Health Hazards Manual
for

AUTOBODY SHOP WORKERS

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Table of Contents:

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, sulpha-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 <u>must</u> be in english but may <u>also</u> 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 forseeable 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 exercize 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 aply 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 infomation 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 (physicans, 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 sysstems: 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 intednded 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 handli;ng 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:

	Vapor Pressure (mmHg)
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 exosure 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:

	Specific Gravity (H_2O = 1)
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 amout 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:

	Evaporation Rate
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:

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

For example:

	Solubility in Water
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 sevaceous 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 ingnite 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:

	Flash Point (° F)
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 site will become an empty patch of ground. Improperly handled chemical products may simply separate, or spoil, or become unfit for the use for which they were developed.

STABILITY: UNSTABLE, STABLE, CONDITIONS TO AVOID

This term deals with whether or not the chemical product has sensitivities to temperature or there are conditions under which the product becomes unfit for its intended use or otherwise dangerous or violently reactive. If the chemical is stable, then this will be indicated; if there are conditions under which instability can occur, then unstable is indicated and the conditions to avoid are described. For example:

> "Unstable. Avoid shock from dropping."
> "Unstable. Avoid temperatures above 150 F."
> "Unstable. Use of organic solvents may cause cracking or crazing."
> (This is a frequent warning for plastic coatings.)

INCOMPATIBILITY (MATERIALS TO AVOID)

This section deals with materials, other chemicals, or other factors which are not compatible with the chemical product. This could be for a variety of reasons, for example:

"Water"	Result could be spattering, heat generation, gas production, etc., such as isocyanate foam.
"Direct sunlight"	Result could be fostering of chemical reactions within the product to form new chemicals or breakdown products, heat, etc. Acrylonitrile is sensitive to light and even when inhibited with aqueous ammonia, it can polymerize and give off heat; this could even lead to a runaway thermal explosion.
"Steel or copper piping"	(Result could be corrosion of metal, release of gases such as hydrogen, explosion, etc.) Such as Violent reaction between acetylene and copper.
"Acids"	(Result could be spattering, heat generation, evolution of poisonous or flammable gases, corrosion of metal, etc.), such as Cyanide salts which react with acid to release poisonous hydrogen cyanide gas.
"Alkalies or bases"	(Result could be spattering, heat generation, corrosion of metal, etc.), such as the corrosion of aluminum

HAZARDOUS DECOMPOSITION OR BYPRODUCTS

This section deals with the breakdown of the product, either spontaneously or due to heat or fire. These decomposition products can also be produced by:

a. Heating or welding of the metal to whose surface a chemical has been applied

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 in 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)