more than three-quarters of all private-sector research and development and drive more innovation than any other sector. One place innovation is increasingly relevant is in the safe handling of hazardous substances that are often required in the manufacturing process.

One such chemical is Toluene Diisocyanate (TDI), a known respiratory sensitizer and a necessary raw material for the production of many types of flexible polyurethane foam. For some workers, exposure to even small amounts of TDI could result in occupational asthma, and a worker who develops this condition may not be able to tolerate further exposure to even safe levels of isocyanates, either at work or at home.

Essentially all of the TDI used as a raw material is consumed during the chemical reaction that occurs in the foam-making manufacturing process, so there is no risk of exposure in the finished product. This case study focuses on TDI in an unreacted, raw material form and the effectiveness of the industry's methods for safe handling and exposure reduction. The flexible foam industry's practices may provide guidance for other industries that handle similar hazardous raw materials.

For more than half a century, the flexible polyurethane foam industry has prioritized worker safety and developed mechanical systems and workplace procedures that help to manage TDI handling in accordance with best practice standards at every stage of the receiving, storage, and manufacturing process.

The industry's trade group, the Polyurethane Foam Association (PFA), has facilitated industry-wide information sharing about state-of-the-art technology and processing innovations. Its foam manufacturing members boast an admirable safety track record

2.2 Cancer Morbidity of workers in the PU Foam industry

Mortality and Cancer morbidity of production workers in the United Kingdom flexible polyurethane foam industry; Tom Sorahan, Debbie Pope; British Journal of Industrial Medicine 1993;50:528-536

Many of the factories that participated in the survey only began the manufacture of polyurethane foam in the 1970s, and the study was designed to supply more useful information in later analyses. The definition of the database is complex, in that for each factory there are different calendar year ranges for the survivor population and the entry cohort. Findings for the entry cohort are simpler to interpret, and in future analyses, more weight can be given to the findings for this sub cohort.

No deaths (from any cause) occurred in female employees with any period of higher or lower exposure to diisocyanates, and it follows that this analysis is not capable of providing any evidence that these exposures played a part in the cancer excesses found in the SMR analysis. Other occupational exposures were also investigated, and although the numbers of cases were small for useful statistical analysis, findings were unexceptional. Furthermore, the distribution of the excesses of cancer by period from first employment suggested strongly that occupational factors in the industry were not important.

Some data on smoking habits were available from the United Kingdom longitudinal study of respiratory effects among workers in this industry.

2.3 A Case Study in PU Foam Industry

TDI sensitization is a respiratory illness having symptoms within the broader category of occupational asthma. Because diagnosing TDI sensitization can be challenging, PFA looked at the industry's history of cases of broader and more easily diagnosed occupational asthma. Through survey techniques, PFA developed a database noting the number of incidences of self-reported and medically diagnosed occupational asthma among foam manufacturing facilities. The occupational asthma database covers a period of 24 years, from 1988 to 2011.

The survey provided historical data for more than 1,300 production-area workers in facilities that collectively produced more than 90 percent of the country's flexible polyurethane foam.

The combined results, reported in a scientific poster and paper entitled "A Survey of the Incidence of Occupational Asthma among Flexible Polyurethane Foam Slabstock

Plants," confirmed that incidences of occupational asthma among flexible polyurethane foam workers in the United States were rare. Self-reported cases represented approximately 1 percent of current production workers and a maximum of 2 percent of workers during the 24-year period. The incidence of medically confirmed cases was even lower, with only six cases of occupational asthma reported among the responding plants during the most recent survey period from 2008-2011. The results become more compelling when compared with the 10 percent incidence rate of asthma among the general adult U.S. population as estimated by the Centers for Disease Control and Prevention.

Thanks to an industry-wide focus on workplace safety in receiving, storing, and handling; medical monitoring, and continuous safety training programs, workers in the flexible polyurethane foam industry maintain a much lower rate of asthma than the general population. As PFA's Luedeka said, "That's a track record we are very proud of, and one which everyone in this industry is hardwired to work at maintaining each and every day."

2.4 Provisions of Safety and Health in National Legislation:

The Labour Act 2074 and Labour Regulation 2075 have covered the Occupational Safety and Health mandatory provisions. All the industry should comply the mandatory provisions to reduce the rate of accident and prevent the occupational diseases.

Formulation of safety and health policy:

It is mandatory under the law that every employer shall formulate a policy on safety and health of the workers and other persons in the workplace. The Policy should be reviewed every year by occupational safety and health committee of the enterprise. The policy should be registered in the labour office and it is the duty of office to monitor it periodically to implement it. It is also mandatory to do self-assessment through audit system under this legislation.

Formation of Safety and Health Committee

Every enterprise having 20 or more workers shall constitute a Safety and Health Committee comprising of representatives of the worker and management. The twenty numbers of workers shall include both the workers employed by the concerned employer.

Prohibited to take any disciplinary action

No employer shall initiate any disciplinary action against any worker for providing any information related to OSH to the Labour Office or assisting to do so or for filing a complaint against employer. Similarly, employer should not take any action in case of stopping the work due to immediate danger on the safety and health of the workers and perform as a member of OSH Committee.

Duties of Employers towards Workers

The Act clearly mentioned about the Duties of employers towards the workers in respect of OSH. These duties are as follows:

- To provide appropriate and safe environment for the workers in the workplace,

- To make sure that there shall be no adverse effect to the health and safety of workers during use, operation, storage and transportation of chemical, physical and other materials,
- To provide necessary information, notice or training on OSH matter to the workers including use or operation of the equipment or material in an appropriate language worker understands.
- To keep workplace safe and secure from any probable danger or emergency situation by providing entrance and exit facility to / from workplace.
- To provide personal protection equipment without any cost to the workers

Responsibilities of Employer towards Non-workers

- Every employer must arrange for the safety and health of every person who walks in and out of the workplace or passes through such workplace.
- In case there is a possibility of having an adverse effect on the safety and health of any person by the operating system of the enterprise, the employer must make an arrangement for giving timely indication or necessary information in that respect.
- It is the duty of employer that she/he manage properly chemical substance or gas or fume and other matter should not affect adversely against any person or environment in general.

Duties of the responsible person for the workplace

- It shall be the duty of the responsible person controlling any workplace or equipment or material to ensure that such place, equipment, or material is safe for the concerned work and is not averse to the health of the workers.
- To determine the responsible person of the enterprises, the person having the ownership or control over the workplace or equipment or material. The word also denotes to the person by an agreement, having ownership or control over it.

Duties of manufacturers, importers, and suppliers

Following shall be the duties of manufacturers, importers, and suppliers of equipment or material used in the workplace:

- Determine suitable way of using or operating any equipment or material without affecting the safety and health of the workers adversely.
- Conduct research, test or to examine the possibility of identifying the risk from the use of such equipment or material or the adverse effect it may have on the safety and health of the workers or the possibility of minimizing or eliminating such risk.
- Provide information in relation to the purpose, use and operation of any equipment or material, the ways of minimizing their adverse effect on the safety and health of the workers and also the suitable method of using any material for the safety and health of the workers.
- The person who manufactures or installs any equipment must ensure that such equipment manufactured or installed for the use of the workplace, if used properly, will not be harmful to the safety and health of the workers.
- If it is found that the equipment or material is not used in accordance with the relevant information or instruction provided by the manufacturer or supplier in relation to their use, such equipment or material, for the purpose of this section, shall be considered to have been used inappropriately.
- The manufacturer, importer or supplier of any chemical substance to be used in the workplace must have material or Chemical Safety Data Sheet related to such chemical substance including other details as prescribed.

Duties of workers

Duties of workers in relation to occupational safety and health shall be as follows:

- A worker must not work carelessly or intentionally whereby the risk of adversely affecting the health of others or his/her own health
- A worker must provide necessary cooperation to the employer or any other person for the fulfillment of the obligations mentioned in the law.
- A worker must operate and use the workplace, equipment or material safely and carefully as per the instructions given.
- Obtain the information in relation to his or her work and use of chemical, material and equipment.
- Use personal safety equipment as provided by employer, violation of which shall be punishable under disciplinary action.

Stoppage of work in case of immediate danger

- Where there is a reasonable ground to believe that if a particular work is not stopped, it may injure any worker or any person or cause risk or may have harmful effect on the health of the workers or may damage any equipment, the worker involved in such work shall inform of the same to the employer or responsible person.
- The concerned worker may halt the work if the employer is not available and inform them as soon as possible.
- Upon receipt of the information the employer shall investigate the matter and accordingly make a suitable safety arrangement to avoid such risk and direct the workers to continue the work if it is possible to do so.
- The employer, subject to the scope of employment contract, may engage the workers in any other risk-free work during the stoppage of work.

Direction to stop the work by Labour Office:

- During the inspection or information received through any other source, the Labor Office may order to stop work in case it is believes that an immediate danger or risk has arisen in a workplace.
- The Office must disclose the causes and basis of such risk while issuing the direction to the employer.
- The Labour Office may issue an order prohibiting the use of such equipment and work place or any part of it may be sealed so that it is not used.

Notice relating to accidents

If any accident takes place in the workplace or any worker or person dies because of the accident or is injured or suffers from occupational disease, the employer must inform the Labour Office immediately.

Provisions related to prevention of communicable diseases

- The employer must make necessary arrangement to prevent communicable disease in the workplace.
- Any worker suffering from any communicable disease may be prohibited from attending the work during the period of medical treatment.
- In case the sick leave is not sufficient for the medical treatment, such worker must be granted additional leave till the period of treatment.
- It is duty of concern worker stay in leave during the treatment period.

Easier work for pregnant worker

- In case any female worker is pregnant, the employer must be informed about it.
- After receiving information, normally, such pregnant worker must not be engaged in the work that adversely affects her pregnancy.

Special provisions related to medical treatment for occupational disease

- In case any worker contracts any occupational disease while working in any enterprise, the medical expense as prescribed or in case if the worker is incapable of working as a result of such disease, the compensation for that must be borne by such enterprise where the worker worked and contracted the disease.
- The establishment shall not be required to bear the medical expense or compensation if the medical expense or compensation as is to be borne by Social Security Fund.

Office may issue directions

- The Office shall conduct a sudden or periodic inspection in order to verify whether the employer has made any arrangement or not in relation to the safety and health of the workers required by the Act or the existing law.
- During the inspection of workplace, if it is found that the employer has failed to arrange appropriately, the office shall provide time frame with a direction to make required arrangement to the employer.
- However, if there is a possibility of immediate danger to the safety and health of the workers or other persons in absence of such arrangement, the Office may issue an order to make such arrangement immediately stating the reasons for the same.

Special Provision relating to some of the establishment:

The concern establishment should arrange safety in accordance with the standard as prescribed in case they are operating following business:

- Protection of eye
- Protection from chemical substance
- Process of operation of pressure plant
- Protection of machine
- Weight lifting standard
- Other related matter

Punishment

In case any person carelessly or intentionally violates the provisions of the Act or the Rules made hereunder in respect to safety and health of the workers and as a result of which any person dies or is incapacitated or injured, the person responsible for such act, the punishment in accordance to the existing law, and if such punishment is not mentioned in any law, the person shall be punished with an imprisonment of up to two years including recovery of compensation to the victim. In case, any establishment is doing such crime, the imprisonment in normally imposed to the responsible person or such person is not identified, the chief executive office shall be sent to the jail and fine and compensation shall be recovered by the establishment.

Chapter - 3

PU Foam Industries in Nepal

Most of the Polyurethane Foam industries are small scale in Nepal. They produce the flexible polyurethane foam (FPF) using as a cushioning material. It's virtually everywhere we turn: in mattresses, seating, and protective panels in vehicles and aircraft; in residential and commercial upholstered furniture; in pillows, apparel padding, air and fluid filtration, office/desk seating, medical braces and restraints; and beneath the carpeting in our homes. It comfortably restrains, supports, and relieves pressure for wheelchair users; allows prostheses to breathe; and provides a medium for collection and absorption in hospitals, laboratories, and testing instruments. FPF protects delicate objects during shipping and helps ink flow in printer cartridges.

Polyurethane (PU) foam began in 1954 using toluene diisocyanate (*TDI*) and polyester polyols. These materials used to produce rigid foams, gum rubber, and *elastomers*. The Polyurethane Foam Mattress is becoming very famous use to sleep. Soft hardness PU foam is only producing in Nepal. Hard foam still imported from other countries. The market of Foam is increasing in day by day. It is mainly for the sleeping mattress, furniture's, cushion, pillow and many more.

3.1 Number of Industries and Labour Structure

Formal data of registered and operated PU Foam industries are not available. Many source claims that 10 PU foam industries are in operation which employees the more than 100 direct employees. These industries are located in Kathmandu Valley and Terai region of Nepal.

Raw Materials and Chemical Used

Silicone, Amine, Stannous Octate, Filler, Colour, Polyol, Toluene Diisocyanate, Methylene Chloride and Water

Hazardous Chemicals

Toluene Diisocyanate (TDI) and Methylene Chloride

3.2 Manufacturing Process

The following steps needed to manufactures the PU foam:

Chemical Preparation

The temperature of Toluene Diisocyanate and Polyol is maintained between 16°C and 23°C in closed room. The temperature of the chemicals is maintained with the help of ice blocks and 1.5 ton of air conditioner, which runs for 24 hours in the summer. The temperature in the winter is maintained with the help of 2000 KW heaters. The gaseous emission in the chemical preparation room is significantly high.

Mixing

After obtaining the optimum temperature of both the chemicals, required quantity of chemicals are weighed and mixed with water in a mixing vessel except TDI. The premix is stirred for 10 to 15 seconds. TDI is added to the premix and once again stirred for 3-5 seconds and poured instantaneously in the foaming box. Because

mixing is done in an open vessel, apart from fumes and gaseous emission, there is also a chance of careless spillage which results in raw material wastage.

Foaming

Within 60 seconds PU Foam block is ready. At the end of the process fumes of the chemicals are emitted.

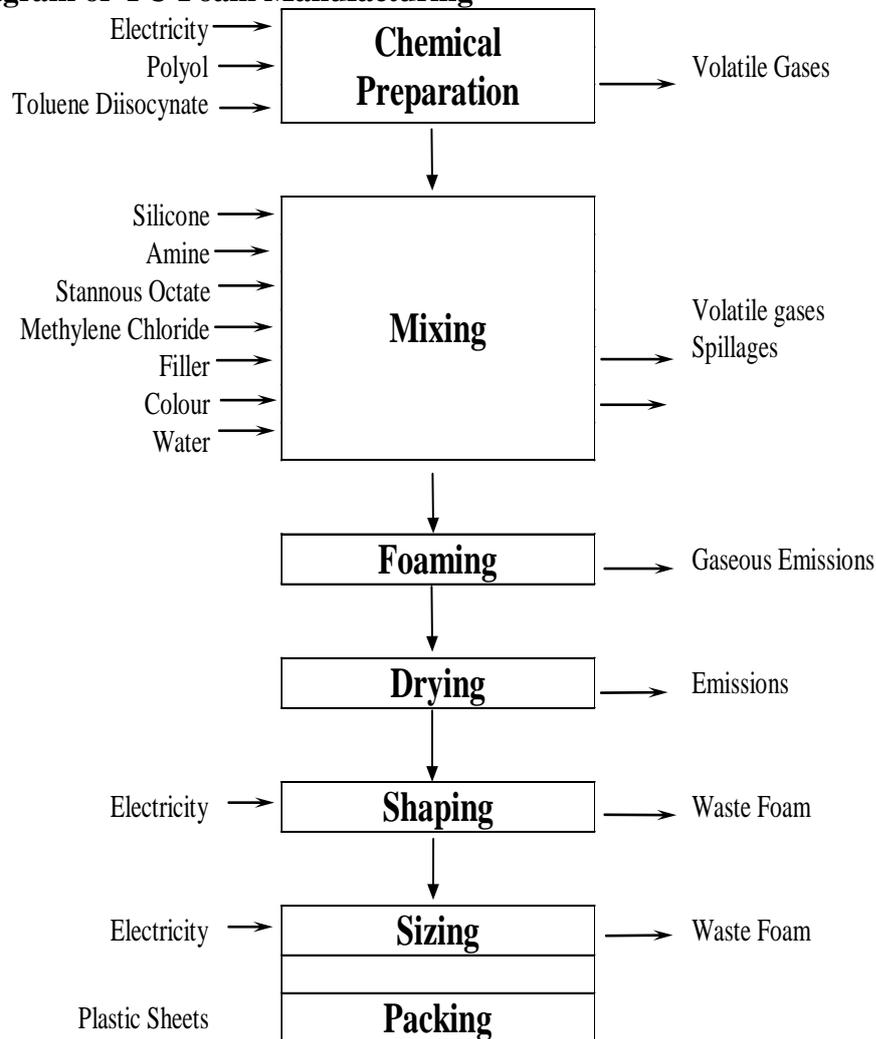
Drying

PU Foam block is left for at least 12 hours for natural drying.

Shaping and Sizing

Dried foams are cut to the required size to make mattresses, cushions and pillows.

Flow Diagram of PU Foam Manufacturing



Chapter – 4

Status of Visited PU Foam Industries

4.1 Visited Polyurethane Foam industries

For the study, five PU Foam industries were visited which are located in Kathmandu, Lalitpur and Rupandehi districts. Total 67 workers including 16 women are working in those five industries.

Table 1: Number of workers in visited foam industries

SN	Name of industries	Location	Number of Workers		
			M	F	Total
1	Allied Foam industries	Patan, Lalitpur	10	2	12
2	Changjiang Grand Sponge Pvt. Ltd.	Nagarjun Municipality-2, Kathmandu	8	4	12
3	Everest Foam industries	Patan, Lalitpur	15	4	19
4	Lumbini Foam Udhog	Padsari-4, Bhairahawa	14	7	21
5	Siddhartha Foam Industries	Udyogpuri-4, Bhairahawa	12	3	15
Total			59	20	79

Being a chemical based industries exposure of various chemicals are the major hazard present in PU foam industries. During the polymerization higher concentration of toxic gases is releases. All the foam industries are batch wise making industries. So every batch there is lots of toxic gas of TDI releasing for few minutes. TDI is a toxic and a very potent sensitizing agent that can enter the body through inhalation, by skin contact or through ingestion. TDI can cause central nervous system damage but the major risk is the risk of sensitizing of the respiratory system.

Methylene Chloride is also using in this industries. It is a toxic chemical and very fast evaporating by nature. Methylene Chloride can enter the body through inhalation, by absorption through skin and from ingestion. Methylene Chloride causes damage to the central nervous system and is a carcinogen.

4.2 Observation and Findings

During the visit of five PU foam Industries the following observations and findings were analyzed:

4.2.1 Safety:

The following common causes of accident found in visited industries:

- Previous record of accident was not found in visited industries, so trend of accident and risky job not analyzed.
- Risk of accident was found due to wearing slipper by all employees even in wet and slippery floors.
- Risk of injury due to manual handling and lifting in store, maintenance.
- Risk of Fire analyzed due to highly combustible foam stored.

- Proper and Suitable Fire Extinguishers were not found available at right place. Fire prevention and emergency response procedures were not adopted.
- Risk of fire was found in electrical lines and its extension because electrical line drawing and maximum draw able ampere not tagged.

4.2.2 Chemical Hazards

The following Chemical Hazards were found:

- Exposure of toxic TDI based gases during and after polymerization. Effective ventilation and gases purification system not available.
- During the handling of solid amorphous chemicals dust exposure observed. Only few industries workers were found working with wearing of dust filter mask.
- MSDS and SDS were not available. Without SDS cannot know and analyze the risk of particular chemicals.

4.2.3 Dust Monitoring

Solid chemical handling and foam cutting process generated the dust. The concentration of dust is very low. No any evidence of occupational diseases seen in visited industries. The following dust level was found in visited industries:

Table 2: Dust level in visited PU Foam industries

Location	Respirable Dust level in mg/m ³					
	1	2	3	4	5	Avg.
Chemical Handling	0.2	0.12	0.11	0.5	0.3	0.246
Foam Cutting	0.15	0.13	0.17	0.21	0.19	0.17

4.2.4 Gases Exposure

During mixing and polymerization (Foaming) process toxic gases were released in very higher concentration. The visited industries are a batch making industry to in every batch completed in 20 to 30 minutes. Premix chemicals stirred for 2 to 3 second and immediately manually poured in foam chamber. Within 60 seconds foam is getting their full shape. During these all steps fumes of TDI, Methylene chloride and Hydrogen cyanide gas generated. After few minutes of batches concentration of fumes and gases diluted. During the each foaming process workers were exposed with these hazards which have potential health effects.



Workers also feeling severe burns in eyes while doing the process. Workers were not found having any personal protecting equipment's. Ventilation system was available in industry but enough to prevent to health hazards.

Table 3: Exposure of Gases

OHS issues	Location/Areas	Measured Value	PEL, Nepal
Fumes and Gases	Foaming	Not Measured but found very irritating	Not Recommended

4.2.5 Physical hazards

Illumination and Noise level were measured in visited industries.

Table 4: Light Measurement

SN	Names of PU foam industries	Location	Illumination (in lux) in different measurement locations					
			Cutting area		Production area		Office area	
			Min	Max	Min	Max	Min	Max
1	Allied Foam industries	Patan, Lalitpur	52	115	69	148	125	265
2	Everest Foam industries	Patan, Lalitpur	57	130	85	157	145	280
3	Lumbini Foam Udyog	Padsari-4, Bhairahawa	63	118	90	167	134	276
4	Siddhartha Foam Industries	Udyogpuri-4, Bhairahawa	58	125	60	85	141	250
5	Changjiang Grand Sponge Pvt. Ltd.	Nagarjun Municipality-2, Kathmandu	76	190	90	110	70	120

Noise level is within Prescribed 90 dBA for 8 hrs per day. Noise generating source was not available in these industries.

Table 5: Noise Level Measurement

SN	Names of PU foam industries	Location	Leq values (in dBA) in different locations	
			Cutting area	Production area
1	Allied Foam industries	Patan, Lalitpur	61.3	59
2	Everest Foam industries	Patan, Lalitpur	67	58
3	Lumbini Foam Udyog	Padsari-4, Bhairahawa	62	57
4	Siddhartha Foam Industries	Udyogpuri-4, Bhairahawa	58	60
5	Changjiang Grand Sponge Pvt. Ltd.	Nagarjun Municipality-2, Kathmandu	63.2	60.1

4.2.6 Mechanical hazards

Cutting, boring, shaping and forming are the mechanical based process in these industries. Risk of accident was very low in these industries. Although various machines where power transmission taking place like flywheels, belts, pulleys, couplings, connecting rods, chains and gears so, any ignorance may have potential of accident. There is no use of unguarded belt drive in foam industries.

4.2.7 Ergonomics/Working Posture

- No any proper sitting facility available in factory where workers can take rest.

- Required light level is very essential for better ergonomics. Measured light level not found as required in all industries.
- Ergonomic survey not ever done.
- Most of the employees complain Musculoskeletal Disorder (MSD).

4.2.8 Health and safety

Polyurethane polymer is a combustible solid and can be ignited if exposed to an open flame. Decomposition from fire can produce significant amounts of carbon monoxide and hydrogen cyanide, in addition to nitrogen oxides, isocyanates, and other toxic products. Because of the flammability of the material, it has to be treated with flame retardants (at least in case of furniture), almost all of which are considered harmful.

Liquid resin blends and isocyanates may contain hazardous or regulated components. Isocyanates are known skin and respiratory sensitizers. Additionally, amines, glycols, and phosphate present in spray polyurethane foams present risks.

Exposure to chemicals that may be emitted during or after application of polyurethane spray foam (such as isocyanates) are harmful to human health and therefore special precautions are required during and after this process.

4.2.9 Occupational Health

- Employees' health monitoring was not conducted
- Personal Hygiene of the workers was not found in excellent condition.
- First aid kit, eyes fountain and shower were not installed in all industries.

4.2.10 Personal Protecting Equipment's (PPE's)

- Gas mask is needed for mixing and foaming process but not available in industries.
- Safety gloves and goggles needed for workers who handling the chemicals but not available in any industries.

4.2.11 OSH Management

- OSH management system i.e. ISO 45001 not adopted.
- Safety responsible person /department /team not designated.



Figure 1: Foam Manufacturing Industry

Chapter - 5

Result and Discussion

Working conditions in the majority of visited polyurethane foams are not satisfactory. Working environment was hazardous and risk to health of the workers. It was found unmanaged industries as compared to other industries of Nepal. During the study it was not found any fatal occupational accidents and occupational diseases suffered workers. The workers are exposed to hazardous chemicals like Toulene Diisocynate (TDI) and Methylene Chloride.

Exposure of chemicals vapours are the main occupational hazards in this industries. Effective ventilation and control system not seen in industries. There is a heavy exposure to the chemicals in visited industries. TDI is a toxic and a very potent sensitizing agent that can enter the body through inhalation, by skin contact or through ingestion. TDI can cause central nervous system damage but the major risk is the risk of sensitizing of the respiratory system. If once sensitized you shall only be exposed to very few molecules of TDI to react. In worst case the allergic reaction to TDI can be fatal.

Methylene Chloride is a toxic chemical that is very fast evaporating. Methylene Chloride can enter the body through inhalation, by absorption through skin and from ingestion. Methylene Chloride causes damage to the central nervous system and is a carcinogen.

Illumination and Noise level measured in visited industries. Illumination level was found low in all industries. Using of natural light not seen in any industries. Artificial light source not cleaned properly was the main causes of low illumination level. Confined workplace with haphazard housekeeping also contributed for the poor light level in these industries.

Working temperature in visited industries located at Kathmandu Valley was in within threshold limit i.e. below 32°C. Working temperature was more than 36°C in terai based PU foam industries.

During washing of mixing vessel, significant quantities of the chemicals are washed off with water to the drain which is dumped in the dump yard and sometimes burnt which results in environmental pollution. Some chemicals like Methylene Chloride can be harmful to aquatic life and can cause adverse effect to the environment. Chemical vapours released in the atmosphere are also a prime concern from environmental point of view.

The following areas of improvement have been found in the industries for better OSH and higher productivity in future.

Areas of improvement

- a. Documentation: Incident and accident records not properly documented.
- b. Safety Policy and Safety Team: Safety Policy not declared by the management and safety accountable team/person/department not formed.

- c. Hazard Identification and Risk Assessment: Hazard Identification and Risk Assessment (HIRA) not done.
- d. Training: Required safety training not conducted for employees.
- e. Signage: Safety related sign, symbol, direction and slogans not found.
- f. Format and Record keeping: Safety related order and data collection format not uniformly maintained. Designated person/department not assigned for data collection and recording.
- g. Don'ts: Risky and hazardous activities and behaviours not prohibited by written company rules.
- h. Good Housekeeping: The entire department not adopted the good housekeeping practices.

Chapter - 6

Conclusion and Recommendation

The overall OSH conditions of the PU foam are not found in satisfactory level. The previous accident record not available at industries but management expressed that except few minor injuries not any employees suffered from major and fatal accidents. The victims of occupational diseases have not been recognised in any workers since PU foam industries started in Nepal.

Exposure of TDI and methylene chloride fumes/gases found in mixing and foaming areas. Workers were exposed with the toxic gas release. Industries are making provision of exhaust system but not working properly. MSDS or SDS not found in all PU foam industries, so potential effect of the chemical is unknown. Light level is low and found as occupational risks to workers. Many workers were complaining to suffer Musculoskeletal Diseases (MSD) due to bad ergonomics. Periodic health monitoring for workers is not doing. Proper and suitable Personal Protecting Equipment's (PPEs) are not used by the workers. None of the visited industries were found ISO 45001 certified.

Recommendations for Better OSH condition in PU foam Industries

The following recommendations will improve the OSH Management:

Table 6: Recommendations for better OSH condition in visited PU foam Industries

Issues	Recommendation	Category
Safety Policy	1. Safety and Health Policy must be adopt and display	High
Safety and Health Committee	2. Formation of Safety and Health Committee as per provision of Labour Law and Labour Regulation 2074	High
Safety Gloves and Safety Goggles	3. Electricians must wear the Nitrile Foam Coated Gloves. 4. Use Chemical Resistance Nitrile Gloves while working with chemicals 5. Use safety goggles while handling of chemicals	High
Exhaust and Ventilation	6. Improve the gas exhaust system (increase suction capturing point) in foaming operation.	High
Electrical Safety	7. Details of voltage, draw able ampere and other electrical information must be available in each socket, distribution box and all panel board. 8. Completely prohibit to use naked wire in any kinds of electrical connections.	High
Risk of Fire and Explosion	9. Foam fire Extinguisher installed near the Chemical storage area and CO2 type fire extinguisher for electrical area. 10. Install the smoke detectors. 11. Develop Emergency Preparedness System and conduct Drill.	High
Occupational Health	12. Lung function test (Forced Vital Capacity) of all workers in yearly.	High

Issues	Recommendation	Category
Chemical Handling	13. Install Eye wash fountain and Shower. 14. All required PPE compulsorily use 15. Display MSDS or SDS of toxic and hazardous chemicals for all relevant employees.	High
Documentation and data collection	16. Safety related data collection format must be available for all dept.	High
Reporting	17. All incident and accident must be report in assigned format within same day to Safety Team and Admin.	High
Training and Orientation	18. OSH Related training must provide to all employees	High
Good Housekeeping	19. Whole industries should implement good housekeeping practice.	Medium
	20.	
Use of Gas Filter Mask and Respirators	21. Use only gas filter mask while working in foaming are or Use self-breathing apparatus (respirator) .	Medium
Lighting Illumination	22. Repair the all damaged lighting fixtures. 23. Use natural light through windows and transparent sheet	Medium
Safety Signage	24. Placed “Danger” sticker in all electrical panels. 25. Placed appropriate safety sign as attached in annex.	Medium

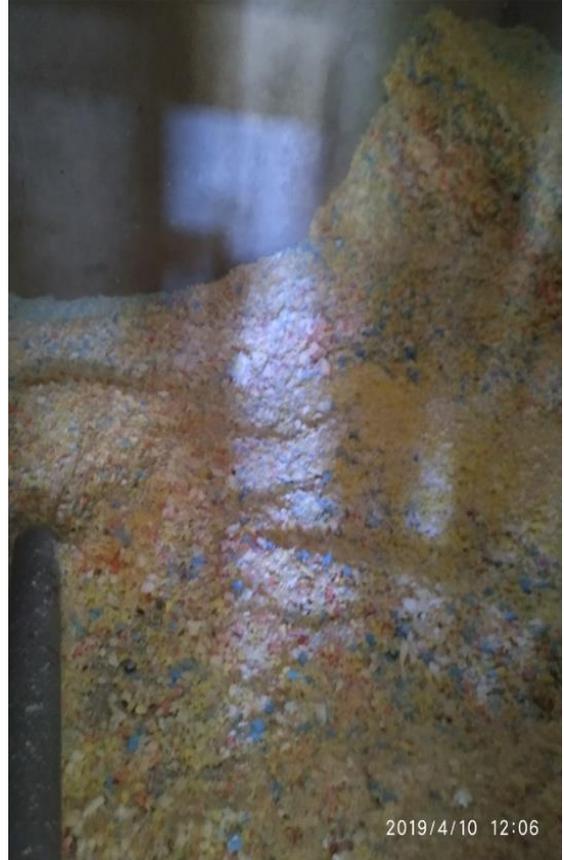
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ANNEX 1: Some photographs taken at visited Foam industries









Annex 2: Globally Harmonized System (GHS) Signage

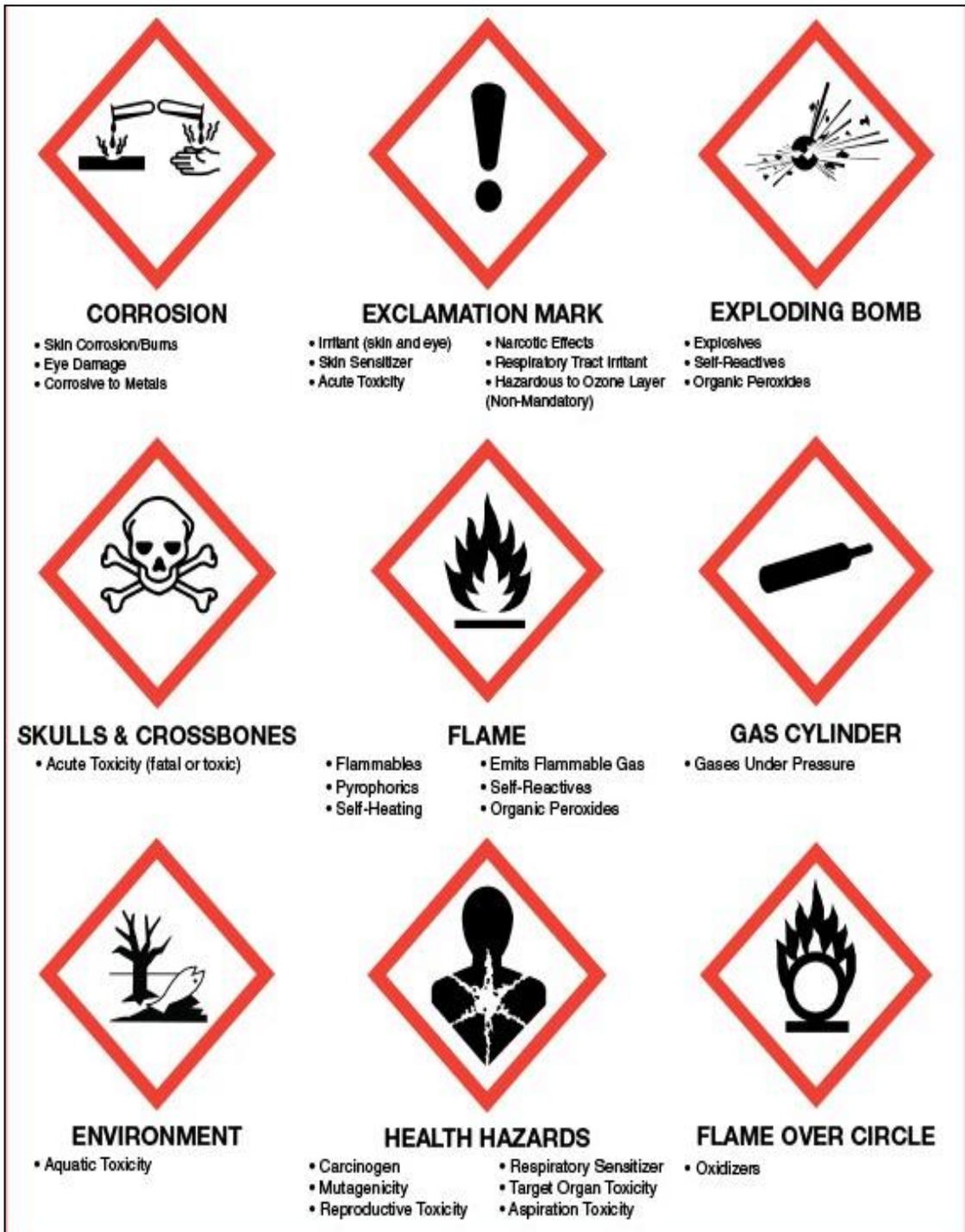


Figure 1: Globally Harmonized System Signage

Annex 3: Personal Protecting Equipment's (PPE's) Symbols



Figure 2: Personal Protective Equipment's symbols