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Health Hazards Manual for Custodians, Janitors and Housekeepers

Nellie J. Brown
Cornell University, njb7@cornell.edu

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Health Hazards Manual for Custodians, Janitors and Housekeepers

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 cleaning products to see what components appear to be particularly hazardous, how you are exposed to them, and what you can do to minimize exposure.

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, custodian, housekeeper, solvent, skin problem, cleaning agent, eye damage, New York State Department of Labor, janitor

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HEALTH HAZARDS MANUAL

FOR

CUSTODIANS,
JANITORS AND
HOUSEKEEPERS

By Nellie J. Brown, M.S.
October, 1990

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Chemical Hazard Information Program
Dr. James Platner, Toxicologist/Director

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HEALTH HAZARDS MANUAL
FOR
CUSTODIANS, JANITORS AND HOUSEKEEPERS

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Why custodians, janitors, and housekeepers?
Because studies indicate many cases of skin problems such as dermatitis and allergies or cases of asthma among workers who perform housekeeping tasks. Some phenolic disinfectants have caused loss of skin pigmentation in workers using them without gloves. Many cleaning products contain acids or caustic which can cause skin or eye burns or irritations. Both male and female workers may have an increased risk of bladder cancer due to exposure to solvents and cleaning agents. The use of highly abrasive pads to sand or buff asbestos floor tiles at high speeds could expose custodians to unacceptable levels of asbestos fibers in the air.

But, if you knew in advance what problems could develop, you could take the appropriate precautions. Much of the information in this manual is not necessarily intended for immediate use, but can serve as a future reference or resource:

- to help you understand how the products you use actually work and what is in them
- to help you select products to minimize hazards
- to ask intelligent questions when purchasing
- to provide information on how you are exposed to chemicals
- how your exposure is related to the use of appropriate ventilation, protective equipment such as gloves use
- to help you read labels and material safety data sheets (MSDSs)
- to help you troubleshoot health problems and trace possible work-related health problems

While you read of product health hazards and case histories, see if the experiences of these janitors, custodians, and housekeepers sound familiar. Have they happened to you or others you know or have heard of who are in this line of work?

The manual 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 cleaning 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; for example, we will examine the health effects of toilet bowl cleaners for the housekeeper who cleans toilets many times a day, not for the consumer whose exposure is perhaps once a week.

People react differently to chemicals. Although comparing symptoms with co-workers can be valuable, one person could react to a product for which no one else at the workplace has a problem.
SOME BASIC IDEAS ON PRODUCT SELECTION HAZARDS, AND SUBSTITUTION

Chemicals can hurt us only if they make contact with us or actually enter the body. When using cleaning products, we should consider how a product can enter the body. This will depend upon the ingredients and how volatile they are, the form of the product (powder, liquid, aerosol, spray), and how the product is actually used or applied in order to do its job. The ways in which chemicals can interact with the body are called ROUTES OF ENTRY. Routes of entry include:

- **inhalation**: aerosols, vapors, or dusts can be inhaled into the nose, mouth, or into the lungs where damage can be done directly causing breathing problems or by absorption into the bloodstream which carries the chemical to other body organs where damage could be done.
- **skin contact**: chemicals can directly damage the skin by defatting the skin causing drying and dermatitis, by actually burning tissue, or by being absorbed through the skin into the bloodstream which carries the chemical to other body organs where damage could be done, or
- **ingestion**: chemicals can be eaten accidentally or by hand-to-mouth contact (such as by eating or smoking without first washing the hands or face).

As we examine product ingredients, we will look at way to prevent these routes of entry. For example:

**TO REDUCE INHALATION**

- Consider buying a product as a liquid rather than as a powder.
- Consider selecting ingredients which give off less vapors and have slower rates of evaporation; use water-based products wherever possible, rather than solvent-based products (this can reduce the flammability hazard as well).
- Consider using a product as a pump spray rather than as an aerosol spray; use coarse-nozzle sprays not fine sprays. Fine aerosol droplets can be inhaled into the deep lung where they can do damage or be absorbed into the body to cause adverse health effects; but large droplets tend to fall out of the air (avoiding inhalation) or are stopped in the nose either one protects the lungs.
- If aerosols are needed, consider using carbon dioxide propellants rather than chlorofluorocarbons (CFCs) or isobutane-propane types. Consider using containers which can be closed or capped in between uses of the cleaning product; this can reduce evaporation (as well as accidental spills).
Certainly inhalation can be reduced by increasing ventilation when using a product or by the wearing of respiratory protection, but product substitution may be a more cost-effective alternative.

**TO REDUCE SKIN CONTACT or SKIN ABSORPTION**
- consider using a product as a pump spray rather than an aerosol spray; use coarse-nozzle sprays not fine sprays
- consider using water-based products rather than solvent-based products since the oily surface of the skin repels water-based products but absorbs solvents very well
- consider using diluted products to reduce the concentration of hazardous ingredients; diluting many corrosive products may reduce their hazard to that of an irritant
- when needed, use gloves, aprons, eye protection, or other protective clothing (such as boots).

**GENERAL GUIDELINES FOR HANDLING CHEMICAL PRODUCTS**
- Read labels and follow directions. Refer to material safety data sheets for additional information.
- Use the proper protective equipment (gloves, apron, eye protection).
- Replace caps and lids of chemical containers immediately after use.
- Wash spills off the skin or out of the eyes IMMEDIATELY. The faster you do this, the less damage that will occur especially to the eyes.
- Know the location of eyewashes and drench showers in your work area. If you have to, you could make do with a sink or water fountain for washing the skin or eye in an emergency.
- Wash your hands after using chemicals especially before eating or smoking.
- Use all chemicals with adequate ventilation. Wherever possible, select the cleaning product to match the ventilation your building has.
- Never mix chemicals unless you are specifically directed to do so. Chemicals can react together to give off poisonous gases, heat and steam, or bubbling and splashing back at you. Mixing is not always on purpose it can happen by pouring chemicals down the same drain (or toilet) without running water (or flushing) in between. Mixing can also happen by reusing a container or bucket without rinsing it out first.
The most common accidents involving mixing chemicals together are:

- AMMONIA with CHLORINE BLEACH
- ACID-TYPE TOILET BOWL CLEANER with CHLORINE BLEACH

These combinations give off poisonous or highly irritating gases or vapors.

Is this product sold as a concentrate? If so, what is the use-dilution of the product for general cleaning and for specialized or heavy-cleaning jobs? Consider reducing the product's hazards by using the highest dilution (weakest concentration) of the product which will do the job. Sometimes an MSDS will show the pH of the product, as a concentrate or as a use-dilution (this information is not required on an MSDS, but some manufacturers show it anyway). pH can be useful in showing how corrosive or irritating the concentrate or dilution will be.
THE OSHA HAZARD COMMUNICATION STANDARD

Of great importance to custodians, janitors, and housekeepers is obtaining good information on the ingredients of the chemicals they work with. Without this information, it is difficult to...

- assess workplace hazards
- trace health effects to their source
- choose products so as to minimize hazards and avoid serious health problems by avoiding troublesome ingredients or by choosing a product in a different form (such as a liquid rather than a powder to reduce a dust hazard)

The OSHA Hazard Communication Standard is an occupational safety and health regulation which came into being in 1985. The purpose of this regulation is to ensure that the hazards of all chemicals produced or imported are evaluated and that information concerning their hazards is transmitted to employers and employees. This Standard requires the manufacturers and importers of chemicals to assess the hazards of the chemicals which they produce or import. Then, employers are required to provide information to their employees about the hazardous chemicals to which they are exposed by means of a hazard communication program, labels (and other forms of warning), material safety data sheets (MSDSs), and informative training. Distributors are required to transmit the required information to employers.

You should use this regulation to obtain material safety data sheets (MSDSs) on all the products you use by asking your distributor, manufacturer, or sales representative to provide them. Try to obtain MSDSs before you purchase products to compare them with respect to their health hazards. MSDSs are useful for writing bid specifications, as well, to help you obtain the products you want. You may wish to deal only with manufacturers who respond to your requests for product information.
An Overview of Occupational Diseases Typical of Custodians, Janitors, and Housekeepers

HEALTH STUDIES

The principal health problems confronting custodial workers tend to involve:

- Inhalation of aerosols, vapors, powders or dusts, and particles or fibers, resulting in irritations or allergies (asthma) or the respiratory tract
- Skin contact with cleaning liquids causing skin irritation, allergies, loss of skin pigmentation, skin burns (this includes eye damage or irritation as well)
- Skin contact with some types of gloves causing skin allergies or loss of skin pigmentation
- Skin contact with wash or rinse waters used in cleaning stainless steel can involve sufficient contact with nickel in solution to bring about nickel allergy
- Skin absorption of liquids such as solvents or disinfectants
- An elevated risk of bladder cancer compared to the general population

Custodial workers are especially exposed to the risks of sensitization (becoming allergic to the products they work with). In small workplaces, if only one person experiences a health problem in relation to a product, that person tends to think of him/herself as an isolated case and the problem as not being work-related. Since many of the reactions to chemicals are allergic-type reactions, only the sensitive individual will respond anyway, so numbers are not significant in indicating risk.

Many allergic reactions to products involve fragrances and frequently dyes used to color products. These can be forestalled by using unscented products (including those without masking fragrances) and by changing colors.

In most cases of occupational allergy, improvement tends to occur when away from the job as long as the exposure ceases. For example, you are not likely to see improvement with workers sensitized to rubber gloves who continue to use them at home.

The following is a preview of the major health problems in janitorial workers arising from inhalation, skin contact, skin absorption, and long term exposure.

INHALATION of aerosols, vapors, and particles can occur from the use of aerosol products such as those using propellants. Many products which are purchased as powders can produce dusts when they are
handled or used. Some cleaning products are applied so as to dry to a powder and then be vacuumed. Fine dusts can be inhaled and can cause irritation of the respiratory tract or asthma.

Inhalation of the propellant itself can also occur. Propellants and solvents or solvent carries such as fluorocarbons (Freon 11), methylene chloride, 1,1,1-trichloroethane, isobutane, propane, and ethanol have been linked to a variety of adverse health problems. Because of the close contact between the air sacs of the lungs and the bloodstream, these chemicals enter the blood through inhalation and are carried throughout the body to cause effects on other body systems. Moreover, hydrocarbon propellants and solvents are highly flammable and can cause a blowtorch effect if ignited.

Asbestos fibers may be released into the air if proper floor wax removal procedures are not followed. USEPA guidelines for wax stripping and provided later in this manual.

**SKIN CONTACT** with cleaning liquids can be a problem since many products contain ingredients which are able to remove greases, oils, and greasy dirt from surfaces. This means that these same products can remove skin oils, causing skin to dry out and even crack or bleed. Repeated skin damage may even increase the potential for developing a skin allergy to an ingredient.

Cleaning products which contain acids, caustics, or harsh germicides can cause skin irritation or even skin burns. The eyes are particularly susceptible to damage from these kinds of products. Some phenolic germicides have caused custodial workers to experience a loss of skin pigmentation which gives the skin a pale pink appearance (looking just like a skin burn). Patches of nonpigmented skin can be very disfiguring and avoiding the use of the germicides has not always caused this condition to reverse itself and the skin pigmentation to return to normal.

**SKIN CONTACT** with the components in some types of gloves has caused skin allergies. The ingredients added to some rubber gloves has resulted in a loss of skin pigmentation for glove wearers. Hopefully, this problem has been solved since glove manufacturers made aware of the skin condition have changed their glove formulations.

Skin contact with wash or rinse waters used in cleaning stainless steel can involve sufficient contact with nickel in solution to bring about nickel allergy. As wash or rinse waters are used over and over again for cleaning stainless steel, nickel (from the stainless steel) builds up on concentration in the water. To avoid this problem, the nickel concentration should be kept lower than the level which can lead to allergy so wash or rinse water should be changed frequently.
SKIN ABSORPTION of liquids such as solvents or disinfectants can enable these chemicals to be taken into the blood stream to cause their adverse health effects elsewhere in the body (just as can occur with inhalation). The face, chest, and groin area are especially permeable to such chemicals, even more than the hands and feet, so it is particularly important to use plastic aprons to avoid splashes on the front of the body and to avoid the wearing of soaked clothing.

Epidemiological evidence suggests that janitors and maids may experience an ELEVATED CANCER RISK when compared to the general population for cancer of the bladder. The difficulty with these studies is that the risk covers the profession as a whole, but does not show which particular chemicals may be responsible among many potential exposures.
BASIC CLEANERS

This section deals with general cleaners which consist of detergents with a few additives. The simplest products are like these. More vigorous cleaners may also contain acids or caustics or alcohol-like solvents. The ingredients discussed below may have more than one function in a product.

To understand how cleaners work, we will start by looking at dirt, soil, and stains. Every cleaning process consists of...

- the surface to be cleaned
- the soil or dirt to be removed, and
- the cleaning solution, a liquid applied to the surface to remove the soil.

Surfaces and soil exist in considerable variety. To clean effectively, a cleaning product should...

- remove the soil from the surface to be cleaned
- suspend the soil in the cleaning solution, and
- prevent the redeposition of the soil onto another part of the surface.

When we clean, we expect to remove the dirt an enable it to be washed away we want to get rid of it, not simply spread it around. We tend to conclude that a product has failed to do its job if the soil is redeposited and we cannot rinse the surface clean, even if the soil was removed initially. For example, if we add a cleaning product to the toilet bowl and scrub the surface with a brush, we expect the suspended soil to be able to be flushed down the toilet. We do not want the soil to resuspend itself as a ring around the surface of the water which then refuses to flush. Similarly, in doing laundry, we expect the detergent to remove the soil from the fabric, suspend it, and enable it to leave the washing machine in the rinse water. We do not want to see greasy white or gray streaks or clumps of detergent-and-soil to be redeposited on the fabric.

Dirt, soil, films, and stains may not only be simply deposited on surfaces such as floors, walls, furniture, tile, and fixtures, but may also be attached to these surfaces. Cleaning agents must break this attachment in order to lift or remove the soil. This is done by adding a variety of ingredients to the wash water to improve its ability to remove dirt.

Since dirt consists of a variety of materials which differ in their chemical structure and in the way they attach to the soiled surface, more vigorous chemicals may be needed to remove some kinds of dirt than others. Moreover, porous surfaces tend to be more difficult to
clean (and disinfect) than those with smooth, hard finishes. For example:

- **OILS, GREASE, OILY-COATED SOOT, and FATS** may be removed using detergents, caustic (or basic) chemicals, or solvents.
- **WAXES** may be removed with caustics or solvents.
- **RUST STAINS, HARD-WATER SPOTS, and SOAP FILMS** may be removed using acids, bleaches, or specialized additives.
- **ACIDS**, such as fruit juices or tomato sauce, or **STAINS**, such as blood or coffee, may require the use of bleaches.
- **BODY SOIL**, consisting of dead skin cells, body oils, and salts from perspiration (which are cooked onto fabric with body heat) may require the use of enzyme cleaners.

When dirt or stains are difficult to remove, more vigorous and usually more hazardous chemicals are needed. It may be possible to select less hazardous general purpose cleaners, and only use the more vigorous products when needed. As we will see throughout this manual, there are generally choices as to the ingredients in a product and their associated hazards, so we can select products of lesser hazard most of the time.

A number of products are multi-purpose; other abilities can be built into cleaning agents. For example, **DIRT-REMOVERS** can be combined with:

- **DISINFECTANTS**
- **AIR-FRESHENERS**
- **STAIN REMOVERS**
- **ABRASIVES**

to enable one-step cleaning. However, when this is done, we tend to find that the number of ingredients in a product increases far more than we might expect from just the number of additives added. This often occurs because additives are not always compatible with each other. Sometimes additives will...

- react with each other, making them form clumps or precipitates which settle out
- interact with each other and prevent each other from performing their functions
- shorten the products useful life or shelf life

To prevent this from happening, even more ingredients must be added.

As a result, all-purpose cleaners can have a disadvantage with more ingredients, each ingredient makes up less of the product. So you may
need to use more product to do any particular job which makes use of only one or two components of the product. So, for some cleaning jobs, you may wish to consider whether a specialty product for removing just one particular kind of soil may be a better choice. When dirt or stains are difficult to remove, more vigorous (and usually more hazardous) chemicals are needed this should alert you to be more cautious.

GENERAL PURPOSE CLEANERS

These cleaners are usually based upon detergents (surfactants) with special purpose additives. The simplest products are almost all detergent; more vigorous cleaners may also contain acids or caustics or alcohol-like solvents. The types of ingredients and their functions are described below; the names of ingredients are also shown to assist you in reading material safety data sheets or labels.

All-purpose cleaners may consist of:

SURFACTANTS: these are detergents and sometimes soaps.
Surfactants alone do not possess any soil-lifting ability, they enhance this ability for water or solvents. "Surfactant" is a contraction of the term "surface-active agent." This indicates that a surfactant is able to alter the surface tension of the water so that water can wet or penetrate surfaces and textiles, rather than "bead-up" on them. By lowering the surface tension of water, water is better able to disperse oils and greases, rather than just float them.

Anionic detergents:

linear alkyl benzene sulfonates such as:
- ammonium dodecylbenzene sulfonate
- ammonium tridecylbenzene sulfonate
- sodium dodecylbenzene sulfonate
- sodium tridecylbenzene sulfonate
- potassium dodecylbenzene sulfonate
- potassium tridecylbenzene sulfonate
- magnesium dodecylbenzene sulfonate

sodium alkyl sulfonates such as:
- sodium tetradecyl sulfonate
- sodium pentadecyl sulfonate
- sodium hexadecyl sulfonate
- sodium heptadecyl sulfonate
- sodium octadecyl sulfonate
- ammonium alkyl sulfate
- sodium alkyl sulfates (includes sodium lauryl sulfate, Duponol C. Drene, Dreft, Teepol, Gardinols, Tergitols)
- potassium alkyl sulfate
- magnesium alkyl sulfate
ammonium alkyl ethoxylate sulfate
sodium alkyl ethoxylate sulfate
potassium alkyl ethoxylate sulfate
magnesium alkyl ethoxylate sulfate
sodium xylene sulfonate
potassium xylene sulfonate
sodium toluene sulfonate
potassium toluene sulfonate
alkyl glyceryl sulfonate

Nonionic detergents:

alkyl ethoxylates or alkyl polyethylene glycol ethers such as
laur eth 9 (dodecyl alcohol nonoxyethylene ether
ethoxylated alkyl phenols such as
ethoxylated nonyl phenol (common trade names are Igepal,
Nonoxynol)
ethoxylated octyl phenol (common trade names are Triton X-
45, X-100, X-102, X-114)
ethoxylated lauryl phenol (common trade name is Brij)
alkyl amine oxides such as
lauramine oxide

BUILDERS: combat water hardness and avoid the complexing of
hardness with surfactant which leaves films or residues or reduces
cleaning effectiveness. Such as

sodium sesquicarbonate
tetrasodium pyrophosphate
potassium phosphate
tetrapotassium pyrophosphate
sodium tripolyphosphate
trisodium phosphate
sodium silicate or metasilicate
chelating agents such as
EDTA (ethylene diamine tetracetic acid)
NTA (nitriloacetic acid)

DISINFECTANTS/GERMICIDES/PRESERVATIVES: many
detergents, and some additives, can spoil readily, especially if diluted.
This type of ingredient acts as a preservative in low concentrations; in
higher concentrations, it gives the product the ability to disinfect as it
cleans. See the section on disinfectants for more information on the
disinfectant-cleaner type of product.

EMULSIFIERS: to keep product from separating, such as

MEA (monoethanolamine)
DEA (diethanolamine)
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TEA (triethanolamine)
isopropylamine

FRAGRANCES: to provide a pleasant fragrance or to mask the odor of the ingredients, such as pine oil

COLORS: to dye the product a pleasant shade; also useful in identifying different cleaners

SOLVENTS: to act as dispersing agents and to assist in grease-lifting ability of the products, such as

- alcohols, such as ethanol, isopropanol
- cellosolves, such as butyl cellosolve (butoxyethanol), ethyl cellosolve (ethoxyethanol)
- stoddard solvent (a type of mineral spirits)
- mineral spirits or petroleum distillates

SOIL-SUSPENDING/ANTI-REDEPOSITION AGENTS: to prevent soil from being left behind as a film and to enable clean rinsing, such as

- carboxymethylcellulose
- PVP (polyvinylpyrrollidone)

ACIDS: to assist in dissolving hard water spots and films, such as

- acetic acid (vinegar)
- sulfuric acid
- hydrochloric acid (muriatic acid)
- hydrofluoric acid
- formic acid
- oxalic acid

CORROSION INHIBITORS: to prevent acid or caustic-containing products from corroding metal surfaces.

BASES/CAUSTICS: to assist in grease-lifting by reacting with fats/oils to form water-soluble soaps, such as

- sodium hydroxide
- potassium hydroxide
- ammonia
- amines; also used as emulsifying agents, see above, such as MEA, DEA, TEA or isopropylamine

ABRASIVES: for scouring, such as

- silica or silica flour
- pumice
calcium carbonate (less harsh or scratchy)

**ENZYMES**: to break the chemical bonds between the soil and the surface to be cleaned, such as proteases from the bacterium bacillus subtilis

**ADVERSE HEALTH EFFECTS ASSOCIATED WITH GENERAL CLEANERS:**

Surfactants (detergents and soaps) are skin and eye irritants and can produce a roughening of the skin surface or swelling and irritation thus altering skin permeability and moisture content. Surfactants dissolve oils on the surface of the skin or natural skin moisturizers within the skin, causing chapping and roughness. This is worse in dry weather due to the low relative humidity. Since the human skin uses body oils as a protective mechanism, chemicals which remove natural skin oils can defat and dry the skin or can penetrate the skin and damage tissue – this is especially the case for detergents, caustics and solvents. So, the properties of detergents, caustics and solvents which make them good cleaners also make them good drying and damaging agents for the skin. The eyes, having no such protective mechanism, are particularly susceptible to burns or damage from acids, caustics and solvents.

Irritation of the nose, throat or upper respiratory tract may result from inhalation of dust from detergent or soap powder products or inhalation of mists or droplets from aerosol spray or pump spray products.

Eye and skin irritation from surfactants appears to depend considerably upon the degree of alkalinity, or pH. For example, sodium soaps have a pH of approximately 9.8. Some manufacturers indicate the pH of the product, concentrate or use-dilution on the material safety data sheet. Acid-containing products will have a pH under 7; base-containing products will have a pH above 7. The further the pH is from the neutral value of 7 (the pH of pure water), the more likely it is that the product will cause irritations or burns to the skin and eyes.

Surfactants can also enter and pass through the outer layer of the skin, interacting with skin proteins and causing swelling of the skin, possibly because detergent anions cause skin's keratin protein to uncoil and expand, becoming more permeable. Fortunately, this effect is reversible and the skin can recover from the effects of detergent exposure and immersion. The greatest swelling results from surfactants with a carbon chain length of 12; these are usually anionic surfactants with the word "lauryl" in them. Anionic detergents in general can be moderate to marked skin irritants, and marked to severe eye irritants. Sodium lauryl sulfate, a common anionic detergent, has been reported to have caused allergic contact dermatitis, but the causative agents tend to be traced to impurities such as nickel,
sultones, or chromium. Thus, the sensitization actually was developed prior to contact with the surfactant which, due to the impurities, simply aggravated an existing condition.

On the other hand, nonionic surfactants do not appear to cause this swelling and, as a rule, produce less skin damage than ionic surfactants. A higher concentration of nonionics is needed to produce the irritation of anionics. Nonionic surfactants rarely sensitize, even at full-strength, or irritate human skin.

Allergic reactions (dermatitis or asthma) may result from exposure to enzyme detergents. (See section on laundry detergents for more information on enzyme problems.)

If a detergent product alone does not provide sufficient cleaning action, especially for greasy dirt or hard water deposits, more vigorous cleaning agents may be needed, consisting of surfactants aided with acids, bases (caustics, alkalis), or chelating agents. These additives assist in breaking the bonds attaching the soil to the soiled surface. Acids and bases are more vigorous cleaners, but at the same time are corrosive in nature and more hazardous to work with.

Acids and acid mists can cause severe lung irritation, erode the skin and respiratory tract tissue, and are particularly damaging to the eyes. Repeated contact with dilute solutions of acids can cause dermatitis. Repeated or prolonged inhalation of acid mist can cause inflammation of the upper respiratory tract leading to chronic bronchitis. However, people repeatedly exposed to low concentrations of acid vapor can gradually lose sensitivity to irritation.

Acetic acid is irritating to eyes, skin and mucous membranes; at high concentrations it is corrosive.

Hydrochloric (muriatic) acid is corrosive and irritating to skin, eyes, and the mucous membranes of the respiratory tract. Severe exposures can result in lung damage.

Hydrofluoric acid is extremely irritating and corrosive to skin, eyes and mucous membranes. Inhalation of the vapor may cause ulcers of the upper respiratory tract. It causes severe skin burns which are slow in healing; deeper tissues may be affected, becoming blanched and bloodless. If hydrofluoric acid-containing products must be used, consider having solutions of benzalkonium chloride available to wash and soak affected skin.

Formic acid is principally an eye and skin irritant.

Oxalic acid is highly corrosive.
Sulfuric acid and sodium hydroxide (caustic soda, lye) can remove water from tissue, causing charring and severe burns on contact with skin. The diluting and mixing of acids or bases with water generate a great deal of heat; this causes local boiling and can produce bubbling and splash-back.

Where removal of hard water deposits is needed, chelating agents such as EDTA or NTA may prove considerably safer to work with than acid-containing Descalers. EDTA is an irritant and a teratogen in animal experiments.

The chelating agent, EDTA (ethylenediamine tetracetic acid or its acetate salt), has been implicated in allergic dermatitis-type reactions, as well as cross-reacting with ethylenediamine (a common stabilizer for rubber latex. A case history of a dermatitis outbreak in an engineering factory involved "an ethylenediamine-type chelating agent" in which 15 workers were affected on the hands and fingers, one worker on the palms, and another worker on the forearms. Chelators are used to complex water hardness (calcium and magnesium, sometimes iron) to prevent its interference with the detergency of the surfactants and to enable the removal of soap scums and hard water scale from surfaces.

Caustic mists, vapors, and dust cause small burns, damage eye tissue, and can cause damage to the airways and to lung tissue varying from mild irritation of mucous membranes to severe inflammation. Prolonged contact with even dilute solutions of bases or caustics can have a destructive effect on tissue, such as eye irritation, drying of the skin, or dermatitis.

Ammonia or ammonium hydroxide, a base or caustic, is highly water-soluble, so its vapors dissolve readily in the moisture of the eyes and upper respiratory tract. As a result, it is an eye and lung irritant and should always be used in a well-ventilated area. The amine-type caustics such as morpholine, triethanolamine, or ethanolamine are also skin irritants. Sodium hydroxide (lye) and potassium hydroxide, whether used as pellets, in solution, or as mists, vapor, or dusts, are corrosives. Both tend to be poisons and are irritating to skin, eyes, and mucous membranes. Because of their penetrating properties, they are extremely damaging to the eyes. Skin injuries may be extremely severe with deep burns and ultimate scarring.

The glycol ether solvents, also called cellosolve solvents (such as 2-butoxyethanol or butyl cellosolve), can be irritants of the skin and eyes and upon inhalation. Animal studies (but not human data so far) have implicated these solvents in possible reproductive effects in both sexes. OSHA is currently contemplating regulatory action on the glycol ether solvents.
See the section on disinfectant cleaners for more health information on preservatives. Formaldehyde, a common preservative, is highly irritating to skin, eyes, and membranes and a possible tumor-causing agent of the nasal passages. Frequent or prolonged exposure can cause hypersensitivity leading to contact dermatitis.

Alcohols, often used as dispersing agents as well as disinfectants, include ethyl alcohol (ethanol), isopropyl alcohol (isopropanol), benzyl alcohol, and glycols such as ethylene, propylene, and triethylene glycol. Ethyl alcohol may cause headache and irritation of the eyes, nose, and throat. Inhalation, if long continued, can cause drowsiness and lassitude, loss of appetite and inability to concentrate. It is also a flammable liquid. Isopropyl alcohol is an eye irritant, local irritant, and in high concentration is narcotic. Splashes in the eyes can cause corneal burns and eye damage. Its ability to cause mild irritation of eyes, nose, and throat at low levels provides a warning to discontinue exposure. Isopropanol is readily absorbed by the skin. Inhalation of large quantities of vapor may cause flushing, headache, dizziness, mental depression, nausea, vomiting, narcosis, anesthesia, and coma. It is also a fire hazard.
PROTECTION AND PREVENTION

Product selection and substitution:

- Use simple product formulations, such as detergents without vigorous caustics, acids, solvents or germicides wherever possible for general cleaning. See section on disinfectant-cleaners for more information.

- Use nonionic detergents instead of anionics. Use mild detergents instead of soaps.

- If a product is purchased as a concentrate, use the highest dilution which will do the job.

- Use products with a pH as close to 7 as possible.

- Use chelating agents to remove hard water spots and soap scum, rather than acid-containing products.

- Use weak potassium hydroxide or sodium hydroxide solutions for removing greasy soil to avoid the eye and nose irritation of ammonia.

- Use caustics instead of solvents for removing greasy soil to avoid inhalation of solvent vapors and their health effects and possible flammability reactions.

- Avoid products with added fragrances and colors to avoid potential allergic reactions.

Engineering controls:

- Do not smoke around flammable or volatile solvents.

- Use adequate ventilation for volatile solvent-containing products or products which give off irritating vapors or dusts.

- Be prepared to handle spills of acids, caustics or solvents with the appropriate neutralizing agents or absorbants.

Personal Protective Equipment:

- Wear gloves when using these products. Match the glove material to the product; also match the glove material to the solvent for solvent-containing cleaners to avoid having the solvent migrate through the glove to the skin or dissolve the glove itself.

- Wear eye protection when using vigorous cleaners, especially acids, caustics, irritating solvents, dusts or aerosol sprays.
DISINFECTANTS, GERMICIDES, AND PRESERVATIVES

The disinfectants and germicides discussed in this section can be used by themselves or they can be added to the general cleaners discussed in the previous section to produce a product which cleans and disinfects at the same time. Sometimes these chemicals are used in small quantities in cleaning products in order to prevent the product from spoiling and thus lengthen its shelf life.

Some common terms used to refer to this group of compounds:

Disinfectant: substance which destroys infectious microorganisms for the treatment of inanimate objects.

Antiseptic: substance inhibiting or preventing the growth of microorganisms under the conditions of usage, generally in hygiene and surgery; a germicide except where inhibitory in use such as wet dressings, ointments, or other use involving prolonged contract with the body.

Germicide: substance which kills all microorganisms.

Sanitizer: similar to disinfectant; infers that it both cleans and reduces bacterial infection to safe levels with respect to public health requirements.

Sterilization: destruction or absence of all microorganisms; often falsely applied when disinfection is really meant.

Typical germicidal-type product formulations may contain:

GERMICIDE or DISINFECTANT: Germicides can be classified in 2 basic types – phenolics and non-phenolics. Some germicides are stable as concentrates but biodegradable and able to spoil if diluted. If the product is sold as a dilute solution, in an easily contaminated container, or is formulated with readily biodegradable surfactants or other ingredients, then another germicide used as a preservative for the first germicide may be needed. Quats are biodegradable and can spoil (usually mold) if diluted too much, whereas the concentrates have good storage potential.

Formaldehyde
Formaldehyde-releasers

Examples are
Phenolics:
phenol (carbolic acid)
cresol, ortho-cresol, meta-cresol, para-cresol, para-chloro-
meta-cresol (PCMC); benzyl cresol may be used alone or
with auxiliary germicides such as PCMC (p-chloro-m-
cresol) or PCMX (p-chloro-m-xylenol) or mixed
chloroxylenols
xylenol, chloroxylenol, para chloro-meta-xylenol (PCMX)
phlorol (4-ethyl phenol)
4-n-propyl phenol
4-n-butyl phenol
4-n-amyl phenol
4-n-hexyl phenol
4-n-heptyl phenol
ortho-benzyl-para-chlorophenol (o-benzyl-p-chlorophenol)
may be used in rug shampoos and in cleaners for
upholstery, wallpaper, leather, artificial leather, plastic
coating, and vinyl floors
para-tert-butyl phenol
ortho-phenyl phenol
para-tert-amyl phenol
dichlorophene
tetrachlorophene
hexachlorophene
salicylic acid (ortho-hydroxy benzoic acid)
methyl paraben (methyl para-hydroxybenzoic acid)
propyl paraben (propyl para-hydroxybenzoic acid)

Non-phenolics:
  pine oil disinfectants, may be boosted with DCMX, benzyl
  chlorophenol, or other phenols
  chlorine
  sodium hypochlorite (chlorine bleach)
  iodine
  iodophors, consist of iodine and surfactants; the high
  acidity of iodophors tends to damage terrazzo floors and
  equipment made of steel or galvanized metal
  iodine and polyvinylpyrrolidone, available in powder form
  (povidone)
  halozone
  azochloramine
  trichloromelamine
  hexachloromelamine
dichloro-dimethyl hydantoin (halane)
trichloro-isocyanuric acid, sodium dichloroisocyanurate
quaternary compounds, such as benzalkonium chloride
(alkyl dimethyl benzyl ammonium chloride), octyl decyl
dimethyl ammonium chloride, cetyl pyridinium chloride
or bromide, dioctyl dimethyl ammonium chloride,
didecyl dimethyl ammonium chloride, and mixed "quats"
such as alkyl (C14, 50%; C12, 40%; C16, 10%) dimethyl benzyl ammonium chloride hydrogen peroxide ethylene alcohol (ethanol) isopropyl alcohol (isopropanol) benzyl alcohol ethylene glycol, propylene glycol, triethylene glycol; often used in aerosol air fresheners imidazolidinyl urea, diazolidinyl urea

SOLUBILIZERS/COUPLERS/BUILDERS: see the section on general cleaners. Some common builders found in detergent products, such as phosphates and silicates do not tend to be compatible with quats; chelating agents are frequently used instead.

COLORS: A product may not list a color in the hazardous ingredients and yet be, for example, blue liquid.

FRAGRANCES: Similarly with odors; such as an ammonia odor, odorless, or a mild odor (not described). An unscented product may actually have a masking fragrance added to cover the natural odors of the ingredients.

HEALTH HAZARDS OF GERMICIDES AND PRESERVATIVES

Phenols and phenolic compounds:

The phenolic group of germicides can coagulate or precipitate protein. This toxicity and destruction of body tissue tends to bar them from many uses except heavy-duty drain, floor, and surface disinfectants. Detergents enhance the irritating nature of phenols by promoting skin penetration. Some phenolic detergent germicides can cause skin depigmentation (leukoderma) after repeated skin contact and possible inhalation.

CHEMICALS WHICH CAN CAUSE SKIN DEPIGMENTATION

This fact sheet deals with chemical exposures which can produce a loss of pigment in the skin of exposed workers. This condition may result from direct contact, inhalation, or ingestion of chemicals. Skin depigmentation may appear after as little as two weeks of exposure, but four to six months is a more common exposure period. Some chemicals require several years of exposure.

This condition is also called:
hypopigmentation
cutaneous chemical depigmentation
occupational vitiligo
occupational leukoderma (or leucoderma)
hypomelanosis
leucomelanodermatosis
toxic vitiligo
chemical leukoderma

All the leukodermas arising from chemical exposure appear similar. The skin has a whitened appearance due to pigment loss, but does not appear otherwise damaged. Depigmentation may be preceded by skin irritations such as reddening or itching which may serve as early warnings signs. Whitening of the skin is sometimes preceded by actual contact dermatitis consisting of redness, swelling, and scaly rash. Some depigmenting chemicals are irritants which produce a "burning" sensation upon contact. Many of these depigmenting chemicals are sensitizers as well and thus can produce eczema-type skin reactions; however, the allergic sensitivity can be independent of the depigmenting effect. The depigmented areas may also redden upon exposure to sunlight.

The depigmentation itself begins as small round or confetti-like spots which may be grouped in a particular region on the body. The depigmented areas may show a mild inflammatory reaction and hair loss. The skin areas involved in direct occupational contact appear to be affected first such as hands, forearms, face, neck, and lower legs. However, other areas not directly exposed may develop lesions as well. In extensive cases, the skin of the genital and anal areas may be affected or extensive and symmetrical depigmentation of the trunk may occur. Since it is typical for the lesions to be symmetrical and to appear on sites in which direct exposure is unlikely to have occurred, it would appear that inhalation (or possibly skin absorption) is also implicated as a route of entry, not just direct skin contact. A rare effect is graying of the hair on the scalp or other areas. Eye color is unchanged.

Before a diagnosis of occupational vitiligo is made, it is necessary to be certain that exposure to an offending chemical has occurred. It is also possible that an inflammatory change alone may cause hypopigmentation. About 1% of the population is born with vitiligo and it is found more frequently in females than in males. It can also be associated with Addison's disease, diabetes mellitus, pernicious anemia, and thyroid dysfunction. Examination of the tissues of biopsy specimens and electronmicroscopy do not distinguish between inherited and occupational vitiligo. Most chemical depigmenting agents appear to act by destroying melanocytes, the cells in which melanin (skin pigment) is manufactured in the skin. Some appear to
act by the inhibition of melanin formation by interfering with the activity or synthesis of tyrosinase (dopa oxidase) or other enzymes involved in the synthesis of melanin or by stimulating tyrosine oxidation. The number and size of melanocytes is decreased; the content of melanocytes and keratinocytes is diminished as well. Prolonged exposure would be expected to cause irreversible loss of all melanocytes. Studies have shown that compounds which interfere with tyrosinase in vitro may not necessarily cause skin depigmentation; however, compounds which do produce depigmentation in vivo (in the living body) inhibit tyrosinase in vitro (in an artificial environment). Thus, products intended for close contact with the human skin should be tested for their ability to inhibit tyrosinase.

In addition to the obvious skin effects, some of the chemicals implicated may have other effects. Phenolic derivatives such as PTBP (paratertiary butylphenol) may cause capillaritis, hepatosplenomegaly; diffuse goiter; altered liver function tests showing BSP elevation, slight increases in serum glutamic oxaloacetic transaminase (SGOT) and serum glutamic pyruvic transaminase (SGPT) levels; increased TSH levels; the presence of antithyroid antibodies; abnormal levels of aspartate aminotransferase; abnormal liver histology with moderate to severe fatty changes; or even cirrhosis. Some studies appear to indicate that the liver damage is not progressive and that liver function tests return to normal once contact with the depigmenting chemical ceases. (Inherited vitiligo is characterized by normal liver function. The presence of antithyroid antibodies, indicating an autoimmune condition, has been found in both inherited and chemically-induced vitiligo.)

If chemical exposure is discontinued, repigmentation may occasionally occur from the margins or from hair follicles; unfortunately, depigmentation is most often likely to be permanent. There are some possible treatments for assisting in repigmentation, but the success rate varies and often is insufficient to significantly reduce the person's cosmetic disability. The administration of topical or systemic psoralens and exposure to ultraviolet light (UV-A) may stimulate repigmentation.

The best approach to this problem appears to be prevention by avoiding physical contact with or inhalation of the offending chemical(s) by chemical substitution, using protective clothing (such as gloves) and adequate ventilation. Protective gloves (or other rubber products to be used in contact with the skin) should be selected so as to avoid those containing antioxidants which are known skin depigmenters.
CHEMICALS IMPLICATED IN SKIN DEPIGMENTATION

The following are chemicals which have been used as antioxidants in rubber gloves and other products; ingredients in lubricating and cutting fluids; as germicides or in germicidal cleaners or parts cleaners; as components in plastics, resins, and adhesives; ingredients in photographic developing chemicals; and in many other products.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Chemical Abstracts Service # (CAS#):</th>
</tr>
</thead>
<tbody>
<tr>
<td>monobenzylether of hydroquinone</td>
<td>103-16-2</td>
</tr>
<tr>
<td>monomethyl ether of hydroquinone (4-hydroxyanisole)</td>
<td>90-05-1</td>
</tr>
<tr>
<td>(p-methoxyphenol)</td>
<td>105-76-5</td>
</tr>
<tr>
<td>monooethyl ether of hydroquinone (p-ethoxyphenol)</td>
<td>62-26-8</td>
</tr>
<tr>
<td>paratertiary butylphenol (p-tert butyl phenol)</td>
<td>98-54-4</td>
</tr>
<tr>
<td>paratertiary amylphenol (p-tert amylphenol)</td>
<td>80-46-6</td>
</tr>
<tr>
<td>o-benzyl-p-chlorophenol (chlorophene)</td>
<td>120-32-1</td>
</tr>
<tr>
<td>p-phenylphenol</td>
<td>92-69-3</td>
</tr>
<tr>
<td>hexachlorophene (2,2'methylene bis (3,4,6-trichlorophenol))</td>
<td>70-30-4</td>
</tr>
<tr>
<td>paratertiary butylcatechol</td>
<td>98-29-3</td>
</tr>
<tr>
<td>hydroquinone</td>
<td>123-31-9</td>
</tr>
<tr>
<td>dihydroxydiphenylmethane</td>
<td>542-86-8</td>
</tr>
<tr>
<td>hydrochlorothiazide</td>
<td>58-93-5</td>
</tr>
<tr>
<td>guanofuracin hydrochloride</td>
<td>94-64-8</td>
</tr>
<tr>
<td>octylphenol</td>
<td>27193-28-8</td>
</tr>
<tr>
<td>nonylphenol</td>
<td>104-40-8, 25154-52-3</td>
</tr>
</tbody>
</table>

Both octyl- and nonylphenol found as free alkylphenol contaminants in detergents containing polyoxyethylene alkylphenylether

p-hydroxypropiophenone (p-propionylphenol) | 70-70-2 |
| p-cresol | 106-44-5 |
| butylated hydroxytoluene (BHT) | 128-37-0 |
| 4-isopropylcatechol (4-IPC) | 2138-33-4 |
| 2-mercaptoethylamine (beta-mercaptoethylamine) | 60-23-1 |
| N-(2-mercaptoethyl)-dimethylamine hydrochloride | 13242-44-9 |
| cystamine dihydrochloride | 56-17-7 |
| 3-mercaptopropylamine hydrochloride | 7211-54-3 |
| sulfanol | 12653-83-7 |
| thiouracil | 141-90-2 |
| 2,3-dimercaptopropanol (BAL); chronic administration has caused graying of the hair | 59-32-9 |
| para-aminobenzoic acid (p-aminobenzoic acid; PABA); taken orally to promote tanning has caused depigmentation | 150-13-0 |
| triethylenetriphosphoramide (thio-TEPA) | 52-24-4 |
| diisopropyl fluorophosphate | 55-91-4 |
| phystostigmine | 57-47-6 |
| mercury | 7439-97-6 |
| bismuth zinc | 7440-66-6 |
Germicidal phenolic detergents containing paratertiary butylphenol or paratertiary amylphenol

<table>
<thead>
<tr>
<th>Product:</th>
<th>Manufacturer:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bactophene</td>
<td>Sanfax Corp.</td>
</tr>
<tr>
<td>Beaucoup</td>
<td>Huntington Laboratories</td>
</tr>
<tr>
<td>Chlorocide</td>
<td>Center Chemicals</td>
</tr>
<tr>
<td>Galahad</td>
<td>Puritan Chemical</td>
</tr>
<tr>
<td>Listophene Enterprise</td>
<td>Paint Manufacturing</td>
</tr>
<tr>
<td>Matar</td>
<td>Huntington Laboratories</td>
</tr>
<tr>
<td>Microphene</td>
<td>Sanfax Corp.</td>
</tr>
<tr>
<td>O-Syl</td>
<td>Lehn and Fink Div., Sterling Drug</td>
</tr>
<tr>
<td>Phenocide</td>
<td>Center Chemicals</td>
</tr>
<tr>
<td>Phenomycin</td>
<td>Franklin Div. of Purex</td>
</tr>
<tr>
<td>Staphene</td>
<td>Vestal Laboratories</td>
</tr>
<tr>
<td>1-Stroke</td>
<td>Vesphene Vestal Laboratories</td>
</tr>
<tr>
<td>Tergisyl</td>
<td>Lehn and Fink Div., Sterling Drug</td>
</tr>
<tr>
<td>TriKem</td>
<td>Airwick Industries</td>
</tr>
<tr>
<td>Ves-Phene</td>
<td>Vestal Laboratories</td>
</tr>
<tr>
<td>Ves-Phene O</td>
<td>Vestal Laboratories</td>
</tr>
</tbody>
</table>

(The chemicals listed above may also be present in personal care products, clothing, or products for home use.)

In addition to the chemicals listed above, it may be possible to predict whether a chemical may be a skin depigmenter by its chemical structure. For further information contact Chemical Hazard Information Program.

Phenol (carbolic acid) is a skin and eye irritant; dermatitis from contact with phenol or phenol-containing products is fairly common. Its absorption through the skin is rapid and is a common route of entry. Exposure can result in acute poisoning whose principal effect is on central nervous system; although chronic exposure can also cause kidney and liver damage.

Ortho-cresol, meta- and para-cresols, xylenols, ethyl-substituted phenols: Cresols resemble phenol in their action on the body but the effects are less severe. They are corrosive to the skin in mucous membranes, producing severe chemical burns and dermatitis.

Substituted phenols: such as 4-ethyl phenol (phlorol); 4-n-propyl phenol, 4-n-buty1 phenol, 4-n-amyl phenol, 4-n-heptyl phenol. Their action is similar but less severe than phenol. These have been implicated in causing skin depigmentation, particularly para-tert-butyl phenol and para-tert-amyl phenol.

Chlorinated phenols: Phenolic detergent germicides containing o-benzyl-p-chlorophenol, p-tert-butylphenol, o-phenylphenol, and para-tert-amylphenol have been implicated in skin depigmentation effects. Dichlorophene, tetrachlorophene, and hexachlorophene can cause
sensitization; but have a low toxicity and a low tendency to cause skin irritation for dilute (1-2%) solutions. Hexachlorophene is a skin and eye irritant and a teratogen in animal experiments; it has also been implicated as a possible carcinogen. It affects the central nervous system recent animal studies show brain lesions at levels only slightly higher than those of hexachlorophene in soaps, shampoos, etc. The use of a hexachlorophene solution to wash patients with extensive burns has been reported to cause poisoning.

Dihydroxy carboxylic phenols: ortho-hydroxy benzoic acid (salicylic acid) is a skin and eye irritant.

Non-phenolics:

Pine-oil is a mixture of alpha-terpineol, dihydro-alpha-terpineol and other tertiary alcohols, borneol and fenchyl alcohols, estragole, and ketones; these tend to be skin irritants.

Chlorine, sodium hypochlorite (bleach), and other chlorine compounds are intensely irritating to the eyes, nose, throat, and respiratory tract, are damaging to lung tissue, and corrosive to eyes and skin. Other chlorinated compounds include halazone, azochloramine, trichloromelamine, hexachloromelamine, dichloro-dimethylhydantoin (halane), trichloro-isocyanuric acid (skin and eye irritant; powerful oxidizer), and dichloro-isocyanuric acid (irritating to eyes and abraded skin).

Iodine in alcoholic solution can be applied directly to tissue, although it has been found to be a skin irritant in certain cases. Iodophors almost completely lack irritancy.

Quaternary compounds: benzalkonium chloride (roccal, zephiran, zephirol, alkyl dimethyl benzyl ammonium chloride) can be a skin and eye irritant. Allergic contact dermatitis from benzalkonium chloride has been known to occur, but is uncommon. the quats can be irritating to the skin, conjunctival membranes, and mucous membranes at concentrations as low as 0.1 - 0.5%, and are especially irritating (even causing tissue necrosis) at concentrations over 10%. Occupational asthma has also been reported. Conjunctivitis has occurred when the quat has been retained by a soft contact lens which acted as a reservoir for slow release of the quat onto the cornea of the eye. Skin absorption does not appear to be a significant route of entry of the quat into the body. Animal studies have suggested that quats can inhibit cholinesterase or have curare-like effects on skeletal muscles; but this has not been well established in humans (except from intravenous administration) except in one woman who received benzalkonium chloride by vaginal instillation during an abortion.

Hydrogen peroxide: wide bacterial spectrum and comparatively safe for cuts and abrasions because its breakdown product is water; especially indicated for use in anaerobic infections. Depending upon solution strength, may be irritant to skin, eyes, and mucous membranes; solutions above 35% can cause blistering of skin. It is a powerful oxidizer and can be an explosion and fire hazard.
Zinc peroxide: used in wet dressings; mixed with castor oil or petroleum base to form cream; or used in ointment made with polyethylene glycol, calcium peroxide, and sulphonamides. It is an oxidizer and can be a skin or eye irritant.

Ethyl alcohol is a flammable liquid and may cause headache, irritation of eyes, nose, and throat, and, if long continued, drowsiness and lassitude, loss of appetite and inability to concentrate.

Isopropyl alcohol is an eye irritant, local irritant, and in high concentration is narcotic. It can cause corneal burns and eye damage. Usually, the mild irritation of eyes, nose, and throat which tends to occur at low levels provides a warning. It can be absorbed by the skin. Inhalation of large quantities of vapor may cause flushing, headache, dizziness, mental depression, nausea, vomiting, narcosis, anesthesia, coma. It is also a fire hazard.

Benzy alcohol is a skin and eye irritant.

Ethylene, propylene, and triethylene glycols used in aerosol air fresheners (virucidal). Very toxic in particulate form upon inhalation. Can be moderate explosion hazard. Propylene glycol is a skin and eye irritant, acts on human central nervous system.

Phenoxyethanol (phenyl cellosolve, phenoxetol) and phemeride: a skin and eye irritant.

Formaldehyde and formaldehyde releasers preservative can be potent skin irritants and/or sensitizers. Formaldehyde-releaser type preservatives may be a problem if workers have been previously sensitized to formaldehyde itself.

Colors and fragrances are common ingredients to which people become sensitized and can develop allergies.

You may also wish to consider if the workers are inhaling a spoiled product and are thus exposed to molds or bacteria or to irritant metabolic products of fermentation (spoilage) of the germicide.

PROTECTION AND PREVENTION

Product substitution:

- Consider using quaternary ammonium germicides or pine oil disinfectants if possible, and avoid using phenols and chlorinated disinfectants. When substituting, just make sure that the substitute is effective against the microorganisms you need to kill.
- Use pump sprays or steam products rather than aerosols if possible; (these should be coarse-droplet pump sprays).
- Apply the product as a liquid from a container rather than as a spray.
Use diluted products if they will do the job. Inspect diluted products for spoilage before use. Consider diluting small quantities to ensure rapid consumption. Date products for prompt turnover and short storage time.

Engineering controls:

• Use these products with adequate ventilation.

Personal protective equipment:

• Wear gloves when using these products. Match the glove material to the product to avoid having the product move through the glove to the skin or dissolve the glove itself.
• If your dermatitis or skin depigmentation problem is due to rubber or neoprene gloves, use other types of gloves such as PVC, vinyl, polyethylene.
• Wear eye protection when using vigorous cleaners and germicides; especially for aerosols and sprays.
The soil most commonly found on tile and porcelain fixtures may consist of:

- dirt, soil, and urine or fecal material
- soap scum
- hard water spots and scale
- mold, mildew and their stains
- rust stains

Some cleaners are intended only to remove simple soil using detergents (sometimes with disinfectants added). Some of these, such as cleansers, have abrasives added to remove the hard water scale and stains by scrubbing. Other products have a variety of ingredients to attack all of these kinds of soil and also disinfect at the same time. The typical ingredients of this group of cleaners may include:

**DETERGENT/SURFACTANT:** as discussed in the first section on general cleaners. If a quaternary germicide is used in this product as a disinfectant, then the detergent is usually nonionic -- anionic detergents react with quats to inactivate them and prevent them from doing their disinfecting action.

**DESCALING AGENT or DELIMING AGENT:** to remove soap scum caused by hard water, hard water spots and scale, and rust stains. This can be accomplished by using

- Acids such as hydrochloric (muriatic) acid or phosphoric acid
- Chelating agents such as:
  - EDTA, ethylenediaminetetraacetic acid or its sodium salts
  - NTA, nitrilotetraacetic acid or its sodium salts
  - sodium citrate
- Builders such as trisodium phosphate or sodium hexametaphosphate

**ANTICORROSION ADDITIVE:** to prevent corrosion of stainless steel or damage to metal drain pipes by acids. Such as:

- sodium metasilicate (sodium silicate)

**DISINFECTANT or GERMICIDE:** as discussed in the previous section. Some common choices of germicides for these products are

- sodium dichloroisocyanurate (a chlorine-releaser)
- quaternary ammonium salt disinfectants ("quats")
COUPLING AGENTS: these help to keep the products ingredients well mixed so they don't separate. They are also useful in suspending oily or greasy soil in water to enable it to rinse well. Such as:

- glycol ethers such as:
  - 2-butoxyethanol (ethylene glycol monobutyl ether, butyl Cellosolve)
  - 2-methoxyethanol (ethylene glycol monomethyl ether, methyl Cellosolve)
  - 2-ethoxyethanol (ethylene glycol monoethyl ether, ethyl Cellosolve)
- alcohols such as ethyl alcohol (ethanol) or isopropyl alcohol (isopropanol)

ABRASIVES: to scour or remove soil by scrubbing action. Such as:

- silica, silica flour, tripoli
- pumice
- calcium carbonate (less scratchy)

FRAGRANCE

COLORS
ADVERSE HEALTH EFFECTS ASSOCIATED WITH TILE AND PORCELAIN CLEANERS and TOILET BOWL CLEANERS

The hazards of the detergents/surfactants and disinfectants were discussed in previous sections.

Acids used as descaling/deliming agents can be corrosive and irritating to eyes, skin, and mucous membranes of the respiratory tract. Severe exposures could actually produce lung damage. Hydrochloric acid tends to produce an irritating vapor as well. When acid-containing products are diluted or mixed with water (such as when adding them to the toilet bowl), they can generate a great deal of heat; this causes local boiling and can produce splashing.

Chelating agents such as EDTA or NTA can be irritants and potential allergens, principally causing dermatitis or skin rashes. EDTA has also been shown to be a teratogen (cause birth defects) in animal experiments. Workers who have existing allergies to quaternary ammonium salt disinfectants or to amine-type emulsifying agents may also respond to EDTA. Sodium citrate does not appear to have significant adverse effects unless injected intravenously. Trisodium phosphate and sodium metasilicate are caustics and are irritating or corrosive to eyes and skin.

Glycol ether coupling agents have low vapor pressures, but can still cause headaches or dizziness or eye irritation. The glycol ethers have produced adverse reproductive effects in animal studies (including birth defects and adverse effects on the testis). There is currently little information concerning such effects upon humans; however, in men exposed to glycol ethers, reduced testicular weights have been observed. The glycol ethers are readily absorbed through the skin and skin contact should be avoided. OSHA is currently engaged in promulgating a substance-specific standard for the glycol ethers which will include ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, and their acetates, but not ethylene glycol monobutyl ether. Inhalation of ethylene glycol monobutyl ether can cause nausea or vomiting, headache, and nose tumors. Respiratory tract effects include irritation of the lungs causing coughing and shortness of breath; higher exposures can cause pulmonary edema. Other effects include irritation of the eyes, nose, mouth, and throat. The vapor can irritate the eyes, nose, mouth, and throat.

Chronic exposure can produce anemia due to the breakdown of red blood cells. Liver and kidney damage have also been reported.

Alcohols such as ethyl alcohol and isopropyl alcohol were discussed earlier in the section on disinfectants.
Abrasives such as silica, silica flour, or tripoli may have dust which is fine enough to be inhaled into the deep lung where respiratory damage can occur. Inhalation of fine dust should be avoided by careful handling of cleansers.

As has been mentioned before, some allergic reactions could be due to colors or fragrances added to products.
PROTECTION AND PREVENTION

Product Substitution:

- Consider using detergent-type cleaners for cleaning lightly-soiled surfaces and then using stronger disinfectants or more vigorous cleaners only when needed.

- For removing hard water scale or rust stains, consider using products containing chelating agents rather than acids. Sodium citrate appears to be a mild alternative to EDTA or NTA.

- Consider using cleansers with calcium carbonate rather than silica or silicates if the abrasion of calcium carbonate will do the job.

- Consider using abrasive cleaners rather than acid-containing cleaners.

- Use pump sprays with coarse nozzles rather than aerosol sprays.

- Use cleansers which have the abrasive power combined with a detergent/gel rather than simply loose powder.

- Consider using less hazardous disinfectants such as quaternary ammonium salt disinfectants.

- Avoid glycol ether coupling agents and use products containing alcohol or no coupling agent (or using detergent as a coupling agent).

- Avoid colors and fragrances

Engineering Controls:

- Use all products with adequate ventilation, especially for products containing acids, coupling agents, or sodium dichloroisocyanurate. Whenever possible, select products to match your building’s current ventilation.

Protective Equipment:

- Wear the appropriate gloves with these cleaners; check the MSDS for recommended glove types.
Wear eye protection to guard against splashes, especially for acid-containing cleaners and for cleaners used as aerosols or pump sprays.
FLOOR FINISHES, STRIPPERS, AND CLEANERS, and ASBESTOS FLOOR-TILE HAZARDS

This section deals with floor wax or other types of floor sealers and the regular and heavy-duty strippers used to remove them. Also discussed is the potential for release of asbestos fibers from the stripping and buffing of asbestos-containing floor tiles.

FLOOR WAXES AND FINISHES; FLOOR AND CONCRETE SEALERS

FLOOR WAXES typically consist of a wax or polymer/resin, solvents and emulsifying agents, and (sometimes) preservatives.

Wax or resin: this is either a vegetable, animal, or mineral wax or a synthetic resin which forms the protective coating for the flooring to provide the durable finish and seal its porous or uneven surfaces to prevent dirt or water penetration. Examples are:

Vegetable waxes such as
carnauba
candelilla
ouricuri
sugar-cane
cotton esparto
jojoba

Animal waxes such as
beeswax
shellac
chinese insect
ghedda

Mineral waxes such as
ozokerite
paraffin
microcrystalline
Fischer-Tropsch
hard waxes
montan

Synthetic resins and waxes such as
chloronaphthalenes
chlorodiphenyls
acrylic polymers of methyl methacrylate
(poly(methylmethacrylate))
polyvinylacetate
polystyrene
polyacrylonitrile
polystyrene acrylate copolymer

Solvents and coupling agents: these act to carry the finish and then evaporate and leave the finish behind as well as to keep the ingredients well mixed. Such as:

- turpentine
- white spirits (petroleum spirits, Stoddard solvent)
- ethylene glycol
- borax (sodium borate decahydrate)
- triethanolamine, diethanolamine, or monoethanolamine
- 2-amino-2-methyl propanol (isobutanol-2-amine)
- morpholine

Preservatives: to prevent the coupling agents or waxes from spoiling. Such as:

- formaldehyde

Pigments: these provide color and coverage of the surface, such as:

- iron oxide
- zinc oxide
- lead oxide
- lead carbonate (white lead)
- calcium carbonate (whiting)
- zinc carbonate

VARNISHES from coatings by chemical reactions during the drying process; so catalysts ("driers") are required. Varnishes typically consist of drying oil, resin, drier, solvent, and pigment.

Drying oil: which reacts with oxygen in the air to form a hard finish, such as

- tung oil
- perilla oil
- oiticica oil
- soybean oil (clear or white finish)
- dehydrated castor oil (clear or white finish)

Resin: these form a hard finish by reacting with oxygen in the air and polymerizing or by the glycol-diisocyanate reactions of the polyurethanes. Examples are:

- natural resins such as
  - common rosin or colophony (derived from pine trees)
  - limed rosin
  - ester gum
synthetic phenolic or alkyd resins such as
glycerol-phthalic anhydride resins
maleic resins
polyester resins
urea-aldehyde or melamine-aldehyde resins (the aldehyde is frequently formaldehyde)
urea-alkyd or melamine alkyd resins
polyurethane resins, typically consisting of two parts; one part contains a glycol and the other part contains a diisocyanate such as polymethylene polyphenol diisocyanate (sometimes with a little free toluene diisocyanate present): May also be formulated with silicone resins

Driers: these are oil-soluble compounds (usually metallic soaps) which act as catalysts to dry and harden the coating, such as

- cobalt naphthenate
- cobalt linoleate
- manganese naphthenate
- manganese linoleate
- lead naphthenate
- lead resinate
- lead linoleate

Solvents: these are needed to reduce viscosity of the varnish so that it is liquid enough to be applied using a brush. Solvents also prevent "skinning" during the drying process in which only the surface of the liquid varnish dries and the remainder of the liquid varnish below the surface stays liquid. Examples are

- turpentine
- dipentene
- toluene
- xylene
- naphtha
- mineral spirits (petroleum spirits)

Pigments: these provide color and coverage of the surface, such as

- iron oxide
- zinc oxide
- lead oxide
- lead carbonate (white lead)
- calcium carbonate (whiting)

LACQUER-TYPE SEALERS may simply consist of a resin and a solvent (such as shellac dissolved in denatured alcohol) or may also
have plasticizer, binder, and pigments. The drying of lacquers is by solvent evaporation, not chemical reaction, so no catalysts are required.

Resin: to seal the floor and provide the durable finish, such as

natural resins such as
dammar
ester gum
glycol esters of rosin

synthetic resins such as
modified phthalic resins
modified maleic resins

Plasticizers: these thicken the sealer and make it flexible and durable, such as

solvent types such as
di-n-butyl phthalate
tricresyl phosphate (tritolyl phosphate)
triphenyl phosphate
camphor

nonsolvent types such as
castor oil
blown soybean oil
linseed oil
tung oil

Binders: to hold the product together and keep the ingredients mixed, preventing them from separating, such as

cellulose tetranitrate
ethyl cellulose
cellulose acetate-butyrate

Solvents and diluents: to dissolve and carry the coating and enable it to be spreadable by a brush, such as

ethyl acetate
amyl acetate
acetone
diisobutyl ketone
glycol ethers such as
2-butoxyethanol (ethylene glycol monobutyl ether, butyl Cellosolve)
2-methoxyethanol (ethylene glycol monomethyl ether, methyl Cellosolve)
2-ethoxyethanol (ethylene glycol monoethyl ether, ethyl Cellosolve)
ethyl alcohol (ethanol)
isopropyl alcohol (isopropanol)
isobutyl alcohol
butyl alcohol
amyl alcohol
naphtha
toluene
xylene

Pigments: these provide color and coverage of the surface, such as

iron oxide
zinc oxide
lead oxide
lead carbonate (white lead)
calcium carbonate (whiting)

FLOOR STRIPPERS

To remove the floor wax-type products described above, the wax or resin must be redissolved. This can be accomplished by using caustic (basic) stripping agents or by using solvent stripping agents. Typically these products principally consist of one or more stripping agents, but may also contain surfactants or emulsifying agents to perform cleaning and degreasing actions or contain chelating agents to enable clean rinsing in hard water areas.

Stripping agents may include:

- caustic or basic stripping agents such as
  sodium hydroxide
  potassium hydroxide
  sodium metasilicate (sodium silicate, sodium metasilicate pentahydrate, alkali metasilicate
  ethanamine (monoethanolamine)
  ammonium hydroxide (ammonia)
  morpholine
- solvent stripping agents such as
  petroleum distillates
  methylene chloride

Surfactants: to also clean and degrease the floor. Such as

soaps such as
  potassium coco soap
detergents such as those listed in the first section on cleaners
Emulsifying agents: to keep the dissolved wax or resin suspended in the wash water and enable it to rinse away. The phosphate-containing agents will also deal with hard water and enable clean rinsing; these are especially needed if the stripper-cleaner contains a soap. Such as

- tetrapotassium pyrophosphate
- trisodium phosphate
- sodium tripolyphosphate
- glycol ethers such as
  - 2-butoxyethanol (ethylene glycol monobutyl ether, butyl Cellosolve or Carbitol)
  - 2-methoxyethanol (ethylene glycol monomethyl ether, methyl Cellosolve or Carbitol)
  - 2-ethoxyethanol (ethylene glycol monoethyl ether, ethyl Cellosolve or Carbitol)
  - dipropylene glycol monomethyl ether
- isopropyl alcohol

Chelating agents: these combat water hardness to facilitate clean rinsing, such as

- EDTA (ethylene diamine tetraacetic acid, may be as sodium salt)
- NTA (nitrilotriacetic acid, may be as sodium salt)

**HEALTH HAZARDS OF FLOOR FINISHES, STRIPPERS, AND CLEANERS, and ASBESTOS FLOOR-TILES**

The animal, vegetable, and mineral waxes tend to have fairly low hazard, however the synthetic waxes such as chloronaphthalenes and chlorodiphenyls are sensitizers and can cause dermatitis and acne. The synthetic resins polymers also tend to be low in hazard. Although polymer dust has caused respiratory effects, such as coughing, as well as itching of the face and ears, the formulation of floor finishes as solutions does not appear to present this hazard.

The resins used in varnishes such as the ester gums, cellulose nitrate, and cellulose acetate are primary irritants and sensitizers and can cause intensely red and itchy skin. Polyurethane resins may present adverse effects, especially if some free isocyanate is present. These may include eye irritation, irritation or dryness of the throat, and tightness of the chest; prolonged or repeated exposure may lead to asthmatic bronchitis or asthma. Hypersensitivity from vapor inhalation may cause recurrence of very severe symptoms after re-exposure to minimal vapor concentrations. Allergic contact dermatitis has occurred among plastic molder workers using this product. If formulated with silicone rests, most of the silicones studied have low toxicity or none at all and little or no irritating effects to skin and eyes.
The plasticizers contained in lacquer-type sealers such as di-n-butyl phthalate, tricresyl phosphate, and camphor are irritants to the eye. Di-n-butyl phthalate has been shown to cause birth defects in animals. The binder, cellulose tetranitrate, is a dangerous fire hazard. the glycol ether solvents have been discussed in earlier sections.

The solvents contained in these products all have some depressing and anesthetic effects on the central nervous system. Solvent exposure can cause a decline in motor coordination and slow the reflexes. Headaches, dizziness, and nausea are common signs of solvent overexposure by either inhalation or skin contact. Contact and wetting of the skin with solvents causes drying and can cause dermatitis since solvents can dissolve the skin's natural protective barrier of fats and oils. Extreme overexposure to solvents can cause sleepiness and even coma or death. The MSDS should be consulted for information on the flammability hazard for solvent-based products.

In addition to these general solvent effects, the solvents listed below have other potential effects:

- naphtha, mineral spirits (including Stoddard solvent), and petroleum distillates are not pure chemicals but are mixtures. Naphtha or VM&P naphtha (varnish makers' and painters' naphtha) can also cause lack of appetite and indigestion.

- turpentine, which is derived from pine trees, could be a sensitizer and could cause serious irritation of the kidneys.

- toluene can also damage the nerves in the fingers and toes causing a loss of sensation in the extremities.

- alcohols can also damage the liver. Ethyl alcohol is the least toxic since the body can digest it. Isobutyl alcohol has also been shown to be a carcinogen in animal experiments.

- methylene chloride has caused cancer and tumors in the lungs, liver, and mammary glands in animal studies. It should be regarded as a potential human carcinogen which may cause pancreatic cancer. It impairs oxygen delivery to the tissues because its metabolism involves carboxyhemoglobin formation – this is especially stressful for people unable to tolerate heart strain. It has caused birth defects in animals.

Ammonia and the various amine-type ingredients in finishes and strippers are caustic (basic) in nature and thus can remove skin oils causing dryness and dermatitis; prolonged or repeated exposure can cause skin burns. Typically these burns do not involve the itching, tingling, or pain which characterizes acid burn – so people are not aware that the skin is being damaged. Ammonia produces an irritating vapor to the eyes and upper respiratory tract, but does not usually
involve any damage to the deep lung. Amines include ethanolamine, diethanolamine, triethanolamine, morpholine, and 2-amino-2-methyl propanol. These can also produce allergic reactions such as dermatitis; however, allergy to one amine does not necessarily indicate that one will react to other amines. Morpholine can be damaging to the kidneys and has caused neoplastic growths in animal studies.

Similar to the amines is EDTA (ethylene diamine tetraacetic acid and its sodium salts). Irritations and allergies to EDTA are known, although rare. A few individuals who are allergic to EDTA may also be allergic to other amines.

Pine-derived rosins used in varnishes are known to produce allergies as well, although these are rare. Skin rashes or asthmatic reactions are possible.

Lead compounds used as pigments tend to be present in these products at much higher concentrations to produce color and coverage than are the lead compounds used as driers in varnishes. Lead compounds are a hazard to the central nervous system. Lead pigments are inorganic compounds and thus are not well absorbed through the skin. Lead driers are organic compounds and could be skin absorbed.

Formaldehyde is typically present in these products at low levels (usually less than 3%). It is irritating to the eyes, skin, and mucous membranes and is a potential sensitizer causing skin rashes or respiratory system reactions. Formaldehyde is a suspect human carcinogen, particularly for nasal carcinomas. Sensitive individuals may respond to very low levels in the air.

Strong caustics such as sodium hydroxide, potassium hydroxide, and sodium metasilicate are highly irritating to eyes and skin and can cause serious burns or eye damage.

**VINYL-ASBESTOS FLOOR TILES**

Vinyl-asbestos floor tiles need proper handling so that mechanical wax stripping is not so aggressive that asbestos fibers are released into the air. Square tiles which are 9 inches on a side are almost certainly going to contain asbestos as a reinforcing agent. When stronger tile materials were developed in the mid-1970s, manufacturers discontinued using asbestos and began making 12-inch tiles. If you are in doubt about the asbestos content, the tile material should be tested. Studies of mechanical stripping of floors after application of stripping solution indicated that the levels of asbestos fibers in the air were greater than 0.01 fibers per cubic centimeter of air – this is greater than USEPA's "clearance level" of asbestos for the completion of an asbestos abatement project. In another study in which an unwaxed tile floor was mechanically stripped with an abrasive pad, extremely high
levels of airborne asbestos were obtained for the general room air. The air samples in the workers' breathing zones were well below OSHAs standard. When floor tiles were mechanically cleaned with a buffing pad and buffing solution, the air levels of asbestos were at background levels.

USEPA has recommended since 1985 against stripping and sanding floors containing asbestos and has recently issued "Interim Guidance for Maintenance of Asbestos-Containing Floor Coverings." USEPA recommends that school officials, building owners, and custodial/maintenance staff consider the following basic guidelines when stripping wax or finish coat from asbestos-containing floor coverings:

■ avoid stripping floors, consider once or twice or less per year
■ train staff to operate properly and safely the machines, pads, and floor care chemicals to be used
■ follow the proper work practices and consult the tile and floor wax manufacturers on proper maintenance procedures
■ strip floors while wet, never when dry
■ run machine at slow speed, about 175 - 190 rpm, during stripping
■ use the least abrasive pad possible
■ do not overstrip floors; remove only the old surface coat
■ do not operate a floor machine with an abrasive pad on unwaxed or unfinished floors

USEPA also recommends that asbestos-containing floor covering be left in place if the material is in good condition. Improperly removing such floor covering could result in the release of high levels of asbestos.

OSHA's proposed new asbestos rule would also forbid sanding or buffing asbestos tiles at speeds greater than 190 rpm or using highly abrasive pads.
PROTECTION AND PREVENTION

Product substitution:

- avoid synthetic floor wax/resins containing chloronaphthalenes and chlorodiphenyls
- avoid floor finish products having lead-containing pigments
- consider using acrylics or waxes rather than polyurethane finishes
- if polyurethanes are used, avoid those containing free isocyanate and use only those containing pre-polymers of isocyanate (check the MSDS)
- avoid products containing glycol ethers
- consider floor stripping products containing sodium hydroxide, potassium hydroxide, or sodium metasilicate rather than solvents, ammonia, or volatile amines

Engineering controls:

- always use adequate ventilation for products containing solvents or volatile ingredients such as ammonia or morpholine
- avoid applying floor strippers as a fine mist; use coarse droplet sprays or apply as a stream or in small quantities
- follow USEPA and OSHA recommendations for care of asbestos-containing floor tiles (as described above)

Protective equipment:

- use the appropriate gloves when handling floor care products. Follow the manufacturer's recommendations on the material safety data sheets to make sure you are using the right glove for products containing solvents or caustics.
- use eye protection to guard against splashes or mists from handling or using these products, especially for those containing solvents or caustics
- wear aprons or boots for protection against splashes for products containing solvents or caustic. Be aware that leather absorbs caustics and is almost impossible to decontaminate. Consider wearing boots or protecting leather shoes with special sealants.
DRAIN CLEANERS

Drain cleaners are intended to remove clogs of grease, hair, food, and soaps by dissolving or emulsifying (dispersing) these materials. Some products produce gases or vigorous boiling action with heat to assist this process. Typical formulations for drain cleaners use strong solutions of acids or caustics, use enzymes, or use terpenes as described below.

Acid-type drain cleaners: these typically contain concentrated sulfuric acid which, when added to standing water in a sink, release considerable heat. Since the acid solution is more dense than water, it sinks to the bottom of the water and into the trap where it dissolves the clog.

Caustic-type drain cleaners: these typically consist of sodium hydroxide (sometimes with potassium hydroxide) as pellets, powder, or in solution. Dry products may also contain finely divided aluminum metal. Sodium hydroxide as a solution or as a quickly dissolving powder or pellet also tends to sink to the bottom of standing water and into the trap where it dissolves hair and emulsifies fats (or converts them to water-soluble soaps), removing the clog. Aluminum metal acts as sites upon which the caustic's boiling action can occur; this generates additional heat and steam to move the clog.

Solvent-based drain cleaners: usually consist of mineral spirits whose degreasing action readily dissolves clogs of grease, fat, or soap.

Enzyme drain cleaners: these contain hydrolase enzymes which break down starches, proteins, fats, and celluloses. The enzymes act as catalysts which promote the breakup of the clog in the presence of water. (They are also biodegradable.)

Terpene drain cleaners: terpenes are natural degreasers which are derived from the white rind of citrus fruits such as oranges, lemons, and grapefruit. They have considerable grease-cutting action even when quite dilute. They are often formulated in weak caustic solutions of sodium or potassium hydroxide. (They are also biodegradable.)

HEALTH HAZARDS OF DRAIN CLEANERS:

Sulfuric acid is extremely irritating and corrosive to eyes and skin. Contact with the body results in rapid tissue destruction and severe, painful burns. Prolonged or repeated inhalation of mist can cause inflammation of the upper respiratory tract leading to chronic bronchitis. Workers exposed to low concentrations of vapor gradually lose their sensitivity to irritation as the mucous in the respiratory tract increases its flow and buffers the acidity.
The use of sulfuric acid drain cleaners on clogs should be avoided in confined spaces (such as small rooms) unless windows are open or extra ventilation is provided. Typically, sulfuric acid reacts with the clog and with metal pipes or traps to produce hydrogen sulfide gas which smells like rotten eggs at fairly low concentrations in air. There have been documented cases of workers generating enough hydrogen sulfide gas to cause death when attempting to free a clogged drain with sulfuric acid.

As sulfuric acid is added to water, it can cause localized boiling and splashing back of the acid toward the worker. Addition should be done slowly to avoid a too-rapid production of heat and steam as the resulting pressure could cause the trap to rupture and splashing occur against the legs and lower body.

Sodium hydroxide (lye) and potassium hydroxide as pellets, in solution, or as mists, vapor, or dusts, are corrosives. They are irritating to the skin, eyes, and mucous membranes. Because of their penetrating properties, they are extremely damaging to the eyes. Skin injuries may be extremely severe with deep burns and ultimate scarring. These caustics are deceptive since they do not produce the itching or pain which acids do; as a result, damage can occur before the worker is aware that anything is wrong. It is extremely important to wash them off the skin and out of the eyes as quickly as possible, even when you don’t think that they are causing any damage.

Mineral spirits can cause irritation to the eyes, skin and mucous membranes. Inhalation causes headache, dizziness, and nausea; high exposures can cause drowsiness, intoxication, and even coma. Overexposures have been reported to cause hemorrhages in various internal organs.

Enzymes have been reported to cause allergic respiratory effects such as asthma upon inhalation of fine enzyme dust.

Terpenes have been reported to be irritants to the eyes and skin. Allergic reactions, such as asthma, have been reported, but are rare. When prepared as solutions with caustics, the hazards described above for caustics may occur.
PROTECTION AND PREVENTION

Product substitution:

- consider using mechanical methods such as a plunger or mechanical snake to dislodge the clog
- consider milder chemicals such as pouring a handful of baking soda and a half cup of vinegar down the grain and covering tightly for one minute. This produces carbon dioxide gas and vigorous bubbling to cause pressure and dislodge the clog. Rinse with hot water and repeat as needed.
- consider pouring a half cup of salt and a half cup of baking soda down the drain, followed by six cups of boiling water. Let sit for several hours or overnight, then flush with water.
- consider using terpenes or enzyme cleaners to avoid the hazards of solvents, caustics, or acids.
- consider using a quarter cup of 35% hydrogen peroxide down the drain to decompose the clog and produce vigorous bubbling. Wait a few minutes, then use a plunger. Repeat a second time if needed. Hydrogen peroxide is a strong oxidizing agent and can cause eye or skin burns. Handle carefully and follow the procedures and protective equipment recommendations described below for acids and caustics.
- consider using caustic cleaners before acids or solvents to avoid hydrogen sulfide production of sulfuric acid or the flammability problem of solvents.

Engineering controls:

- add acids and caustics to standing water very slowly, allowing them to slowly flow down the side of a sink. This will help to avoid rapid boiling and splashback.
- if sulfuric acid is used, provide extra ventilation for the resulting hydrogen sulfide gas. Avoid using sulfuric acid on copper pipes due to the copious amounts of hydrogen sulfide produced and the possible damage to the pipes.
- when vigorous chemicals are used, do not stand in front of the sink or trap; stand to the side and let the chemicals do their work.
- after using drain cleaners, flush the drain and pipes with water for several minutes so that these chemicals are well diluted and the next user of the sink will not encounter hazards.
Protective equipment:

- use protective gloves when handling drain cleaners. Follow the recommendations on the material safety data sheet to select the appropriate glove material.
- wear eye protection when adding drain cleaners to water due to potential boiling, splashing, or splashback.
- wear a protective apron when using acids, caustics, or solvents due to splashing or splashback.
LAUNDRY DETERGENT

Cleaning of textiles involves two processes:

the removal of soil from the textile, and
the suspension of soil and prevention of its redeposition.

Soil consists of

liquid soil: skin fats (sebum), fatty acids, mineral and vegetable oils, fatty alcohols, and some cosmetic ingredients
solid soil: soot (hydrophobic and hydrophilic carbon), skin proteins, iron oxide, clay particles

The difficulty of removal is especially evident with body soil, which consists of oils, dead skin, and salts which have been cooked onto fabrics with body heat (such as "ring around the collar").

Laundry detergent may consists of detergents, foam stabilizers, builders, silicates, anti-redeposition/anti-yellow agents, bleach, optical dyes, perfumes, enzymes, and fabric softeners/conditioners.

**DETERGENT:** these are typically linear alkyl sulphonates (about 80% biodegradable) or sulphonated alcohols (about 100% biodegradable). Linear alkyl sulphonates (LAS) are not truly "linear", they are simply less highly branched than early detergents whose excessive branching made them about 40% biodegradable. Detergents are surfactants which lift oily soil by rolling it up into droplets which are removed by the motion of the liquid in the washing machine (or by hand). The dirt is thus emulsified in the liquid. The activity of these detergents is destroyed by chlorine-containing bleaches.

**FOAM STABILIZER:** C12 or coconut fatty acids with monoethanolamine, mono-isopropanolamine, or diethanolamine.

**BUILDERS:** for fabric resistance to graying and to assist in water-softening, dirt removal, soil suspension, as well as help in forming a granulated product (in powdered detergents). Hard water interferes with soil suspension by decreasing the surface charges of dirt and by serving as linkages between the soil itself and the surfactant, preventing the roll-up phenomenon. Hardness can also cause dirt to flocculate and redeposit back onto fabric. If water is very hard, the surfactant itself may precipitate onto the fabric. These include:

phosphates
nitrilotriacetic acid (NTA)
polyelectrolytes
Type A zeolite ion exchangers (crystalline sodium aluminosilicate)
SILICATES: function as corrosion inhibitors, modify hard water, and assist in forming granulated product (for powdered detergents). Usually sodium silicate

ANTI-REDEPOSITION/ANTI-YELLOWING AGENTS: these keep soil suspended and dispersed to allow rinsing. Such as:

- carboxymethyl cellulose
- polyvinylpyrrolidone (PVP)

BLEACH: for stain removal (see bleaches below); such as:

- sodium perborate (may be stabilized with magnesium silicates or EDTA)

OPTICAL DYES: to counteract fabric yellowing caused by bleaching or the build-up of detergents, additives, and softeners. These are fluorescent dyes which truly dye the fabric, not bleach it. They work by absorbing ultraviolet light and reflecting bluish light back to the eye; thus, the treated fabric reflects more visible light than untreated fabric. (Since they depend upon UV Light, they are not effective in artificial light which is weak in UV.) The consumer tends to believe that blue-white (especially towards the violet rather than the green) is "whiter" than yellow-white --that is, that the fabric appears cleaner. Such as:

- aesculetin
- beta methyl umbelliferone
- 4,4'-diaminostilbene-2,2'-disulfonic acid
- naphthatriazolylstilbene sulfonic acid

PERFUMES

ENZYMES: these are proteolytic enzymes for breaking down the protein stains and to break down protein binders which link body soil to clothing, without damaging textiles. They are not cleaners in themselves, but must be combined with detergents; when this is done, their action is synergistic. Germicides, especially chlorine bleaches and quaternary ammonium salts, destroy enzyme activity; so enzyme-containing detergents should not be used with bleaches.
ADVERSE HEALTH EFFECTS ASSOCIATED WITH LAUNDRY DETERGENTS:

Dusts and liquids from detergents can be eye and respiratory irritants. Inhalation of dusts and powders of proteolytic enzymes can cause nasal irritation and bronchitis; they can also be moderate eye irritants and possible skin allergens.

Contact dermatitis is possible from detergents (see surfactants section of personal care soap/detergent products).

Perfumed products may also be irritants or sensitizers.

PROTECTION AND PREVENTION:

- Wear gloves when hand washing.
- Avoid making dust when using powders. Use liquid detergents to avoid the dust problem.
- Use products which do not contain additives such as perfume, bleaches, or optical dyes. Then use bleaches separately when needed.
- Avoid enzyme-containing products.
FABRIC CONDITIONERS/SOFTENERS

Fabrics which are repeatedly washed in detergents or soaps become harsh and roughened in texture and may rub or chafe the skin; softeners are intended to alter the "feel" or "hand" of textiles to avoid this problem. However, conditioners also make fabrics fluffy, suppress static, reduce needle catch when stitching, and reduce ironing friction. Spin drying time is also decreased because the fabric is made somewhat hydrophobic.

Liquid-type softeners are usually an emulsion of the conditioner, perfume, color, viscosity modifiers, and optical whiteners. Dryer sheets are non-woven rayon cloth with conditioner added.

FABRIC CONDITIONER: these work by attaching to the fabric with the oily-like ends of the molecules facing outward. This produces a lubricated surface and also causes repulsion of fibers and thus fluffiness. Such as:

- alkyl quaternary ammonium compounds such as dihydrogenated tallow dimethyl ammonium chloride (tends to have a "greasy" feel and builds up on fabrics causing yellowing), usually with detergent dispersants
- imidazolines ("satiny" feel, amphoteric, blend better in the wash cycle; do not tend to form complexes with detergents), usually with detergent dispersants
- alkyl amides, usually with alcohol or glycol dispersants

VISOCITY MODIFIERS: electrolytes such as sodium acetate (if formulation is too thick) or thickening agents (if product is too fluid)

PERFUME

COLOR: to mask off-white appearance of basic product, usually blue or pink, such as

- Astra Blue 6GL
- Cibracrin Turquoise blue TGE
- Red TZB-D
- Rhodamine B extra

OPTICAL BRIGHTENERS: see laundry detergents
ADVERSE HEALTH EFFECTS ASSOCIATED WITH FABRIC SOFTENERS

There are possible sensitization reactions to the perfumes, colors, and the quaternary-type softeners. Dermatitis may occur from wearing of the clothing, especially noticeable in moist areas of the body such as the armpits and groin.

PROTECTION AND PREVENTION

- Change to an alternative softener formulation
- Use unscented products.
- Use the softener in the dryer (dryer sheet) instead of the washer to avoid excessive deposition on clothing.
LAUNDRY BLEACHES

The function of the bleach is stain removal of blood, grass stains, food stains, and heavy soil. The bleaches sold for household use are vigorous oxidizing agents. Bleaches consist of the bleaching agent and may also contain stabilizers, enzymes, builders, and activators.

**BLEACHING AGENTS:** there are basically two types

- chlorinated bleaches, such as sodium or lithium hypochlorite, chlorinated isocyanurates, chlorinated sodium phosphate
- oxygenated bleaches, such as hydrogen peroxide or sodium peroxide, sodium perborate, sodium percarbonate, potassium monopersulfate, sodium perpyrophosphate

These work by forming hydrogen peroxide when added to water, which then releases active oxygen – the actual bleaching agent. Thus, liquid oxygen bleaches tend to need stabilizers to avoid losing strength and prolong shelf-life.

**STABILIZERS:** prevent the destruction of bleaching action by trace metals, also. Usually several stabilizers are used together since their action is synergistic. Such as:

- sodium hydroxide
- EDTA
- NTA
- magnesium or calcium salts
- 1-hydroxy-ethyldine-1,1-diphosphoric acid (HEDP) or its salts

**ENZYMES:** see laundry detergents

**BUILDERS:** usually sodium silicate to reduce corrosion on metal parts of washing machine.

**ACTIVATORS:** enhance the bleaching effect, such as:

- m-chlorobenzoyl dimethyl hydantoin
- N-benzoyl-2-methylimidazole

**ADVERSE HEALTH EFFECTS ASSOCIATED WITH LAUNDRY BLEACHES**

See laundry detergents for enzyme health effects.

Laundry bleaches are caustic in nature and can cause serious caustic burns; this is especially true for chlorine bleaches. Eye burns are particularly serious. Inhalation of dusts from powder bleaches can
cause respiratory tract irritation; eye irritation is also possible from the

dusts.

PROTECTION AND PREVENTION

■ Avoid making dust when handling powder bleaches. Use
  liquid oxygen bleaches instead of powders to avoid dust
  problem.
■ Wear gloves when using bleaches. Avoid skin and eye contact.
■ Do not mix chlorine bleach with ammonia-containing cleaners
  or hydrogen chloride-containing cleaners – poisonous gases
  are released.