

CHAPTER 26.0

SAFETY AND HEALTH IN THE PROTECTIVE COATINGS INDUSTRY

by

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I. INTRODUCTION

In 1991, 6.3 million U.S. workers became ill or were injured on the job. The total includes both minor discomfort and serious injury. Roughly 8 people in every 100 were affected. Of course, some industries are more dangerous than others. In the painting and paperhanging industry, (no breakdown for painting only is available), the rate was somewhat higher than average — 9.9 per hundred, while the injury rate for ship building and repairing was 44.1. By contrast, the rate in the financial industry was only 2.3 per hundred.

Workers in the painting industry have to be alert to the possibility of falling from scaffolds, being struck by material falling from above, becoming caught or being electrocuted by the machinery their jobs require. They also need to be aware of occupational illnesses that may result from coating and coating removal operations. Exposure to lead pigments and silica in abrasives can cause serious and even fatal illness. Various solvents affect the nervous system and are known or possible carcinogens.

About 2,800 workers were killed on the job in 1991, or 4.3 per 100,000 full-time workers. According to the Bureau of Labor Statistics, although fatalities are not available for the painting industry alone, the incidence is not much higher than this national average.

These figures suggest that it is in the best interest of everyone engaged in the painting and coating trades, employers, employees, managers and suppliers, to take health and safety issues quite seriously.

A. COST BENEFITS FROM SAFETY

Of course no company wants to see workers hurt or killed, but there are also external incentives to safety, particularly the costs of such incidents. Lost worktime decreases worker productivity and lowers morale.

Many facility owners and general contractors are pre-qualifying contractors based on their safety record, and companies cannot afford to present the image of safety being anything but a top priority.

Workers compensation and health care costs are becoming more of a drain on all businesses, particularly small companies, and any costs that can be avoided will benefit

these firms. An effective safety program may help reduce these costs. While the workers compensation system has traditionally precluded a worker suing an employer for workplace injury, various exceptions have been granted by the courts, and more can be expected to follow. For instance, because several different entities are often involved in a painting job, an injured worker employed by a contractor may bring suit against a third party such as the specifier.

B. ROLE OF OSHA, NIOSH, AND OTHER ORGANIZATIONS AND SAFETY PROFESSIONALS

In 1970, Congress passed the Occupational Safety and Health Act, which created the Occupational Safety and Health Administration, a division of the Department of Labor. OSHA is responsible for developing and enforcing mandatory job safety and health standards.

OSHA receives assistance from NIOSH, a complementary agency established under the Act as a branch of the Department of Health and Human Services. NIOSH conducts research on safety and health issues, and provides technical assistance to OSHA.

Safety and health organizations such as the American Industrial Hygiene Association, the American Conference of Governmental Industrial Hygienists, the American Society of Safety Engineers and the National Safety Council provide information to help managers with many other responsibilities, as well as the health and safety professional, stay abreast of developments in this rapidly changing field.

Professional organizations for the painting and coating trades, such as the Steel Structures Painting Council, the International Brotherhood of Painters and Allied Trades, the National Paint and Coatings Association and the Painting and Decorating Contractors of America, can provide information specific to the industry.

C. WHY OWNERS AND SPECIFIERS NEED TO BE AWARE OF SAFETY AND HEALTH

Owners and specifiers have a stake in ensuring that contractors they employ have the capability to comply with health and safety regulations. Many painting specifications require the successful bidder to comply with all applicable safety regulations during the performance of a contract. In order to comply, a contractor must know what materials employees

*Authors of Chapter 5.3, "Safety in Paint Application," from the second edition of Volume 1, portions of which have been incorporated into the current chapter.

may be exposed to and what federal, state and local regulations require. The contractor must also be familiar with various approaches to compliance, including engineering, work practice and administrative controls, air and personnel monitoring and the proper use of personal protective equipment.

A contractor who does not have the expertise to keep abreast of safety regulations and to comply with them may be subject to regulatory fines and civil and criminal liability. The owner who hires such a contractor runs the risk of being included in legal actions against the contractor. For instance, according to OSHA guidance to inspectors, when one employer is not meeting requirements to inform employees of workplace chemical hazards at a multi-employer work site, the other employers may be cited also.

Contractors who do not make health and safety a priority often suffer reduced productivity and lower worker morale. The owner may also be affected by unnecessary work stoppages and slow downs, and unfavorable publicity as a result of a serious accident or pattern of occupational injury and illness at its work site.

Contracting firms who value their employees and practice safety on each job every day will reap many benefits not only for themselves but for the owners that hire them. Good safety performance reduces lost work hours, which in turn reduces the contractor's insurance costs while increasing productivity. A contractor with lower insurance costs can do the job at less cost to the owner. Everybody wins.

D. RESPONSIBILITIES OF EMPLOYERS, EMPLOYEES AND INSPECTORS, CONSULTANTS AND ENGINEERS

Conscientious painting contractors have written safety programs based on all safety standards applicable to the industry, and make every effort to routinely train their employees to comply with the written program. Many progressive firms have active safety committees which include management and worker representatives and continuously refine the safety program and refer suggestions for improvement to upper management.

A truly professional contractor evaluates the hazards of each job undertaken before any equipment is brought on site, and develops a plan to control the hazards expected during each phase of the job. For example, the project manager may hold a pre-job safety meeting with workers and supervisors, and follow up with weekly tool box meetings with workers to ensure that expected hazards are being controlled and unexpected hazards are recognized as they develop. Daily routine job site safety inspections by the person responsible for safety and health are also advisable. Workers who consistently violate safety regulations should be suspended, and in some cases terminated.

Owners and specifiers can reduce the odds of contractor safety violations by pre-qualifying contractors before they allow them to submit a bid. OSHA's recent regulation on process safety management (PSM) requires owners in the chemical process industry to evaluate the safety record of

contractors before they are hired. Although other sections of the industry are not required to do this, it is a good way for them to protect themselves.

Examples of indicators to measure a firm's safety performance include the contractor's worker's compensation experience modification rate (EMR), total cases and lost workday incident rates and serious and willful OSHA citations.

In addition to pre-qualifying contractors, owners and specifiers should routinely outline in their specifications the safety responsibilities of the contractor and enforce the safety and health section of the specification just as stringently as the quality assurance sections. Owners can also require the low bidder to submit a site specific safety and health plan which the owner must approve before awarding a contract.

II. HAZARDOUS OPERATIONS IN THE PROTECTIVE COATINGS INDUSTRY

A. MATERIALS

1. Fire Hazards and Explosions

a. *Causes* — Most solvent-thinned paints and paint solvents are highly flammable and extremely dangerous when they, or especially their vapors, are exposed to open flames, sparks or very high temperatures. The results may be fire or explosion, if in a confined area, unless proper precautions are taken. A certified industrial hygienist or certified safety professional should be consulted for advice about safe working conditions, particularly in confined spaces.

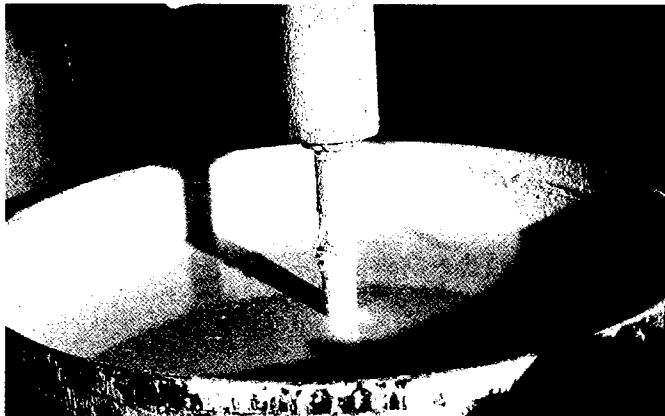


FIGURE 1
Paint vapors can be flammable if adequate ventilation is not provided.

b. *Flammability of Paints* — Many solvent-thinned paints are flammable and precautions need to be taken when handling these types of coating systems. Two examples of solvent-thinned paints include:

- (1) *Two-Component Paints* - Two-component paints should never be mixed in large quantities, generally no more than five gallons at a time.

They usually create heat because they react immediately upon mixing. The larger the volume mixed, the higher the temperature. The temperature may become high enough to create a hazard.

(2) Oil Paints and Specialty Coatings - Waste or wiping rags soaked with paints based on linseed oil may catch fire spontaneously if left lying around, especially during warm weather. Spillage of peroxide catalysts used in polyester laminates and other similar chemicals can cause combustion.

c. Flammability of Solvents and Thinners — Most paint solvents and the solvents used in solvent-thinned paints are volatile and will flash in the presence of a flame or electric spark. Usually, the faster the solvent evaporates — the lower its flash point. Therefore, solvent-thinned brushing or rolling paints, which dry relatively slowly, will contain solvents with a flash point of about 105°F or somewhat higher. A solvent-thinned spray paint that requires fast evaporating solvents may contain solvents that flash as low as 30°F. A spray gun, which applies a pint to many quarts of paint per minute under high pressure, will produce a greater volume of solvent vapor than brushes or rolled paint. Therefore, all spray equipment must be grounded to prevent accidental ignition by static electricity. This includes containers. Painters should bond their empty bucket to the bulk drum while filling it and the drum should be properly grounded.

Pure solvent vapors are heavier than air and tend to move along the ground when in confined areas. Thus, all flames near the area must be extinguished. Solvent vapors must be mechanically exhausted from all enclosed areas with the ventilation designed for efficient air flow. Explosion proof lights must be used. All electric motors should be turned off.

d. Prevention of Fires — The following precautions will help prevent the possibility of fires:

- (1) Store solvents in Underwriter's Laboratory (UL) listed containers.
- (2) Prohibit smoking anywhere solvent-thinned paint is stored, mixed or used. Allow no other sources of ignition such as electric coffee pots, hot plates, or other such appliances in the area.
- (3) Provide adequate ventilation in all working areas to prevent a build-up of explosive concentrations of solvent vapor. Properly calibrated direct reading detection instruments should be used to monitor confined areas or closed spaces to be sure vapor concentrations are maintained below explosive limits.
- (4) Do not use metal ladders in confined areas or within 10 feet of exposed electric wiring.
- (5) Use non-sparking tools to clean metal sur-

faces where fire hazards are present.

(6) Extinguish all sources of flame in the area. Turn off all gas valves and open all electrical switches if working in confined areas or near electrical equipment.

(7) Be sure that all equipment, motors and lights in the area are grounded and consider using only explosion proof lighting.

(8) Keep fire extinguishers nearby. Be sure that they are of the proper type, as follows:

Class A - Paper, wood, rubbish, where water is effective;

Class B - Burning liquids, where smothering action is required;

Class C - Electrical equipment, where the extinguishing agent must be non-conductive.

(9) Keep pails of sand or similar absorbent materials near dispensing pumps and spigots to absorb any spills. Replace all leaking containers.

(10) Clean up before, during and immediately after painting operations. Wet down sweepings, rags and waste with water and store in closed metal containers. Dispose of daily.

(11) Always clean up paint or solvent spills immediately.

2. Health Hazards

a. Causes — A variety of paint ingredients or chemicals may be harmful to the human body. For instance, some chemicals may cause irritation, sensitization, central nervous system effects, or systemic effects. Most people can withstand chemical exposures for short periods of time at low doses; however, some people are immediately sensitive to some ingredients and almost everyone will be affected to a degree if exposed for a sufficient period of time. Continued exposure may cause the body to become sensitized so that subsequent contact may result in an aggravated reaction, especially for anyone with a chronic illness.

b. Types and Components of Paints — The term paint is commonly used to identify a range of products including conventional paints, varnishes, enamels, and lacquers. Conventional paint is an inorganic pigment dispersed in a vehicle consisting of a binder and solvent, with selected fillers and additives. Varnish is a nonpigmented product based on oil and resin in a solvent that dries first by the evaporation of the solvent and then by the oxidation and polymerization of the resin binder. A pigmented varnish is called an enamel. Lacquers are coatings that are commonly based on a cellulose ester in a solvent that dries by evaporation leaving a film that can be redissolved in the original solvent.

(1) Alkyd Paints — employ metal soaps of organic acids to catalyze the oxidation of the drying oil component. Because lead soaps are commonly used, lead is a potential hazard in any drying-

oil-type paint (alkyd, epoxy ester, oleoresin, and urethane-oil). Lead used as an oxidation catalyst may comprise 0.5 to 1.0 percent of the paint solids by weight. (See also discussion of lead under pigments.)

(2) Liquid Epoxy Resins and Curing Agents - are primarily used in solvent-borne and waterborne two-component epoxy paints. These liquid resins are modified by the addition of reactive diluents (glycidyl ethers). These reactive diluents are themselves irritants to the skin, the eyes, and the respiratory tract.

(3) Aliphatic and Aromatic Polyamines, Polyamine Adducts and Polyamides - are used as curing agents in two component epoxy coating systems. The aliphatic amines are potent irritants and sensitizers; the aromatic amines are somewhat less potent. The polyamide resins are relatively harmless. Acid anhydrides and formaldehyde resins are used as cross-linking agents in powder coatings and baking enamels. The acid anhydrides are irritants and sensitizers. Formaldehyde is a strong irritant and is also considered a human carcinogen.

(4) Epoxy Resins - are commonly reacted with fatty acids to produce epoxy esters. Because coatings produced with these resins contain no unreacted epoxy groups, no hazard exists.

(5) Urethane Resins - organic isocyanates are the principal hazard associated with urethane coatings. Isocyanates can cause severe irritation to the conjunctiva, and respiratory distress. They react with various protein functional groups and should be capable of forming antigens. A typical response to isocyanate inhalation, either as a vapor or an aerosol, is the manifestation of an asthma-like syndrome, characterized by a feeling of chest constriction and difficult breathing, sometimes accompanied by a dry, irritant cough. A small percentage of the population may become sensitized to isocyanates, whereupon the above symptoms are produced on exposure to even low airborne concentrations. The toxicity can be minimized by avoiding use of smaller molecular weight species.

c. Hazards of Solvents and Thinners — Most solvents are toxic to some degree, depending upon exposures. Solvents may enter or affect the body in three ways. The most frequent way solvents affect the body is by skin contact. When a solvent is allowed to contact the skin, even for a short period of time, it will start to damage the skin or cause dermatitis. Dermatitis is reddening and swelling of the skin. The second route of entry of solvents into the body is by breathing, or inhalation.

Once solvents are inhaled, the vapors can pass from the lungs directly to the blood. The solvent

may irritate the respiratory tract and/or cause adverse health effects to other body systems by being transferred via the blood stream. The third route of entry of solvents into the body is by ingestion. Ingestion of solvents may affect the gastrointestinal tract as well as other body organs. The following precautions should be used while working with toxic solvents:

- (1) Properly label, seal and store all toxic solvents when not in use.
- (2) Adequately ventilate all areas where solvents are used or stored.
- (3) Wear the proper respirator and eye protection.
- (4) If a solvent gets splashed into the eye, immediately flush the eye with water for a *minimum of fifteen minutes* and seek medical attention.
- (5) Wear the appropriate gloves and clothing when handling solvents.
- (6) Practice good personal hygiene after handling any solvents.
- (7) Consult the Material Safety Data Sheet (MSDS) to determine the toxicity of the material that is in use, and the specified protective equipment needed when using the material.
- (8) If permissible exposure limits are exceeded, as determined through air monitoring conducted by an industrial hygienist, then engineering control and respiratory protection becomes necessary.

d. Prevention of Health Hazards — The following precautions should help reduce potential hazards. They describe a common sense approach to avoiding contact:

- (1) Identify and seal all toxic and dermatitic materials when not in use.
- (2) Adequately ventilate all painting areas. Provide general exhaust ventilation in the form of blowers/fans supplying "fresh" outside air to the work area where necessary and use National Institute for Occupational Safety and Health/Mine Safety and Health Administration approved respiratory protection equipment if the vapors cause irritation or intoxication.

When surface preparation involves removal of old paint films, take care to minimize dusting, to protect workers from the dust and to properly dispose of coating residues, in accordance with applicable state and federal regulations.

- (3) Wear goggles and the proper respirator when spray painting or performing any operation where an abnormal amount of vapor or dust is formed.
- (4) Wear appropriate gloves and clothing when handling dermatitic materials. Change and clean work clothing daily.
- (5) Avoid touching any part of the body when handling dermatitic materials. Wash hands, face and arms thoroughly before eating and at the end of

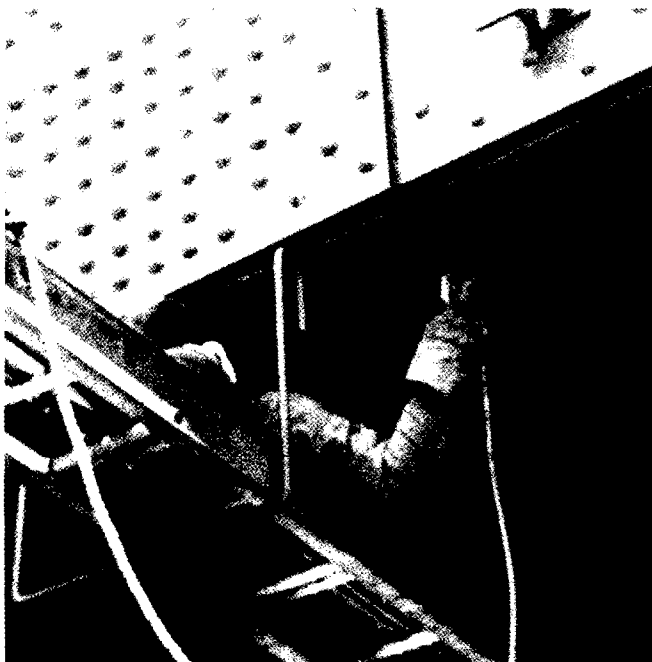


FIGURE 2

Eye and respiratory protection are needed for spray painting.

the day. Try to shower at or near the jobsite. Change clothing before leaving. Toxicants can be transferred easily.

(6) Paint removers containing solvents are often toxic. They should be used only with ventilation controls and/or respiratory protection.

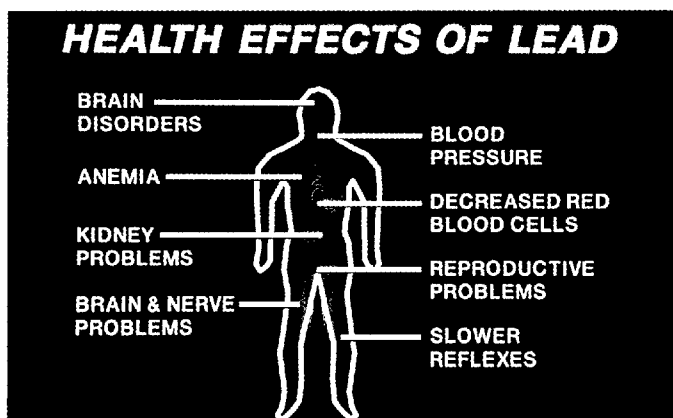


Table 1. Health Effects of Lead

e. Hazards of Pigments and Other Additives

(1) Heavy Metal Pigments - Pigments are another paint component that may be toxic to the human body. The most common contain lead, chromium, and oxides of iron, titanium, and zinc. Precautions such as ventilation, respirators, hygiene facilities, and personal protective clothing should be implemented when applying or removing paints containing these pigments. The substitution of hazardous pigments with non-hazardous pigments is the best method of controlling future occupational health hazards.

The removal of paints containing heavy metal pigments without control measures greatly increases an employee's chances of developing a heavy metal poisoning. Airborne pigments such as lead may enter the body by inhalation and ingestion. Exposure to lead may affect each person differently. Even before symptoms appear, lead may cause unseen injury to the body. During early stages of lead poisoning, mild symptoms may be overlooked as everyday medical complaints, including: loss of appetite, trouble sleeping, irritability, fatigue, headache, joint and muscle aches, metallic taste, decreased sex drive, lack of concentration and moodiness. Brief intense exposure or prolonged overexposure may result in severe damage to the blood-forming, nervous, kidney and reproductive systems. Some noticeable medical problems include: stomach pains, wrist or foot drop, high blood pressure, nausea, anemia, constipation or diarrhea, tremors, convulsions or seizures.

(2) Silica - Silica (both crystalline and amorphous) and the silicates clay, diatomaceous earth, mica, and talc are widely used as extender pigments. With the exception of clay, all have been demonstrated to produce fibrosis of the lung. A preliminary study of the health hazards in the painting trades suggested that "mixed dust pneumoconiosis" is common among painters. While extender pigments are used in substantial quantities in some paint formulations, these materials may be at least partially locked up by encapsulation in the resinous binder.

(3) Organic pigments - The chronic hazards posed by these materials are largely unknown. Many of the pigments are based on dyestuffs; the dyestuff is combined with an inorganic compound to produce an insoluble pigment. The dyestuffs have been studied more extensively than the pigments, and several have been implicated as cancer risks. In paint the biological availability of these materials is probably limited by the insolubility of the pigments and their partial encapsulation in the paint resin matrix. Fat and/or water soluble dyes are used in some wood stains, increasing the potential hazard.

(4) Activators and Catalysts - Activators and catalysts found in some coatings, such as mercury compounds, can be very harmful if proper protective clothing and respiratory protection is not used.

f. Hazards of Surface Preparation Materials

(1) Dusts and Abrasive Fines - Blast cleaning can turn paint, rust and substrate surfaces into a dust cloud consisting of many airborne particles, some too small for the naked eye to see. Whether or not any of the airborne dust particles are a potential health hazard depends on the size of the dust particles, the toxicity of the materials in the dust, and the amount of dust breathed into the lungs. To determine the toxicity of the dust refer to the MSDS for the abrasive in use, and identify the chemical makeup of the coating being removed and the substrate or object being cleaned. To control workers' exposures to potentially toxic dust, a well designed ventilation system should be installed. Respirators and proper protective equipment should also be used to ensure adequate protection.

Abrasive fines used to remove paint coatings that contain lead, cadmium, chromates, zinc or nickel should be treated as hazardous unless testing can prove otherwise. In addition, abrasives may contain small amounts of toxic heavy metals such as lead, copper, arsenic, cadmium and beryllium. Respiratory devices and protective clothing should be worn when working with abrasive fines. Of particular concern is the presence of silica (quartz) in sands and other mineral abrasives. (See below.)

(2) Silica and Silicosis - Chronic or acute short-term exposure to silica dust can cause a debilitating disease known as silicosis. Air-supplied respirators, operated in accordance with OSHA respiratory standard 1910.134, can protect blasters from this hazard. However, because of poor maintenance of respiratory equipment and poor hygiene, many workers have been exposed to and injured by excessive levels of silica. NIOSH recommended as early as 1974 that abrasive blasting be restricted to abrasive with a maximum of 1 percent silica content. In a recently issued Hazard Alert, NIOSH described specific health hazards from silica, and cited several case histories where blast cleaners had died from this condition. NIOSH also identified inadequate engineering controls, inadequate respiratory protection, and failure to conduct adequate medical surveillance programs as contributing to the development of silicosis. NIOSH recommends a series of measures, including substitution of alternative abrasives, air monitoring, use of containment structures, personal hygiene, protective

clothing, respiratory protection, medical monitoring, posting of warning signs, and worker training.

The Texas Department of Health also issued an advisory on the hazards of using silica abrasives to the oil and gas pipe coating industry. Both documents strongly recommend observing OSHA's PEL of 100 $\mu\text{g}/\text{m}^3$ based on an 8-hour time-weighted average.

(3) Chemical Strippers - Chemical strippers are used to soften the existing coating for removal by scraping and/or flushing. Chemical strippers eliminate airborne hazards but proper protective clothing such as coveralls, gloves and glasses should be worn to prevent skin and eye irritation. Caustic compounds in some chemical strippers can cause burns if not immediately washed off the skin and can cause eyes, nose and throat irritation upon inhalation. Solvent-based strippers are also available. Health hazards may vary from irritation and central nervous system depression possible with substances such as xylene to the possibility of human carcinogenicity, as with methylene chloride. Chemical strippers containing solvents may require use of respiratory protective devices.

(4) Acids and Alkalis - Acids and alkalis commonly found in "wash primers" and chemical strippers (e.g., sodium hydroxide and phosphoric acid) are highly corrosive, and appropriate measures should be instituted concerning storage, handling, waste disposal, ventilation, personal protection and first aid.

(5) Chemical Spills - Clean up spills immediately and wash immediately if skin comes into contact with a hazardous substance. If a solvent/chemical gets splashed into the eye, immediately flush the eye with water for a *minimum of fifteen minutes* and seek medical attention. Wear the appropriate gloves and clothing when handling spills. Practice good personal hygiene after handling any spills. Consult the Material Safety Data Sheet (MSDS) to determine the toxicity of the material that is in use, and the specific protective equipment needed when using the material. Store and dispose of all oily or solvent wetted rags in metal containers with a tightly sealed lid. Respiratory protection should be worn if the spill creates a hazardous atmosphere, or the MSDS indicates it is necessary.

(6) Materials Removed From Surfaces - A pre-job analysis of the surface materials should be conducted to determine whether the coating contains hazardous materials. If the coating contains potentially hazardous constituents then respiratory and protective clothing should be worn when working with the removed material.