Fire and Risk Analysis of Paint Shops of an Automobile Industry

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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 role 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 sensitisers 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.

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.

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.

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. In case the hood is not operational, close the hood sash, call Plant Operations at extension 1141 and notify the lab coordinator immediately.

4.1 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 4.1 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. 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.
4.2 PAINT SHOP PROCESS

Figure 4.2 Paint Shop Process

4.3 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.

5. PETROLEUM ACT 1934 & PETROLEUM RULES 2002

5.1 PETROLEUM ACT 1934

5.1.1 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.

- 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.

- Nothing in sub-rules (1) and (2) shall apply to containers in the possession of the Defense forces of the Union.

5.1.2 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”.

- The containers shall be so constructed and secured as not to be liable except under circumstances of gross negligence or extraordinary accident to become defective, leaky or insecure in transit and they shall be kept in proper repair.

- The containers shall have well-made filling aperture which shall be fitted with well-fitting and secure airtight screw plugs or screw caps or other caps.

- The capacity of any container, other than those approved by the Chief Controller for specific purposes, shall not exceed 300 liters.

- An air space of not less than 5 percent of its capacity shall be kept in each container.

- The container shall bear a stamped, embossed or painted warning exhibiting inconspicuous characters the words “Petrol” or “Motor Spirit” or an equivalent warning of the highly inflammable nature of the petroleum.

- Nothing in sub-rules (1), (3), (4), (5), (6) and (7), shall apply to containers in the possession of the Defense Forces of the Union.

5.1.3 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.

- Nothing in this rule shall apply to containers in the possession of the Defense Forces of the Union.

5.2 PETROLEUM RULES 2002

License For Storage

Save as provided in sections 7, 8 and 9 of the Act, no person shall store petroleum except under and in accordance with a license granted under these rules. Provided that no license shall be necessary.-

- For the storage of petroleum in well-head tanks; or
- For the storage of petroleum as transit cargo within the limits of a port subject to such conditions as may be specified by the Conservator.

Precautions Against Fire

- No person shall smoke in any installation, storage shed or service station saves in places specifically authorized by the licensing authority for the purpose.
No person shall carry matches, fuses or other appliances capable of producing ignition or explosion in any installation or storage shed, which is used for the storage of petroleum.

No fire, furnace or other source of heat or light capable of igniting inflammable vapor shall be allowed in any installation, storage shed or service station save in places specially authorized by the licensing authority for the purpose.

An adequate number of portable dry chemical powders or any other fire extinguisher capable of extinguishing oil fires shall always be kept in every storage shed and small class B or C installations at strategic point and all persons employed at such locations shall be conversant with the use of such fire extinguishers.

Scale of firefighting provided in other areas of installation should be asper the requirement given in OISD Standard -117 for all installations approved by the Chief Controller after publication of the original standard OISD-115. For Installations existing prior to the publication of this standard the firefighting facilities shall be improved to the extent feasible (keeping this standard in mind) and approved by the Chief Controller.

Supervision Of Operations Within An Installation, Service Station Or Storage Shed

All operations within an installation, service station or storage shed shall be conducted under supervision of an experienced responsible agent or supervisor who is conversant with the terms and conditions of the license held for the installation, service station or storage shed as the case may be and those persons should have proper safety training.

Cleanliness Of Installation, Service Station Or Storage Shed

The ground in the interior of an installation or service station and the protected areas surrounding any installation, service station or storage shed shall be kept clean and free from all vegetation, waste material and rubbish.

Drainage

- All enclosures surrounding above ground tanks in an installation shall be provided with proper drainage facilities in such a way that no water is allowed to accumulate in the enclosures.
- No part of the enclosure referred to in sub-rule (1) shall be below the level of the surrounding ground within the protected area.
- Where drainage is affected by means of a pipe, the pipe shall be fitted with a valve which is capable of being operated from the outside of the enclosure or with any other arrangements approved in writing by the Chief Controller.
- All valves and other opening for draining off water shall be kept closed except when water is being drained off.
- The nature of the drainage arrangements and the position of all openings and valves therein shall be shown in the plan submitted with the application for a license.

Exclusion of unauthorized persons

- The protected area surrounding every installation and storage shed shall be surrounded by a wall or fence of at least 1.8 meters in height.
- In case of service station 1.2 meter high boundary wall or fence on sides other than the drive way shall be provided.
- Precautions shall be taken to prevent unauthorized persons from having access to any storage shed or installation.

Petroleum only to be stored

No installation, service station or storage shed shall, without permission in writing from the Chief Controller be used for any purpose other than the storage and distribution of petroleum and for purpose directly connected there with.

Prior approval of specifications and plans of premises proposed to be licensed

- Every person desiring to obtain a license to import and store petroleum in Form XIV, Form XV, Form XVI or in Special Form, as the case may be, shall submit to the licensing authority an application along with,-
  - Specification and plans drawn to scale in duplicate clearly indicating,
  - The manner in which the provisions prescribed in these rules will be complied with;
  - The premises proposed to be licensed, the area of which shall be distinctly colored or otherwise marked.
  - The surroundings and all protected works lying within 100 meters of the edge of all facilities which are proposed to be licensed;
  - The position, capacity, materials of construction and ground and elevation view of all storage tanks, enclosures around tanks, all valves, filling and discharge points, vent pipes, dip pipes, storage and filling sheds, pumps, fire-fighting and all other building and facilities forming part of the premises proposed to be licensed;
  - The areas reserved for different class of petroleum including petroleum exempted under section 11 of the Act; and
  - A scrutiny fee of rupees four hundred paid in the manner specified in rule 13.

- If the Chief Controller, after scrutiny of the specification and plans and after making such enquiries as he deems fit, is satisfied that petroleum may be stored in the premises proposed to be licensed, he shall return to the applicant one copy each of the specifications and plans signed by him conveying his sanction subject to such conditions as he may specify.

Pumping:

No internal combustion engine or electric motor in an installation shall be used for driving pumps for pumping petroleum save in a pump house or pumping area specially constructed for the purpose and approved by the Chief Controller.

5.3 STORAGE OF PETROLEUM CLASS “C” NOT REQUIRING A LICENSE

Application

- The provisions of this chapter shall apply to petroleum Class C stored otherwise than under a license as provided in section 7 of the Act but shall not apply to petroleum Class C in the possession of the Defense Forces of the Union.
- The provisions of Chapter V shall not apply to petroleum Class C permitted to be stored without a license under section 7 of the Act.

Restriction of Storage:

Petroleum Class C shall not be stored together with any other class of petroleum except under and in accordance with a license granted under these rules.

Storage of exempted Petroleum Class C in bulk:

- Petroleum Class C in bulk shall be stored in a tank constructed of iron or steel or any other material approved in writing by the Chief Controller.
The tank referred to in sub-rule (1) shall be properly designed and erected and the tank with all its fittings shall be so constructed and maintained as to prevent any leakage of petroleum.

All tanks of capacity exceeding 5,000 liters for the storage of petroleum Class C shall be surrounded by an enclosure wall or placed inside a pit, so constructed and maintained as to be able to contain without leakage the maximum quantity of petroleum capable of being contained in largest tank within such enclosure or pit.

A drainage pipe with a valve capable of being actuated from outside the enclosure wall shall be provided in the enclosure or pit referred to in sub-rule (3) and the valve shall be kept closed.

A distance of not less than 1.5 meters shall be kept clear between protected works and the edge of such enclosure wall or pit.

Storage of Petroleum Class C in non-bulk:
Petroleum Class C which is not in bulk shall, if the quantity at any one time exceeds 2,500 liters be stored in a storage shed of which either.

The doorways and openings shall be built up to a height of 30 centimeters above the floor, or

The floor shall be sunk to a depth of 30 centimeters.

Prior report of storage of Petroleum Class C:
Every person intending to store petroleum Class C in quantity exceeding 5000 liters otherwise than under a license shall submit the following to the Chief Controller before commencing storage-

plans drawn to scale of the storage facilities showing compliance of rule138 and site plan of the storage premises and surroundings up to 100 meters identifying the locations of premises; and A scrutiny fee of rupees five hundred.

5.4 FACTORIES ACT AND RULES
Storage of flammable liquids

The quantity of flammable liquids in any work room shall be the minimum required for the process or processes carried on in such room. Flammable liquids shall be stored in suitable containers with close fitting covers.

Provided that not more than 20 liters of flammable liquids having a flash point of 21 degrees centigrade or less shall be kept or stored in any work room.

Flammable liquids shall be stored in closed containers and in limited quantities in well ventilated rooms of fire resisting construction which are isolated from the remainder of the building by fire walls and self-closing fire doors.

Large quantities of such liquids shall be stored in isolated adequately ventilated building of fire resisting construction which is isolated from the remainder of the building by fire walls and self-closing fire doors.

Effective steps shall be taken to prevent leakage of such liquids into basements, sumps or drains and to confine any escaping liquid within safe limits.

Accumulation of flammable dust, gas fume or vapor in air or flammable waste material on the floors
Effective steps shall be taken for removal or prevention of the accumulation in the air of flammable dust, gas, fume or vapor to an extent which is likely to be dangerous.

No waste material of a flammable nature shall be permitted to accumulate on the floors and shall be removed at least once in a day or shift, and more often, when possible. Such materials shall be placed in suitable metal containers with covers wherever possible.

Fire exits

"horizontal exit” means an arrangement which allows alternative egress from a floor area to another floor at or near the same level in an adjoining building or an adjoining part of the same building with adequate separation; and

“Travel distance” means the distance an occupant has to travel to reach an exit.

An exit may be a doorway, corridor, passageway to an external stairway or to a verandah or to an internal stairway segregated from the rest of building by fire resistant walls which shall provide continuous and protected means of egress to the exterior of a building to an exterior open space. An exit may also include a horizontal exit leading to an adjoining building at the same level.

Lifts, escalators and revolving doors shall not be considered as exits for the purpose of this sub-rule.

In every room of a factory exits sufficient to permit safe escape of the occupants in case of fire or other emergency shall be provided which shall be free of any obstruction.

The exits shall be clearly visible and suitably illuminated with suitable arrangement, whatever artificial lighting is to be adopted for this purpose, to maintain the required illumination in case of failure of the normal source of electric supply.

6. ASSESSING THE RISKS IN PAINT SHOPS

6.1 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:

- 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 electro pump drives the electro statically charged liquid paint out of the nozzle which is then applied to the object which is earthed.

8.1.2 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. Process The powder coat process is pretty basic and relatively straightforward. The secret is in the actual material—a combination of finely ground plastics with various hues and pigments, which determine the final color of the finished product. This powder is applied to the surface being powder coated via electrostatic transfer. We’ll explain what this means a little later. A wide range of items can be powder coated but there’s always one common denominator. The key to having an amazing-looking finished product, a chassis in our case, is very similar to painting a body—it all lies in how well you prepare the surface of the part you’re powder coating. There can’t be any rust, metal shavings, paint, or any other foreign matter on the surface being powder coated or the granules won’t properly adhere to it. You have two choices to accomplish this task: sandblasting or chemical washing. If you read “Bomber Foundation” (on page 58), then you know that Frank Kimmel and his crew chose to sandblast the frame and usable parts of a ’76 Chevelle. While both methods are acceptable, I, like Frank, personally prefer sandblasting largely because it creates a rough surface that will only assist the powder coat in sticking to the frame. Once the sandblasting or chemical washing is completed, you have to ensure that the chassis is completely dry— but simply letting it air dry will not be enough. It has to be 100 percent dry, so it’ll be baked in a large oven at 300-350 degrees for approximately 30 minutes. Once the part is completely dry and clean, it’s time to apply the powder coat. Like we said before, the powder coat is finely ground plastics made up of hues and pigments. It’s applied dry with a special powder coating gun that resembles a hairdryer. The gun simultaneously applies an electrostatic charge to the powder coat granules and metal. This basically means that the electrostatic charge holds the granules in place on the chassis/frame until it gets baked in the oven. The baking step involves moving the chassis into a very large oven where it will get baked for 45 to 60 minutes at 350 degrees F. This process melts and cures the powder granules and pigments onto the chassis in one step. The result is a very even and uniform look along with an exceptionally durable finish. Advantages of powder coating some might say that the main advantage of powder coating your frame is because of the great uniform finish and availability of many vibrant colors. Granted, there are no drips, runs, or puddles with powder coating but realize that painting offers just as many color options, and in some cases more. And while those odd color options may be available in powder coating too, they can drive the cost up. No, the main advantage to powder coating your frame is the durable finish that the powder coating process leaves. Ultimately, powder coating’s main purpose is to protect and preserve the metal. If you were to paint your chassis and then, while bleeding the brakes, accidentally spill brake fluid on it, the brake fluid would eat through the paint and leave bare spots on the frame. However, that won’t happen with a powder coated frame. The finish is chemical resistant and all you would have to do is wipe up the spilled fluid. Another advantage with powder coating is that as soon as the chassis cools it’s ready to be handled, unlike paint which can take up to a couple of days to cure before it’s ready to touch. With powder coating, Frank and his crew can get right back to work on Project Bomber. An added benefit is that when properly done, powder coating is a very “green” process, in other words it’s really environmentally friendly. The idea of “green racing” is still a somewhat new phenomenon, but powder coating really fits the bill. The powder granules are not a significant health, fire, or environmental hazard. In its dry form, it’s called a nuisance dust largely because it will make a dusty mess if it gets spilled. However, there’s nothing dangerous about it. It has virtually no volatile organic compounds, or VOCs, it’s not flammable, and is non-carcinogenic. Compare that to wet automotive paint which is flammable, carcinogenic, and full of VOCs. In addition, because the powder coat granules are applied in dry form, electrostatically, very little is ever wasted. Some professional powder coaters report 95 percent of the granules ending up on the parts being coated. In some cases, powder that doesn’t end up on the parts can even be reclaimed and reused by sweeping the floor and putting it back in the gun. As a comparison, wet paint-transfer efficiencies can easily drop below 50 percent, and overspray goes right into the atmosphere creating a big hole in the ozone layer unless, of course, you’re inside a paint booth with the proper air reclamation system. Are there any disadvantages? A quick and simple answer—not really. If there’s one disadvantage to powder coating it’s the fact that the process is not something you can do yourself. You’ll need to get it professionally done, but that’s not necessarily a bad thing. 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...
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.

7. CONTROLLING THE RISK IN PAINT SHOP

7.1 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:

7.1.1 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

7.1.2 Isolation

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

7.1.3 Implementing engineering controls

- Use control measures such as ventilation systems, including spray booths, to reduce exposure to vapors 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

7.2 CONTROLLING THE RISKS OF SPRAY PAINTING

7.2.1 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).

7.2.2 Types of Spray Booths Include

Open-faced spray booths generally have two walls, roof with air extraction, a filtered rear wall and an open 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.
- Tunnel or production spray booths for mass produced items requiring a continuous painting application process. These booths are usually down draught or cross draught and have open ends.
- Full downdraft spray booths, where air enters the booth from the ceiling through a filtering system, and moves downwards vertically. Heavy and large objects, like cars, which are not easy to handle are often painted in the down draft spray painting booths.
- Semi downdraft booths, where fresh air enters the booth from outside the building, is ducted through the roof intake filters, and is drawn towards the rear exhaust wall of the booth where it is exhausted through filters.

7.2.3 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,
- be inspected at regular intervals and maintained according to manufacturer’s specifications, and
- Have a sign indicating the time people should allow for chemicals to clear before entering the spray booth.

7.2.4 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. RESULTS AND DISCUSSIONS

8.1 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 liquids, 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.

8.5 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.

8.6 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.

9. 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.

10. REFERENCE


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