

Health Hazard Manual for

COSMETOLOGISTS

HAIRDRESSERS

BEAUTICIANS AND

BARBERS

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HEALTH HAZARDS MANUAL FOR COSMETOLOGISTS, HAIRDRESSERS, BEAUTICIANS AND BARBERS

Why hairdressers?

Because studies indicate that approximately 20% of hairdressers leave the profession due to health problems such as allergies or dermatitis. After such an investment in time, money, training, and experience - what a waste!

Because studies show that there is an increase in cancer risks and reproductive risks for hairdressers (male and female) compared to the general population.

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

While we look at product health hazards and case histories, see if the experiences of these hairdressers/cosmetologist/barbers sound familiar. Have they happened to you or others you know or have heard of who are in this profession?

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 hairdressing 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 hairdressing products are based upon the exposure of the professional, not the consumer; for example, we will examine the health effects of hair dyes for the hairdresser who dyes hair several times a day, not for the patron whose exposure is once every one or two months.

We will not be looking at products used to clean the salon, but information on this subject is available upon request.

I REGULATIONS OF INTEREST TO COSMETOLOGISTS

Food, Drug and Cosmetic Act and the Coal Tar Exemption

The Food and Drug Administration (FDA) does not have the legal authority to require pre-market testing of products by their manufacturers. For cosmetics, the FDA has the burden of proof of demonstrating that a product is a hazard to the public rather than the industry demonstrating that their product is safe. Also, the FDA does not have the authority to require a cosmetic manufacturer to provide them with the necessary information to enable the FDA to conduct its own pre-market testing. Consumer products such as hair dyes which are sold for professional use in salons and shops, do not require the ingredients listed on the label.

If a cosmetic contains a substance considered to be adulterated, the FDA may ban or restrict its use. However, the FDA can only seize or restrict products after sufficient evidence is gathered (customer complaints/research) to prove a product harmful. This can be difficult because the FDA was not given the authority to require manufacturers to:

- register manufacturing plants or products;
- file data on a product's ingredients;
- file reports of injuries related to a cosmetic's use;
- test products for safety before marketing them.

How does the FDA find out about adverse reactions to cosmetics?

This is done by:

- direct consumer complaints;
- voluntary reporting by the cosmetics industry;
- the National Electronic Injury Surveillance System (NEISS) through which selected hospital emergency rooms make reports;
- surveys conducted under contract to the FDA, such as by the North American Contact Dermatitis Group (NACDG).

In 1938, due to the bright future of the coal tar derivative industry, both industry and labor argued successfully before Congress that coal tar dyes should be exempt from regulation. Therefore, coal tar-derivative colors are not regulated, even though there is information indicating that some of them are carcinogenic.

It should be noted that FDA warnings on products were primarily aimed at consumers who use hair dyes every few weeks, not at hairdressers who apply the products on a daily basis.

The OSHA Hazard Communication Standard

A principal complaint of cosmetologists, hairdressers, and barbers is the difficulty they have in obtaining 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.

More information on ingredients is required for sale of the same or similar products to consumers than is required for sale to professionals. This lack of information will hopefully be filled now that the Occupational Safety and Health Administration (OSHA) Hazard Communication Standard has been expanded to cover all workplaces. Expansion of the Standard was urged by groups such as the United Food and Commercial Workers International Union (AFL-CIO and CLC) and opposed by industry groups such as the Cosmetic, Toiletry and Fragrance Association.

The OSHA Hazard Communication Standard is an occupational safety and health regulation which was extended to all industry, including the service sector, as of August 24, 1987. The purpose of this regulation is to ensure that the hazards of all chemicals produced or imported are evaluated and that this information 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.

For cosmetologists, this means that the hazardous ingredients and health effects of the chemical products which you use are now available in the form of the above-mentioned MSDSs. The labeling of cosmetic products as covered by the Federal Food, Drug and Cosmetic Act has not changed. Chemical manufacturers, importers and distributors must provide MSDSs with every shipment of hazardous chemicals to employers after September 23, 1987. All employers must be in compliance with all provisions of this regulation by May 23, 1988.

You may wish to take advantage of this newly expanded 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 as to help you obtain the products you want. You may wish to deal only with manufacturers who respond to your requests for product information.



II AN OVERVIEW OF OCCUPATIONAL DISEASE TYPICAL OF HAIRDRESSERS

The principal health problems confronting hairdressers tend to involve:

- inhalation of solvents and dusts or particles resulting in allergies;
- skin contact with instruments or equipment;
- skin absorption of liquids or skin contact with dusts (this includes eye hazards as well);
- an elevated cancer risk compared to the general population;
- an increased risk of adverse reproductive effects relative to the general population;
- ingestion of hair dressing chemicals by holding combs, pins, or clips in the mouth while working.

Beauticians are especially exposed to the risks of sensitization (becoming allergic to the products or instruments that they work with). Generally speaking, atopic individuals, that is, individuals with a history of allergies prior to becoming cosmetologist, do not tend to do well as hairdressers. 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. In allergic-type reactions, only the sensitive individual will respond anyway, so numbers are not significant in indicating risk.

Adverse reactions to products seem to have changed over the years as the formulation of products has changed. For example, younger workers tend to have allergic contact dermatitis due to p-phenylenediamine and hair dyes; older workers tend to have allergies to formaldehyde. Allergies tend to develop faster in younger workers due to these chemicals. In fact, chronic exposure of young hairdressers to irritant effects of shampoos makes them more susceptible to allergic contact sensitization when they use dyes, waving solutions, and other chemicals later on. **This is why it is so important to inform young hairdressers and apprentices of the occupational risks with irritants and how to minimize these risks.**

Many allergic reactions to products involve fragrances and dyes used to color products which 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 hairdressers sensitized to rubber gloves who continue to use them at home.

Health Studies

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

Inhalation: Particulates and solvents can be inhaled from the use of hairsprays (and other aerosol products), from the solvents and dusts from artificial nail preparations, or from the asbestos in some hair dryers. These exposures can lead to pulmonary and respiratory abnormalities; even cosmetologists with only a few years of exposure have shown early signs of chronic obstructive lung disease which appears as a reduction in the functional volume of the lung. You may wish to consider having your lung function evaluated with inhalation testing. Possible thesaurosis due to aerosol product use has been linked to an accumulation of inhaled nonbiodegradable polymers, especially PVP (polyvinylpyrrolidone) found in many hairsprays. Usually these lesions lessen when exposure is discontinued, but accumulation of these chemicals in the lower lung can result in alveolar-capillary-block syndrome, a condition in which the oxygen and carbon dioxide exchange is impaired between the lungs and blood.

Propellants, solvents, or solvent carriers such as fluorocarbons (Freon 11), methylene chloride, 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.

Skin Contact: Hairdressers tend to have a high rate of nickel allergy, and experience contact sensitization to the nickel in scissors. It may be possible to avoid this by using silver-plated scissors or scissors with plastic-coated handles. Contact allergy to rubber gloves is also a frequent cause of sensitization. This appears to be due to antioxidants in the rubber and could probably be avoided by using gloves of other materials such as PVC.

Skin Absorption: This is a major route of exposure for permanent hair dyes which may cause sensitization and thus allergies (skin rashes, asthma, etc.). They are considered mutagenic and thus potentially or definitely carcinogenic. Permanent wave solutions also tend to be absorbed through the skin; these are linked with sensitization and/or irritation. Another type of adverse skin effect is increased skin pigmentation (phytophotodermatitis) caused by perfumes and eau de cologne when followed by exposure to the ultraviolet light in sunlight.

Epidemiological evidence indicates that cosmetologists, hairdressers and barbers may experience an **elevated cancer risk** when compared to the general population for cancers of the bladder, lungs/respiratory system, digestive organs, breast and genitals; and a possible elevated risk of leukemia. The National Institute for Occupational Safety and Health (NIOSH) epidemiological studies show increased cancer incidence among cosmetologists, especially bladder cancer and multiple myeloma. 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. However, bladder cancer, a predominantly male disease, has appeared in textile dyeing workers exposed to some of the same dyes.

The cosmetologist should avoid skin exposure to permanent hair dyes. Studies with animals have shown that dyes such as 2,4-diaminoanisole (4-methoxy-m-phenylenediamine) do penetrate the skin. Although substitute dyes have been suggested, a cautious use of substitutes is best since some of these are chemically, almost identical to the original chemical. Certainly protective gloves should be worn in working with these dyes. Although the International Agency for Research on Cancer (IARC) concluded that there was an elevated risk of cancer in those with occupational exposure to certain hair dyes (barbers and hairdressers), they suggested that the evidence was inconclusive relating specific cancer sites to hairdressing.

There appears to be a possible higher incidence of cancer of the larynx in males in this profession. Females appear to experience a higher incidence of uterus and ovarian cancer, stomach cancer and lung cancer. It is difficult to conclude from these studies if there is truly a higher incidence of lung cancer because some of these studies did not take into consideration smoking habits.

Exposure to carcinogens is not limited to the known ingredients in hairdressing products, but has also been linked with chemicals such as dioxane and NDELA (a nitrosamine), contaminants which are formed during the manufacture of hair care products and cosmetics.

Reproductive Effects: Epidemiological studies indicate that there appears to be an increase in toxemia of pregnancy (a condition during pregnancy whose symptoms include high blood pressure, excessive protein in urine, and leg swelling), miscarriages, premature deliveries and smaller babies among cosmetologists.

III SHAMPOOS AND CONDITIONERS

Shampoos

At the base of each hair follicle are the sebaceous glands which secrete the oily substance called sebum. Sebum passes along the hair shaft by capillary action and coats the hair with a greasy layer. It lubricates and conditions hair, but tends to collect dirt. Therefore, cleaning the hair involves the removal of this greasy layer of sebum. This is usually done with liquid shampoos consisting of surfactants (detergents) along with additives such as colors, fragrances, preservatives, anti-dandruff agents, opacifiers, viscosity modifiers, solubilizers and conditioners (which may be packaged separately as cream rinses.)

Principal Surfactants: Their purpose is to foam and clean hair. These are generally surfactants (detergents) based on sulfated fatty alcohols (such as lauryl and myristyl alcohols) and give rich foams. Some manufacturers feel that triethanolamine- or ammonium-laurylsulfate should be preferred over sodium-laurylsulfate. Sodium-laurylsulfate is believed to be too harsh, despite its better degreasing action. This harshness could also be overcome by coupling sodium lauryl sulfate with conditioners or other surfactants such as:

- sodium lauryl sulfate;
- sodium laureth sulfate;
- triethanolamine (TEA) lauryl sulfate;
- diethanolamine (DEA) lauryl sulfate;
- monoethanolamine (MEA) lauryl sulfate;
- ammonium lauryl sulfate;
- polyethylene glycol sulfates.

Modifying Surfactants: Modifying additives may be used to improve foam characteristics, improve condition of hair, modify eye-irritancy effects of primary surfactant, or improve cleansing power. These are usually other detergents used as secondary surfactants, such as fatty acid alkanolamides; usually ethanolamides of lauric, myristic, palmitic, stearic or oleic acids. Most commonly used is lauric monoethanolamine. Others include:

- monoglyceride sulfates;
- secondary alkyl sulfates;
- sodium decyl (or dodecyl) benzene sulfonate;
- alkyl sulfosuccinates such as sodium dioctyl sulfosuccinate;
- isothionates;
- cocamides such as cocamide DEA;
- methyl taurides;
- acyl amino acids or acyl peptides;
- acyl sarcosines;
- amine oxides, such as lauramine oxide.

Opacifiers: These give the shampoos an opaque or pearlized appearance, rather than transparent. Cream shampoos may actually be liquid shampoos to which an opacifier is added for a thicker appearance. These include:

- glycol stearates such as polyethylene glycol 400 stearate;
- metal stearates such as magnesium stearate;
- alkylolamides such as stearic amides;
- stearyl alcohol;
- cetyl alcohol.

Viscosity Modifiers: These modifiers make the shampoo more viscous so it is thicker and less able to flow easily. Examples are:

- electrolytes such as sodium chloride;
- alkylolamides;
- sodium stearate;
- stearic amides.

Solubilizers - Couplers: If present, these enable the product to stay mixed, that is, keep the ingredients from separating, such as:

- ethyl alcohol;
- isopropyl alcohol;
- glycerol;
- propylene glycol monethyl ether;
- diethylene glycol monoethyl ether.

Preservatives: These are usually germicides which are used because mild surfactants readily spoil. The choice of germicide is important since some detergents tend to interfere with the antibacterial action of some germicides. Preservatives include:

- p-hydroxy benzoic acid and its esters (methyl or propyl paraben);
- formaldehyde;
- 2-bromo-1, 2-diol (Bronopol);
- methyl- or methylchloro-isothiazolinone;
- dibromosalicylanilide;
- bithionol.

Anti-Dandruff Agents: The causes of dandruff are not yet fully understood; many of them are not microbiological in origin, yet the majority of anti-dandruff preparations tried have been germicidal. Sometimes the white scale called dandruff is actually residue from incomplete rinsing of the hair after shampooing. Anti-dandruff additives include:

- salicylic acids such as dibromosalicylanilide;
- resorcinol;
- hexachlorophene;
- cadmium oxide;
- tellurium oxide;
- selenium disulfide;
- zinc pyridinethione, zinc pyridinium-thiol-N-oxide (Zinc Omadine);
- zinc undecylenate;
- undecylenic acid and diethanolamine (Loramine DU185);
- sodium salt of undecylenic acid monethanolamide sulphosuccinate (Loramine SBU185);
- trimethyl-mercapto-4-cyclohexene-2,2-dicarboximide;
- quaternized polythionates;
- hydroquinolines;
- tar;
- biphenamine hydrochloride;
- polyvinylpyrrolidone-iodine complexes;
- allantoin.

Conditioners

These are cationic compounds (positively-charged) which are used to counteract the anionic (negatively-charged) nature of shampoo which causes the tangling of hair and static fly-away. Conditioners increase the lubricity of hair making wet combing easier and make the texture smoother. Protein-containing conditioners add body, gloss and luster to hair. Conditioners include:

- beer;
- egg;
- balsam;
- proteins such as hydrolyzed animal proteins;
- lanolin;
- polyvinylpyrrolidone (PVP);
- silicones;
- modifying surfactants (see page 8);
- stearyldimethyl benzylammonium chloride;
- glyceryl esters;
- glycol esters.

Adverse Health Effects Associated with Shampoos and Conditioners

Skin irritation, dermatitis or allergies associated with shampooing may result from the detergents/surfactants or additives such as preservatives, fragrances or colors. The hairdresser experiences repeated exposure to the hands while shampooing which may involve many cycles per day of wetting and defatting with removal of natural skin oils by detergents and drying. In addition to this, some shampoo ingredients (such as isopropyl myristate and triethanolamine) are skin irritants. Irritant dermatitis, the most common form of dermatitis in hairdressers, is especially prevalent among the younger workers such as apprentices and appears to be due to shampooing. The younger or newer workers in a salon tend to be the ones doing a large proportion of shampooing, rather than other hairdressing tasks.

Allergic contact dermatitis to germicides in shampoos has been associated with formaldehyde, isothiazolines and dibromo-salicylanilide. Individuals sensitive to dibromosalicylanilide may also be sensitive to other germicides such as hexachlorophene and bithionol.

Some coal tar-derived colors used in shampoos may be carcinogenic. Shampoo colors and fragrances have also been found to sensitize. Some fragrances have also been linked with increased skin pigmentation.

Case History: *occupational allergy to lavender oil*

“An 18-year old female hairdresser had a red, scaly, itchy dermatitis on the back of her hands and fingers and front of the wrists. She had worked as an apprentice hairdresser for 4 years, mainly shampooing but also in contact with permanent wave liquids and dyes. She usually had dry fissured skin on the back of the hands, but in the previous 6 months it had become worse with extension to the fingers and itching. She had a history of nickel allergy but not atopy (inherited allergy). She was patch tested with the standard and hairdresser's series with several shampoos and other products with which she was in contact in her job. The lavender shampoo was the one she used several times a day. Although we could not obtain its composition from the manufacturer, she was patch tested some weeks later with lavender oil and several formaldehyde release preservatives. A strong positive reaction to lavender oil was observed.”¹

Allergies to other hairdressing chemicals can be enhanced by shampoo exposures. For example, allergies to hair dyes can be aggravated by handling the detergents in shampoos. Chronic exposure of young hairdressers to the irritant effects of shampoos seems to make them more susceptible to allergic contact sensitization when they later use dyes, waving solutions and other chemicals.

¹Brandao, F.M. Occupational allergy to lavender oil. *Contact Dermatitis* 15(4): 249. 1986.

Protection and Prevention

Product Substitution:

- Try milder detergents such as lauryl sulfates buffered with monoethanolamine, diethanolamine, triethanolamine or ammonium ions.
- Try different preservatives; avoid formaldehyde or formaldehyde-releasing preservatives and use parabens or isothiazolinones instead.
- Try different fragrances or avoid scented products or those containing a masking fragrance. Try unscented products. Change fragrance families.
- Consider natural rather than artificial colors. Avoid coal tar-derived colors.
- Change color families. For example, D & C Green No. 5 is an anthraquinone color and is a possible skin irritant. An individual who reacts to one anthraquinone color, may react to others of this family.

Protective Equipment:

- Wear protective gloves when using shampoos or conditioners.

IV HAIR COLORING: DYES AND RINSES

Hair colorants are usually classified according to how long the color lasts and how durable it is on the hair. There are temporary, semi-permanent and permanent colors - these also imply the degree of coverage of depth of coloring. We will look at each color type in detail below. Chemical names for dye components are given below to assist you in interpreting labels and material safety data sheets (MSDSs).

Temporary Coloring Preparations

These are typically applied in shampoos (rinses) or hair sprays. They are temporary dyes because they only produce a film over the hair shaft, so the color tends to be completely removed by the first shampooing. These products generally contain 0.5 - 2.0% of color, but may also contain urea or other compounds which increase the solubility of the color in the shampoo or hairspray.

There are 3 types of rinses:

water soluble acid dyes (generally azo dyes; see table below) with weak acids (such as citric or tartaric) in an shampoo base;

basic dyes, such as methylene blue, rhodamine, safranine, Bismark brown, chrysoidine, methyl violet, thioflavine or nigrosine; and

combination (anionic/cationic) complexes.

Colors Used in Temporary Hair Coloring¹

FDA Designation	Classification	Color Index No.	Common Name
FD&C Yellow No. 5	pyrazolone	19140	Tartrazine
FD&C Yellow No. 6	monoazo	15985	Sunset Yellow FCF
D&C Orange No. 4	monoazo	15510	Orange II
Ext D&C Orange No. 3	monoazo	14600	Orange I
FD&C Red No. 4	monoazo	14700	Ponceau SX
Ext D&C Red No. 8	monoazo	15620	Fast Red S or A
D&C Red No. 13	monoazo	15630	Lithol Red Sr
D&C Red No. 22	xanthene	45380	Eosin YS, Eosin G
FD&C Green No. 3	triphenylmethane	42053	Fast Green FCF
FD&C Blue No. 1	triphenylmethane	42090	Brilliant Blue FCF
FD&C Violet No. 1	triphenylmethane	42640	Wool Violet 5BN or Acid Violet 6B
D&C Brown No. 1	disazo	20170	Resorcin Brown

¹NIOSH (National Institute for Occupational Safety and Health). Information Profiles on Potential Occupational Hazards. Volume III, Industrial Processes. Publication SRC TR 80-610. July, 1980.

Semi-permanent Coloring Preparations

These are also typically applied in shampoos, but tend to dye more deeply and are retained longer by the hair. This occurs because they penetrate the hair somewhat and are only gradually washed out by repeated shampooing. They may be applied as rinses or used full strength and left on the hair for 5-30 minutes before being rinsed out. Many of these dyes are the same chemicals used in permanent oxidation dyes but without the addition of the oxidizing agent. These tend to be aromatic, nitro and amino dye compounds such as the nitrophenylenediamines or nitroanilophenyls. Some color directly, while others react with oxygen in air to produce colored compounds. Some also contain metal-complex dyes, usually azo dyes complexed with either cobalt or chromium; the metal is bound within the molecule and does not appear to cause sensitization.

Permanent Coloring Preparations

These almost exclusively use oxidation dyes to produce a permanent color which lasts until the hair grows out. Typically this is a two-part preparation: an alkaline solution of dye intermediates (small colorless molecules) is mixed with an oxidizing agent (usually peroxide) just before application to the hair. The alkali cause the hair to swell, allowing dye penetration. The coloring preparation contains dye "intermediates" because the dye pigment is formed within the hair by a chemical reaction. Within the hair shaft, the dye oxidizes to form a lightfast pigment in the hair itself. The resulting giant colored molecules are too large to exit through the hair cuticle and thus remain inside the hair cortex.

The permanent chemical oxidation type dyes consist of the dye intermediates, color modifiers/couplers, color vehicles, solubilizing agents, conditioners and antioxidants; the separate oxidizing agent, a developer, is added just before application to the hair.

Oxidation dye intermediates are the main color producers; generally p- and o-benzenediamines such as p-phenylenediamine; 2, 5-diaminotoluene; p-amino-diphenylamine; or other diamino and phenolic amines are used to produce intense shades (see table on following page). These so-called "para dyes" (indicated by "p-" or 4-amino. . .) are usually used for black shades or as mixtures for lighter shades. Permanent coloring preparations typically contain 1 to 4 % of dye intermediates.

Color modifiers/couplers such as m-diamines, m-aminophenols, naphthols, or polyhydroxyphenols also function as antioxidants, stabilizers and chemical timers to control the rate of color development.

Color vehicles or dye bases are the aqueous solutions of soaps or detergents which enable the product to wet the hair, spread and penetrate as needed. These are ammonium oleate soap, alkanolamides, fatty alkyl sulfates, fatty acid-polypeptide condensates, or oxyethylated fatty alcohols.

Solubilizing agents are used to increase the solubility of the dye intermediates; usually propylene glycol, ethyl alcohol or isopropyl alcohol.

Conditioners enable more even coloring by decreasing the porosity of the hair cuticle or replacing it as a filler if it has been damaged or lost. These are usually glycerol lanolin, oleyl alcohol or cetyl alcohol or cetyl alcohol.

Antioxidants, which help to prevent premature oxidation for better color control, may be sulfite or bisulfite compounds (such as sodium sulfite) or thioglycolic acid.

pH adjusters such as ammonium hydroxide, are used to make the dye base more basic or caustic (pH 9) to swell the hair cuticle and enable dye penetration.

The **oxidizing agent** or developer is usually hydrogen peroxide (a 6% solution) because it is easy to use, completely oxidizes the dyes, is fairly safe to work with, does not produce undesirable by-products. Urea peroxide is the typical oxidizer in cream type developers.

Colors Produced by Various Oxidation Dye Intermediates, Color Couplers and Modifiers

BLACK	DARK/MEDIUM BROWN
p-aminodiphenylamine	p-aminodiphenylamine
p, p' -diaminodiphenylamine	o-aminophenol
2,5-diaminophenol-4-sulfonic acid	p-aminophenol
1,8-diaminonaphthalene	N-(p-aminophenyl)-glycine
o-phenylenediamine	o-anisidine
p-phenylenediamine	2,4-diaminophenol
m-toluenediamine	N,N-dimethyl-p-phenylenediamine
p-toluenediamine	N-(p-hydroxyphenyl)-glycine
	p-methylaminophenol
	4-nitro-o-phenylenediamine
	m-phenylenediamine
	p-phenylenediamine
LIGHT BROWN	REDDISH
o-aminophenyl	2-amino-4-nitrophenol
p-aminophenol hydrochloride	4-amino-2-nitrophenol
p,p'-diaminodiphenylamine	2,4-diaminophenol
2,4-diaminophenol	4,6-dinitro-2-aminophenol
2-nitro-p-phenylenediamine	5-nitro-m-phenylenediamine
m-phenylenediamine	4-nitro-o-phenylenediamine
p-phenylenediamine hydrochloride	2-nitro-p-phenylenediamine
p-tolylenediamine	2,4,6-trinitroaniline

BLONDS

p-aminodiphenylaminesulfonic acid
4-amino-2-nitrophenol
p-aminophenol hydrochloride
2-aminophenol-4-sulfonic acid
4-aminophenol-2-sulfonic acid
5-aminophenol-2-sulfonic acid
2,5-diaminophenol-4-sulfonic acid
N-(2-hydroxy-5-nitrophenyl)glycine
N-(p-nitrophenyl) glycine
m-phenylenediamine hydrochloride
p-phenylenediamine sulfate

BLUE/GRAY MODIFIERS

p-aminodiphenylamine hydrochloride
N-(p-aminophenyl)-glycine
2,4-diaminoanisole (also called 4-MMPD or 4-methoxy-m-phenylene-diamine)
p,p'-diaminodiphenylmethane
2,4-aminophenetole
1,5-naphthalenediol
m-phenylenediamine
procatechol
pyrogallol
resorcinol
p-tolylenediamine

There are also one-part preparations which are oxidation dyes not requiring chemical oxidation. Considerable research has gone into developing dyes of this type which can be used under normal (non-oxidizing) conditions, without adding the oxidizing agent or developer. Oxidation dyes which do not require chemical oxidation may be:

- aromatic polyhydroxy compounds (di- and trihydroxybenzene derivatives);
- aromatic polyamino compounds (substituted diaminobenzenes, aminophenols, polyaminophenols, polyamino benzenes);
- substituted naphthalene compounds (aminohydroxynaphthalene);
- substituted pyridine compounds.

Another type of permanent coloring is the metallic dye made of metals which form insoluble metal oxides and/or sulfides. Lead acetate is the most commonly used; others are silver, nickel, cobalt, bismuth, copper, or iron salts.

Also, one type of permanent dye is the vegetable dye such as henna, a potential sensitizer source of occupational asthma.

Adverse Health Effects Associated With Hair Colorants

When considering the adverse health effects of hair dyes, consider not only how severe the health effect can be, but also how frequently you are exposed. Where available, the health effects discussed here were drawn from the actual experiences or health studies of hairdressers; however, the skin absorption and resulting health effects (such as cancer-causing potential) are the result of studies examining adverse effects on the person whose hair is being dyed; that is, effects on the consumer or patron. Some of the effects on the professional whose work involves repeated exposure to dyes may have to be inferred from the effects of dyes on textile workers and on patrons.

Serious injury or possible blindness could result if hair coloring chemicals are accidentally gotten into the eyes. Ammonia-containing pH adjusters can severely injure the eyes, especially strong ammonia solutions, because ammonia has a particular tendency to penetrate the cornea and damage the deeper structures within the eye. Speed is essential in washing the eye immediately with clean water. Strong ammonia solutions can also burn the skin; weak solutions, especially upon repeated exposure, can cause skin irritations. Hydrogen peroxide is also irritating to the eyes and can cause skin irritations; immediate flushing with water is necessary.

Dyes and color modifiers can be sensitizers; that is, can cause allergic reactions such as rashes and other skin irritations. Those dyes and modifiers with the amine in the para position (the "para" dyes discussed above) tend to be sensitizers. In fact, intolerance to "para" dyes is the most frequent of all sensitizations observed in hairdressers. The reaction is a dermatitis which appears most often on the left hand between the index and middle finger and on the dorsal face of the last three fingers; the hairdresser holds the hair being dyed between the index and middle fingers which can then contaminate the other fingers. p-Penylenediamine has been known to be an allergen since 1898. Suggested substitutes for it, such as p-toluylenediamine, p-aminophenol and diaminophenol, also tend to be allergenic, as is p-aminodiphenylamine (Diphenyl Black). See the table for other "para" dyes entitled "Colors Produced by Various Oxidation Dye Intermediates, Color Couplets and Modifiers" on page 18.

Reactions to henna tend to be asthmatic involving sneezing, nasal congestion, runny nose, cough, chest tightness, or wheezing when exposure occurs to the henna powder during mixing or preparation of the dye.

Case History:

"S.K. aged 21 years....had worked as a hairdresser for about 5 years, dealing almost exclusively with hair bleaching and tinting. Over the last year she noticed that she would get marked rhinitis and conjunctivitis soon after she, or someone else in the salon, used henna. She was largely free of symptoms away from work. Recently her symptoms had become so bad that she could only manage 3 days work in 5. She later changed her job and her problem was resolved."¹

Allergy to dyes can be enhanced by handling detergents (such as shampoo) or irritants (such as thioglycolic acid in liquids from permanents). Permanent liquids can induce sensitization to dyes. For example, hairdressers which used cold perms for several months could not then handle dyes which their skin had previously tolerated.

¹Pepys, J.; Hutchcroft, B.J.; and Breslin, A.B.X. Asthma due to inhaled chemical agents - persulphate salts and henna in hairdressers. *Clinical Allergy*. Vol. 6, pages 399-404. 1976.

Other dye health hazards include:

- p-aminophenol which has also been linked with bronchial asthma and methemoglobinemia (a condition of the blood in which some of the hemoglobin has been rendered incapable of transporting oxygen);
- azo dyes of the Disperse Red 1 type (or Cibacete 2B Scarlet) used in temporary rinses which can also be sensitizing;
- 4-EMPD which can cause irritation of skin and eyes;
- aniline derivatives which may also cause dermatitis;
- resorcinol which may also cause methemoglobinemia and restlessness.

Potential Carcinogens, Mutagens, and Teratogens

Hair dyes may be carcinogenic (cancer-causing) in man. This issue has been examined in studies of cancer mortality and incidence among beauticians and hairdressers with occupational exposure to hair dyes, and in studies of hair dye use and cancer among individuals (patrons). While studies among both beauticians and patrons have largely been negative, there has been findings among patrons showing an excess of cancers of the cervix, vagina and vulva.

However, aromatic amine hair colorants do exhibit possible carcinogenic or mutagenic effects in animal studies and these are suggestive of potential human health problems. Mutagens cause a relatively permanent change in hereditary material.

For example, 2,4-diaminotoluene (banned in hair dyes since 1971) was demonstrated to be a carcinogen in animals. Of 169 commercial oxidative-type permanent hair colors tested, 150 were found to be mutagenic in "in vitro" testing which involved investigating effects on the genetic material in bacteria. Hair dyes and components found to be mutagenic include:

- 4-amino-2-nitrophenol;
- 2,4-diaminoanisole sulfate;
- 1,2-diamino-4-nitrobenzene;
- 1,4-diamino-2-nitrobenzene;
- 2,4-diaminotoluene;
- 2,5-diaminotoluene;
- m-phenylenediamine;
- p-phenylenediamine;
- 2,5-diaminoanisole sulfate;
- 2-amino-5-nitrophenol;
- 2-amino-4-nitrophenol.

Hair dyes found to be carcinogenic in animals involved feeding studies which give the test animal a far higher systemic exposure than is experienced by an individual having his/her hair dyed. These dyes include:

- 4-amino-2-nitrophenol;
- 2-nitro-p-phenylenediamine;
- 2,4-diaminotoluene;
- 2,4-diaminoanisole.

Hair dyes containing aromatic amines mixed with 6% hydrogen peroxide have been found to be teratogenic (cause birth defects or spontaneous abortion) in animals following skin exposure to the dye. These studies were performed with the intention of simulating scalp absorption by the patron; it was discovered that as much as 1% of hair dye chemicals in general could be absorbed through the scalp. Further, dyes have been found in the urine of patrons. Extending this information to the hairdresser who is exposed by the hands several times a day could amount to considerable absorption of coloring preparation ingredients. Those found to be teratogenic in animals following skin exposure include:

- 2,4-diaminoanisole sulfate;
- 2,5-diaminotoluene sulfate;
- p-phenylenediamine;
- m-phenylenediamine;
- o-phenylenediamine.

Protection and Prevention

Product Substitution:

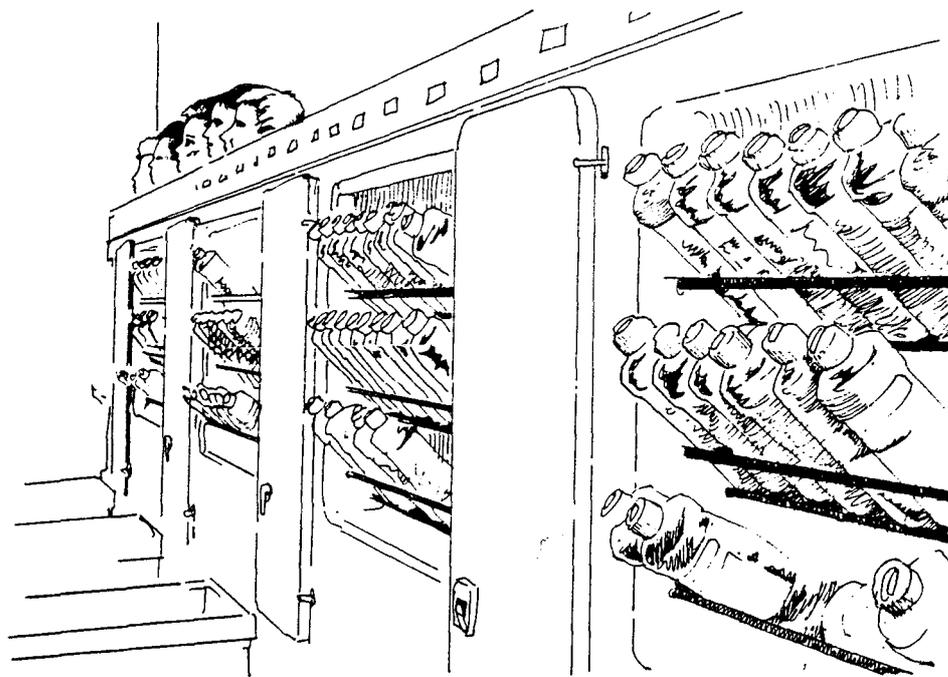
- Use dyes of lesser health hazard such as henna or other vegetable dyes.
- Use semi-permanent colors rather than permanent colors.
- Avoid temporary dyes containing metals, especially lead acetate.
- Bleaching is safer than dyeing with anything other than a vegetable dye; although bleaches contain irritants, they do not appear to have the long term health effects of high sensitization, mutagenicity or carcinogenicity.
- Consider new coloring techniques, such as alternating henna and semi-permanent hair colors each month.

Engineering controls or safe work practices:

- Do not eat or smoke when using dyes; this reduces hand-to-mouth contact and the unintentional ingestion of dyes.

Protective equipment:

- Wear gloves to protect against possible amine irritation and sensitization, irritations from ammonia and peroxide solutions, and prevent skin absorption of hair colorants and components.



V BLEACHING, BLANCHING AND DYE REMOVAL

These procedures involve the use of chemicals to destroy either the natural or artificial pigments in the hair cortex, to lighten hair color, or to provide a light background color for subsequent hair dyeing with blonde, light-gray and light-brown shades.

Bleaching

Bleaching agents consist of the oxidizing agent, activator, accelerators/boosters, and conditioners/fillers. Bleaching may be followed by applying a colored toner.

Oxidizing Agent: This chemically alters the melanin pigments in the cortex of the hair by converting them to oxymelanins, such as:

- hydrogen peroxide (may include stabilizers such as phenacetin);
- sodium peroxide.

Activator: This swells the hair fiber to enable penetration of the peroxide into the hair:

- ammonium hydroxide (ammonia);
- urea peroxide.

Accelerators/Boosters: These are added to the hydrogen peroxide-ammonia mixture just before use to improve its bleaching activity:

- ammonium persulfate;
- potassium persulfate;
- sodium perborate;
- sodium percarbonate;
- magnesium carbonate.

Conditioners/Fillers: Their purpose is to improve the condition of bleached hair. These alter the cuticle (outer surface of the hair) to decrease its porosity or replace the cuticle if it is damaged or missing. Conditioners give the hair a uniform consistency so that it absorbs or responds evenly to hair dyes, waving solutions, etc. These include:

- ammonium soaps;
- lipophilic surfactants (detergents);
- lanolin derivatives;
- cholesterol;
- cream bases;
- hexamethylenediamine;
- polyvinyl pyrrolidone or other pyrrolidone resins.

Colored Toners: Usually a blue rinse, since the human eye considers a blue-white color to be “whiter” than white:

methylene blue;
other blue colors.

Blanching

Blanching is usually done to mixed gray hair to produce an even snowy white appearance. Blanching agents include:

sulfur dioxide;
potassium permanganate, followed by sodium thiosulfite.

Dye Removal

Removal of **oxidation dyes** is accomplished using reducing agents such as:

sodium hydrosulfite;
sodium thiosulfate;
formaldehyde sulfoxylate;
formadine sulfinic acid.

Removal of **metallic dyes** using chemicals is a dangerous process since metals catalyze many chemical reactions and may result in the violent production of heat which could damage hair and skin.

Removal of **semi-permanent dyes** may be accomplished by vigorous washing with shampoos, especially if ammonia is added. More resistant dyes may use reducing agents (some of the same reducing agents as listed above for the removal of oxidation dyes) and bleaches (see page 21) to assist the shampoo.

Adverse Health Effects Associated With Bleaching, Blanching and Dye Removal

Bleaching appears to be safer than dyeing with anything other than a vegetable dye since the chemicals involved have not been associated with the long-term health effects of mutagenicity or carcinogenicity, although sensitization has been reported.

Ammonium hydroxide (ammonia) and hydrogen peroxide can cause skin and eye irritation. Irritation caused by hydrogen peroxide does not tend to subside upon flushing of the skin with water.

The ammonium and potassium persulfate boosters have been found to cause a variety of reactions. Skin reactions include irritant dermatitis and allergic eczematous dermatitis of a delayed variety. It has been suggested that potassium persulfate is more likely to cause irritant dermatitis than ammonium persulfate. However, ammonium persulfate appears to be more frequently implicated in allergic-type responses.

Besides allergic dermatitis, other reported allergic effects include urticaria (pale wheals or papules [bumps] often accompanied by severe itching), rhinitis (nasal inflammation, often with runny nose, sneezing and crusting), asthma, shortness of breath upon exertion, and fainting. The severity of the reaction depends upon the strength or amount of the persulfate in the bleach – higher concentrations produce stronger reactions. Also since persulfate loses its strength with time, fresher boosters produce more severe reactions than older ones.

A study of occupational asthma among hairdressers appears to show that the response in the lungs seems to be a restriction in the size of the airways and not a decrease in lung volume. Animal studies have shown that persulfate salts can directly cause the release of histamine (thus bringing about the allergic response); but this does not explain why some individuals are affected and others are not.

The severity of the allergic reaction (especially the asthma) has caused hairdressers to leave the profession; however, some have been reported to continue their work by avoiding bleaching.

Case History: allergic reaction

“A 29 year-old woman had had atopic eczema since childhood, but had never had asthma. Soon after she began working as a hairdresser, she experienced rhinitis and asthma whenever she worked at the beauty salon. She was free of respiratory symptoms on weekends or when she did not work. An allergist was not able to determine the cause of the asthma. None of the allergists consulted were aware that ammonium persulfate hair bleach formulations could be a cause of rhinitis and asthma. A scratch test was performed with a 1 percent aqueous solution of ammonium persulfate. A wheal immediately appeared, followed by a mild asthma attack that required administration of epinephrine. On follow-up examination, the patient reported that no further attacks occurred since she stopped working as a hairdresser. In this instance, the rhinitis and asthma would appear to have been allergic reactions.”¹

Protection and Prevention

Product Substitution:

- Try doing bleaching without adding the boosters.
- Use non-persulfate boosters such as sodium perborate, sodium percarbonate or magnesium carbonate.
- Try potassium persulfate rather than ammonium persulfate boosters and see if the allergic response is lessened.

¹Kellett, J.K. et al. Ammonium persulphate sensitivity in hairdressers. Contact Dermatitis. Vol. 13:26. 1985.

Engineering Controls or Safe Work Practices:

- Avoid doing bleaching and see if the adverse health effect diminishes.
- Avoid attempting to remove metallic dyes.
- Do not eat or smoke when doing bleaching.
- Use good personal hygiene. Do not touch the face or eyes when bleaching.

Protective Equipment:

- Wear protective gloves when doing bleaching.



VI HAIR SPRAYS AND HAIR SETTING LOTIONS

Hair Sprays

These consist of a film-forming agent (shellac or synthetic polymer) which holds the shape of the hair; modifiers or plasticizers to alter the properties of the film (such as making it possible to comb the hair after spraying); emulsifiers to keep the product from separating; solvents to carry the film onto the hair and then evaporate and leave the film behind; humectants or moisture occluders to keep the product from drying out on the hair and yet keep moisture from destroying the set; perfumes; and propellants if the product is an aerosol.

The **Film-Forming Agent** holds the shape of the hair.

Lacquers were the first hair sprays marketed. These contain about 1 - 4% shellac which has been dewaxed, decolorized, and sometimes bleached as well. If bleached there may be residual chlorine from the bleaching process. The shellac may be coupled with dimethylhydantoin-formaldehyde. The resulting films tend to be difficult to remove from the hair, therefore, lacquer modifiers are added to make shellac more water-soluble. These include:

castor oil;

glycols or glycol esters, such as propylene glycol or polyethylene glycol; dilaurate;

lanolin or lanolin products, such as ethoxylated lanolin.

Nonlacquer Bases are resin-like synthetic polymers, typically 3% in alcohol solution, which are water soluble and wash out easily. These include:

- PVP, polyvinyl pyrrolidone;
- PVP/VA, copolymers of PVP with vinyl acetate;
- dimethyl hydantoin formaldehyde resins;
- partially esterified copolymers of methylvinyl ether and maleic anhydride;
- amphoteric or carboxylated acrylic resins;
- poly-N-vinyl-5-ethyl-2-oxazolidone;
- copolymer of lauryl methacrylate and diethylaminoethyl methacrylate quaternized with dimethyl sulfate;
- vinyl terpolymers, or carboxylated vinyl acetate polymers (vinyl acetate-crotonic acid copolymers) or N-vinyl-5-methyl-2-oxazolidone-vinyl acetate copolymer.

Neutralizing Agents: These nonlacquer bases or polymers which are acidic in nature are neutralized with a base (usually an amine or amino-alcohol) such as:

- morpholine;
- 2-amino-2-methyl-1-propanol (AMP);
- 2-amino-2-ethyl-1,3-propanediol (AEP);
- tris hydroxy methyl-amino methane (THMAM);
- ammonia;
- 2-amino-2-methyl-1,3-propanediol (AMPD);
- diethylaminoprophylamine;
- triisopropanolamine.

The amount of neutralizing agent added determines the solubility of the film and the film hardness which controls the flexibility of the set.

Plasticizers: Unfortunately the nonlacquer resins tend to take up moisture and become tacky under humid conditions. To avoid this, plasticizers and moisture occluders are added to increase sheen, reduce the tendency to pick up moisture, and to give the film the flexibility to enable combing without destroying the set. Humectants may be used to prevent flaking of the spray in dry conditions.

Plasticizers include:

- lanolin and derivatives;
- silicones;
- vinyl acetate;
- shellac (which lowers the cost of the product as well);
- dimethyl or diethyl or dibutyl phthalate;
- isosteareth stearate.

Solvent-Carrier for Film: These solvents carry the film onto the hair and then evaporate to leave the film behind, such as:

- specially denatured ethyl alcohol (such as SD alcohol 40) denatured with sucrose octa-acetate, cetrimide or diethyl phthalate);
- isopropyl alcohol;
- methylene chloride;
- glycol ethers;
- water.

Propellants: (if aerosol products) These are usually present as solvent-propellant systems such as:

- methylene chloride/hydrocarbon (isobutane/propane in a 90/10 ratio);
- methylene chloride/carbon dioxide;
- water/hydrocarbon (isobutane/propane in a 90/10 ration);
- water/carbon dioxide;
- fluorocarbons (or freons) such as propellant 11: (dichlorodifluoromethane) or propellant 12: (trichloromonofluoromethane).

Flammability with the hydrocarbon-containing aerosols is still a problem; using water in the formulation is an attempt to limit this hazard. Most fluorocarbon aerosols contain a large proportion of alcohol which can ignite when sprayed as a fine mist through a naked flame.

Hair Setting Lotions

These tend to be basically the same formulations as used in hair sprays – only the method of application differs (that is, no propellant).

Adverse Health Effects From the Use of Hair Sprays or Hair Setting Lotions

Hair spray in the eyes could be quite irritating due to the solvents and other ingredients in the formulation.

Inhalation of spray particulates

Hair spray particles are respirable with as much as 77% to over 90% of the particles less than 1 micron in diameter. Anything less than 5 microns a respirable particle. Droplets from a pumpspray can be as small as aerosol droplets, although the proportion of small particles may be less. It appears that inhalation risk with pumpsprays may be less than with aerosols; however, studies of particle size distributions from aerosols and pumpsprays show considerable disagreement on this issue.

Some individuals who have been repeatedly exposed to hair spray have exhibited clinical symptoms such as acute upper respiratory infections, shortness of breath on exertion, frequent colds, or chronic cough, and have shown X-ray abnormalities. These conditions (called thesaurosis, sarcoidosis or "storage disease") are believed to result from the storage of nonbiodegradable molecules or particulates (principally polyvinylpyrrolidone [PVP] and its copolymers) in the lung tissue. PVP has been found in lesions in the lungs and in the lymph nodes; the lesions usually regress when exposure to the hair spray is discontinued. The existence of this condition has not been conclusively established since it has not been confirmed by animal studies or by surveys of hairdressers; in fact, PVP has not been found in the lungs of several people with so-called thesaurosis. However, once deposited in the lungs, PVP appears to be taken up by pulmonary macrophages (cells that protect the body against infectious and noxious substances) and deposited in the lymph nodes, so it is not surprising that it often does not appear in the lungs.

Some cases may result in alveolar-capillary-block syndrome in which the air sac walls of the lungs increase in thickness; the result is that less oxygen can reach the blood from the lungs. Although there is not a definite correlation of PVP with thesaurosis, there seems to be some reaction occurring – it does appear that hairdressers as a group do have a higher incidence of pulmonary abnormalities. It is possible that sarcoidosis may require susceptible or hypersensitive individuals, thus its relative infrequency in persons exposed to hair sprays. This may indicate that an allergic reaction is involved and that the dose-response relationship simply is not known at present.

Gum shellac tends to exhibit a foreign body reaction in the lungs as well as causing lung fibrosis (elasticity is lost in lung tissue). In shellac-containing sprays, high oil content may be a major part of the problem.

A study involving student and graduate cosmetologists demonstrated that cosmetologists have more early chronic obstructive lung disease (COLD) which may progress toward more severe changes. The length of time in the industry is important in the development of respiratory disease since the graduate cosmetologists showed more dysfunction than the student cosmetologists. Since poorer ventilation systems tend to be found in small salons, they tend to have the highest concentration of airborne particulates; thus the cosmetologists working in small salons showed increased prevalence of chronic respiratory disease with abnormal chest X-rays, reduced vital capacity and atypical sputum.

The International Agency for Research on Cancer (IARC) reviewed the data on polyvinylpyrrolidone but concluded that there was insufficient evidence to determine that it is carcinogenic in humans. Animal studies indicated that PVP may be carcinogenic to mice, rats and rabbits following subcutaneous and intravenous injection. They did note that PVP is retained in the body, since molecular weight polymers (smaller than 25,000 microns) can be excreted by the kidneys.

Inhalation of solvents and propellants

Methylene chloride is a skin and eye irritant, a narcotic, and a possible carcinogen. A risk estimate made by the FDA in 1985 estimated that one out of every 100 hairdressers may develop cancer from continued use of methylene chloride-containing hairsprays. No action has been taken on the FDA's proposed ban of methylene chloride use in cosmetics. Industry groups representing manufacturers and distributors of chlorinated solvents feel that this risk projection is not appropriate since epidemiological and biochemical studies conducted since 1985 appear to have downgraded the risks.

Animal studies on exposure to methylene chloride in air have shown cancers and tumors of lung liver, salivary glands and mammary glands. Although epidemiologic data from workers in industries exposed to methylene chloride are inconclusive, OSHA criteria have been met with these animal studies and OSHA's cancer policy considers methylene chloride a potential occupational carcinogen. The National Institute for Occupational Safety and Health (NIOSH) recommends that worker exposure to methylene chloride be controlled to the lowest feasible limit.

Isobutane and propane propellants principally constitute a fire hazard and they are possible asphyxiants at high concentrations. Since their vapors are heavier than air, properly located ventilation should be used to minimize the inhalation hazard.

Protection and Prevention

Product Substitution:

- Use carbon dioxide propellants instead of fluorocarbons or hydrocarbons.
- Use pump sprays instead of aerosols.
- Use water based hairsprays whenever possible.
- Use alcohol solvent carriers instead of methylene chloride.
- Use hair setting lotions rubbed into the hair instead of hairspray.

Engineering controls or work practices:

- Use good ventilation; if no vent system, open doors and windows.
- No smoking due to breakdown products of fluorocarbons or methylene chloride.

Protective equipment:

- Wear protective gloves when using hair setting lotions.

VII PERMANENT WAVES AND STRAIGHTENERS

Heat waving, an older procedure, involved using heat from 180-200 degrees and wetting the hair with an alkaline solution followed by cooling. Alkaline solutions contained ammonia, sodium carbonate or triethanolamine. Early waving solutions used ammonia, sodium carbonate, ammonium carbonate, sodium borate, sulfite and sodium bisulfite.

Cold permanent waving and straightening is a two-part procedure which involve these basic steps:

- The hair is first softened with a wave solution which breaks chemical bonds in the hair. While in this state, the hair is wound upon rollers to give the desired waving or straightening result.
- Then the hair is hardened again with a neutralizing agent which reforms most of these chemical bonds in the hair but in its new shape, making the permanent wave or straightened hair.

Lukewarm permanents fall in between these procedures.

Other methods for permanents involve chemicals such as epoxies; for example, ethylene glycol diglycidyl ether.

Permanent Waving

Permanent waving is a two-part process consisting of the application of a waving solution followed by a neutralizing solution. The waving solution is made up of reducing agents, emollients, conditioners, surfactants and opacifiers. The neutralizer consists of oxidizing agents, surfactant-thickener/opacifiers, catalysts/reaction controllers, and fire retardants. Both the waving and neutralizing solutions are explained in detail below.

Waving Solution

Reducing Agents: These break the disulfide chemical bridges between the neighboring protein strands within the hair which give it much of its strength and shape. These are chemicals such as:

- sodium thioglycollate;
- potassium thioglycollate;
- ammonium thioglycollate;
- thiodiglycollic acid;
- monoethanolamine thioglycollate;
- thioglycerol;
- 2,5-dimercaptoadipic acid.

Emollients and Conditioners: These alter the cuticle (outer surface of the hair) to decrease its porosity or replace the cuticle if it is damaged or missing. Conditioners give the hair a uniform consistency so that it absorbs or responds evenly to the waving chemicals. Proteins act as fillers to fill in damaged areas on the cuticle. These proteins are clear gels of chemically extracted and purified proteins derived from sources such as scrap leather, cattle hooves or turkey feathers. Conditioners containing mild acids tend to shrink and harden the cuticle. These include:

- mineral oil;
- sulfated oils;
- lanolin and its derivatives;
- amino acids;
- hydrolyzed proteins.

Surfactants: These are non-ionic type detergents which help to keep the other ingredients well-mixed and prevent them from separating. Examples are:

- oxyethylated fatty alcohols;
- oxyethylated alkylphenols;
- fatty acid-polypeptide condensates.

Opacifiers: These give the waving lotion a thick appearance; they tend to be suspensions of synthetic resins or polymers, for example:

- urea-formaldehyde resins;
- melamino-formaldehyde resins;
- latex emulsions;
- polyacrylates.

Neutralizing Solution

Oxidizing Agents: These harden the hair by rebuilding the disulfide bridges between neighboring protein strands within the hair. These include:

- hydrogen peroxide (stabilized; no bleaching effect);
- potassium bromate;
- sodium bromate;
- perborate compounds; such as sodium or potassium perborate;
- percarbonate compounds; such as sodium or potassium percarbonate.

Surfactant-Thickeners/Opacifiers: These give the product a thicker appearance and help to keep the ingredients from separating. Examples are:

- polyglycol palmitic amid;
- alkyloamides;
- oxyethylated lauryl alcohol.

Catalysts/Reaction Controllers: These control the rate at which the oxidation agent reacts. These include:

- dehydroascorbic acid;
- iron salts;
- sodium nitrate.

Fire Retardants: These are generally added to combat the vigorous chemical reactivity of the perborates oxidizing agents, such as:

- urea;
- ammonium salts.

Hair Straightening

Straightening Solution

Hair straightening consists of a process like permanent waving involving similar chemicals, as shown below:

Reducing Agents:

- ammonium thioglycolate adjusted to a pH higher than 9.0 with ammonia or ammonium monoethanol amine;
- sodium hydroxide (pH between 10 and 11);
- ammonium sulfite.

Emollients and Conditioners:

- stearic acid;
- oleic acid.

Surfactants:

- sodium lauryl sulfate;
- glycerol monostearate.

Opacifiers:

- ceresin (wax);
- paraffin.

Neutralizing Solution

Oxidizing Agents:

potassium bromate
sodium perborate
hydrogen peroxide

Other Ingredients:

Similar to those in permanent waves.

Adverse Health Effects Associated With Permanent Waves and Straighteners

Permanent liquids tend to be irritating or corrosive to the skin and can be especially damaging to the eyes, possibly causing blindness. This is due to the high alkalinity of waving solutions, as well as to the presence of thioglycollates. Dermatitis from wave solutions tends to particularly affect the fingertips, but usually does not involve the web spaces. Skin and eye damage is facilitated by the detergent/surfactant additives which defat the skin and assist in skin penetration. Thioglycolates may also cause dermatitis or eczema of the hands with reddening, fluid retention or swelling, or subcutaneous hemorrhages. This is possibly due to prolonged or repeated contact with the skin. Waving solutions which have been buffered to a pH of between 6.5 and 6.9 tend to have the least irritation potential. The thioglycolates in general are more irritating than are other constituents such as thiodiglycolic acid compounds, monoethanolamine thioglycolate, thioglycerol and 2,5-dimercaptoadipic acid.

Waving solutions are not usually sensitizing, but allergic reactions to thioglycerol have been observed and to the synthetic plastic resin opacifiers. Sensitization to the epoxy-type waving solutions is also possible.

Some of the additives used for pH adjustment (monoethanolamine, diethanolamine and triethanolamine) may be hazardous due to the presence of nitrosamine, which is a carcinogenic contaminant.

Neutralizing solutions containing bromate and perborate may be strongly irritating. Bromate-containing solutions may have serious systemic effects on the body if ingested. Those include central nervous system effects, hemoglobin effects, and kidney failure.

Protection and Prevention

Product Substitution:

- Avoid permanents containing triethanolamine (TEA), diethanolamine (DEA), and monoethanolamine (MEA).
- Try ammonium thioglycolate (ATG) rather than glycerol monothioglycolate (GMTG) to avoid GMTG allergic reactions.
- Use the heat-pressing method of hair straightening instead of chemical straighteners.
- Use hair straighteners containing bisulfite rather than sodium hydroxide.
- Use neutralizers containing hydrogen peroxide rather than bromates.

Engineering Controls or Safe Work Practices:

- Use good personal hygiene; wash hands before eating or smoking to avoid hand-to-mouth contact and the accidental ingestion of hair products.
- Do not eat or smoke when giving permanents to avoid accidental ingestion of hair products.
- Do not touch the face or rub the eyes when giving a permanent.

Protective Equipment:

- Wear gloves when giving a permanent. Neoprene gloves have been found to be protective. Allergy to GMTG has been experienced through a variety of glove fabrics including butadiene, latex surgeon's, vinyl exam, and vinyl household gloves.

VIII NAIL PRODUCTS

Nail Polish, Enamel, Basecoats and Hardeners

These nail products consist of film-formers, resin, plasticizers, solvents, colors, pigment dispersers and mixers. Undercoats, basecoats and topcoats differ from enamels mainly in their proportions of resins and nitrocellulose.

Film-Formers: Provide gel structure and give body and gloss to nail enamel.

Examples are:

- nitrocellulose (cellulose nitrate);
- ethyl cellulose.

Resins: Thermoplastic resins which provide adhesion to the nail, gloss and flexibility of the polish when dry. Examples are:

- toluene sulfonamide formaldehyde resin;
- nylon resins (especially used in nail hardeners);
- alkyl polyester resin (used in hypoallergenic products; tends to wear poorly since it chips and peels easily).

Plasticizers: Help to minimize shrinkage of the polish as it dries and contribute to the flexibility of the dry enamel. These include:

- dibutyl phthalate;
- butyl acetate;
- castor oil;
- camphor.

Solvents: Act as carriers to solubilize the films and resin, then evaporate to leave the enamel behind. Examples are:

- ethyl acetate;
- xylene;
- toluene;
- acetone;
- ethanol;
- methanol;
- glycol ethers;
- methyl ethyl ketone.

Colors: These may be fluorescent or nonfluorescent colors. Clear polishes contain small amounts of colors to give a faint tint.

Fluorescent colors:

eosin;
erythrosin;
fluorescein;
rhodamine B.

Nonfluorescent colors:

D&C Red No. 19;
D&C Red No. 31;
crystalline guanine (2-amino-6-hydroxypurine for an irridescent, pearlized or frosted look);
bismuth oxychloride (frosted look);
mica coated with titanium dioxide (frosted look).

Pigment Dispersers: Prevent pigment settling by keeping it evenly dispersed in the product. These include:

organically modified clay;
bentonés (bentonite clay treated with quaternary ammonium compounds);
dammar gum;
sandarac gum.

Mixers: Usually pellets of nickel or plastic which help to mix the polish when the bottle is shaken.

Cuticle Softener or Remover

Cuticle Softener: Used to soften or dissolve the keratin protein of the cuticle. Such as:

potassium hydroxide;
sodium hydroxide.

Humectants: These keep the product or the skin from losing moisture and drying out, usually glycerin.

Fragrance: Usually an essential oil.

Nail Bleaches:

citric acid;
potassium binoxalate.

Nail Whites

Type: Cream

Color: titanium dioxide (white).

Vehicles: Provide the substance of the cream. For example:

beeswax;
cetyl alcohol;
oxycholesterin;
petrolatum;
cocoa butter.

Preservatives: Prevent spoilage. Such as:

tincture of benzoin;
sodium borate.

Type: Liquid

Color: titanium dioxide (white).

Vehicles: Provide the substance of the liquid or lotion. For example:

glyceryl monostearate;
beeswax;
petrolatum.

Fragrance: almond oil.

Nail Polish Remover

Solvents: Used to dissolve polish or enamel.

acetone;
ethylacetate;
butyl acetate;
butyl stearate.

Emollient/Moisturizer: Used to moisturize the skin or combat the skin drying effects of the solvents.

lanolin;
cetyl alcohol;
castor oil;
olive oil;
spermaceti;
ethyl oleate.

Fragrance: An essential oil.

Artificial Nails

Stick-on type nails consist of a plastic tip and an adhesive to attach the artificial nail to the human nail.

Sculptured artificial nails are made from synthetic monomers ("nail liquid") and polymers ("nail powder") which are mixed and molded onto the natural nail or an artificial nail extension. When the resin hardens (cures or polymerizes), it is filed into shape and then nail polish or enamel is applied.

Type: Liquid

methyl ethyl methacrylate;
butyl methacrylate;
isobutyl methacrylate;
ethylene glycol dimethacrylate;
trimethylolpropane trimethacrylate;
methacrylic acid;
tetrahydrofurfuryl methacrylate;
diethylene glycol dimethacrylate.

Type: Nail powder

Polymer Powder: polymethyl methacrylate

Initiator: Acts as a catalyst for the curing or polymerization chemical reaction.

benzoyl peroxide;
N, N-dimethyl-p-toluidine.

Acrylic Monomers in Various Nail Preparations¹

Brand name	Contains
Mona Sculptured Nails Liquid	Ethyl methacrylate monomer Ethylene glycol dimethacrylate
Andette Artificial Nail Set	Ethyl methacrylate monomer Butyl methacrylate monomer Trimethylolpropane trimethacrylate monomer
Polynail Artificial Nail Set	Ethyl methacrylate monomer Isobutyl methacrylate monomer

¹Reprinted with permission of the author: Fisher, Alexander A. Short Communications: Cross reactions between methyl methacrylate monomer and acrylic monomers presently used in acrylic nail preparations. Contact Dermatitis. Vol. 6: pages 345 and 346. 1980.

Brand name, continued	Contains, continued
Magic Sculptura Nails	Methacrylic acid monomer Ethyl methacrylate monomer Isobutyl methacrylate monomer
Pattinail Nail Extender	Ethyl methacrylate monomer Isobutyl methacrylate monomer
House of Nails Nail Extender	Ethyl methacrylate monomer Butyl methacrylate monomer
Super Nail Artificial Fingernail	Ethyl methacrylate monomer Isobutyl methacrylate monomer
Lee Nails Nail Extender	Ethyl methacrylate monomer Tetrahydrofuryl methacrylate monomer Diethylene glycol dimethacrylate monomer

Adverse Health Effects Associated With Nail Products

When using nail products, the patron's hand is one or two feet below the manicurist or nail sculptor's breathing zone. As a result, both patron and manicurist are exposed to dusts and solvent vapors during the time it takes to do that particular service; but the professional has the repeated or prolonged exposure of doing many customers in a day.

The film-forming resin used in nail polishers or enamels, toluene sulfonamide formaldehyde resin, is a sensitizer when wet. Cosmetologists have experienced nail enamel dermatitis on the face and neck from contact with the wet enamel and then touching or scratching the neck or face. Adverse reactions have also occurred on the legs when nail polish was used to stop runs on stockings. However, as the enamel dries, it loses its sensitizing potential and becomes a weak allergen. These sensitization reactions appear to be the result of free formaldehyde, but in persons allergic to the resin there is often a cross-sensitization with formaldehyde and only rarely with sulphonamide.

Nail hardeners containing more than 5% free formaldehyde have been banned by the Food and Drug Administration. Nail products manufactured in the U.S. are not supposed to have free formaldehyde (a sensitizer); but foreign products may contain it and not all states bar foreign products. In the past, the formaldehyde in nail hardeners has been linked to nail loss, discoloration of the nail plate, inflammation of the nail, and even bleeding of the lips in nail biters. Newer nail hardeners containing toluene sulphonamide formaldehyde resin should not contain the free formaldehyde which cause these nail problems.

Persons sensitized to wet nail polish enamel have successfully used it by applying the polish carefully to the nail only, avoiding skin contact, allowing the nails to dry thoroughly (about 15 minutes) and checking for dryness with a cotton swab. When this procedure has been followed, dermatitis has not occurred.

Nail polish colors, especially the fluorescent colors (eosin, erythrosin, fluorescein and rhodamine B) are photosensitizers. Photosensitization involves the darkening of the skin after exposure to ultraviolet light (such as in sunlight or from tanning lamps) where the skin has absorbed or come into contact with these colors. Pigment dispersers, nonfluorescent colors and iridescent finishes rarely sensitize; but nonfluorescent colors have been known to stain the nail plate of the user.

The solvents in nail polish or remover are dehydrating and may cause irritant dermatitis from skin exposure, headaches, or nausea by inhalation. Inhalation of higher concentrations may cause central nervous system effects; chronic (long-term) exposure to toluene can cause liver disease. However, animal experiments with exposure to butyl stearate suggest that it has a low toxicity.

The nickel in pellet mixers used to mix polish or hardeners are potential sensitizers.

The sodium hydroxide and potassium hydroxide in cuticle removers are strong caustics; they can be skin irritants, cause skin burns, or be damaging to the eyes.

The nail powder used in sculptured nails contains methacrylates which are possible sensitizers, and can cause allergic contact dermatitis. Formerly these resins were methacrylates and polymethylmethacrylates but these were banned by the Food and Drug Administration in 1974 due to consumer complaints involving nail discoloration, irritation and loosening or detachment of the nail from the nailbed, or permanent nail loss. Sensitization to one of the methacrylates or from past use of one of the now-banned methacrylates may confer sensitization to others. For the nail sculptor, exposures can result from the methacrylate vapors and from the dust of the nail powder during mixing/preparation and during grinding to smooth and shape the nails. Dust on the arms, face or torso of nail sculptors has caused itching or rashes and should be minimized.

Animal studies to determine adverse effects such as embryonic-fetal toxicity and teratogenicity of methacrylates have shown that these reproductive effects do occur. However, these studies involved the injection of methacrylates into the animal body. It is unknown at present whether methacrylates pose any problem to nail sculptors who are chronically exposed to low levels of methacrylates by inhalation and skin absorption.

The adhesive used for stick-on nails may be a sensitizer for some individuals.

Protection and Prevention

Product Substitution:

- Instead of sculptured nails, use plastic tips or linen strips.
- Try a sculptured nail product containing a different methacrylate ingredient and see if this minimizes the health effects. There appears to be cross-sensitivity between ethyl methacrylate, methyl methacrylate and N-butyl methacrylate; a reaction to one would probably indicate avoiding both of the others (see table on page 38).
- Substitute plastic pellet mixers for nickel ones in nail polish/enamels.
- Consider nail polish/enamel or remover having butyl stearate as the solvent.
- Avoid products containing formaldehyde.

Engineering Controls or Safe Work Practices:

- Avoid contact with the face and neck when handling wet nail polishers or enamels.
- Wash the hands and face during the day to remove the dust from sculptured nail products. Do not eat or smoke without removing the dust.
- When using cuticle removers, wash hands right away and do not rub eyes.
- Use good ventilation to minimize vapor or dust inhalation.
- Where vented manicure tables are used, replace the charcoal filters monthly to prevent their overloading with organic vapors.

Protective Equipment:

- Use a barrier cream to block the dust from sculptured nail ingredients.
- Where there is dust exposure to sculptured nail ingredients, wear long sleeves and high-necked clothing to cover the chest and neck as much as possible.

IX COSMETICS AND PERFUMES

Basic Cosmetic/Toiletry Ingredients

Colors: See below

Preservatives:

methyl or propyl paraben (p-hydroxybenzoic acid);
quaternary ammonium compounds: Cetrimide, benzalkonium chloride;
ethyl or isopropyl alcohol;
p-Chloro-m-cresol, p-chloro-m-xyleneol, dichlor-m-xyleneol;
ethylene or propylene glycol phenyl ether; glycerol or ethylene glycol p-
chlorophenyl ether;
bithionol;
essential oils: eucalyptus, origanum, thyme, savory and rectified lemongrass
oil, undecylenic aldehyde, benzaldehyde, eugenol, octyl alcohol,
geraniol, citronellol;
dehydroacetic acid;
citrus oils;
methol;
imidazolidinyl urea;
methyl or methyl chloro isothiazolinone;
boric acid or borax;
cinnamic acid;
salicylic acid or salicylanilide;
acriflavine or proflavine;
formaldehyde or formaldehyde-releasing compounds;
vanillates;
propionates.

Antioxidants:

benzoic acid;
BHA (butylated hydroxyanisole), BHT (butylated hydroxytoluene); sometimes
with dodecyl gallate, citric acid, hexylene or propylene glycol;
tocopherol.

Film-Formers:

acrylic resins.

pH Adjustment:

citric acid;
ammonium carbonate;
ammonium bicarbonate;
calcium carbonate;
tartaric acid.

Moisture Content (Humectants):

glycerine;
propylene glycol;
calcium silicate.

Fragrances: see below

Processing Aids**Surfactants/Emulsifiers/Foaming Agents:**

dodecyl benzene sulfonic acid;
sodium lauryl sulfate;
alumina gel;
sodium sulfonate.

Texturizers/Bodying Agents/Thickeners:

acacia (gum);
oils such as spermaceti and castor oil;
mineral waxes such as ceresin, beeswax, carnauba wax;
tragacath mucilage;
lanolin;
cocoa butter;
fats;
PEG (polyethylene glycol) ethers;
clay;
chalk;
starch.

Clarifying and Chelating Agents:

tannin;
EDTA.

Opacifiers:

stearyl alcohol;
cetyl alcohol.

Common Fragrances in Cosmetics and Personal Care Products

These may be natural (such as herbs or essential oils) or synthetic products, including:

sandalwood	lavender
cassia	thyme
oak moss	juniper berries
calamus	coriander
sweet orange	bitter orange
peppermint	clary sage
sassafras	cedarwood
pine needle	guaiac wood
spike	clove
angelica root	rosemary
bergamot	camomile
lemon	ylang-ylang
eucalyptus	geranium
citronella	petitgrain bigarade
petitgrain Paraguay	vetiver
abies alba	litsea cubeba
cananga	oak "moss" (atranorin)
Balsam of Peru	Balsam of Tolu
neroli	
bay oil (eugenol, chavicol, methyleugenol, citral, myrcene, pinene, dipentene, phellandrene)	

Common Colors in Cosmetics and Personal Care Products

These may be natural colors, minerals, or synthetic colors such as coal tar colors. F D & C dyes are those originally permitted for use in Foods, Drugs and Cosmetics when the batch was certified by the Food and Drug Administration. D & C dyes were originally permitted only for Drugs and Cosmetics. Ext. D & C dyes are permitted for externally applied Drugs and Cosmetics only and are specifically prohibited from use on the lips (such as lipstick) or any mucous membrane (such as around the eyes or lips or in toothpastes or mouthwashes). As more testing and information becomes available, permitted usages for colors may change – note the restrictions for the colors described below.

Natural Colors: Derived from plant or animal sources:

- alkanet;
- *annatto, also called Natural Orange 4;
- *caramel;
- *carmine, also called Natural Red 4, aluminum calcium lake of carminic acid (an anthraquinone-type color);
- *b-carotene;
- chlorophyll, a or b, also called Natural Green 3;
- Cochineal;
- *guanine, 2-aminohypoxanthine, may also be synthetically prepared (pearlized or iridescent look);
- *Henna (coloring scalp hair only, not for eyelashes or eyebrows or in area of eye);
- Saffron;
- Turmeric, also called Natural Red 3.

Mineral or Metallic Colors: These may be natural or synthetically prepared:

- *aluminum powder: external use only, near eyes is permitted;
- *bismuth citrate: may be used only in coloring hair on the scalp, not for the eyelashes, eyebrows, or hair on other parts of the body;
- *bismuth oxychloride (BiOCl): external use only, near eyes is permitted;
- *bronze powder (alloys of copper with zinc and small amounts of aluminum and tin);
- *Chinese white, also called Pigment White 4; a colloidal clay;
- *chromium hydroxide green [Cr₂O(OH)₄]: external use only, near eyes is permitted;
- *chromium oxide greens (Cr₂O₃): external use only, near eyes is permitted;
- *copper powder;
- *disodium EDTA - copper: may be used only in shampoos;
- *ferric ammonium ferrocyanide: external use only, near eyes is permitted;
- *ferric ferrocyanide, also called Prussian blue; external use only, near eyes is permitted;
- *iron oxides and hydrated iron oxide [Fe₂O₃, FeO(OH), NH₂, Fe₃O₄]: red, yellow, or brown; hydrated form also called Pigment Brown 6 or 7;
- *lead acetate: may be used only for coloring hair on scalp;
- *manganese violet (ammonium manganese pyrophosphate);
- *mica: silicate minerals, with or without coating of titanium dioxide;
- *potassium sodium copper chlorophyllin: may be used only in dentifrices; pumice, also called Pigment White or 26;
- *pyrophyllite: external use only;

- *silver: may be used only in fingernail polish;
- talc, also called Pigment White 26 (magnesium silicates);
- *titanium dioxide, also called Pigment White 6;
- *ultramarines (blue, green, pink, red, violet): calcined complex sodium aluminum sulfosilicates; external use only, near eyes is permitted;
- *zinc oxide (ZnO);
- zinc sulfide, also called Pigment White 7.

*According to FDA regulations, unless otherwise noted, these may be safely used in coloring cosmetics generally, including cosmetics intended for use in the area of the eye, in amounts consistent with good manufacturing practice. These are also exempt for certification requirement of the Food, Drug and Cosmetic Act.

Artificial Colors

- * dihydroxyacetone: external use only; to apply color to body;
- **D&C Blue 4: external use only; diammonium salt of 4-[[4-(N-ethyl-p-sulfo benzyl amino)-phenyl]]-2(sulfoniumphenyl)-methylene]-[1-(N-ethyl-N-p-sulfo benzyl)-[^]2,5 cyclohexadieneimine];
- **FD&C Green No. 3: disodium salt of 4-[[4-N-ethyl-p-sulfo benzylamino)-(4-hydroxy-2-sulfoniumphenyl)-methylene]-[1-N-ethyl-N-p-sulfo benzyl]-[^]2,5-cyclohexadienimine];
- **D&C Red No. 30: 5,5'-dichloro-3,3'-dimethyl-thioindigo;
- * Guaiazulene: external use only; 1,4-dimethyl-7-isopropyl-azulene;
- **FD&C Blue No. 1: disodium salt of ethyl [4-[p-[ethyl(m-sulfo benzyl)amino]-a-(o-sulfo phenyl)benzylidene]-2,5-cyclohexadien-1-ylidene] (m-sulfo benzyl)ammonium hydroxide inner salt;
- **D&C Blue No. 4: diammonium salt of 4-[[4-(N-ethyl-p-sulfo benzylamino)-phenyl]]-(2-sulfoniumphenyl)-methylene)-[1-(N-ethyl-N-p-sulfo benzyl)-[^]2,5-cyclohexadienimine]; external use only;
- **D&C Green No. 8: external use only; not to exceed 0.01% by weight of finished cosmetic product.

Fluorescent Colors:

Among these, the fluoresceins containing chlorine, bromine, or iodine used in lipsticks have caused irritations or dermatitis of lips (cheilitis) in sensitive persons. See also the nail products chapter; the fluorescent colors used in nail polish can be photosensitizers.

- **D&C Yellow No. 7: fluorescein; external use only;
- **D&C Orange No. 5: dibromofluorescein; for mouthwashes and dentifrices; lipsticks or other lip cosmetics not to exceed 5.0% by weight or finished product;
- **D&C Orange No. 10: di-iodofluorescein; external use only;

- **D&C Orange No. 11: erythrosine yellowish Na; disodium salt of 9-o-carboxylphenyl-6-hydroxy-4,5-di-iodo-3-isoxanthone; external use only;
- **D&C Red No. 19: 3-ethochloride of 9-o-carboxyphenyl-6-diethyl-amino-3-ethyliminio-3-isoanthene; rhodamine B; external use only;
- **D&C Red No. 21: tetrabromofluorescein;
- **D&C Red No. 27: tetrachlorotetrabromofluorescein;
- **D&C Red No. 22: disodium salt of 2,4,5,7-tetrabromo-9-o-carboxyphenyl-6-hydroxy-3-isoxanthone; Eosin YS;
- **D&C Red No. 28: disodium salt of 2,4,5,7-tetrabromo-9-(3,4,5,6-tetrachloro-o-carboxyphenyl)-6-hydroxy-3-isoxanthone; phloxine;
- **D&C Yellow No. 8: disodium salt of 9-o-carboxyphenyl-6-hydroxy-3-isoxanthone; external use only.

Azo Colors:

- **D&C Red 17: dioxy-azo-benzene; external use only;
- **FD&C Yellow No. 5: tartrazine; 4,5-dihydro-5-oxo-1-(4-sulfophenyl)-4-[(4-sulfophenyl)azol]-1H-pyrazole-3-carboxylic acid trisodium salt;
- **D&C Brown No. 1: sodium salts of 4[(5-(dialkylphenyl)-azol)-2,4-dihydroxyphenyl]-azol-2,4-dihydroxyphenyl]-azol-benzene sulfonic acid (alkyl is generally methyl); external use only;
- **FD&C Yellow No. 6: disodium salt of 1-p-sulfophenylazo-2-naphthol-7-sulfonic acid; external use only;
- **FD&C Orange No. 4: monosodium salt of 1-p-sulfophenylazo-2-naphthol; external use only;
- **D&C Orange No 17: 1-(2,4-dinitrophenylazo)-2-naphthol; external use only;
- **D&C Red No. 4: disodium salt of 2-(5-sulfo-2,4-xylazo)-1-naphthol-4-sulfonic acid; external use only;
- **D&C Red No. 6: monosodium salt of 4-(o-sulfo-p-tolylazo)-3-hydroxy-2-naphthoic acid;
- **D&C Red No. 7: calcium salt of 4-(o sulfo-p-tolylazo)-3-hydroxy-2-naphthoic acid;
- **D&C Red No. 8: monosodium salt of 1-(4-chloro-o-sulfo-5-tolylazo)-1-naphthalenesulfonic acid; cosmetic lip products not exceeding 0.1% by weight of finished product; external use only;
- **D&C No. 9: barium salt of 1-(4-chloro-o-sulfo-5-tolylazo)-2-naphthol; cosmetic lip products not exceeding 0.1% by weight of finished product; external use only;
- **D&C No. 17: 1-p-phenylazo-phenylazo-2-naphthol; external use only;
- **D&C No. 31: calcium salt of 3-hydroxy-4-phenylazo-2-naphthoic acid; external use only;
- **D&C Red No. 34: calcium salt of 4-(o-sulfo-2-naphthylazo)-3-hydroxy-2-naphthoic acid; external use only;

- **FD&C Red No. 40: disodium salt of 6-hydroxy-5-[(2-methoxy-6-methyl-4-sulfophenyl)azo]-2-naphthalene sulfonic acid;
- **FD&C Yellow No. 6: disodium salt of 1-p-sulfophenylazo-2-naphthol-7-sulfonic acid;
- **Ext. D&C Yellow No. 7: disodium salt of 2,4-dinitro-1-naphthol-7-sulfonic acid; external use only.

Anthraquinone Colors:

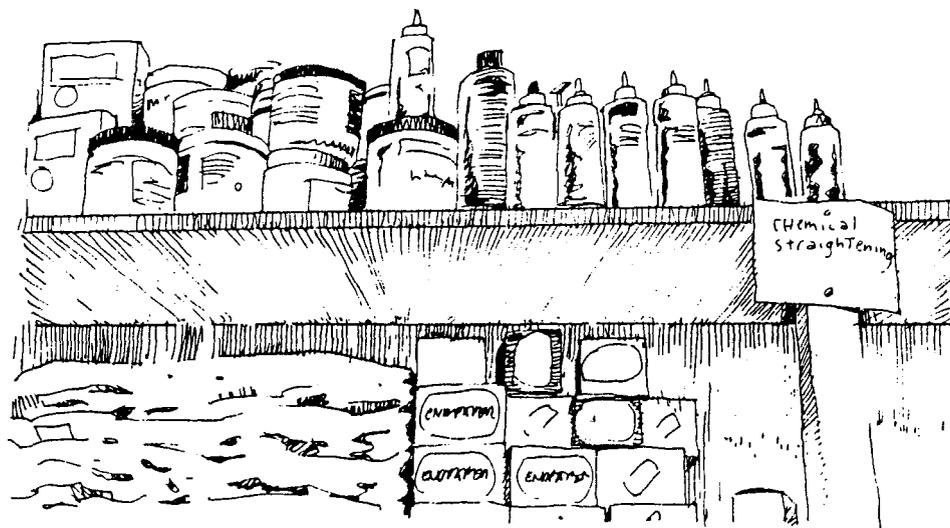
- **D&C Green No. 5: disodium salt of 1,4-bis(p-toluino)-anthraquinone; not in area of eye;
- **D&C Green No. 6: 1,4-bis(p-toluino)-anthraquinone; external use only;
- **D&C Violet No. 2: 1-hydroxy-4-p-toluinoanthraquinone; external use only;
- **EXT D&C Violet No. 2: monosodium salt of 2-[(9,10-dihydro-4-hydroxy-9,10-dioxo-1-anthracenyl)amino]-5-methyl-benzene sulfonic acid; external use only.

Quinoline Colors:

- **D&C Yellow No. 10: disodium salt of disulfonic acid of 2-(2-quinolyl)-1,3-indandione;
- **D&C Yellow No. 11: 2-(2-quinolyl)-1,3-indandione; external use only.

*According to FDA regulations, unless otherwise noted, these may be safely used in coloring cosmetics generally, including cosmetics intended for use in the area of the eye, in amounts consistent with good manufacturing practice. These are also exempt from certification requirements of the Food, Drug and Cosmetic Act.

**According to FDA regulations, unless otherwise noted, these may be safely used for coloring cosmetics generally in amounts consistent with current good manufacturing practice. All batches shall be certified as per FDA regulations.



Common Cosmetic Ingredients

Eye Liner (liquid)

Film formers: usually acrylic resins or PVP colors, usually inorganic, such as:

- titanium dioxide;
- carbon black;
- iron oxides;
- chromium oxide;
- ultramarine;
- carmine.

Humectants:

- Emulsifiers and thickeners;
- alkanolamine stearate;
- higher fatty alcohol;
- cellulose ether;
- polyol.

Preservatives:

- parabens;
- propylene glycol;
- butylene glycol;
- imidazolidinyl urea.

Eye Shadow (powder)

Fillers: usually talc

Inorganic colors (cream-types often add pearlescent agents), usually:

- carbon black;
- iron oxides;
- chromium oxide;
- ultramarine;
- carmine.

Bodying agents such as oils (cream and stick-type shadows add waxes to this formulation).

Barrier agents: zinc stearate (a metallic soap).

Humectants

Preservatives

Mascara

Bodying agents:

- triethanolamine stearate (a soap)
- carnauba wax
- beeswax
- paraffin
- lanolin

Preservatives

Colors and pigments: (insoluble), usually:

- carbon black;
- iron oxides;
- chromium oxide;
- ultramarine;
- carmine.

Lash-lengthening types may contain rayon or nylon fibers.

Foundation Creams

May be oil-in-water emulsions (oil phase may represent 10-40% of the formulation), water-in-oil emulsions, solvent-based (usually water), or water-free anhydrous forms (such as the stick or crayon-type). These consist of:

Bodying agents:

- stearic acid;
- mineral oil;
- lanolin isolates and derivatives;
- synthetic esters (glyceryl, glycol, polyethylene glycol monostearate);
- waxes (beeswax, spermaceti);
- content of kaolin clay and talc control the degree of matte finish on the skin.

Emulsifiers (such as anionic, cationic, and nonionic surfactants):

- Arlacel 60 (sorbitan monostearate);
- Tween 60 (polyoxyethylene sorbitan monostearate);
- triethanolamine;
- soaps often used to disperse pigments.

Humectants:

sorbital;
propylene glycol;
glycerol.

Opacifiers:

cetyl alcohol.

Pigments (insoluble):

titanium dioxide (in the water phase) is used to control the coverage (ability of cream to conceal skin blemishes or conceal or alter skin coloring).

These pigments are wet in the oil phase already – this makes them less likely to turn “orangy” when they contact skin oils.

Perfume**Preservatives:**

borax
parabens

Barrier agents:

zinc stearate, cellulose derivatives, silicones.

Thickeners:

sodium alginate, gum tragacanth, quince seed, mucilage.

Lipsticks**Bodying agents:**

castor oil;
spermaceti;
cocoa butter;
hydrogenated fats and oils;
mineral waxes (ceresine);
tetrahydrofurfuryl acetate;
waxes (beeswax, candelilla);
lanolin.

Fragrance

Color (FDA approved, including pearlescent agents) soluble dyes and insoluble color lakes.

Antioxidants

Flavoring agents

Opacifiers:

cetyl alcohol.

Emulsifiers/surfactants:

polyethylene glycol ethers;
propylene glycol monoesters.

Preservatives (parabens)

Rouges and Blushers

Powder types

Bodying agents powders:

talc (transparent and regular);
clay;
chalk;
starch; with liquid petrolatum (oily binder) and thickeners such as tragacanth,
mucilage barrier agents such as zinc oxide, zinc stearate.

Perfume

Colorants:

titanium dioxide or titanium dioxide-coated mica pearlizing agents;
red, yellow, or brown iron oxides;
inorganics such as ultramarine blue, pink, and violet;
for vivid shades, organic colors and lakes are used such as carmine,
D&C Red #7, 9, 19, 30.

Preservatives

Liquid or cream types

Bodying agents:

mineral and/or vegetable oils;
lanolin;
stearic acid;
oleic monoglyceride;
beeswax;
cocoa butter.

Color**Fragrances:**

essential oils.

Thickeners:

ethyl cellulose.

Preservatives may also contain:

opacifiers, such as cetyl alcohol;

pH adjusters, such as potassium hydroxide, ammonium hydroxide;

humectants, such as glycerin, sorbitol;

emulsifiers, such as sorbitan sesquioleate, ethyl alcohol.

Face Powder**Powder:**

talc (finely powdered hydrous magnesium silicate).

Vehicles and Texturizers:

polyethylene;

dimethicone (dimethyl polysiloxanes and silica gel);

stearic acid.

Preservatives:

methyl paraben;

propyl paraben;

imidazolidinyl urea.

Antioxidants:

tocopherol.

Pigments/Colors:

(see earlier tables).

Adverse Health Effects Associated With Cosmetics

Typical problems with make-up involve irritations or allergies. Allergic or sensitization reactions may occur to an ingredient resulting from previous sensitization to that chemical or to a structurally similar one. Allergic reactions do not have a typical relationship of dose to response. For allergic reaction to occur, the chemical or a metabolic product of the chemical must combine with a body protein to form an antigen; the body produces antibodies as a result and the antigen-antibody interaction provokes the allergy. For cosmetics, common responses include dermatitis and itching of the skin or inflammation of the eye membranes.

Some problems are isolated incidents, such as products applied to damaged skin or use of weak sensitizers affecting a very small portion of the population. "Hypersensitivity" refers to individuals which are at the low end of the response to dose reaction.

Studies probably show only a fraction of the adverse reactions which actually occur since a consumer who suspects a product is causing a problem will discontinue its use without making a complaint to the FDA or visiting a physician. As a result, reports tend to come from products causing acute, disabling, or chronic dermatoses.

Pre-market testing by manufacturers typically uses animal studies such as the Draize rabbit eye test to screen eye make-up for irritancy or the rabbit ear tests for comedogenicity. However, these tests have limitations. For example, some ingredients cause human skin to form pustules rather than comedones (blackheads). The rabbit ear can only respond with comedones, and thus this could cause an under-reporting of an ingredient's ability to cause pustules.

Common problems or ingredients include:

- Fragrances are often removed when studies indicate irritation or allergic reactions.
- Preservatives may cause adverse reactions, yet the product is used in such a way that microbial contamination readily occurs. Organic mercury is allowed to be used in mascara because of the serious nature of eye infections (especially *Pseudomonas aeruginosa*).
- Residual monomer is often present in incompletely purified polymers.
- Nitrosamine may form due to the presence of 2-nitro-1,3 propanediol.
- Comedogenic effects of oils such as isopropyl myristate and other isopropyl esters and usually related to the concentration of the ingredient. A low level may be safe, but past a threshold of 15% -20%, the formulation may cause comedones in products intended to remain on the skin. If more than one comedogenic ingredient is used in a product, the effects are additive.
- Glycols, especially propylene glycol, are common and should be substituted with butylene glycol or polyethylene glycol (PEG).
- Soap emulsifiers can be irritating.

- Volatile bases can be irritating, such as morpholine, ammonia, 2-amino-methyl-1-propanol.
- Rayon and nylon fibers used in lash-lengthening mascara are irritants, especially for contact lens wearers.
- Allergic reactions to shellac, used as thickener, are common.
- Solvents used in eye make-up can be irritants.
- Irritations may occur from removers for waterproof mascara and eye shadow.

Reactions to eye area cosmetics can be particularly serious.

- Stinging or burning of the eyes and eye lids, usually short-lasting and without obvious irritation; generally caused by the evaporation of volatiles (mineral spirits, isoparaffins, alcohol) or potential irritants (propylene glycol, soap emulsifiers). Sometimes the repeated use of the product produces tolerance to it.

Allergic (so-called) conjunctivitis, not always a delayed hypersensitivity, may be caused by:

- physical irritants - mascara flakes, eye shadow dust, particles of eyeliner, mascara extenders of nylon or rayon fibers
- chemical irritants - solvents, soap emulsifiers
- potential allergens - fragrance, preservatives

Contact dermatitis of the lids and periorbital area is most frequently caused by cosmetics applied to the hair (especially dyes), face, fingernails (especially nail polish); although the reaction may not be produced on these sites. This may also be a reaction to face creams, foundations, and blushers, or the rubber edges or nickel in eyelash curlers. Allergic or irritant contact dermatitis is possible, and may involve make-up removers or treated tissues used for make-up removal. Hypersensitivity may also be caused by preservatives (parabens, imidazolidinyl urea), propylene glycol, antioxidants, and lanolin derivatives.

Infection due to contaminated or inadequately preserved products can cause chronic conjunctivitis and blepharitis (inflammation of the eyelid) due to mascara and eyeliner. Keratitis and corneal ulcers (especially caused by *Pseudomonas aeruginosa*) can cause vision loss, especially where damage to the cornea has occurred by a mascara wand or a fingernail scratch. Besides *Pseudomonas*, other common organisms include *Staphylococcus epidermis*, *Staphylococcus aureus*, and *Fusarium solanae* (a fungus).

Conjunctival pigmentation caused by eyeliner applied to the conjunctival side of the eyelid instead of the exterior lid back of the lashes may sometimes cause discomfort, tearing, and itching, but is usually asymptomatic.

Colors derived from coal tar may be carcinogenic. See above for sensitization reactions to fluorescent colors.

Fragrances cause allergies or skin pigmentation (especially photosensitization, which occurs after exposure to sunlight or tanning lamps). Sensitization can occur from:

- the essential oil itself;
- the fragrant chemical itself (which has been purified or extracted from the oil);
- additives which retard the evaporation of perfumes (such as benzyl salicylate);
- additives used to strengthen the odor (such as the fixative musk ambrette).

Protection and Prevention

Product Substitution

- Consider using products containing vegetable oil derivatives such as propylene glycol caprate or propylene glycol caprylate, octyl palmitate, isostearyl neopentenoate.
- Change preservatives. Reduce the use of products preserved with parabens, formaldehyde or formaldehyde releasers (such as Quaternium-15). Use synergistic blends instead, such as combinations of alcohol, glycols, and phenoxyethanol.
- Consider changing color families; for example, D&C Green No. 5 is an anthraquinone color and is a possible skin irritant. An individual who reacts to one anthraquinone color may react to others of this family.
- Avoid shellac and natural resin containing products due to allergic and spoilage potential.
- Consider changing color types such as mineral colors rather than natural or synthetic colors.
- Consider uncolored products.
- Consider changing fragrance families such as terpenes vs. nonterpenes; or natural vs. synthetic. The terpenes include limonene, geraniol, citronellol, linalool, citral; the nonterpenes include cinnamon oil (cinnamic aldehyde, "oriental bouquets"), clove oil (eugenol, vanillin), coumarin, Balsam of Peru (coniferyl benzoate).
- Avoid soap emulsifiers.
- Avoid propylene glycol; substitute butylene glycol or polyethylene glycol (PEG).
- Consider unscented products; that is, truly unscented products, not those containing masking fragrance.
- Avoid irritating volatile bases such as morpholine, ammonia, 2-amino-methyl-1-propanol.

- Consider using mascara which only colors the lashes, but does not thicken them or extend them using fibers.
- Handle cosmetics carefully to avoid contamination. Do not spit in products to moisten them. Use disposable or washable applicators instead of the fingers.
- Replace products frequently; especially avoid old makeup around the eyes.
- Do not apply products to broken or irritated skin.
- Apply makeup carefully around the eyes; avoid touching the conjunctival membranes.

APPENDIX A

Salon-type Dryers Containing Asbestos*

Name	Model Number
General Electric	
Portable Professional	UH-20 HD-55
Salon Style Speed	HD-30/UH31
Salon Style	HD-56, HD-54, HD-52 HD-51
Salon Style Mist	HD-63/63SS
Super Speed Salon	HD-63SS/5063-008
Salon Style Mist	HD-53
National Presto Industries	
Professional Hood	PP18A
Mist Hood	PP19A, PP19B
Schick Incorporated	
Salon Type	307, 315, 316, 317 320, 321, 322
Hatchet Type	339, 340
Westinghouse Electric Incorporated	
Salon Type	PHD-74-1 PHD-84-1 PHD-94-1

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APPENDIX B

Formaldehyde-Containing Cabinet Fumigants

State Boards of Cosmetology may require that sanitized instruments, combs and appropriate items be stored in closed cabinets containing an effective fumigant. Fumigants based upon formaldehyde are in common use: some are solid tablets of paraformaldehyde, while others are liquids prepared from formalin solutions. Formalin solutions tend to be 37 to 50% aqueous solutions of formaldehyde; if inhibited, formalin typically contains methanol as a polymerization inhibitor.

Adverse Health Effects

Formaldehyde irritates the eyes, respiratory tract and skin. Itching and watering of the eyes, dry and sore throats, sneezing, headaches, disturbed sleep and unusual thirst have also been reported by exposed workers. There is documentation that irritation of the eyes and nose occurs down to 0.5 ppm of formaldehyde in air. The hypersensitive person may be particularly susceptible at low air concentrations of formaldehyde. Inhalation of high concentrations of formaldehyde has caused severe irritation of the respiratory tract; in two instances this has proven fatal. Pulmonary edema and pneumonitis have been reported at air concentrations of 25 to 30 ppm of formaldehyde. Prolonged or repeated exposure may result in respiratory impairment. Some persons may develop asthma or bronchitis following exposure; most often the result of an accidental spill involving a single exposure to a high concentration of formaldehyde.

OSHA, NIOSH and the American Conference of Governmental Industrial Hygienists (ACGIH) consider formaldehyde as having the potential to cause cancer in humans. Formaldehyde exposure has been associated with lung, nasopharynx and oropharynx and nasal passage cancers.

An inhalation study done for periods of up to 24 months on rats and mice concluded that formaldehyde was a carcinogen in rats. This study reported that 3 rats were found to have nasal cavity squamous cell carcinomas after 12 months exposure to 15 ppm of formaldehyde in air. At this level of exposure, a total of 95 nasal cavity carcinomas in rats have been found at the end of 24 months of exposure.

Skin contact with formaldehyde has produced severe skin irritation as well as a white discoloration, smarting, drying, cracking and scaling. Prolonged and repeated contact can cause numbness and a hardening or tanning of the skin. Allergic eczematous dermatitis or hives have been associated with repeated contact with formaldehyde. Formaldehyde solutions splashed in the eye can cause injuries ranging from transient discomfort to severe, permanent corneal clouding and loss of vision. The severity of the effects depends upon the concentration of formaldehyde in the solution and whether or not the eyes are flushed with water immediately after the accident.

The perception of formaldehyde by odor and eye irritation does tend to become less sensitive with time as people can adapt to formaldehyde. This could lead to overexposure if a worker is relying on formaldehyde's warning properties to alert him or her to the potential for exposure.

NIOSH recently reported on an investigation to determine the formaldehyde exposure of cosmetologists by sampling formaldehyde levels in the air in the cosmetology departments of two vocational schools. Three formaldehyde-containing fumigants were evaluated: two were made of solid paraformaldehyde tablets containing 93% and 69% paraformaldehyde, the third fumigant was a liquid prepared from a 37% formalin solution. The results of this investigation are shown below.

Type of fumigant	Room air levels	Air inside cabinets
93% paraformaldehyde tablets	0.014 - 0.038 ppm	0.89 ppm
69% paraformaldehyde tablets	0.011 - 0.015 ppm	1.7 - 2.1 ppm
formalin solution (for 11 minutes while fumigant being prepared)	0.037 - 0.9 ppm	2.9 ppm

OSHA's current formaldehyde standard (29 CFR 1910.1048) and other agencies' recommendations on formaldehyde exposure limits

OSHA PEL	1 ppm as 8-hour TWA 2 ppm as STEL (15 minutes)
NIOSH REL	0.016 ppm as 8-hour TWA 0.1 ppm ceiling (15 minutes)
ACGIH TLV	1 ppm as 8-hour TWA 2 ppm as STEL (15 minutes)

As a result of this study, NIOSH is currently working with several State Boards of Cosmetology to determine if the use of formaldehyde is appropriate for fumigation of towel cabinets and equipment drawers.

For information concerning compliance with the OSHA PEL and STEL for formaldehyde, employers and employees should refer to the following Standard: United States Department Of Labor. OSHA. 29 Code of Federal Regulations 1910.1048 ; Formaldehyde.



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