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Health Hazards Manual for Autobody Shop Workers

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Health Hazards Manual for Autobody Shop Workers

Abstract

[Excerpt] We will look at the principal occupational health hazards and exposures themselves and some of the related issues. We will look closely at the chemical composition of autobody shop products to see what components appear to be particularly hazardous, how you are exposed to them, and what you can do to minimize exposure. The health effects discussed for these products are based upon the exposure of the professional, not the consumer. This manual deals with chemical exposure only; other issues of interest to the autobody shop worker may include occupational exposure to noise and neuromuscular problems such as Raynaud's phenomenon (possibly from pneumatic hand tools).

Keywords

ILR, Cornell University, chemical hazard information program, work environment, working conditions, employee, health, safe, contract, union, collective bargaining, work, member, labor, human resources, chemical exposure, health hazard, auto repair, employer, business, hand tool, United States, Raynaud's phenomenon

Disciplines

Occupational Health and Industrial Hygiene

Comments

Suggested Citation

Brown, N. J. (1990). *Health hazards manual for autobody shop workers*. Ithaca, NY: Cornell University, Chemical Hazard Information Program.
<http://digitalcommons.ilr.cornell.edu/manuals/7>

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Preparation of this manual was funded by New York State School of Labor Grant #87044.

Health Hazards Manual
for

**AUTOBODY SHOP
WORKERS**

By Nellie J. Brown

Cornell University
Chemical Hazard Information Program
New York State School of Labor Grant #87044

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INTRODUCTION

This manual is intended to serve as a reference or resource for workers in autobody shops and for mechanics:

- to help you select products to minimize hazards
- to ask intelligent questions when purchasing
- to provide information on chemical exposures and routes of entry and how these are related to the use of appropriate ventilation, protective equipment, use or form of a product
- to help you read product labels and material safety data sheets (MSDSs)
- to help you to troubleshoot health hazards and trace possible work-related health problems

When we look at product health hazards and case histories, see if these experiences sound familiar. Have they happened to you or others you know or have heard of who do autobody work?

Hopefully, if you knew in advance what problems could develop, you could take the appropriate precautions.

We will look at the principal occupational health hazards and exposures themselves and some of the related issues. We will look closely at the chemical composition of autobody shop products to see what components appear to be particularly hazardous, how you are exposed to them, and what you can do to minimize exposure. The health effects discussed for these products are based upon the exposure of the professional, not the consumer. This manual deals with chemical exposures only; other issues of interest to the autobody shop worker may include occupational exposure to noise and neuromuscular problems such as Raynaud's phenomenon (possibly from pneumatic hand tools).

In 1986, autobody and auto repair (SIC 753) employed 27,676 employees at 6,651 sites in New York State. Of these sites, only one employed over 100 employees; thus the majority of this occupation is performed by small businesses. According to the U.S. Bureau of Labor Statistics, in 1980, there were an estimated 179,000 small automotive body repair workers in the United States with most of these as one to four man operations. Their work involves exposures to solvents, paints, metal pigments, asbestos,

dusts, synthetic plastic dusts, synthetic resins in body fillers and finishes, cleaning or restoring products or dyes for leather/vinyl interiors or vehicle tops, lubricants/greases, fluids, antifreeze, and detergents with solvent cleaners.

Potential chemical exposures among auto and truck mechanic occupations, as described in the NCI National Bladder Cancer Study, include: aromatic amines, benzene, paint thinners, betanaphthylamine, rubber and rubber products, petroleum or its products, coal gas, chlorinated compounds, nitro or nitroso compounds, organic solvents, listed metals, sulphha-containing compounds, and antifreeze.

OSHA Hazard Communication Standard

Title 29CFR §1910.1200

Summary

HISTORY

The federal OSHA Hazard Communication Standard (HCS) was expanded to cover all industries in June 1988. The New York Right-to-Know Law (RTK), which has been in effect since 1980, is pre-empted (or replaced) by HCS in the private sector. In the public sector both laws continue to apply. This summary is a learning aid to assist you in understanding how these changes might affect you.

Companies which are primarily manufacturers (SIC codes 20 to 39) have been subject to the HCS since May 1986. As the result of legal action by organized labor interests, the HCS standard was expanded to apply to non-manufacturing industries after June 24, 1988. As a result of recent court actions, the Standard was expanded to apply to the construction industry on January 30, 1989.

LEGISLATIVE INTENT

"To ensure that the hazards of all chemicals produced or imported by chemical manufacturers or importers are evaluated, and that information concerning their hazards is transmitted to affected employers and employees..."

The laws were passed to ensure that the hazards of all chemicals produced or imported are evaluated and that information concerning their hazards is transmitted to affected employers and employees, for two reasons:

- (1) Employees have a right to make an informed decision about the possible costs of employment to health and life.
- (2) Employees can observe symptoms of toxicity in themselves and understand the relationship between the symptoms and exposure, and can therefore evaluate the need for any corrective action.

Major Components of the Hazard Communication Standard (HCS)

- A. Hazard Determination** Manufacturers and employers must systematically determine which materials in use are hazardous. The HCS establishes a minimum group of materials which must be considered hazardous. For many materials the employer/manufacturer must establish criteria for determining this. These specific criteria or procedures are a required component of the Written Plan.
- B. Labeling** of all containers of hazardous materials, except temporary transfer containers, with the identity of the material as used on the MSDS and appropriate hazard warnings. This includes tanks as well as secondary containers. Placards or batch tags may be used. For materials leaving the site, manufacturer's name and address must also be listed. Labels must be in english but may also be in other languages.
- C. Material Safety Data Sheets (MSDS)** must be available in the work area on all work shifts for the hazardous materials which are used in that work area. MSDSs must be provided and updated by manufacturers or importers with a shipment to employers and distributors must pass these along.
- D. Employee Training** For hazardous materials which employees work with, training must be provided initially and whenever new hazards are introduced into the workplace. In addition, this is a so-called "performance" standard which means that the test of training adequacy is work practices and the response of employees to inquiries by an OSHA inspector. Training must:
 - Explain the law and the employer's Written Hazard Communication Plan
 - Explain labeling of hazardous materials
 - Explain how to read MSDSs and where they are available in work area
 - Explain hazards from unlabeled pipes and other than regular operations
 - Location of toxic substances
 - Properties of toxic substances
 - Name or names of substances, including generic or chemical names
 - Trade names or commonly used names

- Symptoms of effects of exposure at hazardous levels
- Potential for flammability, explosion and reactivity
- Appropriate emergency treatment
- Proper conditions for safe use and exposure to the substances

E. Recordkeeping

Written Hazard Communication Plan

Employers must develop and make available to US Dept of Labor, and on written request to employees, a "Written Hazard Communication Plan". This plan must detail how compliance will be achieved and maintained for each component of the law including hazard determination, labeling, employee training, collection and distribution of MSDSs, communication with other employers on site. A list of all hazardous materials on site or by work area, and all corresponding MSDSs are also required components of the written plan.

Employee Rights

- To have available in the work area MSDSs for each hazardous material for which there is foreseeable exposure.
- To obtain a copy or an opportunity to copy a MSDS.
- To receive training on chemical hazards which provides an understanding of the information outlined in the standard.
- To obtain a copy or opportunity to copy the entire Written Hazard Communication Plan within 15 work days of a written request
- Cannot be required to waive any rights under OSHA as a condition of employment
- To file a complaint with the U.S. Dept. of Labor, OSHA, concerning violation of this standard.
- To exercise these rights without fear of discrimination.
- To file a complaint with the U.S. Department of Labor, OSHA if she/he has been discriminated against in violation of the OSH Act.

Employer Responsibilities

- To evaluate chemical hazards in the workplace
- To create and make available on request a Written Hazard Communication Plan describing all actions to comply with these regulations.
- To provide education and training to employees on toxic substances in use
- To make available in the work area on all work shifts current MSDSs on all hazardous materials to which employees may be exposed
- To label all hazardous materials containers except for temporary transfer containers
- To provide hard copies or opportunity to copy MSDSs or the Written Hazard Communication Plan to OSHA inspectors, employees or their representatives.

Agency Responsibilities

U.S. Department of Labor OSHA

- To conduct general schedule workplace inspections
- To respond to complaints from employees and employee representatives concerning workplace health or safety hazards
- To establish schedules for abatement or elimination of hazards and issue citations (fines) to employers who fail to comply with OSHA
- To act on complaints of employee discrimination resulting from OSHA

New York Department of Labor

- To provide workplace consultation at the request of private employers

New York Department of Health

- To provide an outreach program to employers-employees (Education Promotion Services)
- To provide an information program to employers (Bureau of Toxic Substance Assessment)
- To provide an investigation program for studying the health hazards of the worksite (Bureau of Environmental Epidemiology and Occupational Health)

USING MSDSs

IDENTITY (AS USED ON LABEL AND LIST)

The name of the chemical product. This name must be consistently used for this product wherever it appears: that is, the product name must be the same on the MSDS as on the container labels, chemical inventory lists, and any other places where the chemical is identified so that it is clear what information goes with what chemical product.

BLANK SPACES ARE NOT PERMITTED ON A MSDS. If any entry is not applicable or no information is available, the entry must so state.

Wherever information is requested on an MSDS, it must be provided. However, there are cases where the requested information simply doesn't apply to the chemical — when this occurs, the space must be marked "not applicable" or abbreviated "N/A" or some similar variation. For example, the MSDS requires information on vapor density, but the chemical product doesn't give off a vapor, therefore vapor density is marked N/A.

It may happen that the information requested on the MSDS does not exist at this time; then the space should be marked to indicate that; such as, "no information is available at this time." For example, the MSDS requires information on the chronic (long-term) exposure to the chemical, but no scientific studies have been done on this substance to indicate what its long-term health effects may be.

In any event, without blank spaces, the reader of the MSDS is not left simply wondering whether the information is unknown and was omitted by accident or is truly unknown or not applicable.

SECTION I.

MANUFACTURER'S NAME AND ADDRESS

The complete address including street address, city, state, and zip code.

EMERGENCY TELEPHONE NUMBER

A number which could be called 24 hours a day for emergency information, such as advice to a physician in the event of a health emergency (such as accidental swallowing of the chemical or spilling it all over the body) or spill handling information. The emergency and first aid section of the MSDS is not intended to be detailed enough to provide all the information that a physician might need to handle administration of antidotes and other supportive medical aids.

TELEPHONE NUMBER FOR INFORMATION

A number which could be called simply to obtain more information on the chemical product, not in an emergency situation. Use this number to reach the manufacturer and speak to knowledgeable people about the information on the MSDS, to understand and interpret the MSDS, or to obtain more information on the product in order to use it properly. Also helpful to understand how material will behave if used improperly or if information from various

sections on the MSDS appears to be inconsistent or contradictory.

DATE PREPARED

Extremely useful for determining the age of the information on the MSDS, whether this is an old MSDS or a recent update. People often wonder if they should discard an old MSDS when they receive an update. The Standard does not strictly require saving old MSDSs, but does require that information on the product and its manufacturer, etc., be retained. Actually, saving the MSDS itself is a good idea because it provides evidence that:

The employer used the best information at the time in using that product even if the new MSDS indicates more serious health effects than were previously known, or other such information.

The product may have contained ingredients with more serious health hazards, but now has a less hazardous formulation. Products change and ingredients with serious health hazards are often removed from a product. Old MSDSs document these changes.

SIGNATURE OF PREPARER (OPTIONAL)

The person responsible for preparing the MSDS — useful person to talk to about additional information on the product or about the contents of the MSDS.

"I once worked in a plant where one of the building had a damp, moist environment which tended to foster large populations of spiders. I was collecting MSDSs on pesticides trying to find one which would kill the spiders, but wouldn't enter the sewer system and kill fish in the receiving stream. I found one chemical which looked promising, but the MSDS had a contradiction in it. In the section marked "Hazardous Decomposition or Byproducts", such as in the case of a fire, one of the decomposition products listed was phosgene. Phosgene is a very poisonous gas used during World War I. Phosgene contains chlorine, but there were no hazardous ingredients in the product which were chlorinated -- so I couldn't figure out where the chlorine was coming from. I called the "telephone number for information" and got hold of the chemist who had worked on the formulation and he told me 'Lady, you don't have to worry about that because that's only going to happen if there's a fire.' I finally was able to get across to him that I realized it would happen if there was a fire; but what I wanted to know was how phosgene could be produced at all if there were no ingredients which contained chlorine. He asked me to look at the list of ingredients and tell him if methylene chloride was there. It wasn't and he said 'there's a good reason for that' we took methylene chloride out of the product a couple of years ago.' So I asked him why he had updated the front of the MSDS but hadn't updated the back. He didn't like that."

SECTION II: HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

HAZARDOUS COMPONENTS

(SPECIFIC CHEMICAL IDENTITY; COMMON NAME(S))

Not all ingredients are required to be shown here; only those ingredients which are considered hazardous and only if those hazardous components make up 1% or more of the composition. There are exceptions to this: if the

component is a carcinogen, then it must be shown here if it makes up 0.1% or more of the product's composition. A component making up <1% (or <0.1%) of the composition must also be listed if, in the workplace, it will bring about an exposure which exceeds the OSHA permissible exposure level for that substance or is otherwise a health hazard.

The manufacturer can avoid listing ingredients if he has his product tested for health and physical hazards as a mixture and reports the test results for the product as a whole. This generally involves considerable expense for test animals to inhale, ingest, or have the product placed on their skin and determine the resulting effects and lethal doses. However, this option is one way for a manufacturer to keep his formulation a trade secret.

Since this is the section in which a manufacturer would claim his formulation is proprietary, it is appropriate to discuss the trade secret issue here. For a formulation to be considered a trade secret, the Standard has several requirements which boil down to two basic concepts:

The product's ingredients cannot be readily discovered by reverse engineering. That is, you can't simply analyze the product in the laboratory and readily discover what is in it. (If it's that easy, it's not much of a secret.)

Revealing the product's ingredients would cause the manufacturer considerable financial harm in the marketplace.

A manufacturer bears the burden of demonstrating that his trade secret claim is bona fide.

If the formulation is kept secret, the MSDS must still contain information on the properties and effects of the product and the specific chemical components must be available to health professionals in the event of a medical emergency. Provisions of the Standard also provide access during non-emergency situations by giving employees and their designated representatives access to trade secrets and also giving access to this information to occupational health professionals (physicians, industrial hygienists, toxicologists, epidemiologists, or occupational health nurses) providing medical or other occupational health services to exposed employees; or to engineers or other technical experts who are designing ventilation systems, etc.

As you might imagine, a manufacturer could avoid the trade secret issue entirely by having his product tested as a mixture for its health and physical hazards so that he could report these hazards for the product as a whole and not have to list the ingredients. Many manufacturers are doing just that, in spite of the expense involved, as a way of dealing with the problem of proprietary information.

The hazardous ingredients must be listed by specific chemical identity; this means the chemical name (such as that assigned by following the naming rules of the International Union of Pure and Applied Chemistry), Chemical Abstract Service registry number, or other listing which uniquely identifies that particular substance. Also, the common or trade names of the chemical must be shown.

For example:

Common name = perchloroethylene, "perc"
IUPAC name = 1,1,2,2-tetrachloroethene

Common name = caustic soda, lye
IUPAC name = sodium hydroxide

Common name = isopropyl alcohol
IUPAC name = 2-propanol

Some chemical substances are themselves mixtures which do not have a unique chemical composition, such as petroleum distillates or mineral spirits. These solvents are obtained from a petroleum cracking tower at a given boiling point range and are composed of mixtures of chemical compounds. The exact chemical composition varies from one petroleum plant to another and depends upon the source of the crude oil; so unique identification is not possible for such materials.

What are hazardous ingredients? They fall into two categories: physical hazards and health hazards.

Physical hazards include substances which are flammable or otherwise subject to chemical reactions which could give off considerable heat or trigger fires. These include:

- Combustible liquids
- Flammable aerosols, gases, liquids, or solids
- Oxidizers
- Pyrophoric materials
- Compressed gases
- Explosives
- Organic peroxides
- Unstable materials
- Water-reactive materials

Health hazards include substances which could cause acute or chronic adverse health effects in doses resulting from normal use or predictable misuse. "Predictable misuse" can be difficult to assess. (As a corollary of Murphy's Law says: It's difficult to make things foolproof because those fools are so ingenious.) Misuse can mean mixing products together which should not be mixed (section on MSDS called Precautions to be taken on handling or storing). Health hazards include:

- Carcinogen - causes cancer
- Corrosive - causes tissue burns (not damage to metal)
- Highly toxic - refers to animal experiments in which low dosages fed, or inhaled, or applied to the skin killed off 50% of the test animals
- Toxic - similar to highly toxic but requiring higher dosages to produce a 50% kill
- Irritant - causes reversible inflammation
- Sensitizer - causes an allergic reaction (for example, skin rash, headaches, asthma)
- Target organ effects - known to cause damage to specific body organs or organ systems: liver, kidneys, nervous system or brain, blood or blood-forming organs, lungs, reproductive system (includes effects on fetus), skin, or eyes.

OSHA PEL, ACGIH TLV, AND OTHER RECOMMENDED LIMITS

Also in Section II are workplace limits such as the OSHA PEL, ACGIH TLV, and other limits recommended. These refer to the concentrations of chemicals, such as dusts, vapors, or gases, to which the average person could be exposed during an 8-hour day, 40-hour work week, which are considered "safe" exposures -- that is, unlikely to cause adverse effects.

The OSHA Permissible Exposure Level (PEL) is a legal limit in the workplace enforceable by OSHA. These limits may be found in the Code of Federal Regulations at 29 CFR 1910.1000 Subpart Z, Tables Z-1, Z-2, and Z-3. The ACGIH Threshold Limit Values (TLV) are recommended limits set by the American Conference of Governmental Industrial Hygienists, a private organization. The ACGIH publishes a booklet containing the TLVs annually. Other recommended limits could include those suggested by NIOSH, the National Institute for Occupational Safety and Health, or by other organizations. With few exceptions, the OSHA PELs were the 1968-69 recommended limits of the ACGIH at the time the Occupational Safety and Health Act was passed in 1970 and may be outdated as to the health effects which could occur at those levels. The ACGIH revises its limits annually to take into account new information on adverse health effects.

These limits are intended to protect the "average" person and generally with respect to acute, not chronic, health effects. They are not intended to protect the person with a pre-existing health condition (such as an allergy or a lung or heart problem), the person who wishes to have or father children, or the pregnant or lactating worker.

These limits are usually expressed as parts per million (ppm) which are parts of gas or vapor in each million parts of air; or as mg/m³ which are milligrams of dust or vapor per cubic meter of air. To know what these levels are in the workplace, it is necessary to measure them.

% (OPTIONAL):

The manufacturer is not required to state the actual percentage of each ingredient present in the product, but many choose to do so. This was left as an option so as to help keep formulations proprietary as much as possible.

SECTION III: PHYSICAL/CHEMICAL CHARACTERISTICS

For some strange reason, people don't tend to like this section. Although we must spend some time defining terms, we will also look at some practical applications -- how these data could be used to provide information on physical or health hazards in the workplace.

BOILING POINT

This is the temperature at which a liquid is converted to a gas at standard atmospheric pressure. This can be used for assessing the proper storage of chemicals, such as solvents like the freons which have very low boiling points (which is why they are used as refrigerants). Products with low boiling points can build up considerable pressure in the container if they get too hot. Knowing that special storage or handling is necessary could be considered before purchasing, such as when writing a purchasing specification, so that

your purchasing department (or buyer) does not look at chemicals for which you do not have the appropriate storage (such as solvent cabinets or refrigeration) as required or are unwilling to indulge in the expense of such storage.

VAPOR PRESSURE (mmHg)

This is a measure of how much vapor is given off by a chemical usually a liquid) (when the vapor is in equilibrium with its liquid) It is reported in units of millimeters of mercury also called a torr. For example, the atmosphere we breathe has a vapor pressure of 760 mmHg, that is, it exerts a pressure which (in a measuring device) can support a column of mercury which is 760 millimeters high. The higher the vapor pressure of chemical, the more vapor is present in the air for us to inhale. For comparison, let's look at some examples:

	<u>Vapor Pressure (mmHg)</u>
Atmosphere @ sea level @ 0° C	760
Stoddard solvent @ 20°C	3
1,1,1,2-tetrachloroethane @ 19.3°C	10
1,1,1-trichloroethane @ 20°C	100
Water Vapor @ 20°C	17.5

So, if we are working near an open container of trichloroethane, at a temperature of about 20 degrees Celsius (68 degrees Fahrenheit), there is a lot of trichloroethane vapor for us to inhale. In fact, if we do a simple calculation

$$(100 \text{ mmHg}/760 \text{ mmHg}) \times 100 = 13 \%$$

We can see that about 13 % of the air we are breathing is trichloroethane. However, if we are working around stoddard solvent, there is considerably less vapor being given off to the air for us to inhale. By using vapor pressure information, we can compare products based upon potential inhalation exposure and try to substitute chemicals for those with lower vapor pressures where possible. When purchasing chemicals, you may wish to consider suggesting upper limits for vapor pressures for chemicals to your purchasing department or buyer. In this way, you can shop around for chemicals with lower potential hazards or whose ventilation or protective equipment requirements fit your current work practices to keep down your expenses for equipment and training.

Shortly, when we look at fire hazards, we will see that high vapor pressures also indicate high volatility; for flammable substances, this term gives us information about flammability potential as well.

VAPOR DENSITY (AIR = 1)

This is a comparison term: if the density of air is taken to be 1, is the vapor in question lighter-than-air (vapor density < 1) or heavier-than-air (vapor density >1)? A vapor which is lighter than air will rise to the ceiling and fill a room by displacing air from the ceiling and working its way toward the floor. A vapor which is heavier than air will sink to the floor and displace air from the floor, working its way toward the ceiling. For example:

Vapor Density (air = 1)

Ammonia	0.59
Methane	0.6
Ethane	1.04
Hydrogen sulfide	1.89
Carbon dioxide	2.04
Chlorine	2.49
Gasoline	3.0 - 4.0
TCE (trichloroethylene)	4.45

As you can see, ammonia and methane rise to the ceiling; chlorine and gasoline vapors stay close to the floor. Vapor density information can help you to look at the work area in terms of vapors collecting in degreasing pits or other lower levels (such as stairwells) -- air will be displaced in these areas and therefore hazardous to breathe due to oxygen deficiency. Also, flammable vapors (such as gasoline or hydrogen sulfide) could move to lower levels and eventually reach an ignition source (such as a pilot light).

Vapor density information can also be used to evaluate existing ventilation and help plan future chemical purchases to fit into your current ventilation system. If you currently have ventilation which draws air from a location directly above your head, then chemical vapors will be pulled past your face (and your breathing zone) as you work before these vapors exit the work area. For vapors which are lighter than air, ventilation should be located so that vapors are drawn away from you (even if the ventilation is located higher than your head). When vapors are heavier than air, ventilation is best located at the level of the work surface or below. This takes advantage of the natural downward movement of the vapor and draws the vapor away from your breathing zone.

SPECIFIC GRAVITY ($H_2O = 1$)

This is another comparative type of term. Specific gravity is a measure of density which compares the density of a substance with the density of water. A substance with a specific gravity greater than 1 is heavier than water and will sink in water. Substances with specific gravities lower than 1 are lighter than water and float on water. For example:

	<u>Specific Gravity ($H_2O = 1$)</u>
Tung oil	0.934
Caster oil	0.961
Fluorocarbon 12 (Freon 12)	1.311
White lead (paint pigment)	6.46

This is also useful information for firefighting since substances which float on water (such as oils) tend to have fires which cannot be quenched with water, but spatter and spread around if water is sprayed on them.

MELTING POINT

This is the temperature at which a solid becomes a liquid. This can be a useful term for assessing the proper storage of a chemical. Some chemical products may be unfit for use if stored at too high a temperature or allowed to melt and re-solidify. This information could be communicated to your purchasing department/buyer so as to make sure that you only purchase products which you can store properly, unless you are willing to engage in

the expense of supplying the proper refrigeration or other storage, as necessary.

EVAPORATION RATE (BUTYL ACETATE = 1)

This is another comparative term which is used to compare the rate of vaporization of chemicals. This rate refers to the time required for a given quantity of the chemical to evaporate as compared to the same quantity of a known solvent. A solvent other than butyl acetate may be used for the comparison; but, if so, that solvent must be indicated on the MSDS. Since this term refers to the amount of time required for evaporation to take place, the larger the number, the longer the time needed to evaporate and therefore the slower the rate.

This term is useful when dealing with chemical products which are mixtures of one or more volatile components. Since the product is not a pure chemical, such as a single solvent, it is difficult to know how much vapor it would give off which could be inhaled (unless the vapor pressure was reported for the product as a whole rather than individual vapor pressures for each component). The evaporation rate helps you to compare the product with a reference solvent. This is useful information for determining how rapidly a spill would evaporate. For example:

	<u>Evaporation Rate</u>
A disinfectant cleaner containing sodium hydroxide	<1 (water = 1)
A black vinyl enamel paint	Slower than ether
Stoddard solvent	0.2 (n-butyl acetate = 1)
A brake parts cleaner	>1 (water = 1)
A synthetic turbo oil	<0.001 (n-butyl acetate = 1)

SOLUBILITY IN WATER

This term is just what it seems to be — how soluble in water a chemical substance is. Water solubility may be expressed in several ways by using:

- Actual test results of water solubility (reported in percent)
- Terms which relate to approximate ranges of water solubility
- Symbols (such as the infinity symbol, ∞).

For example:

	<u>Solubility in Water</u>
Fluorocarbon 12 (Freon 12)	0.028%
TCE (trichloroethylene)	immiscible
Sulfuric acid	∞
A floor wax stripper	complete
An insecticide for crawling insects	negligible
A disinfectant cleaner	100%
A carburetor cleaner	<1%

Terms and symbols relate to ranges of percent solubility as follows:

immiscible, insoluble	not soluble
negligible	<0.1 %
slight	0.1 - 1 %
moderate	1 - 10 %
appreciable	>10 %
complete, ∞ (infinite)	in all proportions

When a substance is completely soluble or infinitely soluble in water, this means that a solution of any concentration could be made from it; in other words, you could make a 5% solution, a 30% solution, a 95% solution, or whatever.

Water solubility can also be used to evaluate a substance in terms of its ability to penetrate intact skin. The human skin is normally slightly oily due to natural body oils secreted by the sebaceous glands. Because oil and water don't mix, the skin tends to naturally protect itself from penetration from substances which are highly soluble in water. However, chemicals which are of low or no solubility in water tend to be able to dissolve oils and enter the skin; once this defense is penetrated, these substances can enter the blood stream and gain access to the rest of the body, doing damage at other locations. Organic solvents fall into this low water solubility category. The exception to this water solubility rule is the family of chemicals called bases or caustics which can convert skin oils to soaps and thus the oils are of no defense.

Water solubility can also be used to predict the fate of a chemical once it enters the body (whatever the route of entry -- skin, inhalation, etc.). Substances which are water-soluble tend to be eliminated in the urine by the kidneys; but substances with little or no water solubility tend to associate with the fatty tissue or internal organs and can remain in the body or accumulate (and thus be able to do more damage).

Since organic solvents tend to have flammability hazards, health effects (usually effects on the brain and nervous system), and require special ventilation or protective equipment, you may wish to consider eliminating solvents in favor of water-based systems when possible. You could recommend to your purchasing department/buyer that high solubility in water is an important characteristic of future chemical purchases.

APPEARANCE AND ODOR

This section is intended to provide a description of the product as a whole and can be useful for:

- Evaluating whether a product has spoiled, separated, or is otherwise past its useful life
- Identifying the contents of chemical containers when the labels are unreadable, defaced, or lost

This is also useful information in selecting products for purchasing because you know the form of the product (liquid, solid, powder, crystal, etc.) and can see if its handling procedures are appropriate for your workplace (such as dealing with dust inhalation from powders).

SECTION IV: FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (METHOD USED)

This is the temperature at which a substance will give off sufficient flammable vapor to ignite if an ignition source is present. The temperature units (degrees Fahrenheit or Celsius) should be indicated as well as the method used (closed-cup, open-cup, etc.) to determine flash point. This term provides

direct information on the flammability hazard of a chemical product. Substances with low flash points tend to have high vapor pressures as well; so, the substance gives off a lot of vapor which can quickly reach a concentration in air that is rich enough in fuel to burn. For product substitution, you may wish to consider purchasing products with as high a flash point as you can -- you want the chemical to have to get awfully hot before a fire is likely. For example:

	<u>Flash Point (° F)</u>
Acetone	0°
Ethanol	55°
Kerosene	100°

FLAMMABLE LIMITS

LOWER EXPLOSIVE LIMIT (LEL)

This is the lowest percentage of a vapor in air at which a fire could happen if an ignition source were present. Below this concentration, the fuel (vapor) mixture is too lean.

UPPER EXPLOSIVE LIMIT (UEL)

This is the highest percentage of a vapor in air at which a fire could happen if an ignition source were present. Above this concentration, the fuel (vapor) mixture is too rich.

Between these limits, a fire or explosion is possible. Where flammable or explosive gases are present in the workplace, it is possible to use sensing equipment to sample the atmosphere. The LEL (or a fraction such as 10% LEL) can be used as a set-point on sensing equipment so that when this concentration of vapor is measured, other devices could be triggered such as: automatic ventilators, automatic alarm systems, or automatic shutdown of electrical or other equipment or ignition sources.

EXTINGUISHING MEDIA

This describes what types of fire fighting procedures should be used and which types of extinguishers, foams, etc. are appropriate -- also, whether using water is appropriate or not.

SPECIAL FIRE FIGHTING PROCEDURES

This describes whether special protective equipment or unusual techniques may be required to fight a fire of this product. For example, the wearing of self-contained breathing apparatus or the use of water to cool the outside of containers.

UNUSUAL FIRE AND EXPLOSION HAZARDS

This describes the unusual hazards associated with the chemical, such as the rupturing of containers from a pressure build-up, the generation of toxic vapors (which are described in the later section on hazardous decomposition products), the substance may react violently with water, or other hazards.

SECTION V: REACTIVITY DATA

This section describes the physical hazards, other than flammability, which may occur with this chemical product and how to avoid them. This does not necessarily mean that if the product is used improperly, then your plant

- b. Smoking in an area containing chemical vapors which are pulled in through the hot end of the cigarette (then the decomposition products are introduced directly into the lungs)
- c. Changes in chemical composition upon aging of the product (such as autoxidation where a substance reacts with itself)

This section could include notations on shelf life.

For example:

Vinyl chloride plastics (PVC, CPVC)	----> heat or fire	Carbon dioxide (an asphyxiant) Carbon monoxide (interferes with body's use of oxygen) Hydrogen chloride (forms hydrochloric acid in lungs, tissue damage)
--	-----------------------------	---

Ethers such as diethylether (syn. ethoxyethane) -upon standing i n air (autoxidation)	---->	Unstable peroxides such as 1-oxyperoxides (dangerously explosive)
--	-------	---

HAZARDOUS POLYMERIZATION

(MAY OCCUR, WILL NOT OCCUR, CONDITIONS TO AVOID)

This section deals with chemical products which are packaged as monomers (chemical subunits) which can react together to form polymers (chemical coatings, plastics, solid resins, etc.). Generally, these products are formulated with a polymerization inhibitor so that the chemical reaction does not occur in the container. However, if the product is stored improperly (such as in an area which is too hot) or if the product contacts air or water or other chemicals, the polymerization reaction may occur spontaneously. When this happens, there may be spattering, a lot of heat may be generated, containers may rupture or burst, etc. If the product is stable, then this is indicated on the MSDS; if polymerization is a possibility, then this is indicated along with the conditions which should be avoided to prevent this chemical reaction. If a polymerization inhibitor is present in the product, then the inhibitor lifetime should be indicated as well. For example;

An incident occurred in a manufacturing plant in which styrene and acrylonitrile were accidentally mixed with catalyst. When the error was discovered, a polymerization inhibitor was added to the vessel but not enough to stop the reaction completely and it slowly heated and eventually burst the container.

SECTION VI: HEALTH HAZARD DATA

In this section are discussed the health hazards associated with exposure to the chemical ingredients listed in the hazardous components section of the MSDS.

ROUTES(S) OF ENTRY

This term indicates the manner in which the chemical must come into contact with the body for the health hazard or toxic effect to occur. It doesn't matter how toxic a chemical is -- it must come into contact with us for it to hurt us. There are 4 basic routes of entry: inhalation, skin contact, ingestion, and injection; but only the first 3 are requested on the MSDS. Injection, which is entry to the skin by means of cuts or puncture wounds so that chemicals can directly enter the bloodstream, is not generally listed separately. This category enables you to see directly what kind of exposure you must have to experience the adverse health effects of the chemical. For example, ethylene glycol (a common ingredient in antifreeze) is highly toxic if ingested (eaten) - - so don't eat any -- but is otherwise a skin irritant and must be inhaled in particulate form, such as mist, to be toxic by inhalation.

When evaluating risks using route of entry information, remember that ingestion is a more common route than you might think. Hand-to-mouth contact via smoking or eating at the work station or without washing the hands and/or face can result in considerable amounts of chemicals being eaten.

HEALTH HAZARDS (ACUTE AND CHRONIC)

This section requires the discussion of the adverse health effects both for short term exposure (acute) and for long term or repeated exposure (chronic). Generally speaking, people experiencing acute effects, if these are not immediately fatal, tend to make a good recovery. Chronic effects, on the other hand, involve progressive damage over time and therefore tend to produce permanent irreversible damage. Chronic effects are a "chronic" omission on MSDS's, so scrutinize your MSDS's for this section. Unfortunately, the long-term, low-level exposure effects of a large number of chemicals are still virtually unknown -- so this section may indicate that the "effects of chronic exposure are unknown at this time."

For example:

2-Methoxyethanol:

(2-Methoxyethanol is a solvent used, among other things, as an antistall additive in gasoline. It has been estimated that as many as 100,000 workers in the U.S. are potentially exposed to 2-ME.)

Acute effects: irritation of the eyes, nose, and throat, drowsiness; weakness; and shaking.

Chronic effects: Prolonged or repeated exposure may cause headache, drowsiness, weakness, fatigue, staggering, personality change, and decreased mental ability. Although no clinically significant reproductive effects have been found yet in humans, in animals such effects appeared in both females and males. Pregnant female experimental animals showed statistically significant increases in embryonic deaths and abnormalities, maternal deaths, and blood effects. Male animals showed effects on the testicles, infertility, and abnormally-shaped sperm. The route of entry for the animal studies was inhalation.

CARCINOGENICITY: NTP? IARC MONOGRAPHS? OSHA REGULATED?

This term means the ability to cause cancer. This section should describe the type of cancer and the internal organs or tissues affected, as well as discussing related effects such as mutagenicity (the ability to cause mutations)

and teratogenicity (the ability to cause birth defects), although these effects might be discussed in Health Hazards section above.

Information must also be provided indicating the agency responsible for designating the chemical as a carcinogen. The NTP is the National Toxicology Program, part of the Centers for Disease Control of the U.S. Dept. of Health and Human Services. The NTP publishes an annual report on its findings. IARC is the International Agency for Research on Cancer, an agency of the World Health Organization. The IARC publishes reports called Monographs which represent the views of the IARC Working Group on the Evaluation of the Carcinogenic Risk of Chemicals to Man. OSHA regulates some carcinogens; these are found in 29 CFR 1910.1000 and other sequential sections in Subpart Z.

SIGNS AND SYMPTOMS OF EXPOSURE

This section is intended to discuss how you would feel and look if you were exposed to this chemical product -- that is, the sensations you would experience, whether you become dizzy, nauseated, drowsy, flushed, pale, etc. With this information, you know what kinds of early warning signs to look for so that you can prevent excessive exposure to the chemical. For example:

"Prolonged or repeated skin contact causes mild irritation and possibly some blistering."

"Eye contact causes some pain and mild transient irritation. No corneal scarring."

"Inhalation of product vapors may cause chemical intoxication at high airborne concentrations."

"Burning sensation in eyes or nose, coughing, sneezing, rash on skin."

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

This is just what it seems to be -- what existing medical condition could you have which would be intensified or otherwise aggravated by exposure to this chemical product. This information is useful for looking at workers' existing health conditions and determining whether the purchase of this chemical product is appropriate, for example:

If this product tends to cause asthma or asthma-like conditions in exposed individuals, workers who already have asthma or respiratory problems will be at greater risk to have their symptoms intensified. These workers may need more ventilation or protective equipment when working with this chemical. The resulting health condition may be such that they simply can't work with the chemical at all.

If the product interferes with the body's ability to deliver oxygen to all of its parts, either due to effects on the lungs or on the hemoglobin in the blood, a worker with an existing lung condition or heart condition will be at much greater risk of a major health problem. This is true for inhalation of methylene chloride vapor: the body attempts to detoxify (breakdown) methylene chloride, but only succeeds in converting it to carbon monoxide. Carbon monoxide ties up the hemoglobin in the blood, preventing it from carrying oxygen; when this happens, the heart must work harder to make up for the oxygen deficiency. An individual with an existing heart condition may not be able to tolerate this added stress on the heart and could have a heart

attack.

For example:

(A polyisocyanate foaming agent for making polyurethane foams) — "May lead to allergic sensitivity in some individuals resulting in asthma-like symptoms upon exposures below the threshold limit value. persons with asthma-type conditions or other chronic respiratory diseases should be excluded from working with MDI."

EMERGENCY AND FIRST AID PROCEDURES

This section is intended to provide information on what you can do right away to handle emergencies such as splashing the chemical in the eyes, spilling it on the skin, accidental ingestion, overexposure to vapors, etc. Brief descriptions of procedures and possible antidotes should be provided; however, this section is not really intended to provide in-depth advice to the physician (call the emergency telephone number instead). For example:

a. Inhalation:

"If difficulty or discomfort in breathing is experienced, remove to fresh air and get medical attention."

b. Skin/eye contact:

"If eye contact occurs, flush eyes with water for 15 minutes, then get prompt medical aid."

"Flush skin with plenty of water and then wash with soap or mild detergent and water. If irritation persists, seek medical aid."

"If burned by contact with molten material, cool as quickly as possible with water and see a physician for treatment of burn. Burns should be treated as thermal burns. Product is a polymer of low toxicity; therefore, there is no need to remove it from the skin because of concern about toxicity. The polymer will come off as healing occurs."

c. Ingestion:

"If swallowed do not induce vomiting. Give large quantity of water. Call a physician if symptoms develop."

"If product is swallowed, drink large amounts of water or milk and seek medical aid."

SECTION VII: PRECAUTIONS FOR SAFE HANDLING AND USE

This section deals with proper handling and storing of the chemical product, how to take care of or neutralize spills, and, finally, how to ultimately dispose of the product. This information is not intended to be the final work on the subject, since it is necessary for you to observe Federal, State, and local regulations regarding disposal, releases to the environment (air, water), or discharge to the local sewer manhole in the process of handling a spill or fire.

The training of personnel to deal with emergencies such as spills is a requirement under the Standard. (This was covered in the section on training.).

When purchasing chemicals, you may wish to consider looking at this

section to determine whether a chemical you plan to bring on the plant site requires a very expensive method of ultimate disposal. An inexpensive chemical may suddenly become less of a bargain if its ultimate disposal method is very costly. Similarly, a chemical substitute may become much more attractive in price if it can be disposed of simply by flushing it down the drain or placing it in the ordinary trash can. Also consider the spill clean-up method when doing purchasing -- the price of a chemical product also involves purchasing spill clean-up or neutralization kits or equipment and the training of personnel to perform clean-up or the hiring of a consultant to perform the clean-up for you.

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

This section covers cleaning up or neutralizing spills and the precautions to be observed while doing so. For example:

"Avoid breathing gases and vapors,"

(It may be necessary to evacuate the work area. Re-entry may require providing ventilation or increasing existing ventilation, or the use of protective equipment.)

"Remove ignition sources."

(This product produces flammable vapor, or dust. Vapors heavier than air will hug the floor and may travel quite some distance, possibly eventually meeting an ignition source. No smoking; extinguish flames, etc. in the area; also consider the nearby presence of electrical equipment, static electricity including not wearing nylon jackets, and nonexplosion-proof ventilation systems.)

"Clean up with glass or plastic scoop."

[Chemicals which are strong oxidizers (examples are peroxides and acids such as nitric or sulfuric acid) should not be cleaned up with combustible materials. Do not use paper towels, brooms, etc; — these could catch on fire. Use inert materials such as glass or plastic to pick up the chemical and place it in an appropriate receptacle for storage until final disposal can be arranged. Avoid placing in waste baskets or trash cans where paper products or other combustibles might be discarded.]

"Flush with water."

(With respect to chemical hazards, this chemical product is desirable for the worksite as far as its disposal method is concerned. This indicates that the chemical can be diluted with water and flushed down the drain. You should check with your local sewage treatment authority to verify that disposal to their facility is acceptable; there may be local regulations of which the author of the MSDS is unaware, especially if the product's manufacturer is not a local firm.)

"Neutralize with soda ash."

(Many chemicals can simply be neutralized or absorbed to make them less hazardous; such materials can be purchased separately or as spill clean-up kits. Neutralization with soda ash is common for acids; bases or caustics may be neutralized with boric acid or citric acid; solvents can be absorbed with activated carbon; and so on.)

WASTE DISPOSAL METHOD

This section deals with the final disposal of the chemical product, including old, unused material, and spilled material, as well as precautions about disposal of the used containers and prohibitions about container re-use for other purposes. For example:

"Sanitary landfill."

(With respect to chemical hazards, this chemical product is desirable for the worksite as far as its disposal method is concerned. You should check with your local garbage hauler or sanitary landfill/garbage dump to verify that disposal to their facility is acceptable; there may be local regulations of which the author of the MSDS is unaware, especially if the product's manufacturer is not situated locally.)

"Incineration."

(This chemical product must be completely destroyed by incineration; may require transport to a licensed waste disposal facility for destruction.)

"Do not let spilled material enter watercourse. May be toxic to aquatic life."

(Prohibitions such as this one indicate that this material cannot enter bodies of water or the sewer system; also consider that land disposal may involve runoff of the chemical or leaching through the ground to a drinking water source such as an aquifer or well. This kind of warning is common for chemicals such as pesticides.)

SECTION VIII: CONTROL MEASURES

This section deals with ventilation, protective equipment, and safe work practices to reduce, control, or eliminate exposure to chemical hazards, both physical and health hazards. Before using such control measures consider product substitution -- select chemical products with low or minimal hazards wherever possible. If this is not an option for your workplace or process, consider using engineering controls such as ventilation and the use of safe work practices. Where this is not possible, protective equipment becomes the next choice. Protective equipment may also be the method of choice when engineering controls are impossible (such as working outdoors where you cannot control the direction and speed of air movement). Sometimes protective equipment can provide an interim solution when budget constraints cannot allow ventilation or work area design changes to be performed right away.

The use and care of protective equipment is another aspect of training required for employees under the Standard.

RESPIRATORY PROTECTION (SPECIFY TYPE)

This section discusses whether a respirator is needed and the type of respirator recommended for use when handling this chemical product, as well as when performing spill clean-up, etc. It should be specified whether an air purifying respirator is recommended, and if so, what type of cartridge or canister should be used; or whether a supplied air respirator is needed, such as self-contained breathing apparatus or apparatus to which a hose supplies air from another area. For example, air purifying respirators which filter out the chemical cannot make up for oxygen deficiency as in the case of a vapor which displaces air. Respirator face masks should be fitted to the faces of the personnel who must wear them and tested for leakage so that the respirator

can protect the workers as designed.

"I used to work in a place where certain work areas required the use of a respirator due to a cancer hazard in the air. I noticed that the supervisors in the area tended to wear their respirators hanging around their necks, but never over their faces. I always supposed that this was because supervision wasn't susceptible to the same kinds of health problems as the ordinary worker!"

VENTILATION: LOCAL EXHAUST, MECHANICAL (GENERAL), SPECIAL, OTHER

This section discusses the manufacturer's recommendations for whether ventilation should be used and, if so, what type. "Local exhaust" indicates that the ventilation should draw the chemical vapors in the immediate area of the work surface; that is, the intake should be located right where you are working. "Mechanical" or "general exhaust" indicates that the ventilation used for the work area as a whole is sufficient; for example, if you work in one area of a large room and the room itself is ventilated. "Special exhaust" indicates any special requirements which the ventilation should have such as spark-proof or explosion-proof ventilation for flammable solvents or corrosion-resistant materials for acidic or basic vapors.

"I used to work in a plant where an ammonia-containing vapor was formed as a by-product of the manufacturing process. The vapors were drawn-off by a ventilation system which consisted of 7 aluminum impeller blades in series. The system was in use for about a year when the engineers noticed that the system did not appear to be drawing well. When it was taken out of service and examined, it was discovered that 4 of the blades were completely eaten away and the other 3 looked rather moth-eaten. Apparently, when the system was priced, the company was given a good deal on aluminum impeller blades, but nobody told purchasing that aluminum dissolves in bases like ammonia."

PROTECTIVE GLOVES

This section discusses whether the manufacturer recommends the wearing of protective gloves and, if so, what type of glove material. There is no single glove material which will hold up in all kinds of chemicals, especially solvents; and each material has its characteristic "break-through time." Supposedly impermeable protective gloves allow a certain amount of solvent to pass through -- it is important that the amount of time for which the glove provides protection is longer than the work shift. If not, then the gloves provide little or no protection at all as the work shift progresses. It may be possible to change gloves frequently, allowing the solvent to evaporate from each used pair of gloves before re-use, or to set gloves aside for cleaning for future re-use. It is important to follow the glove manufacturer's recommendations for which glove product will work with a particular chemical.

EYE PROTECTION

This section discusses whether the manufacturer recommends the use of protection equipment to guard against vapors, mists, dusts, or splashes, and, if so, what kind of protection should be worn. Safety glasses are shatter-resistant glasses designed to protect the eyes from direct impact -- not from mists, vapors, dusts, and splashes of liquids. Chemical goggles protect the eyes

from chemical splashes but, due to their air vents to prevent fogging, are not designed to prevent vapor or gas entry. Unventilated goggles are needed to prevent exposure to vapors or gases. To further protect the eyes from splashes, use a full face shield; these may be purchased so as to attach to a helmet or hard hat. However, the face shield does not protect the eyes from vapors or dusts which can blow under or around the shield; for this kind of protection, goggles should be worn as well.

OTHER PROTECTIVE CLOTHING OR EQUIPMENT

This section discusses whether the manufacturer has any other recommendations for protective clothing and equipment other than those already discussed. These could be plastic aprons, hoods, boots (such as solvent- or acid-resistant, etc.), encapsulating suits, rubber-coated pants and jackets, acid-resistant or flame-resistant clothing, etc. The important factors are insulation and permeability; it is important to realize that all protective clothing and equipment has its limitations and its leakage, so it is necessary to choose the items appropriately and work within their limits. For example:

"Neoprene coveralls are recommended."

"To prevent repeated or prolonged skin contact, wear impervious clothing and boots."

"Wear gloves and footwear impervious to solvents. Wash clothing before re-use."

"I used to work with a man who swore by his acid-resistant pants and shirts, he thought they were just the greatest. One day he came into the lab and hopped up to sit on the lab bench to eat his lunch. Some acid had been spilled on the bench; although it had been cleaned up, the bench top hadn't been neutralized, so some residue of the acid must have still been left. Anyway, when he went home that night he discovered that his acid-resistant clothing was fine. Of course, he had holes in his underwear and burns on his buns -- but his acid-resistant clothing was fine."

WORK/HYGIENIC PRACTICES

This section discusses safe work practices and any other recommendations for control measures which were not covered in the previous parts of Section VIII above. For example:

"Avoid contact with used solutions of this product, as these may also be hazardous."

"Eye wash stations should be readily available."

"Earth-ground and bond all lines and equipment associated with the system. All electrical equipment should be non-sparking or explosion proof."

"Good industrial hygiene practice should be followed which includes minimizing skin contact. A safety shower and washing facilities should be available."

"Follow normal good work practices such as washing hands before food contact."

HEALTH STUDIES/EPIDEMIOLOGY

Air samples of dust levels in autobody repair shops have ranged from 0.5 to 12.0 mg/m³; during sanding activities these tend to average 9.8 mg/m³. Aerosols in the paint area average higher than dust levels in the body area. Paint solvent exposure levels are highly variable, depending upon paint type, object being painted, painter techniques, and building ventilation conditions. A common practice is to paint quarter panels and other small areas of cars in the shop paint area while reserving paint booths for complete car paint jobs. It is important to note that while time-weighted-average (TWA) exposures for individual solvents may not exceed the recommended exposure levels; when the TWA is calculated for solvent mixtures, painters; exposures may be at or above the action level. However, short term exposure levels may be quite high (50 - 800 ppm for toluene, 100 - 1000 ppm for total hydrocarbons). Frequent skin exposure may occur when painters use solvent-soaked rags to wipe down cars before painting.

A death certificate study in Massachusetts using death records for the years 1971 - 1973 identified automobile mechanics and repairmen as showing an association between lung cancer and occupation for cancer of the trachea, bronchus, and lung; especially noteworthy is the excess in lung cancer in occupations (such as autobody shop workers and mechanics) with known or suspected exposure to asbestos. These associations remain unchanged even when the data are adjusted to correct for cigarette smoking.

A death certificate study in New Hampshire using death records for the years 1975 - 1985 for automobile mechanics indicated an elevated risk for leukemia, cancers of the oral cavity, lung, bladder, rectum, and lymphatic tissues; nonmalignant blood deprecases and cirrhosis of the liver. The benzene content of gasoline and other solvents may be a potential cause of the nonmalignant blood disorders as well as for leukemia, with which benzene has already been associated. Gasoline has also been used as a solvent or cleaner. Increased rates for suicide were also observed; the authors make an argument for the central nervous system effects of solvents including irritability, depressive symptoms, and emotional instability--relating this information to findings in other studies that there is an increased risk of suicide among solvent-exposed workers in other industries. It is possible that the neurotoxic effects of workplace solvent exposure were potentiated by ethanol drinking use. In this group, the likelihood of alcohol abuse appears

indicated by the observation of deaths from cirrhosis of the liver, cancers of the buccal (throat) cavity, and alcoholism.

A study of auto and truck mechanics using data from the NCI National Bladder Cancer study shows a small increased risk of bladder cancer; but did not show an increase in risk with increasing duration of occupational exposure.

Recommendations:

- discontinue use of gasoline as a solvent for removing grease from auto parts

- do not use gasoline for hand cleansing

- do not siphon gasoline by mouth

- use vapor recovery systems to reduce occupational exposure to gasoline and benzene vapors during refueling

A study of car painters exposed to vapors and aerosols of paint containing polyisocyanates showed increases in IgG antibodies of subclass 4 against hexamethylene diisocyanate. The workers also had symptoms of rhinitis and/or conjunctivitis, or bronchial symptoms (such as asthma). There was no significant association between symptoms and levels of specific antibodies. The symptoms may be due to irritative effects of exposure.

Case history: "A 32-year-old automobile mechanic presented to his family physician with the complain of headaches that were global in location, daily in occurrence, and not associated with visual auras, nausea, localized weakness, or sensory disturbance....He did feel that his problem was associated with the institution one month earlier of several heat-conserving measures in his workplace at the beginning of the cold weather season. These measures included keeping the garage doors partially or completely closed (even when cars were running), placing plastic trash bags over the roof vents, and using an unvented, catalytic kerosene heater indoors. He had been off work for several days at the time of the first visit, and while there had been some improvement in his symptoms, he still complained of occipital headaches....he was instructed to return to work and to report for another carboxyhemoglobin determination at the close of his second day back at work....the patient reported a good therapeutic response only until he had been back in the workplace for a few hours, after which time his headache recurred. The diagnosis was made of headaches secondary to carbon monoxide intoxication when the second carboxyhemoglobin level

workplace for a few hours, after which time his headache recurred. The diagnosis was made of headaches secondary to carbon monoxide intoxication when the second carboxyhemoglobin level was reported to be 17 percent."

ASBESTOS EXPOSURE IN BRAKE AND CLUTCH ASSEMBLY WORK

Asbestos exposure is of interest to mechanics and autobody workers due to the use of asbestos as a reinforcing material in brake pads and clutch assemblies. A review of the scientific literature dealing with the association between asbestos exposure and mesothelial tumors of the pleura and peritoneum has revealed several cases of these rare tumors in persons employed in jobs doing servicing of automobile brakes. The following discusses the potential for asbestos exposure, the occupational exposure limits for asbestos, and some suggestions for reducing asbestos exposure.

Exposure to asbestos during brake maintenance varies due to:
the asbestos content of the brake and clutch assembly,
the nature of the braking technique of the driver, and
whether the car is front-wheel-drive or rear-wheel-drive.

An interest in asbestos substitutes began during the 1970s due to concern that government restrictions on the use of asbestos might limit its availability as a raw material. This led to a number of nonasbestos friction materials being developed and to continuing research in friction material composites. Hopefully, as a result, asbestos exposure for mechanics will be lower in the future than it has been. However, what this means is that, currently, the mechanic will probably not know whether the brake/clutch assemblies he works on will contain asbestos or not. For automobile brake linings containing asbestos, the asbestos content tends to be about 55%. For trucks, it is about 33%.

Semi-metallic brake pads, which were originally developed for use on police cars and ambulances, were the first major nonasbestos friction product and are in common use in automobiles today. Heavy-duty trucks are beginning to have their brake blocks replaced with disc brakes with semimetallic pads which allow safer stops with greater axle loads. Here, asbestos-based clutch facings are being replaced with sintered-bronze buttons. Nonasbestos clutch facings used in passenger cars and light trucks are being investigated for heavy truck use. These clutch-facing materials are a mixture of fiberglass, temperature-resistant man-made fibers, and other resins and elastomers.

Braking technique is an important consideration because normal braking tends to grind down the brake lining to a dust which

contains silicates (particularly magnesium silicates) and other materials. This silica is typically amorphous rather than crystalline (and when crystalline, it is a nonfibrous crystal), and thus is not likely to be of much concern as a cause of silicosis. However, during rapid or "panic" braking, there appears to be short-term high-temperature stress. Under such severe braking conditions, the brake temperature reaches 320 - 370 C, compared with the design maximum temperature of 290 - 320 C. This tends to decompose the brake lining matrix which holds the asbestos, enabling the asbestos fibers to be released. It is probably panic braking which is responsible for causing the asbestos fiber content of brake drum dust and thus potential inhalation exposure for mechanics. The amount of asbestos fibers in the dust can vary enormously from 1 to 15%, although investigators believe that fiber contents of <1% are more common. Clearly, the asbestos content of the dust is much less than that of the original lining material. However, it is important to note that when a mechanic sets out to repair brake drums and clutch assemblies, it is unlikely that he knows whether the driver did any panic braking -- it is probably safer to assume that the dust will contain asbestos.

On a front-wheel-drive passenger car, 85% of the stopping is done by the front brakes. For rear-wheel-drive cars, 70% of the stopping is done by the front brakes. This results in even higher brake pad temperatures for front- than for rear-wheel-drive vehicles, causing asbestos-based products to wear rapidly and lose their friction properties. Thus, repairs on front-wheel-drive cars may involve greater potential asbestos fiber exposure than on rear-wheel-drive vehicles.

Filing or grinding of brake lining material may give rise to considerable increased air contamination by asbestos.

Therefore, overall it would appear that brake mechanics have low and intermittent exposure to asbestos.

Occupational exposure limits for asbestos in air:

OSHA permissible exposure level 8-hr time-weighted-average	0.2 fibers/cc (200,000 f/m ³)
ACGIH Threshold limit value 8-hr time-weighted-average chrysotile type of asbestos	2 fibers/cc (2,000,000 f/m ³)

NIOSH recommended
exposure limit
8-hr time-weighted-average
in a 400-liter air sample

0.1 fibers/cc (100,000 f/m³)

A common method for removing dust from brake parts has been to blow it out with a compressed air hose. Air samples of asbestos based on personal samples taken within 10 feet of the operator during car and truck brake service using the blowing-out procedure have resulted in average peak air concentrations as high as 37.3 fibers/cc. Analyses have revealed that almost all of the asbestos fibers found were shorter than 0.4 microns in length. Measurable concentrations have also been found to exist at least 75 feet from the worksite for about 15 minutes after compressed air blowing.

PROTECTION AND PREVENTION:

___reduce exposure levels by wearing protective equipment such as a NIOSH-approved air purifying respirator, either single use or with replaceable particulate filter(s) during all procedures following removal of the wheels, including reassembly and during arcing and riveting operations

___use alternative (non-asbestos) friction materials in the replacement of brake and clutch assemblies

___consider changing brake shoes in all brake repairs rather than grinding old shoes for continued use.

___Clean dust from brake drums, brake backing plates, brake assemblies, and clutch assemblies using an industrial type vacuum cleaner equipped with a high efficiency filter system (HEPA filter unit). After vacuum cleaning, any remaining dust could be removed using a rag soaked in water and wrung until nearly dry. Compressed air or dry brushing should NOT be used.

___grinding (arcing) machines should be provided with local exhaust ventilation. The dust bag of the arcing machine should be removed and replaced with the hose of the high efficiency industrial vacuum described above

___Industrial vacuum cleaner bags containing asbestos dust and cloths used for wiping brake/clutch assemblies should be sealed in plastic bags and labelled with the following:

Caution

Contains Asbestos Fibers

Avoid Breathing Dust

Breathing Asbestos Dust May Cause Asbestosis and Cancer

Dispose of all asbestos waste as per the OSHA asbestos regulation (29 CFR 1910.1001 (h)). During removal of vacuum bags, an approved respirator (as described above) should be worn.

___all floor cleaning in the break/clutch repair area should be done with the high efficiency vacuum cleaner described above. Clean the grinding (arcing) machines with this vacuum cleaner and wipe up any remaining dust with a damp cloth. Wear an approved respirator (as described above) during this cleaning.

___to avoid bringing asbestos home on the work clothing, follow the OSHA asbestos regulation concerning clothing (29 CFR 1910.1001(d)(3 and 4)). Household contacts of asbestos workers have also been described as being at risk for mesothelioma.

___teach these safer methods in vocational schools

AUTOBODY FILLERS, POLISHES, SANDING, AND BUFFING:

Plastic autobody fillers may be of the epoxy-type or polyester-styrene type.

Epoxy-type plastic autobody fillers typically consist of:

- epoxy resin

- amine hardener such as diethylene triamine (DETA)

 - triethylene tetramine (TETA)

 - diethylamino propylamine (DEAPA)

filler:

- aluminum stearate

- titanium dioxide

- calcium carbonate

- silica

- fiberglass

- alumina

- ferric oxide

- kaolin, clay

Polyester-styrene types consist of:

Resin:

- styrene monomer

- alkyd resin

- talc filler

- dialkyl aniline

Hardener:

- methyl ethyl ketone peroxide or benzoyl peroxide or dimethyl aniline (in dibutyl phthalate)

- Calcium phosphate

- Metallic naphthenates

- Fiberglass

- Dyes

POLISHES AND RUBBING COMPOUNDS:

Automotive rubbing compounds may consist of:

Abrasives such as:

- tripoli (silica)

Wax or oil for polishing:

- mineral oil

waxes

fatty acids

silicone and oil

some of these may also be used as perfumes, such as:

pine oil, caraway oil, cedar oil, citronella oil

Solvent to dissolve the wax or oil:

kerosene

naphtha

trichloroethylene

turpentine

xylene

cyclohexanol

amyl acetate

ethanol

methanol

Emulsifiers such as:

soap: soda type or amine type such as ethanolamine oleate

sulfonated vegetable oils

glycerine

morpholine

Thixotropic agents (thickeners) such as:

vegetable gums

Dye

Preservatives to prevent spoilage of the oils and emulsifiers such as:

formaldehyde

phenol (1%)

butoben (p-hydroxy-n-butyl benzoate)

Automobile polishes are very similar to rubbing compounds, but the abrasives are less harsh and the waxes may include carnauba wax.

Paste wax typically consists of:

Paraffin, carnauba and microcrystalline waxes

Solvents such as petroleum naphtha

Dye

HEALTH HAZARDS OF FILLERS, POLISHES, RUBBING COMPOUNDS:

Epoxy Plastic Fillers and Epoxy Paints

During sanding or grinding of plastic body fillers, the dust covers the worker's hair and clothing and rapidly coats the nasal passages. Dust from handling and sanding of autobody fillers has correlated with the metals and particles found in the lungs of autobody workers. Clearly, inhalation of some types of dust is of interest because these particles can be fibrogenic in nature, that is, cause fibrotic lung conditions and an associated loss of lung function. A high lung burden of inorganic contaminants may be a cause of interstitial pulmonary fibrosis. This may be the case with clay, aluminum, and some silica-based fillers, but appears to be less significant with fiber glass reinforced polyester fillers.

Air samples of dust levels in autobody repair shops have ranged from 0.5 to 12.0 mg/m³; during sanding activities these tend to average 918 mg/m³. Although average exposures may be low; short-term exposure can be excessive.

Some of the oils used in polishes and rubbing compounds are potential sensitizers; that is, they can cause allergic reactions.

Although solvents are not a problem for epoxy fillers, there may be some solvent exposure by inhalation or skin absorption during application of polishes or rubbing compounds. The solvents discussed here readily penetrate the skin. This may not be as significant a solvent exposure as other autobody operations such as degreasing or painting operations, but should still be avoided. Defatting of the skin and possible dermatitis is also a possibility with polishes and rubbing compounds.

Epoxies do not release water or solvent during curing (thus solvent inhalation is not a potential occupational exposure problem) and thus work on non-absorbant surfaces. Epoxies have low shrinkage tendencies and thus less strain is put in the bonding film; alumina and silica additives reduce this contraction even further. Fillers such as alumina, ferric oxide, and amorphous silica also increase tensile shear strength at room temperature; titanium oxide, nickel oxide, and lead oxide improve tensile shear strength at higher temperatures (82 C). Other fillers such as salt-free sand or amorphous silica may also be used.

The epoxy compounds may produce a range of toxic effects, but those seen with greatest frequency are dermatitis (either irritative or secondary to sensitization), eye irritation, and pulmonary irritation. Animal studies have indicated that the mode of action of

irritation. Animal studies have indicated that the mode of action of these resins in general is central nervous system depression with death resulting from depression of the respiratory center.

The resins are not volatile and do not present a serious hazard by inhalation, but the amine hardeners do so.

This particular type of resin system has been shown to cause minimal eye irritation with no evidence of permanent corneal damage. Resin dusts produce more eye irritation due to mechanical abrasion of the eye.

Epoxy resins can cause dermatitis and possibly skin sensitization upon prolonged or repeated exposure; all skin contact with uncured resins should be avoided. Epoxy compounds, hardeners, and curing mixtures individually cause similar types of surface tissue irritation. In humans, the typical contact dermatitis seen involves redness, intense itching, swelling, and edema with weeping followed by crusting and scaling. In severe cases, the skin may peel off and secondary infections may occur. A similar reaction on the face may be caused by vapors of the hardener or epoxy, although contact with contaminated gloves or droplets may be the cause. In animal studies, a single skin application left for 24 hours was practically nonirritating; but when repeatedly applied, moderate irritation was observed. Prolonged and repeated skin contact with liquid resins caused severe irritation.

Sensitization reactions involve development of bumps and vesicles with considerable itching and extension beyond the point of original contact. Lesions may assume a brownish color with scaling. In one study of European factory workers, 43% of epoxy resin workers suffered dermatitis; 22% of these were severe and involved lost work time amounting to 3 days. Generally, sensitization to epoxy resins based on bisphenol A is rare; somewhat more common is sensitization to the hardeners. With good industrial hygiene practice, sensitization should tend to be about 2%. The cured resin does not appear to cause any allergic reactions. Bland ointments and soaps are usually recommended, as well as no further contact with the epoxy.

These resins alone do not tend to penetrate the skin. Due to their sticky nature, resins are difficult to remove from the skin -- however, solvents should not be used to remove them because the

however, solvents should not be used to remove them because the solvent may facilitate penetration of the resin through the skin. When removing the contaminant, particular care should be paid to the nails. When resins are dissolved in solvents and allowed to penetrate the skin, animal studies showed effects on liver and kidneys.

The uncured resins do not appear to represent a substantial carcinogenic hazard in humans; chronic skin application studies in mice have shown weak carcinogenic responses. Although mutagenic in bacteria, animal test results are generally negative.

The amine curing agents are more active physiologically than the epoxy resins, as well as more volatile, and skin and eye irritation may occur. Diethylene triamine (DETA), if undiluted, cause necrosis (tissue death) of the skin in rabbits; dilutions cause severe eye burns in rabbits. This amine is corrosive to skin and a potential skin sensitizer. Since the epoxy hardening reaction is exothermic (produces heat), the resulting fumes may cause bronchial asthma in sensitized individuals. For the cured resin, if the hardener has been used in excess, later grinding, sanding, or polishing of the resin may produce dusts and fumes causing same allergic or asthmatic reactions. Triethylene tetramine (TETA) in animal experiments did not show any liver, kidney, lungs, or myocardial effects.

The fillers should be bound in the resin matrix during curing and thus should not present a health hazard unless the cured product is subjected to grinding, sanding, or polishing. If so, there may be inhalation risk from the amorphous silica dust; very high exposures would be needed to produce adverse effects from titanium dioxide.

PROTECTION AND PREVENTION:

- adequate ventilation is necessary whenever working with epoxy/hardener products or solvent-containing products; use ventilation and/or respiratory protection to avoid dust inhalation
- wear goggles to avoid the mechanical abrasion of the eye from dusts

- do not remove resins by using solvents
- gloves should be worn and contamination of the skin avoided
- using protective clothing (such as gloves) and personal protective creams

cover bench and floor areas with disposable paper to facilitate the cleanup of resins
use medical monitoring to assess lung function
if necessary, avoid further contact with epoxies and curing agents

PAINTS, THINNERS/SOLVENTS:

Automotive refinish paints are paint products applied at any time after the initial manufacturing process. In the factory, a finish is appealing to a car body is finished when it consists of metal only; this allows the use of products which can be cured at temperatures up to 150 - 160 C (302 - 320 F). The completely manufactured vehicle, however, is fitted with plastics and fabrics, as well as having fuel in the tank, so refinish paints cannot be cured at these high temperatures. Also, the manufacturing site has a strictly controlled environment which the refinish workshop is unlikely to possess. Automotive refinish products reflect this as they may be air-drying finishes or stoving finishes (using 60 - 80 C (140 - 176 F) metal temperature). Air-drying products are usually formulated to be fast drying (within a few minutes) because the autobody shop environment can be dust-free for only a short time -- these products are typically lacquers which dry by solvent evaporation. Products which cure by reaction with oxygen in the air or products consisting of 2-part resin/hardener systems cure more slowly but can be used if a dust-free environment is available. These can be applied in spray booths which are either linked to a "low-stoving" oven or to a combination spraybooth/oven.

Formulations for refinishes has tended to be based upon speed of application and the requirement by many car makers to use materials capable of sustaining extended anti-corrosion warranties. As a result, topcoat materials tend to be higher-solids, higher-build in nature so that fewer coats are needed. They also tend to be glossy, so that little or no polishing is required. Durable resin systems able to accomplish these needs are mostly acrylics, such as:

- ___nitrocellulose lacquers plasticized with solvent plasticizers, polymeric plasticizers, and non-drying alkyds
- ___thermoplastic acrylic (TPA) lacquers composed of solvents, a high proportion of methyl methacrylate copolymerized with several other acrylic monomers, and solvent plasticizers
- ___alkyd finishes: typically are short oil, fast-drying; air-dried with cobalt and lead driers; or they may be applied as two component products by the addition of a melamine or polyisocyanate resin. If melamine is used, stoving is required at 70 -80 C (176 F) metal temperature; for isocyanate, "force-drying at 40 - 60 C (140 F) is commonly used. Since alkyds are true enamels, they are glossier and tend to eliminate the need for excessive polishing. However,

they must be applied in a dust-free environment and must be fully cured before the next coat can be applied (otherwise the underlying coat tends to soften). Two component alkyd finishes cure quickly and can be recoated more quickly than straight alkyds.

acrylic enamel: these are alkyd/TPA copolymers which may be used a 2-component systems with a polyisocyanate second component

acrylic urethane: these are 2-component finishes using a hydroxy functional acrylic resin with a polyisocyanate second component. They are slow to cure (compared to lacquers), but are tending to replace other types of finishes. They have high solids contents and can cure at a range of temperatures, even at an acceptable rate at temperatures just above freezing. Curing can be accelerated with heat; typically at 30 -40 minutes at 80 - 100 C (176 - 212 F) air temperature (metal temperature about 60 C(140 F)).

Basecoat/clear metallics are typically aluminum flake in a basecoat based upon cellulose acetate butyrate (CAB) with hardens by solvent evaporation only. This may be modified with polyesters, acrylics, or nitrocellulose. Polyethylene wax may be added to control the aluminum flake. (Some basecoats may contain melamine.) These may be formulated with UV absorbers and light stabilizers to provide protection in very sunny climates,

Color is produced in a mixing scheme generally based upon 30 -40 pigments, including a selection of grades of aluminum flake for metallic colors. A pearlescent finish may contain mica. Typical pigments and their composition are listed below:

white	titanium dioxide
blue	copper phthalocyanine indanthrone potassium ferro/ferricyanide
green	chloro-brominated copper phthalocyanine chlorinated copper phthalocyanine
yellow	lead chromate lead chromate/sulfate flavanthrone

tetrachloroisindoline
azomethine copper complex
hydrated iron (III) oxide
cadmium

red/orange

iron (III) oxide
molybdated lead chromate
monazo naphthol AS
quinacridone
dibromoanthrone
naphthol AS type
perylene
dimethylquinacridone
thioindigo derivative
linear, trans, quinacridone
dioxazine

black carbon black/furnace black

aluminum

fine, medium, coarse

SOLVENTS: Typical solvents for refinish paints may include:

acetone
benzene
n-butyl acetate
butyl cellosolve
cellosolve
cellosolve acetate
cumene
cyclohexane
cis-decalin, trans-decalin
dichloromethane
ethanol
ethyl acetate
ethyl benzene
n-hexane
2-hexanone
iso-hexanes
iso-octane
isopropanol
methyl cellosolve
methyl cellosolve acetate

methyl cyclopentane
methyl cyclohexane
methyl ethyl ketone
methyl isobutyl ketone
nonane
n-octane
n-propyl acetate
propylene dichloride
toluene
1,2,3-trimethyl benzene; 1,2,4-trimethyl benzene;
1,3,5-trimethyl benzene
xylene

HEALTH HAZARDS OF PAINTS AND SOLVENTS:

The hazards of paints and solvents for autobody workers involve inhalation of metallic pigments (especially cadmium, chromium, and lead), synthetic resins (especially isocyanates), and solvents. Although occupational chemical exposure on a full-shift, time-weighted-average basis may not be exceeded, short-term-exposure-levels may be quite high and often exceeded. A typical paint/solvent overexposure is illustrated by the following case history:

"A representative two-man jointly owned shop, limited to autobody and frame repair, was selected and judged to be typical of the small one- to four-man 'bump and paint' garages operating along the east coast of the U.S. At this shop one worker/partner does most of the painting; however, since painting actually takes comparatively little time, he also gets involved with all other operations. Both men experience occasional solvent intoxication...Some years ago, one partner experienced chest pain which he suspected was related to his exposure to enamel paint. He began using a particulate/organic vapor respirator and reports no recurrence of the symptoms...Most of the spray painting is done in the spray booths; however, some is done in the workbay area when many cars are being handled. Ventilation is provided by opening the door between the workbay area and the spray booth and running the spray booth fan while spraying in the workbay. During the summer, all outside doors are open and two floor fans help dilute the vapors...Winter workbay spraying with closed external doors results in considerably higher exposure levels than spraying in the spray booth with the booth fan on. In extremely cold weather (less than 19 F outside), the exhaust fan can be run for only a few minutes or the shop loses heat rapidly. Although spraying in the workbay without the use of the booth fan is

recognized by the workers as an explosion hazard, it is still done on occasion as an expedient. During the sanding or grinding of plastic body filler...it is not uncommon for body shop operators to displace the plugged filters to allow the air to flow. This practice causes paint particles to coat the duct and fan blades and introduces a fire hazard...the design ventilation rate exceeds the capacity of the heating system to keep pace with the energy loss. In extremely cold weather, prolonged use of the exhaust fan is impossible, since painting cannot be done below 50F. Standard operating procedure during the winter is to paint with the fan off and then run the booth fan for 2 - 3 minutes to clear the vapors, producing excessive short-term exposure levels...during one session the painter became visibly intoxicated within the first 5 - 10 minutes of painting."

The solvents used tend to be irritants or central nervous system depressants; a few may target the blood for toxic effects.

Hazard of cadmium, chromium, and lead include:
(to be added at later date)

Hazards of isocyanate-based paints:
(to be added at later date)

PROTECTION AND PREVENTION:
(to be added at later date)

DEGREASING

Degreasing is frequently done using solvents such as trichloroethylene, 1,1,1-trichloroethane, and others. A number of less hazardous alternatives exist for degreasing of metals and plastics; these include:

- (1) aliphatic naphtha
- (2) a Stoddard solvent; there are 4 basic types including 140 flash
- (3) terpene-based degreaser
- (4) combination alkali/surfactant degreaser used with or without heated tank (typically a blend of potassium hydroxide, potassium phosphate, nonionic surfactant, ethylene glycol butyl ether, and sodium oleate)
- (5) high pressure alkaline cleaner (usually an aqueous solution of potassium hydroxide and sodium hydroxide)
- (6) Water-based surfactant solution (usually heated) followed by an ultrasonic cleaner

Aliphatic naphtha has the disadvantage of being flammable. Stoddard solvent of the 140 flash type has a flashpoint range of 59 - 60C (138 - 140 F) and is thus in the combustible range. The other cleaners have the advantages of being aqueous solutions rather than organic solvents which minimizes their health hazards via inhalation or skin absorption. The terpenes are relatively rare sensitizers. The last four choices are typically in alkaline solutions and thus have the potential hazards of being either corrosive or irritating, depending upon the concentration.

The last four choices also have the advantage of easy disposal of the spent solution since it does not require the special handling and expensive disposal of solvents (and especially of chlorinated solvents). Depending upon the concentration of the solution, it may require neutralization or its pH may be close enough to neutral to enable direct disposal down the drain. Terpenes have the advantage of being biodegradable since they are derived from the white pulpy part of the rinds of citrus fruits; they have excellent degreasing action even when quite dilute.

METALWORKING

RADIATOR REPAIR:

Exposure to lead can occur during automobile radiator repair when soldered joints are heated. After cleaning of radiators and testing for leaks, radiators may be disassembled by melting the solder joints using propane-air flame or oxygen-acetylene torches heated to at least 260 C (500 F). Radiator cores may then be cleaned (often involving abrasive blasting) or excess solder may be removed using pneumatically driven grinders. Reassembly of the units tends to involve the use of standard 40% tin-60% lead solder. An investigation of automobile radiator repair shops conducted by NIOSH found that 62% of the radiator mechanics experienced excessive air exposures to lead; 81% had blood lead levels higher than 40 ug/deciliter. Studies of the work sites have concluded that, in general, the shops were small and ventilation was inadequate. As lead exposure has not been well recognized in some industries, medical practitioners may fail to identify cases of lead poisoning.

Case history:

"A 32-year-old automobile radiator mechanic who consulted his physician because of headache, dizziness, fatigue, and increased irritability was treated with diazepam for a presumed anxiety reaction. One year later, at the request of the worker, the physician tested his blood for lead and found that the level was 72 ug/deciliter. The worker was then referred to [a doctor] for further evaluation. At that time, the worker reported that his original symptoms continued and also reported a decreased ability to concentrate, episodic nausea and abdominal pains, and low back pain...The patient's occupational history revealed that as an automobile radiator mechanic, he soldered radiators with an acetylene torch at a temperature of about 482 C (900 F) and a lead-tin solder...The blood lead level was 60 ug/deciliter."

Lead exposure may occur from inhalation of lead fumes produced during soldering and burning. Exposure to lead-containing dust may occur when lead drippings drop to the floor and are collected by sweeping, often to reclaim the lead. Dust exposure may also occur when ventilation and filtration systems (such as electrostatic precipitators) used for the cleaning of radiator end caps inside an

precipitators) used for the cleaning of radiator end caps inside an abrasive blasting box fail to remove the dust adequately due to poor positioning, poor maintenance, or simply lack of use.

Ingestion of lead dust can occur through hand-to-mouth contact. Autobody shop workers who smoke have shown higher blood lead levels than those who did not smoke, probably by transferring lead dust from the fingers to the lips.

PROTECTION AND PREVENTION:

___ use of proper ventilation systems

___ use of proper personal protective equipment, such as NIOSH-approved respirators; proper fitting and training in respirator use is needed.

___ enclose grinders

___ change work clothes; keep work clothes separated from street clothing; special laundering; childhood lead poisoning has been traced to the contaminated clothing of parents

___ do not eat or smoke in the work area.

___ wash the hands and face before eating or smoking.

___ consider medical monitoring for blood lead levels and/or lead effects. Blood screening for determination of whole blood zinc protoporphyrin is an indicator of the biochemical effect of lead on heme synthesis and reflects the absorption of lead over the preceding four months. Long-term effects on kidney function can be assessed using blood urea nitrogen and creatinine levels. Hypertension found in autobody shop employees may be related to renal damage.

Quantitative assessment of eye movements may be an important tool for studying subclinical central nervous system dysfunction due to chronic, low-level lead exposure may also occur from paint spray operations (such as primers and undercoatings), leaded gasoline, lubricant oils and greases (see the appropriate sections in this manual for more information)

For additional information: consult OSHA regulation 29 CFR 1910.1025 - lead.

WELDING FUMES

Welding in confined spaces may cause oxygen deficiency or buildup of explosive or toxic gases. See supplementary information on welding. Welding of painted surfaces can produce toxic fumes containing lead or cadmium; cadmium is very hazardous due to

containing lead or cadmium; cadmium is very hazardous due to severe and possibly fatal lung irritation without warning signs; chronic exposure causes emphysema and kidney damage. Cadmium is also used in some stainless steel welding rods. Welding of metal surfaces contaminated with oily stock, paint resins, or chlorinated solvents can produce fumes containing formaldehyde, lead, carbon monoxide, hydrogen chloride, or phosgene. Welding fumes may contain iron oxide and oxides and fluorides of manganese, potassium, sodium, calcium, and silicon.

Fluoride fumes cause respiratory tract irritation with chills, fever, shortness of breath, and cough; repeated exposure causes buildup that can lead to bone changes. Iron oxide fumes produce benign pneumoconiosis called siderosis.

Argon welding produces ozone (irritating gas; headaches, chest pain and dry throat; acute exposures can cause pulmonary edema) and nitrogen dioxide (deadly poison; inhalation affects lungs and respiratory system).

Ultraviolet and infrared radiation from arc welding, especially UV, causes skin burning but without producing tanning and is especially painful to the eyes.

Zinc fumes from galvanized metal can cause metal fume fever.

GASOLINE AND ADDITIVES

Gasoline is a mixture of octanes and n-heptane. When an automobile engine under stress is accelerated too rapidly, it may produce a knocking sound. This indicates the engine has exceeded its ability to perform efficiently with the particular gasoline. In the down-stroke of the piston, a mixture of air and gasoline vapor and droplets is drawn from the carburetor into the cylinder. On the up-stroke, the mixture is compressed. The compression ratio is the ratio of the initial volume to the final volume. Knocking increases with increasing compression ratio. An engine develops more power and requires less fuel with increasing compression ratio so developing efficient high-compression engines is dependent upon the knocking tendencies of available gasolines. Fuels are compared by octane rating. Isooctane (2,2,4-trimethylpentane; octane rating = 100) detonates only at high compression. n-Heptane (octane rating = 0) is prone to knocking. Octane number is the percent of isooctane blended with n-heptane which produces a given set of knocking characteristics when it is tested in a standard one cylinder engine operated under specific conditions.

Repeated or prolonged skin contact with gasoline causes dermatitis and can cause blistering. Inhalation causes depression of the central nervous system and can cause severe pneumonia-like symptoms. Some addiction to fumes has been noted. Brief inhalation of high concentrations can cause fatal pulmonary edema. Gasoline vapors can cause inflammation of the mucous membranes of the eyes.

Gasohol: 90% unleaded gasoline and 10% ethanol. Ethanol is the least toxic of the alcohols since the body breaks it down into carbon dioxide. Inhalation may cause headache; irritation of eyes, nose, and throat; and, if long continued, drowsiness, lassitude, loss of appetite, and inability to concentrate.

Any of all of the additives listed below may be present; many are multi-purpose.

Oxygenates: to improve octane quality or extended gasoline volume. Such as methanol, ethanol, tertiary butyl alcohol, and methyl tertiary-butyl ether (see MSDS companion sheet on solvents).

Anti-knock additives: to improve octane quality. These are lead alkyls such as tetraethyllead, tetramethyllead, or mixtures of these two (see supplementary information on lead). (methylcyclopentadienyl manganese tricarbonyl, MMT, once used for this purpose has been banned by EPA). These also contain an identifying dye and organic halides. The organic halides, such as ethylene dibromide, scavenge the combustion products of the lead alkyls from the combustion chamber during the exhaust cycle and prevent lead deposits.

Ethylene dibromide is an animal positive carcinogen according to the International Agency for Research on Cancer. In animal experiments, it has been shown to be a teratogen, a carcinogen, a possible tumor-causing agent, and a cause of tissue outgrowths; it has also been implicated in worker sterility. It causes irritation and injury to skin and eyes, respiratory tract inflammation, anorexia and headache with recovery after discontinuance of exposure; weakness and rapid pulse; and cardiac failure leading to death.

...Combustion deposit modifiers: minimize surface ignition, rumble, preignition, and spark plug fouling. These include organophosphorus compounds.

Metal deactivators: deactivate copper ions which are powerful oxidation catalysts. Such as N,N-disalicylidene-1,2-propanediamine.

Rust inhibitors: minimize rust formation in fuel systems and storage facilities. Includes organic acids, amine salts, and derivatives of phosphoric acid. A widely used type is based on dimerized linoleic acid.

Anti-stall additives: such as glycol ethers (2-methoxyethanol, 2-ethoxyethanol). Inhalation and skin absorption have produced adverse reproductive effects in male and female experimental animals, including embryonic death, teratogenesis, growth retardation, testicular atrophy and sterility. In humans, irritation of eyes, nose, and throat; drowsiness, weakness, shaking; prolonged or repeated exposure causes personality changes and decreased mental ability.

Anti-carburetor icing additives: freezing point depressants (act as antifreeze) such as alcohols and glycols, and surfactants (prevent adhesion between ice and metal surfaces) such as derivatives of carboxylic and phosphoric acids.

Detergents: remove and/or minimize deposits in throttle of carburetor. Such as amines and derivatives of carboxylic and phosphoric acids having surface active properties; some are polymers.

Dispersants: remove and/or minimize deposits in carburetor, intake manifold and ports, and intake valves. Such as polymeric materials containing amines or other functional groups; these may be used combined with synthetic polymers or special oils.

Demulsifiers; minimize emulsion formation. These are generally complex mixtures of surfactants.

Dyes: oil-soluble solid and liquid dyes for various identification purpose (see below under aviation fuels).

DIESEL FUEL AND ADDITIVES

Diesel fuel is a mixture of cetane (n-hexadecane) and 1-methylnaphthalene. The ignition quality is expressed in terms of the cetane number, which refers to a mixture of cetane (value = 100) and 1-methylnaphthalene (value = 0). Most automotive diesel engines require a fuel of cetane number greater than 45.

Diesel fuel may contain some of all of the following additives:

Ignition quality improvers: to raise the cetane number and promote faster starts and less white smoke. Includes alkyl nitrates

Oxidation inhibitors: to minimize oxidation and gum and precipitate formation and improve storage life. Includes alkyl amines and amine-containing complex materials.

Biocides: to inhibit the growth of bacteria and fungi which feed on hydrocarbons and help prevent filter-clogging caused by these organisms. Examples are boron compounds, quaternary amine compounds, or ethers of ethylene glycol. The glycol ethers (such as 2-methoxyethanol and 2-ethoxyethanol or ethyl cellosolve) by inhalation or skin absorption have produced adverse reproductive effects in male and female experimental animals, including embryonic death, teratogenesis, growth retardation, testicular atrophy and sterility. In humans, irritation of eyes, nose, and throat; Can be absorbed by skin; causes drowsiness, weakness, shaking, prolonged or repeated exposure causes personality changes and decreased mental ability. Ethylene glycol mono ethyl ether affects brain, blood, and kidneys; causes personality changes. Less toxic than ethylene glycol monomethyl ether or ethylene glycol monobutyl ether.

Rust preventives: To minimize rust formation in fuel systems and storage facilities. Such as organic acids and amine salts; a widely used type is based on dimerized linoleic acid.

Metal deactivator: to deactivate copper ions which are powerful oxidation catalysts. Such as N,N'-disalicylidene-1,2-propane diamine.

Pour Point Depressant: to improve low-temperature fluidity properties by modifying the wax crystal growth, structure, and/or agglomeration. (Waxes are present in the original petroleum product and not all are removed by processing.) Consist of polymers such as polyolefins, polyacrylates, polymethacrylates, modified polystyrenes, ethylene-vinyl acetate copolymers, and

modified polystyrenes, ethylene-vinyl acetate copolymers, and ethylene-vinyl chloride copolymers.

Demulsifiers and dehazers: to improve the separation of water from distillate fuels and prevent haze. These are surface-active materials which increase the rate of water/oil separation.

Smoke suppressants: to catalyze more complete combustion or maintain fuel spray patterns. Examples are barium compounds assisted by detergents.

Detergent-dispersants: to promote engine fuel system cleanliness, prevent nozzle deposit formation and injector sticking, and maintain filtration characteristics. These are surfactants and polymers containing amines and other functional groups.

Conductivity improvers: to improve the dissipation of electrostatic charge. Such as amine salts, metallic salts, and polymeric compounds.

Dyes: for various identification purposes including tax status. Oil-soluble solid and liquid dyes (see below under aviation fuels)

De-icers: to reduce the freezing point of small amounts of water to prevent fuel line plugging. Such as ethanol, methanol, isopropanol, ethylene glycol monomethyl ether or diethylene glycol monomethyl ether (see MSDS companion sheet on solvents).

COMPOSITION OF ENGINE EXHAUST

Workers exposed to high concentrations of automotive emissions may experience elevated levels of blood carboxyhemoglobin and lead. USDHHS-NIOSH recommends that whole diesel exhaust be regarded as a potential occupational carcinogen based upon results of animal studies. Increased rates of lung cancer have been associated with occupational exposure to diesel engine emission. Workers exposed to diesel exhaust have exhibited eye irritation and decreased lung function; the lung function loss is reversible.

Vehicle exhaust from gasoline or diesel engines may contain:

Carbon monoxide: a teratogen in animal experiments; affects human central nervous system. Inhalation causes asphyxiation since carbon monoxide combines with hemoglobin in blood, preventing it from carrying oxygen and thus depriving the tissues of oxygen. Recovery from brief exposures is possible by inhaling fresh air. Repeated exposure to low concentrations have been found to produce hearing disturbances, contraction of field of vision, and heart irregularities.

Lead aldehyde: organic lead compounds are carcinogens of the lungs and are possible tumor causing agents. Lead is a cumulative poison, so prolonged exposure can produce industrial lead poisoning. Affects central system: mild cases of short duration show headache, dizziness, insomnia; more severe exposures show stupor, coma, and death.

Nitrogen oxides and Sulfur oxides: Nitric oxide and nitrogen dioxide irritating to skin, eyes, and mucous membranes; deadly poison; inhalation affects lungs and respiratory system; reaction with moisture in lungs forms nitric and nitrous acids/sulfurous and sulfur acids which damage lung tissue.

Smoke and other hydrocarbons produced by incomplete combustion of fuel: including ethylene, formaldehyde, methane, benzene, phanel, 1,3-butadiene, acrolein, and polynucleararomatic hydrocarbon (several are carcinogens) as well as particulate with absorbed contaminants. Aldehydes are highly irritating to eyes and mucous membranes of the respiratory tract; they are perceptible by eye and nasal irritation at >1ppm; all the aldehydes possess anesthetic properties. "Tars" produced by gasoline engine exhaust have caused cancer in animal experiments.

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FLUIDS, CHEMICALS, AND EXPOSURES INVOLVED IN VEHICLE MAINTENANCE

Anti-freeze:

Methanol: irritant to skin, eyes, mucous membranes; narcotic; toxic to nervous system, especially the eyes causing atrophy of optic nerve and leading to blurring of vision, photophobia, irritation of mucous membranes of the eyes, and eventually eye lesions and blindness. It is slowly eliminated from body, so repeated daily exposures can build up in body to cause illness. Oxidized by body to formaldehyde and formic acid which are both toxic. Causes headache, gastrointestinal disturbances, dizziness, feeling of intoxication, coma. Skin may become dry and cracked due to solvent action of methanol. Dangerous fire hazard.

Ethylene glycol: irritant to skin, eyes and mucous membranes; very toxic in particulate form upon inhalation.

Windshield washer solvent: methanol (see above).

Batteries:

Sulfuric acid: extremely irritating, corrosive, and toxic to tissue. Contact with the body results in rapid tissue destruction and severe, painful burns. Repeated contact with dilute solutions can cause dermatitis. Repeated or prolonged inhalation of mist can cause inflammation of upper respiratory tract leading to chronic bronchitis. Workers exposed to low concentrations of vapor gradually lose sensitivity to irritation.

Lead: see supplementary information on lead.

Asbestos exposure during servicing of brake and clutch assemblies: workers inhaling brake drum dust have developed lung tumors; (see supplementary information on asbestos). Brake lining composition includes: asbestos, resins and polymers, oxides and pigments, metals, and carbon, graphite, etc. Normal braking conditions tend to destroy asbestos and produce drum dust containing amorphous magnesium silicate which is nonfibrous. Severe ("panic") braking conditions produce high temperatures which cause decomposition of the brake lining binder and the release of free asbestos fibers.

Sources of exposure to the garage mechanic and automobile repairman include (1) debris of brake or clutch lining wear when housing is cleaned using a high pressure air hose, (2) use of autobody filler, and (3) dust disseminated during mixing and application of undercoating materials which have contained the

application of undercoating materials which have contained the fiber in previous years. Short term asbestos concentrations during brake maintenance work can be high. Measurable concentrations of asbestos can persist in the workplace for as long as 15 minutes after in air blowing as far as 75 feet away. Therefore, a generally, low-level background contamination of asbestos can exist throughout a garage where brake repair is conducted. In past years asbestos was used as a reinforcing agent in plaster autobody fillers used for dent patching. Extensive dust exposure was common as the material was sanded smooth. Most persons previously exposed should be aware of their asbestos exposure.

Brake fluid and additives: glycol ethers (2-methoxyethanol, 2-ethoxyethanol) are anti-icing additives. (see above)

Lubricating oils: may contain residuals of phenol (high toxic, rapidly absorbed through skin), furfural (2-furaldehyde, highly toxic in humans via inhalation but of low volatility, highly irritation to eyes, skin and mucous membranes; poisonous to central nervous system), n-methyl pyrrolidone (n-methyl pyrrolidinone, low toxicity via skin), methyl-ethyl ketone (2-butanone, strong irritant; affects peripheral and central nervous system; a teratogen in animal experiments), or propane (affects central nervous system at high concentrations; an asphyxiant) used for extraction of substances present in the crude stock which could adversely affect engine performance.

The base fluids used to manufacture lubricating oils may be derived from petroleum, plant or animal oils, synthesized, or mixtures of any or all of these. Synthetic base fluids include chlorofluorocarbon polymers, fluoroesters, fluoroethers, phosphate esters of isopropyl phenol and cresylic acids, polyphenyl ethers (such as meta bis (m-phenoxyphenyl) Benzene), silicate esters (such as disiloxane derivatives), and silicones.

Additives:

Engine protectors: anti-wear agents, extreme pressure agents, anti-rust agents, corrosion inhibitors, detergents, dispersants, and friction modifiers.

Modifiers: pour point depressants (prevent condensation of waxes), seal swell agents, viscosity index improvers (which extend the upper temperature limit at which an oil will still provide satisfactory lubrication).

Base stock protectors: anti-form agents, antioxidants, and metal deactivators.

Greases: Solid or semisolid gels prepared by adding hydrocarbon-soluble metal soaps or salts or higher fatty acids (such as calcium stearate, lithium stearate, aluminum naphthenate) to mineral oils. The soap content varies from < 1% to 30%. Calcium soaps of rosin acids are used in greases. Greases also contain some water as a stabilizer.

Hazards of Air conditioner refrigerant: Several fluorocarbons have been used as refrigerants, of which dichlorodifluoromethane, freon 12 or FC 12, is probably the most common for mobile units. Exposure may occur during repair by the routine venting and replacement, or "topping-off" of the intact system. Venting to enter the system may occur with replacement of the compressor or its seal, replacement of the receiver-drier bottle, and changing of the hoses, condenser, or evaporator. Leak testing and purging of the system is required for this work. During repair of air conditioning systems, workers are sometimes exposed to rather high peaks of fluorocarbons when they fill or empty these systems or when leakage occurs. Fluorocarbon exposures may be below the occupational exposure limits on a time-weighted-average basis, but may exceed short-term-exposure levels.

Health effects of fluorocarbon refrigerants include reflexes from the respiratory tract which may influence the heart. Increases in airway resistance and bronchospasm has occurred in human subjects inhaling fluorocarbons; most subjects developed bradycardia and a change in the electrocardiogram. Bradycardia in man may originate from the fluorocarbon causing irritation of the upper respiratory tract. Animal experiments suggest that the heart may become sensitized to epinephrine and that a reduction in the elasticity of the lung may occur. Blood analyses indicate that these refrigerants are slowly taken up. Mechanics engaged in such vehicle air-conditioner repair have reported heart palpitations, although electrocardiograms have not shown arrhythmias.

Workers with chronic exposure to fluorocarbon refrigerants have been reported to develop coronary thrombosis.

Fluorocarbon refrigerants are defatting agents of the skin and can cause dermatitis.

PROTECTION AND PREVENTION:

good ventilation; fluorocarbon refrigerants are heavier than air and can displace air, causing dizziness, unconsciousness, or death by asphyxiation.

wear proper gloves

do not smoke around fluorocarbon refrigerants; as these gases are drawn through the hot end of the cigarette, they break down to produce potent lung irritants such as phosgene, which are then drawn into the lungs where they can cause chemical pneumonia or pulmonary edema