ISSN XXXX XXXX © 2018 IJESC

Research Article Volume 8 Issue No.6

Fire and Risk Analysis of Paint Shops of an Automobile Industry

S. Arun Kannan [1], J.Gunasekaran ME[2]
ME Student (Industrial Safety Engineering)[1], Assistant Professor[2]
Department of Mechanical Engineering
Cauvery College of Engineering and Technology, Trichy, India

Abstract:
In most of the industries, fire imposes the greatest threat both in terms of financial loss as well as loss to life and property. The presence of combustible materials, their physical arrangement, the likelihood of ignition and the necessary amount of heat required are the factors on which the risk of fire depends upon. It is widely recognized that solvents and paints play an important in many areas of automobile industry. This paper concentrates on the causes of fire and explosion inside the paint shop section of an automobile industry. Thus it considers how fire risk is affected by the storage and handling of flammable substances in the workplace and the effectiveness of the existing measures. This pilot study shows a gap analysis between the existing control measures and the required IS/OSHA/NFPA standards for fire and explosion safety while working with paints and solvents. It focuses on solvents and thinners that are highly flammable and makes the area a high risk zone.

Key words: Fire, Combustible Materials, Automobile Industry, paint Shop, Highly flammable, high risk zone.

1. INTRODUCTION

Fire, a process in which substances combines chemically with oxygen from the air and typically gives out bright light, heat, and smoke leading to combustion or burning. For premises where flammable substances are handled or stored, the fire precautions will comprise both 'process fire precautions' (i.e. those which affect fire initiation and the early stages of fire growth) and 'general fire precautions' (e.g. the provision of firefighting and fire detection, and emergency routes and exits). The application of paints and solvents which act as the combustible material, when handled either by spraying, dipping or other processes, can present fire or explosion hazards. These results not only from the solvent vapors that are emitted but also from mixed paint deposits which may be liable to spontaneous combustion from subsequent drying or baking processes. The term "solvents" refers to liquid organic chemicals used to dissolve solid materials. Solvents can be made from natural sources such as turpentine and the citrus solvents, but most are derived from petroleum or other synthetic sources. Solvents are used widely because they dissolve materials like resins and plastics, and because they evaporate quickly and cleanly. Two properties which affect a solvent's capacity to cause fire and explosions are evaporation rate and flash point. In general, the higher a solvent's evaporation rate, the faster it evaporates and the more readily it can create explosive or flammable air/vapor mixtures. All, solvents, flammable or not, should be isolated from sources of heat, sparks, flame, and static electricity. The products used by the paint department require special storage protocols so that they do not become a danger to those working with them, to those working near them or to the general public. Dillon Consulting Ltd. states that solvents and thinners are incompatible with oxidizing agents; as oxidizing agents increase the risk of fire if they come into contact with flammable materials. Therefore, thinners and solvents should be stored away from agents such as peroxides. According to Occupational Safety and Health Act 1984 and Occupational Safety and Health Regulation 1996, use of flammable materials in spray painting (e.g. organic solvents), increases the risk of fire and explosion because of the amount of solvent vapor in the air. Solvents Industry Association has also suggested that for a liquid fire sufficient air and high enough temperature have to be present to ignite the liquid. The temperature may be from the ignition source such as a static spark or from the liquid itself being above its auto-ignition temperature.

The study focused on:

- Areas such as the paint storage area, the paint kitchen, the rag/tag area and the painting area the paint-baking oven and the CO2 bank.
- Flammable substances considered were flammable solvents such as thinner and primer and the paint, which was used for painting the automobile parts.
- The study concentrated on storage and handling of paints and solvents in the workplace and control of ignition sources.

2. PROBLEM IDENTIFICATION

The automobile industries paint shop in the one of the important area concern because Thousands of chemical compounds are used in paint products as pigments, extenders, binders, solvents and additives. Painters are commonly exposed by inhalation to solvents and other volatile paint components; inhalation of less volatile and nonvolatile components is common during spray painting. The automobile paint shops hazards associated with paints and solvents are **toxicity and flammability**. Solvents contained in paints often have acute effects on the central nervous system, initially causing giddiness and then, with further exposure, unconsciousness. The paints may also contain other hazardous chemicals, such as chromates, that are carcinogenic, or isocyanides that are respiratory sensitizers leading to asthma. The substitution of highly flammable solvents with aqueous formulations, or at least with less Flammable organic solvents. Likewise, the use of many toxic chemicals, such as lead compounds, has been eliminated except for some very specialized purposes. However, the technology of spray coating still entails the use of flammable solvents and paints

with toxicity issues, especially in relation to asthma. The paint shop considers **two major problems fire hazards and health issues.** So both the safety and health of paint sprayers need to be considered in automobile point shops.

3. STORAGE OF CHEMICALS AND SOLVENTS

3.1 STORAGE OF CHEMICALS AND SOLVENTS IN PAINT SHOP

The State of Delaware enacted a Hazardous Chemical Information Act in July, 1985. This act provides students and employees access to information regarding hazardous chemicals to which they may be exposed either during their normal employment activities or during emergency situations. Be sure that you read The Safety Department "Hazardous Material Safety Manual" and that you receive "Right To Know" training before using any laboratory facility.

i. **Labeling**

Label all chemicals in the laboratory with permanent labels. The label includes the primary hazard associated with the chemical (e.g., flammable, toxic), the full chemical name, manufacturer and date opened. Triple rinse chemical reagent, salt and solvent bottles before discarding in the broken glass container, even if the bottle is intact. Recycle brown glass bottles after the triple rinse by removing the label or crossing out the chemical name and warning with a black marker.

ii. Protective Equipment

Wear face shields and rubber gloves when concentrated acids are poured. Wear personal protective equipment (PPE) when any highly reactive or toxic chemicals are handled, such as elemental sodium or cyanide. The Chemical Hygiene Plan requires that appropriate PPE is used when handling toxic chemicals, carcinogens, reproductive toxins or chemicals with unknown toxicity. Use the Hyper CPC Stacks database on the Mac In tosh Lab file server to help you select the best make and model of gloves and protective clothing to meet a challenge from a specific solvent or toxic chemical.

iii. Barrier

You may need engineering controls in addition to a fume hood to keep a barrier between you and the process. These include closed reactor or gas control systems of glass or stainless steel, glove bags, glove boxes, steel or polycarbonate barricades. Use a laboratory hood as an engineering control with flammable solvents, toxic gases and chemicals, reproductive toxins or known or suspect carcinogens. It may be recalled that the best ventilating efficiency is attained with the hood sash closed. Keeping all items 6 inches behind the sash line and minimizing the quantity of equipment within the hood area will greatly improve its exhaust effect. The operating condition of a hood should be determined before the hood is put to use; be certain that the Magnehelic gage shows a positive reading before the hood is used.

iv. Storage

All chemicals must be organized and stored on shelves or in cabinets where they will not be knocked over. One way to organize chemicals is to store organics by number of Carbon atoms (not by alpha sort) and separate from inorganics, which should be stored in alphabetical order.

3.1.1 Flammable solvents

Properties of flammable liquids:

Flash Point: Temperature at which the vapor pressure is sufficient to form an ignitable vapor mixture with the air.

Ignition Temperature: Minimum temperature required to cause self-sustained combustion.

3.1.2 Classification Flammable Liquid

Table 3.1 Classes of Flammable Liquid

S.NO	CLASSES OF LIQUID	FLASH POINT
1.	Class IA	below 73°F and below 100°F
2.	Class IB	Below 73°F and above 100°F
3.	Class IC	between 73°F to 100°F
4.	Class II	between 100°F to 140°F
5.	Class IIIA	between 140°F to 200°F
6.	Class IIIB	above 200°F

Table 3.2The maximum allowable size of flammable liquid containers (NFPA 30)

FLAMMABILITY CLASS:	IA	IB	IC	IIC	IIIC
Glass/plastic	1 pt	1 qt	1 gal	1 gal	1 gal
Tinplate can	1 gal	5 gal	5gal	5 gal	5 gal
Safety cans	2 gal	5 gal	5 gal	5 gal	5 gal

3.2 REACTIVE CHEMICAL HAZARDS

Untrained individuals (Engineers doing Chemistry) attempting organic synthesis and other reactions, who are not absolutely confident of the stability or toxicity of their intermediate products and end products must always seek advice from knowledgeable colleagues or from the literature before proceeding. (Example: nitro methane will detonate at its critical temperature).

4. FIRE RISK ANALYSIS PROCESS

4.1 FIRE RISK ANALYSIS PROCESS: Fire risk is defined as the product of the probability of fire occurrence and the consequence or extent of damage to be expected on the occurrence of fire.

Table 4.1 List of Fire Risks Associated with the Paint Shop

Area	Raw Materials	Risk
Paint Storage	Flammable paints, Thinner	Fire hazard due to storage of flammable paint and thinner
Paint Kitchen	Flammable paints, Thinner	**1.** Fire due to flammable Paint and thinner. **2.** Fire due to mobile phones inside the paint kitchen
Rag/Tag area	Thinner	Fire due to Thinner
Painting booth	Thinner, Flammable paints	**1**. Fire due to storage of thinner inside the paint booth 2. Fire due to flammable paints and fumes
Paint baking oven	Flammable paint fumes	Fire and explosion hazard due to explosive and flammable paint fumes
CO2 Bank	CO2, PNG lines	Fire due to bursting of PNG lines

Fire hazard not only effects life but also property and the environment. In this study, fire risk analysis is carried out in five areas within the paint shop: the paint storage area, the paint kitchen, the rag/tag area, the painting booth and the CO2 bank. The risks associated in these areas are shown in the table below.

4.2 EXISTING CONTROL MEASURES

As per the MSDS of Thinner it is seen that OSHA Regulatory classifies this material as hazardous under OSHA Regulations. Section 3 of the MSDS indicates thinner to be highly combustible liquid and vapor. Section 5 illustrates the fire fighting measures of thinner as follows:

- Flash Point: 114º F or 45.5ºC
- Explosive Limit: Lower: 1.5%, Upper: 7.0%
- Auto ignition Temperature: 670ºF or 354ºC
- OSHA Flammability Class: Combustible Liquid-
- Class II

The vapors of thinner are heavier than air may travel along the ground or may be moved by ventilation and ignited by pilot lights, other flames, sparks, heaters, smoking, electric motors,static discharge, or other ignition sources at locations distant from material handling point. The extinguishing media that is suggested to be used is carbon dioxide, dry chemical and regular foam. Also, water may be used to keep fire-exposed containers cool until fire is out. Section 7 illustrates the Handling and storage of thinner as:

• **Handling:** All hazard precautions given in the data sheet must be observed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling. Use only with adequate ventilation. Do not breathe vapours or spray mist. Do not take internally. Close container after each use.

• **Storage:** Store material in a cool, well-ventilated area. For maximum product quality, avoid prolonged storage at temperatures above 75°F (25°C). Do not use or store near heat, sparks, or open flame. Keep container tightly closed. Avoid contact with incompatible materials.

OSHA makes reference to NFPA 86 under paragraph 1910.107, the law related to coating processes utilizing flammable or combustible liquids. NFPA 86 is therefore the minimum standard required by law, and should be applied in all processes falling under OSHA regulations. Also OSHA 910.106 which is primarily based on NFPA 30 applies to the handling, storage, and use of flammable and combustible liquids with a flash point below 200°C. These standards along with IS standard were compared to those of the existing control measures in place and it was found that most of the measures were according to the above standards giving all necessary importance to fire safety.

Table 4.2 Existing Control Measures

Area	Controls
Paint Storage	Open flames and smoking shall not be permitted in flammable or combustible liquid storage areas, fire protection system like carbon dioxide, water spray is provided
Paint Kitchen	Fire extinguishers, no smoking area, flame proof lightening, CO2 floodingsystem, prohibition of mobile phones, proper grounding to prevent static electricity.
Rag/Tag area	Fire extinguishers, no smoking area, flame proof lightening, CO2 flooding system, prohibition of mobile phones, proper grounding to prevent static electricity.
Painting booth	Limited quantity is being stored. Flame proof fittings, no smoking area, mobile prohibition, restricted entry, CO2 flooding system. Fire extinguisher, no smoking area sign board, proper grounding to prevent static electricity.
Paint baking oven	Flame proof lightening, CO2 flooding system, trained and experience person, safety caution displayed.
CO2 Bank	Safety valves, Isolation Valves, Fire tender and fire- extinguisher

5. PAINT SHOP PROCESS IN AUTOMOBILE INDUSTRY

5.1 PAINT SHOP

The objective of painting is to form a coating film on the surface of an object in order to protect the object and give a fine appearance. Painting may also have other special functions. There are various types of painting methods, and spray painting is currently used in many types of industrial painting.

Figure 5.1 Paint Shop

In the painting operation, various types of painting methods are used according to the shape, size, quality, and quantity of the object(s) to be painted. The “transfer efficiency” differs, in other words, the ratio of the quantity of the coated film formed on the object to the quantity of the paint sludge generated from overspray differs according to the differences in these operational conditions.

5.2 PAINT SHOP PROCESS

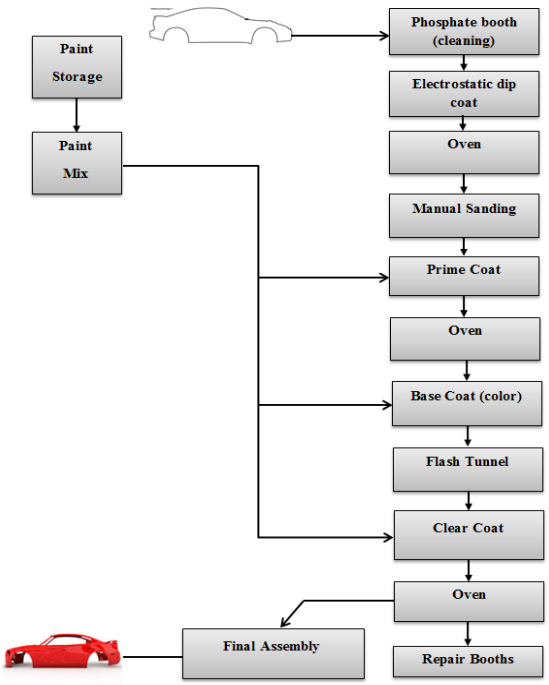

Figure 5.2 paint shop process

5.3 PAINT MIX ROOM

The amount of flammable or combustible liquid stored in the paint mixing room must be within the following limits. Paint mixing rooms within 6' of the spray area may contain up to two (2) litres per square foot of enclosure floor area but may not exceed 60 litres. Paint mixing rooms further than 6' from the spray area may contain up to two (2) litres per square foot of enclosure floor area but may not exceed 300 litres.

Paint Mix Rooms are engineered for two distinct purposes; to control contamination, and to remove harmful fumes during the mixing process. This allows for a higher quality finish and a safe work environment, which is vital to the success of your business. GFS offers Paint Mix Rooms in multiple configurations and they can be connected to certain types of paint booths for direct entry.

Figure 5.3 Paint Mix Room

5.4 PAINT MIXING ROOM (PMR) PROCESS & SOLVENT STORAGE AREA:

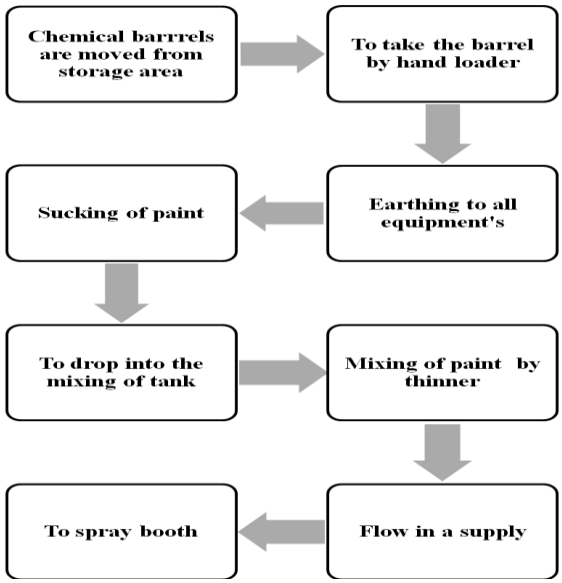

Figure 5.4 Paint Mixing Room

5.5 FLAMMABLE AND COMBUSTIBLE LIQUIDS

Flammable and combustible liquids are liquids that can burn. They are classified, or grouped, as either flammable or combustible by their flashpoints. Generally speaking, flammable liquids will ignite (catch on fire) and burn easily at normal working temperatures. Combustible liquids have the ability to burn at temperatures that are usually above working temperatures. There are several specific technical criteria and test methods for identifying flammable and combustible liquids. Under the Workplace Hazardous Materials Information System (WHMIS) 1988, flammable liquids have a flashpoint below 37.8°C (100°F). Combustible liquids have a flashpoint at or above 37.8°C (100°F) and below 93.3°C (200°F).

Figure 5.5 Flammable and Combustible Liquid

5.5.1 Flashpoint

The flashpoint of a liquid is the lowest temperature at which the liquid gives off enough vapor to be ignited (start burning) at the surface of the liquid. Sometimes more than one flashpoint is reported for a chemical. Since testing methods and purity of the liquid tested may vary, flashpoints are intended to be used as guides only, not as fine lines between safe and unsafe. Work safely with them.

5.5.2 Classification of Chemicals

Table 5.1 Chemicals are classified based on Flash Point as mentioned in Petroleum act 1934

S.NO	Classified classes	Flash point
1.	Class A	below 23°C
2.	Class B	below 23°C at or above 65°C
3.	Class C	above 65°C but below 95°C

6. PETROLEUM ACT 1934 & PETROLEUM RULES 2002

6.1 PETROLEUM ACT 1934

6.1.1 Approval of Containers

Containers exceeding one liter in capacity for petroleum Class A and five liters in capacity for petroleum Class B or petroleum class C shall be of a type approved by the Chief Controller. Where the approval of the Chief Controller is sought to a type of container not previously approved, an application together with copies of drawings thereof to scale showing the design, materials to be used, the method of construction and capacity of the container together with two samples containers and a fee of rupees one thousand for scrutiny shall be submitted to the Chief Controller.

6.1.2 Containers For Petroleum Class A

Containers for petroleum Class A shall be constructed of tinned, galvanized or externally rust proofed sheet iron or steel and are of a type approved by the Chief Controller. Provided that glass bottles of a capacity not exceeding 2.5 liters and of a type approved by Chief Controller can be used as a container for laboratory chemicals classified as petroleum Class "A".

6.1.3 Containers For Petroleum Class B And Class C

Containers for petroleum class B or petroleum class C shall be constructed of steel or iron and are of a type approved by the Chief Controller.

An air space of not less than 5 percent of its capacity shall be kept in each container for petroleum Class B and not less than 3 percent of its capacity in each container for petroleum Class C.

6.2 HANDLING AND STORAGE

Figure 6.1 HandlingAnd Storage

Flammable and combustible liquids are present in nearly every workplace. Gasoline, diesel fuel, and many common products like solvents, thinners, cleaners, adhesives, paints, and polishes may be flammable or combustible. Flammable and combustible liquids play a part in our lifestyle. However, if used or stored improperly, serious fires and death may occur. This article discusses flammable and combustible liquid terminology, handling, and storage practices.

Terminology

A review of the properties and hazards of flammable and combustible liquids is in order.

- **Auto ignition Temperature**: The auto ignition temperature is the lowest temperature at which a liquid will ignite without an external ignition source. While most flammable and combustible liquids have auto ignition temperatures in the range of 500°F to 1000°F, some have very low auto ignition temperatures. For example, ethyl ether has an auto ignition temperature of 356°F, and its vapors have been ignited by heated surfaces.
- **Flashpoint**: This is the minimum temperature of a liquid at which sufficient vapor is given off to form an ignitable mixture with the air, either near the surface of the liquid or within the vessel used.
- **Fire Point**: The fire point is the lowest temperature at which a liquid will ignite and achieve sustained burning when exposed to a test flame.
- **Vapor Pressure**: Pressure, measured in pounds per square inch–absolute exerted by a liquid.
- **Combustible Liquid (***per30***)**: A combustible liquid has a flashpoint at or above 100°F.
- **Grounding and Bonding:** When flammable and combustible liquids travel through a pipe or through the air, static charges are accumulated. Grounding and bonding is necessary during the transfer of flammable liquids that have a flashpoint below 100° F to prevent a static spark from igniting the flammable vapors. An example of grounding and bonding is illustrated.

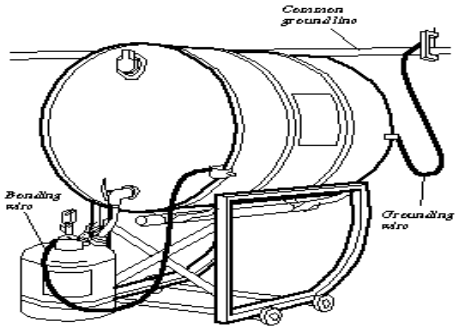

Figure 6.2 Grounding and Bounding

- **Container**: Any vessel with capacity of60 liters *or less* that is used for transporting or storing liquids is referred to as a "container".
- **Portable Tank**: Any closed vessel having a liquid capacity *over 60 liters* and not intended for fixed installation is called a "portable tank".
- **Safety Can**: A safety can is a listed container with a capacity of no more than 5 liters that has a spring-closing lid and spout cover and is designed to safely relieve internal pressure when exposed to fire.
- **Flammable Storage Cabinet**: A "flammable storage cabinet" is a listed storage cabinet designed in accordance. Such a cabinet is designed and constructed to limit the internal temperature to no more than 325°F from the center of the cabinet to within 1 inch of the top of the cabinet when subjected to a 10-minute fire test.
- **Fire Area**: A "fire area" is an area of a building separated from the remainder of the building by special construction. This area has a fire resistance of at least 1 hour and has all communicating openings properly protected by an assembly that also has a fire resistance rating of at least 1 hour.
- **Storage:** Storage of flammable and combustible liquids is usually a necessity. Whenever flammable and combustible liquids are stored improperly, however, they become a significant fire hazard. For instance prohibits Class I flammable liquids from being stored in a basement. 29 CFR 1910.106 has established the following storage practices to ensure flammable liquids are not stored in excessive quantities.

7. ASSESSING THE RISKS IN PAINT SHOPS

7.1 TYPES OF PAINTING METHOD IN AUTOMOBILE INDUSTRY

7.1.1 Spray Painting

Spray painting, including electrostatic spray painting, is a process by which liquid paint is applied under pressure to an object. Spray painting may be carried out by hand or automatically. There are several methods used to atomize the paint for spraying:

Figure 7.1 Spray Painting in Automobile industry

using a conventional air compressor – air is driven across the mouth of a small outlet under pressure to draw liquid paint out of the container and produce an air-paint mist from the nozzle of the spray-gun airless spray painting – the paint container is pressurized pushing the paint to the nozzle where it is atomized by the spray gun, or Electrostatic spray painting – an electric pump d rives the electro statically charged liquid paint out of the nozzle which is then applied to the object which is earthed.

7.1.2 Powder coating

Powder coating is a process by which electro statically charged powder is applied onto an earthed object. Spray painting and powder coating are carried out in a variety of industries. For example, items that are commonly spray painted include motor vehicles, buildings, furniture, white goods, boats, ships, aircraft and machinery. A few months ago we highlighted how to paint your race car so that you ended up with a great-looking paintjob for your fans and sponsors alike. Having that great-looking paintjob is nice, but what about your chassis? At one time or another we've all worked on a race car with a chassis that was in pretty rough shape. To avoid that worn-out, beat-up, rough look you have two options: You can paint your chassis or you can powder coat it. But which one is better? Well, Circle Track has done the legwork for you by following the Frank Kimmel/Circle Track Project Bomber through the powder coating process. The bottom line? Powder coating will always be a wiser choice over painting your chassis. Read along as we explain why by showing you the process and its advantages. Powder coating Project Bomber, as you saw here, cost a mere $350. You'd be hard pressed to paint a chassis for that dollar amount. Typically, you can expect prices to range from $350 to $550 for a powder coating job like this one. The price is largely dependent on the color you choose–the more exotic the color, the higher the price. If you go really crazy, you can easily exceed that $550. But the bottom line is that by opting for powder coating you're getting an amazing-looking frame that's extremely durable and resistant to chemicals and spills .Conclusion In reality, a powder coated chassis is far superior to a painted chassis. You can't even make the argument that the painted chassis is more vibrant. The chassis might look nearly the same during the start of the season, but as the season wears on, the painted chassis will start to chip and wear, whereas the powder coated frame will look nearly the same as the first day you unloaded it from the professional who powder coated it. So the next time you're deciding to paint or powder coat your frame, have it done right and take a powder

Figure 7.2powder coating in Automobile industry

7.2 ASSESSING THE RISKS

Hazards have the potential to cause different types and severities of harm, ranging from minor discomfort to a serious injury or death. For example, exposure to spray painting or powder coating chemicals can adversely affect a worker's health in ways ranging from minor illness (for example, headaches) to major illness (for example, asthma). Many liquid paints and powder paints contain flammable substances. Spray painting vapors and mists, as well as powder paints used in powder coating can spread rapidly, particularly in an enclosed space, and create a potentially explosive atmosphere. If the aerosol, mist, vapor or powder paint is ignited, for example by static electricity, a lit cigarette or spark, it could result in an explosion that could destroy the building and kill or injure anyone nearby. Each of the outcomes involves a different type of harm with a range of severities, and each has a different likelihood of occurrence. Under the WHS Regulations, a risk assessment is not mandatory for spray painting or powder coating, however, it is required for specific situations, for example when working with asbestos. In many circumstances a risk assessment will assist in determining the control measures that should be implemented. It will help to:

- identify which workers are at risk of exposure
- determine what sources and processes are causing that risk identify if and what kind of control me assures should be implemented, and
- Check the effectiveness of existing control measures. The following questions may help to assess the risk:
- How often, and for how long, will exposure to the hazard occur?
- In the event of exposure to the hazard, will the outcome be severe, moderate or mild?
- How do workers interact with the hazard (for example, being exposed to hazardous chemicals by breathing it in or skin contact)?

Table 7.1 Hazard Categories of Spray Painting or Powder Coating Substances

High risk chemicals	A hazardous chemical should be considered as high risk if it is: a chemical that is carcinogenic• a chemical that is mutagenic, geotaxis or has reproductive Hazards a chemical which affects the central nervous system (which can Also affect hearing due to autotoxin effects). That is, they may Cause hearing loss or exacerbate the effects of noise. Evaluating the use of these chemicals should be carried out in conjunction with the Code of Practice: Managing Noise and Preventing Hearing Loss at Work. • a skin or respiratory sensitizer or if it is corrosive or has acute irritant effects • a chemical which causes severe effects after a single, repeated or prolonged exposure • a flammable liquid, vapor or aerosols Many chemicals that are used in spray painting, including 2-part polyurethane paints containing isocyanides and toluene (an ingredient in many oil-based paints), and in powder coating, such as triglycidyl isocyanurate, hydrofluoric acid and chromic acid are known to present significant health risks and should be Assessed as high risk.
Medium risk chemicals	Medium risk hazardous chemicals include any substances that contain organic solvents that are not already assessed as high risk, Or flammable liquids or combustible dusts.
Low risk chemicals	Hazardous chemicals that are low risk include any other substances not already assessed as high or medium.
High risk chemicals	A hazardous chemical should be considered as high risk if it is: •a chemical that is carcinogenic a chemical that is mutagenic, geotaxis or has reproductive Hazards a chemical which affects the central nervous system (which can Also affect hearing due to autotoxin effects). That is, they may Cause hearing loss or exacerbate the effects of noise. Evaluating the use of these chemicals should be carried out in conjunction with the Code of Practice: Managing Noise and Preventing

	Hearing Loss at Work. a skin or respiratory sensitizer or if it is corrosive or has acute irritant effects a chemical which causes severe effects after a single, repeated or prolonged exposure a flammable liquid, vapor or aerosols Many chemicals that are used in spray painting, including 2-part polyurethane paints containing isocyanides and toluene (an ingredient in many oil-based paints), and in powder coating, such as triglycidyl isocyanurate, hydrofluoric acid and chromic acid are known to present significant health risks and should be Assessed as high risk.

8. CONTROLLING THE RISK IN PAINT SHOP

8.1 THE HIERARCHY OF CONTROL MEASURES

Some control measures are more effective than others. Control measures can be ranked from the highest level of protection and reliability to the lowest. This ranking is known as the hierarchy of control. You must always aim to eliminate a hazard and associated risk first. If this is not reasonably practicable, the risk must be minimized by using one or more of the following approaches:

8.1.1 Substitution

For example:

- use a water-based paint instead of an organic solvent based coating
- use a brush or roller instead of a spray gun
- use a triglycidyl isocyanurate-free (TGIC) powder coating instead of one containing TGIC
- use high volume low pressure (HVLP) spraying rather than airless spraying. use a low hazard cleaning
- solvent

8.1.2 Isolation

- Conduct all spray painting in a spray booth ensures that other workers are not affected by the spray painting.

8.1.3 Implementing engineering controls

Use control measures such as ventilation systems, including spray booths, to reduce exposure to vapours and aerosols. If risk then remains, it must be minimized by implementing administrative controls, so far as is reasonably practicable, for example restricting access to spray painting areas or keeping the quantity of hazardous chemicals to minimum in the spray painting area. Any remaining risk must be minimized with suitable personal protective equipment (PPE), for example breathing protection, gloves, aprons and protective eyewear. Administrative control measures and PPE rely on human behavior and supervision, and used on their own, tend to be least effective in minimizing risks. A combination of these control measures may be required in order to adequately manage the risks with spray painting and powder coating. You should check that your chosen control measure does not introduce new hazards.

8.2 CONTROLLING THE RISKS OF SPRAY PAINTING

8.2.1 Spray Painting in Spray Booths

Spray booths are enclosed or partially enclosed structures designed to prevent or reduce exposure to hazardous chemicals or vapors. A spray booth should be used when spray painting with a hazardous chemical, except when:

- the shape, size or weight of an article cannot be easily moved or fit into a spray booth, for example,
- painting a building, bridge or a large boat, or
- the painting involves minor work such as spotting or touch-ups, for example, painting a scratch or stone
- Chip on a car (painting a car panel with two-pack polyurethane paint would not be regarded as minor work).

8.2.2 Types of Spray Booths Include

Open-faced spray booths generally have two walls, roof with air extraction, a filtered rear wall and anopen front. Enclosed type batch booth is a room or large cabinet where the operator enters and spraying is conducted. The airflow is either down draught, cross draught, end draught or any combination thereof.

8.2.3 Spray Booths Should

Be designed, constructed and installed to comply with AS/NZS 4114.1: Spray painting booths, designated spray painting areas and paint mixing rooms – Design, construction and testing and AS/NZS 4114.2: Spray painting booths, designated spray painting areas and paint mixing rooms – Installation and maintenance.

- Be fitted with an exhaust capture system and a ventilation system that includes a filter for removing airborne contaminants
- have ventilation systems capable of producing a minimum air movement of: 0.3 m/s for a full downdraft booth 0.4 m/s for electrostatic spraying 0.5 m/s for any other booth.

8.2.4 Spray Booth Ventilation

Control systems should operate a pre-purge cycle to remove any residue contaminants and also operate a minimum of a 5 minute post-purge period following spraying. Whenever possible, the spray should be directed towards the exhaust air outlet of a booth. For example, when spraying a tall object in a down-draught booth no spraying should be performed above shoulder height. Extension poles or lift platforms should be used so that the operator can get above the object and spray towards the air exhaust outlet in the floor. The spray painter should never be positioned between the spray gun and the exhaust air outlet. See Figures 1 to 8 below for further guidance.

8.3 CONTROLLING THE RISK OF POWDER PAINTING

Powder coating is a process by which powder is applied onto a charged object. It is the electrostatic charge on the powder and the object that will make the powder stick onto the surface of the object being sprayed. It is through powder coating process that workers are more likely to encounter hazards and risks associated with the use of electrical equipment, for example, static electricity and potential ignition sources. Workers are also more likely to be exposed to triglycidyl isocyanurate and experience adverse health effects. Hazardous chemicals Triglycidylisocyanurate (TGIC) TGIC is classified as a hazardous chemical and is commonly used in powder coating activities. It is:

- a skin sensitizer
- toxic by ingestion and inhalation
- genotoxic, and
- capable of causing serious eye damage. You should check safety data sheets and labels to determine if the product you are using contains TGIC.

Figure 8.1 The Operator Is Exposed To Overspray Because Of Poor Positioning In Relation To The Airflow

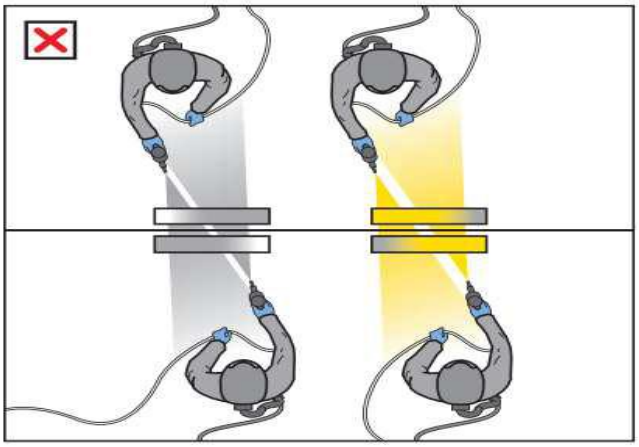

Figure 8.2 Spraying with a 'long' nozzle avoids overspray of the operator

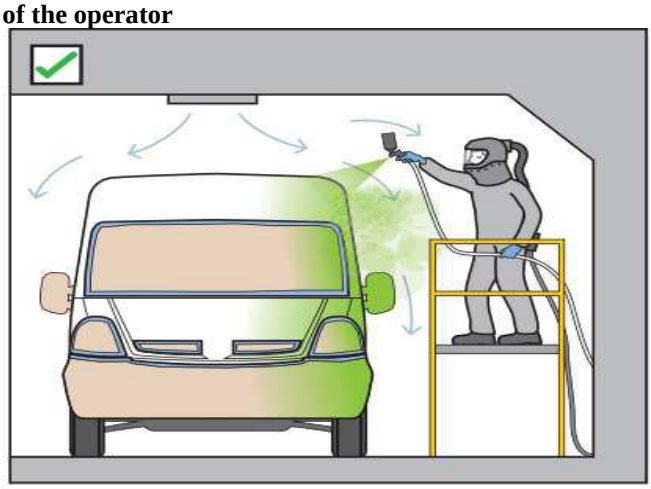

Figure 8.3 The Use Of A Gantry Or Lift Avoids Overspray On To The Operator And Avoids Them Having To Stretch And Reach

9. ELECTRICAL RISKS IN PAINT SHOP

9.1 ELECTRICAL RISKS IN PAINT SHOP

Electricity used in spray painting poses unique health risks including:

- electrocution from direct or indirect contact with electricity, and
- Burns – flashes and arcing due to short-circuiting may lead to severe tissue burns or the ignition of flammable gases. Electrical equipment should be kept at a safe distance from spray painting exclusion zones. This includes fans, turntables, drying lamps, fixed lighting and switches, heating equipment, electrical appliances used during cleaning and repairing operations and appliances used to mix paint formulations. Operating electrical equipment that is damaged or not designed to give explosion protection in spray painting and paint mixing areas creates an immediate risk. Further guidance is available in the Code of Practice: Managing Electrical Risks in the Workplace.

9.2 STATIC ELECTRICITY

Static electricity charges can be generated during a spray painting process if two differently charged materials come into contact. A common source of static generation is steam, air or gas containing particulate matter flowing from any opening in a pipe or hose. Static electricity discharge is most likely to happen during mixing and pouring of hazardous chemicals, specifically when the containers of hazardous chemicals are not correctly earthed. Static electricity charges can be generated in any spray painting process if two differently charged materials come into contact. It can be generated by:

- touching two metal cans together during decanting
- clothing or synthetic fibres prone to accumulation of static charge including nylon, pure wool, wool blends
- (unless treated) and non-conducting footwear
- liquid flowing in pipes or vessels, and
- airless spray painting using high fluid pressure (control this by electrically earthing the airless spray gun
- And any conductive article that is being sprayed including a container that the flow from the gun is directed into).

9.3 RECOMMENDED FOR COMMON SPRAY PAINTING AND POWDER COATING HAZARDS

Figure 9.1 PPE for Paint Shops

- Eyes, face and head protection
- Hearing protection (e.g. ear muffs and ear plugs)
- Gloves and clothing
- Foot protection (e.g. boots and shoes)
- Respiratory protective devices (e.g. dust masks, half face respirators and air supplied respirators)

10. RESULTS AND DISCUSSIONS

10.1 PAINT STORAGE

As per OSHA 1910.106/ NFPA 30, suitable fire control devices, such as small hose or portable fire extinguishers, shall be available at locations where flammable or combustible liquids1, open flames and smoking shall not be permitted in flammable or combustible liquid storage areas. Fire protection system shall be sprinkler, water spray, carbon dioxide, or other system should be in place. Though, all the above requirements are met by the organization, the sprinkler system is not in place and has to be installed. As per IS 9109:2000 Paint containers shall be supported either by resting on the ground

or on masonry supports. Wood or steel supports without fire-proofing shall not be permitted; all containers shall be suitably earthed to dissipate static charge, the containers' vents shall be provided with flame arrestors or pressure-vacuum vent and firefighting measures should be in place. On comparing its seen that, the thinner and paint containers are opened/cut using a brass hammer so as to avoid electrocution. Also, flame proof lighting is being provided.

10.2 PAINT KITCHEN

The requirement for paint kitchen as per OSHA 1910.106/ NFPA 30 is same as that for paint storage area. However, as per OSHA 1926.66 there are additional requirements such as areas are illuminated through glass panels or other transparent materials, only fixed lighting units shall be used as a source of illumination, Panels shall be so arranged that normal accumulations of residue on the exposed surface of the panel will not be raised to a dangerous temperature by radiation or conduction from the source of illumination. The organization has maintained all the necessary requirements as per this standard by providing fixed lighting units and suitable panels for accumulations of residue. As per IS 9109:2000, all the requirements for paint kitchen are same as that of paint storage area except that there are two more additional requirements such as Flammable solvents such as thinner should not exceed boiling point. All lighting fittings and switches shall be of the enclosed type. It is observed that the paint shop personnel takes utmost care to monitor the boiling point of thinner such that it doesn't exceed the desired limit.

10.3 RAG/TAG AREA

According to OSHA 1910.106/ NFPA 30 Flammable liquids shall be kept in covered containers when not actually in use and where flammable or combustible liquids are used or handled, except in closed containers, means shall be provided to dispose promptly and safely of leakage or spills. Also as per IS 7969-1975, paint scrapings and paint-saturated rags and debris shall be removed daily from the premises and, preferably, destroyed by burning at a safe place. All these are very well followed by the organization as per the IS norms.

10.4 PAINT BOOTH

OSHA 1910.106/ NFPA 30 say that mechanical exhaust ventilation system designed to provide for a complete change of air within the room at least six times per hour and All nonmetallic equipment and piping where an ignitable mixture could be present shall be given special consideration and all necessary firefighting systems should be in place. 29CFR 1926.66 states that areas should be illuminated through glass panels or other transparent materials, only fixed lighting units shall be used as a source of illumination. The paint shop is well illuminated with flame proof lighting and has proper firefighting installations. As per 1926.66(c)(9)(i) all metal parts of spray booths, exhaust ducts, and piping systems conveying flammable or combustible liquids or aerated solids shall be properly electrically grounded in an effective and permanent manner. The IS 9109:2000 states all lighting fittings and switches shall be of the enclosed type. The electrostatic guns used in the paint booth of the organization are well earthed and the booth has a static electricity disposer at the door.

10.5 PAINT BAKING OVEN

According to 29CFR 1910.107/NFPA 86 prior to the furnace heating system startup, provision shall be made for the removal of all flammable vapors and gases that have entered the heating chambers during the shutdown period, the regulators, relief valves and switches shall be vented to an approved location and heating elements must be securely fastened. IS 9109:2000 states that

- Oven shall be constantly watched during the process. An excess temperature alarm shall be provided to attract attention of persons to manually control the situation.
- Safe operating temperature shall not be exceeded. An automatic control shall be provided to ensure against excessive temperature. Such a system shall be interlocked with a device to shut off the heating medium. In the organization, the paint baking oven has an electrical panel with interlock system. The interlock system maintains the temperature of the oven. If the temperature goes higher than the actual temperature, it will cut off the supply the hot air from the PNG gas pipes and will reduce the temperature and thus preventing fire and explosion.

10.6 CO2 BANK

29CFR 1910.160 states

- Automatic detection equipment shall be approved, installed and maintained in accordance with 1910.164.
- At least one manual station is provided for discharge activation of each fixed extinguishing system.
- Automatic actuation of total flooding systems by means of an approved fire detection device installed and interconnected with a pre-discharge employee alarm system should be provided.
- Assure that the weight and pressure of refillable containers is checked at least semi-annually. If the container shows a loss in net content or weight of more than 5 percent, or a loss in pressure of more than 10 percent, it shall be subjected to maintenance.
- All fire protection systems must have pipes and fittings that are suitable for the expected temperature extremes with good corrosion resistance properties.
- IS 15528: 2004 states that the extinguishing media used shall be carbon dioxide complying with the requirements of IS 15222.As per the above requirements, the CO2 bank operates as follows: The areas are fitted with three smoke detectors. If there is smoke inside the area, at least two of the smoke detectors should send a signal to the electrical panel for the CO2 flooding system to be activated. Once the signal reaches, the electrical panel sends signals to the pivot cylinders which in turn pressurize the CO2 cylinders and through the pipes and discharge holes CO2 gas is released and fire is extinguished. In case of small fires, pilot cylinders are kept at appropriate places along with sand buckets for extinguishing fire. The fire department periodically checks the CO2 cylinders and keeps a track of the pressure inside them.

11. CONCLUSION

An organization's asset is its workforce, the property it deals with and the surrounding environment. The standards have been formulated by various regulatory boards so as to have zero accidents and hence no loss of life, no property loss and no environmental effect. It is mandatory to abide by these regulations so as to achieve a 100% profit both in terms of production and safety. This paper tried to make a gap analysis between the existing safety measures and that recommended by various regulatory bodies. The automobile industry taken into consideration has in no means sacrificed to follow the safety norms and as can be clearly seen has taken safety as an utmost important aspect along with its production interest.

12. REFERENCE

[1]. Roger Bentley (2014) "Risk assessment for paint spraying" Vol.4 PP 251-458 ISSN 2789-4562

[2]. El Mahdy N.M. and Radwan N.M. (2009) “Assessment Of Different Health Hazards In Painting Industry”Vol.2 2009; 33 (2) : 211-232

[3]. Reulen RC, KellenE, Buntinx F, Zeegers MP (2007) “Occupational Exposure As A Painter” Vol .2 PP [2451-234]

[4]. Tina Porwal (2015) “ Paint Pollution Harmful Effects On Environment” Vol.3 (Iss.9:SE): Sep, 2015**]** ISSN- 2350-0530(O) ISSN- 2394-3629(P)

[5]. Keerthi T, Murugan (2016) “Legal Compliance Of Paint Mix Room In CarManufacturing Plant” vol 7 PP [5891-2560]

[6]. R.Dinesh, Dr.S.Kumaraguru (2014) “Integration of Fire and Safety System with Industrial Automation Control System” volume1 issue1July 2014

[7]. AliasgharFarshad, Hamid KhabaziOliaei (2013) “Risk Assessment Of Benzene, Toluene, Ethylbenzene, And Xylenes (Btex) In Paint Plants Of Two Automotive Industries In Iran By Using The Coshh Guideline” vol.3 ISSN: 1857 – 7881 (Print) e - ISSN 1857- 7431

[8]. GuraySalihoglu, NezihKamilSalihoglu (2016) “A review on paint sludge from automotive industries: Generation, characteristics and management” vol.3 PP [1284-5641]