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Control of the Health Hazards Incidental to Spray Painting

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CONTROL OF THE HEALTH HAZARDS INCIDENTAL TO SPRAY PAINTING

Changes in the painting industry in the last twenty years have affected both materials and methods of application. Chemists are constantly developing new substances, and in particular, the cellulose lacquers and synthetic resins, which have taken the place of paint for many purposes. Faster methods of application have been developed, such as spraying or dipping tanks, and these are rapidly eliminating the old hand brush method. The introduction of the spray gun has brought many changes in the painters' trade. Formerly, brush work was considered as skilled labor but any man with ordinary intelligence can learn to spray in a short time. Consequently the use of spray guns in many instances has fallen into the hands of workers who admittedly have little or no knowledge concerning the harmful ingredients of the materials used. The use of these new substances and new methods of application has and will continue to increase the possible health hazards in this industry.

The extent of the hazards in connection with spray-painting or spray-coating work depends upon the nature of the ingredients of the coating used and upon the proper use of precautionary measures. Unfortunately, the toxicity of these new compounds may be entirely or practically unknown and a constant vigilance and an increasing use of proper safeguards are essential to health protection.

In general the danger from coatings lies not in the solid part but in the liquid portion or vehicle—solvent. The use of lead pigment has been displaced to a large extent by other materials which are for the most part harmless. Thus the dangers from the highly toxic lead compounds are gradually giving away to much less harmful substances. Lacquer solids, with the exception of a few types of pigments, are usually quite free from harmful effects on the worker who breathes them.

The toxicity of the liquid portion depends largely on the evaporation of the volatile liquid fraction, because the more volatile the liquid, the more quickly is the air in the workroom contaminated. A quick drying thinner is therefore always to be regarded with suspicion. The degree of harmfulness depends upon the particular toxic property of the solvent upon the human body. While the tendency in recent years has been to eliminate the more dangerous of the solvents and the present use of coatings is far less dangerous than it was a few years ago, no solvent can be classed as being inert.

It is often heard that "your nose knows," but this saying does not apply to solvent vapors. Benzol does not have as penetrating an odor as amyl acetate but it is considerably more toxic. Solvent vapors in general do not possess properties of irritation to nose and throat but rather the odors are pleasant, which means absorption goes unnoticed and the worker does not realize the air he is breathing is injurious to his health.

Solvents and diluents may be divided into several groups[1] according to their chemical structures, such as: (1) Ester Solvents. These usually consist of methyl, ethyl, propyl, butyl and amyl acetates. (2) Ketones. These are widely used and their action is similar to the alkyl esters. (3) Ethers. These are usually the mono-methyl, mono-ethyl and mono-butyl ethers of ethylene glycol. (4) Hydrocarbons. Those in use are usually benzine (petroleum naptha), benzol (benzene), toluol, xylol and mixtures of these and some of the higher aromatic hydrocarbons. (5) Alcohols. Usually methyl, ethyl, propyl, butyl and amyl alcohols, in addition to the cyclohexanols, are used in lacquers. It should be remembered that the toxicities of the volatile lacquer components are not necessarily dependent upon the harmfulness of each ingredient. Paints and lacquers contain mixtures of organic solvents and the toxicity of the mixtures of these materials in the majority of cases is not known. It should be remembered that any volatile organic material will produce narcosis or asphyxia if present in sufficiently high concentrations. Some of the solvents, such as benzol, toluol, butyl alcohol and others, are known to have a serious damaging effect upon the blood.

Control of the Health Hazard

Of course the most efficient way to protect the health of the painter is to select coatings that are free from poisonous constituents, but this is an impossibility, since there are over one thousand paint manufacturing plants in the United States and these use so many and varying formulae, including many new materials, the harmfulness of which is not known, that research laboratories could devote all their time to studying the toxicity of these materials and products of the paint industry and still be unable to keep up to date. Much has been accomplished in recent years in the control of the painting hazard by the elimination of certain toxic substances or by reducing their concentrations in the lacquer. It is known that benzol and methyl alcohol have been for the most part eliminated from lacquer solvents. Continued research will make possible the avoidance of the use of these more toxic substances and still retain the desirable properties and characteristics of the coatings. Until these paints and lacquers have reached a state where they are non-toxic to the employee, we must resort to other protective measures.

Since the usual route of the absorption of volatile substances is through the lungs, the important item in control

is to minimize the concentration of vapors in the atmosphere breathed by the worker. If the concentration of solvent vapor is kept below a certain limit specific for each solvent, then it may be considered that the condition is non-injurious.

During spraying operations, the paint or lacquer is broken up into fine droplets or mist. A certain amount of the mist contaminates the working atmosphere and must not be breathed in the amounts given off by spray painting. This air contamination, as well as being a hazard to health, is also a potential explosive and fire hazard. Spray-painting operations should be conducted within an enclosure or booth which is constantly ventilated for the removal of the fumes. Figures 1 and 2 illustrate a typical design of spray booths.

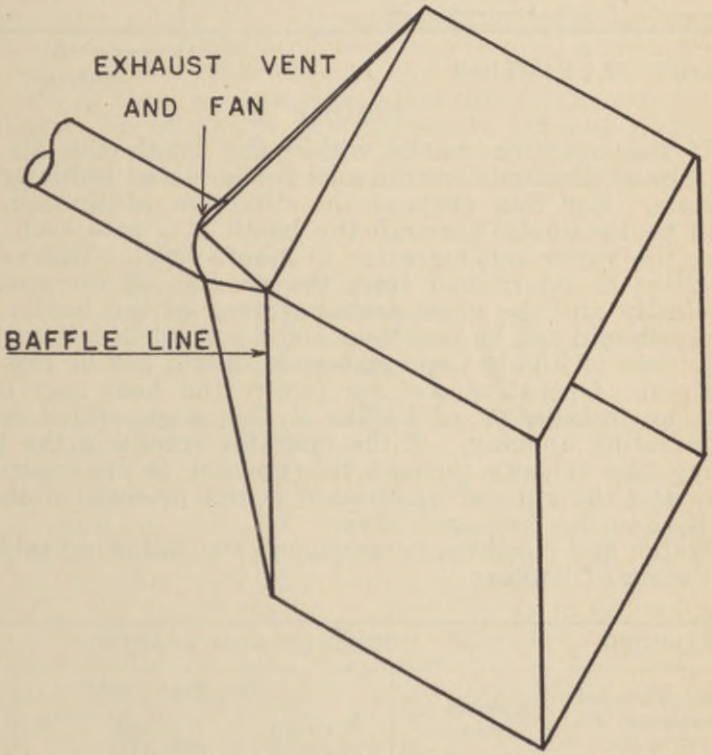

FIGURE 1

The size and depth of the booth are dependent upon the magnitude and shape of the objects to be sprayed. Likewise the position of the operator is important in determining the size of the booth. If the operator remains outside as with a bench booth, then the dimensions are made as small as possible to permit the work. The depth should be greater than the cross sectional area in order to permit operation of the spray gun well within the booth. This will allow for exhausting the mist before it can escape into the air in the workroom. Air velocity should not be less than 100 f.p.m.

and in cases where benzol, lead or other highly toxic substances are present, the air velocity should not be less than 150 f.p.m.

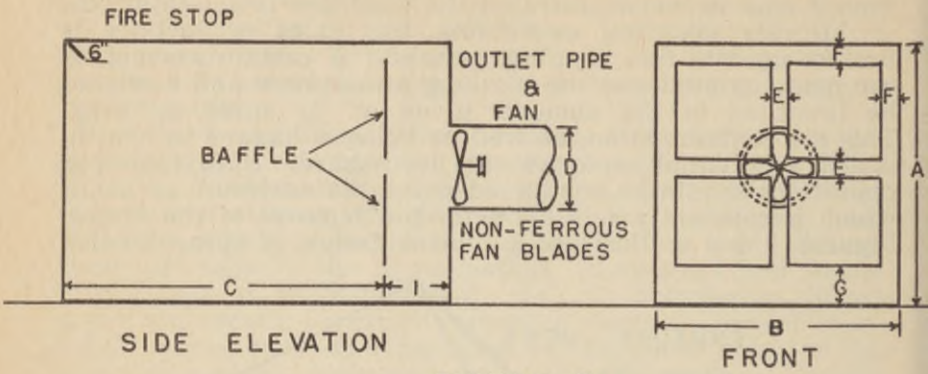

FIGURE 2

If the operator works within the booth the air flow should be so directed that the mist is eliminated in his breathing zone. For this purpose the direction of the air flow should be horizontal through the booth at a rate such as to reduce the vapor concentration to a safe level. This rate of ventilation is determined from the product of the specified air velocity and the cross sectional area of the booth. Air velocity should not be less than 100 f.p.m. at breathing zone and in case of highly toxic materials should not be less than 150 f.p.m. Operating cost for power and heat may be reduced by installation of baffles or fire stops which reduce the operating opening. If the operator stands in the booth opening, the velocity through this opening is the controlling factor and the rate of ventilation is the product of the air velocity and the free open area.

Hatch and Northrup[2] recommend the following table for installation of baffles:

BAFFLES	NUMBER AND SPACING			
Cross-Sectional Dimensions: Ft. (A x B)	Number of Panels	Spacing: Inches		
		Between Panels (E)	Top and Side (F)	Bottom (G)
3 x 3	1	*	*	*
6½ x 4	3	4	6	12
6½ x 6	4	4	6	12
6½ x 8	6	4	10	12
6½ x 10	9	6	10	18
9 x 12	9	8	12	18
12 x 14	12	8	18	24

* For booths 3′ x 3′ and smaller: 1 panel 6″ larger than fan diameter

The air outlet from the spray booth should be direct to the outside, either through a wall or discharged at some point above the roof. Precautions should be taken in the location of the point of discharge so that the solvent vapors do not enter occupied rooms through open windows and doors.

The construction of piping should follow modern engineering standards, and cleanout openings should be installed near the fan and at bends.

Fresh-air inlets for the booths should be free from harmful materials and should be clean, so that the painted surfaces will not be contaminated. The air should be heated to prevent rapid cooling of the operation during cool weather. Air inlets should be arranged so as to prevent any short circuiting of the air currents in the booth.

In cases where it is impracticable to conduct spray painting operations in ventilated booths or rooms, as encountered in the spraying of large objects, the vapors can be controlled by means of local exhaust ventilation through floor-type grille openings. These grilles are essentially exhaust hoods in a face-up position in which the floor itself acts as a flange. The quantity of air required can be computed from the following formula:

$Q = V (10X^2 + A)$
Q = Cubic feet per minute
V = Controlling air velocity (f.p.m.)
X = Distance from source to face of hood (feet)
A = Area of hood opening (sq. ft.)

For ordinary spray painting work, V can be assumed to be 75 f.p.m. and X to be 3 feet.

For fire prevention the following items should be considered: (1) All parts of the booth should be constructed of fire resistant material, (2) all electric lights inside the booth should be of the vapor proof type and no motor, switches or other sparking devices should be located inside the booth, (3) booths should be kept free from accumulations of material and should be cleaned periodically, and (4) all materials should be mixed and stored in a fireproof room.

After the materials have been sprayed they are usually stored nearby the operation to dry. The vapors given off during this drying process should be exhausted either by means of a well-ventilated room or by local exhaust ventilation as used for exhaust tables or grille openings.

Personal Protective Respiratory Equipment

The use of positive pressure respirators, if properly designed and operated, will furnish adequate safeguard against inhalation of paint fumes. These require the accompanying air pump and hose line through which fresh air is delivered into the respirator. However, this type of respirator with its hose attachment is not entirely satisfactory for all purposes, particularly if the painter must travel around con-

siderably or work on scaffolds or walk planks. Where the concentration of paint or lacquer vapors is particularly high, the positive pressure hooded masks have been found to be satisfactory.

While there are available commercially several types of filter respirators, it should be remembered that with the exception of the specially approved respirators, they are of little or no value for protection against organic vapors and mists. **Dust respirators do not give protection in spray painting.** In respect to the chemical cartridge respirators, these are provided with special chemical filters designed for specific vapors, and with their use particular attention should be given to the replacement of the chemical filters at such times when they become inefficient in filtering out the solvent vapors. The United States Bureau of Mines has approved a number of respiratory protective devices which have satisfactorily passed tests for effectiveness in protecting the wearer against dust, fumes, mists, and gases. A list of these approved devices may be obtained upon request to this department.

Paint Dermatitis

Solvents may be absorbed directly through the skin. Contact with the skin may lead not only to systemic poisoning but also to irritation of the skin itself. The dermatitis is due to allergy to the varied ingredients, to the solvent action of the volatile substances or to the practice of painters washing with gasoline or other solvents. Control of paint dermatitis can be accomplished by means of protective clothing, such as overalls, caps, gloves, through the use of protective skin creams, such as lanolin, vaseline or other water soluble creams, and by preventing the use of solvents for washing.

The deciding factors as to what type of control is to be used always must be the nature and amount of vapors to be removed and controlled. The Industrial Hygiene Division of the New Hampshire State Board of Health is prepared to aid the industries of New Hampshire by determining whether a hazard to health exists and by recommending the most inexpensive and practical control measures.

References

[1] Hazards Incidental to Industrial Uses of Nitrocellulose Lacquers. Indust. Bull., New York Dept. of Labor, 17, 314 (July 1938) Burk, William J., and Goldwater, Leonard J.

[2] Hatch, Theodore, Northrup, Robert B. Exhaust Booth Designed to Insure Health and Safety in Spray Painting. Indust. Bull., New York Dept. of Labor, 18, Sept. 1939.