



# PUBLIC HEALTH STATEMENT

## Formaldehyde

CAS # 50-00-0

**Division of Toxicology and Environmental Medicine**

**September 2008**

This Public Health Statement is the summary chapter from the Toxicological Profile for Formaldehyde. It is one in a series of Public Health Statements about hazardous substances and their health effects. A shorter version, the ToxFAQs™ is also available. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present. For more information, call the ATSDR Information Center at 1-800-232-4636.

This public health statement tells you about formaldehyde and the effects of exposure to it.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites are then placed on the National Priorities List (NPL) and are targeted for long-term federal clean-up activities. Formaldehyde has been found in at least 29 of the 1,699 current or former NPL sites. Although the total number of NPL sites evaluated for this substance is not known, the possibility exists that the number of sites at which formaldehyde is found may increase in the future as more sites are evaluated. This information is important because these sites may be sources of exposure and exposure to this substance may harm you.

When a substance is released either from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. Such a release does not always lead to exposure. You can be exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance, or by skin contact. There are other sources of formaldehyde that may lead to exposure, such as consumer products, that are indicated in the document.

If you are exposed to formaldehyde, many factors will determine whether you will be harmed. These factors include the dose (how much), the duration (how long), and how you come in

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contact with it. You must also consider any other chemicals you are exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

### 1.1 WHAT IS FORMALDEHYDE?

<b>Description</b>	Formaldehyde: <ul style="list-style-type: none"><li>• is a colorless, flammable gas at room temperature,</li><li>• has a pungent, distinct odor, and</li><li>• may cause a burning sensation to the eyes, nose, and lungs at high concentrations.</li></ul>
<b>Sources</b>	Formaldehyde is a gaseous pollutant produced by both human activity and natural sources. <ul style="list-style-type: none"><li>• Combustion processes account directly or indirectly for most of the formaldehyde entering the environment.</li><li>• Large amounts are produced in the United States during manufacturing processes and as components of many end-use products.</li><li>• Small amounts are produced naturally by plants, animals, and humans.</li></ul> Formaldehyde can mostly be found in the air. <ul style="list-style-type: none"><li>• Outdoor air releases include:<ul style="list-style-type: none"><li>○ power plants,</li><li>○ manufacturing facilities, and</li><li>○ automobile exhausts.</li></ul></li><li>• Indoor air releases include:<ul style="list-style-type: none"><li>○ building materials,</li><li>○ consumer products, and</li><li>○ tobacco smoke.</li></ul></li></ul> Formaldehyde can also be found in rain water and surface water after release from the manufacture, use, and disposal of formaldehyde-based products.

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<b>Uses</b> <ul style="list-style-type: none"><li>• <b>Manufacturing</b></li><li>• <b>Consumer products</b></li></ul>	<p>Formaldehyde is widely used to make resins for wood products.</p> <p>Consumer products containing formaldehyde include (IARC 2006):</p> <ul style="list-style-type: none"><li>• antiseptics and cleaning agents,</li><li>• carpets and permanent press fabrics,</li><li>• cigarettes,</li><li>• cosmetics,</li><li>• fertilizers,</li><li>• insulation for electrical uses (i.e., wiring and appliances),</li><li>• manufactured wood products (i.e., furniture, plywood, particle-board),</li><li>• medicines and vitamins,</li><li>• paints and varnishes, and</li><li>• preserved foods.</li></ul> <p>These consumer oriented products mainly contain aqueous solutions of formaldehyde.</p>
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### 1.2 WHAT HAPPENS TO FORMALDEHYDE WHEN IT ENTERS THE ENVIRONMENT?

<b>Break down</b> <ul style="list-style-type: none"><li>• <b>Air</b></li><li>• <b>Water and soil</b></li></ul>	<p>Formaldehyde is quickly broken down in the air, usually within hours.</p> <p>Formaldehyde in water may be broken down by bacteria or other microorganisms.</p> <p>Formaldehyde evaporates from shallow soils.</p>
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**1.3 HOW MIGHT I BE EXPOSED TO FORMALDEHYDE?**

<p><b>Air—primary source of exposure</b></p>	<p>The primary way you can be exposed to formaldehyde is by breathing air containing it. Releases of formaldehyde into the air occur from:</p> <ul style="list-style-type: none"> <li>• industries using or manufacturing formaldehyde,</li> <li>• wood products (i.e. particle-board, plywood, furniture),</li> <li>• automobile exhaust,</li> <li>• cigarette smoke,</li> <li>• paints and varnishes, and</li> <li>• carpets and permanent press fabrics.</li> </ul> <p>Rural or suburban air generally contains lower concentrations of formaldehyde than urban air. Indoor air often contains higher levels of formaldehyde than outdoor air. Examples of concentrations of formaldehyde:</p> <ul style="list-style-type: none"> <li>• 0.0002–0.006 parts per million (ppm) in rural and suburban outdoor air</li> <li>• 0.0015–0.047 ppm in urban outdoor air</li> <li>• 0.020–4 ppm in indoor air</li> </ul> <p>A ppm in air represents the fraction of volume of air occupied by formaldehyde. 1 ppm is equivalent to 1 unit volume of formaldehyde per 1,000,000 units of air.</p>
<p><b>Workplace air</b></p>	<p>A large number of workers are potentially exposed to formaldehyde.</p> <ul style="list-style-type: none"> <li>• The highest potential exposure occurs in the formaldehyde-based resins industry, where workers may be exposed to high air concentrations and also have dermal exposure from liquid formaldehyde.</li> <li>• Other types of employees at risk for exposure to formaldehyde include:             <ul style="list-style-type: none"> <li>○ dentists,</li> <li>○ doctors,</li> <li>○ embalmers,</li> <li>○ nurses,</li> <li>○ pathologists,</li> <li>○ teachers and students who handle preserved specimens in laboratories,</li> <li>○ veterinarians, and</li> <li>○ workers in the clothing industry or in furniture factories.</li> </ul> </li> </ul>
<p><b>Water and soil</b></p>	<p>Formaldehyde is occasionally detected in rain water and fogwater.</p> <p>Formaldehyde has not been detected in soils, likely due to its high removal rate when released to soils.</p>

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<b>Food</b>	Low levels of formaldehyde occur naturally in a variety of foods, such as fruits. Food may contain small amounts of formaldehyde from its use as a fumigant, fertilizer, or preservative.
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### 1.4 HOW CAN FORMALDEHYDE ENTER AND LEAVE MY BODY?

<b>Enter your body</b> <ul style="list-style-type: none"><li>• <b>Inhalation</b></li><li>• <b>Ingestion</b></li><li>• <b>Dermal contact</b></li></ul>	<p>When you breathe air containing formaldehyde, most of the formaldehyde is quickly broken down in the cells lining your respiratory tract and breathed out. Only at high levels does formaldehyde enter your blood.</p> <p>Formaldehyde in food or water may also rapidly enter your body through the digestive tract.</p> <p>A very small amount may enter through your skin when you come into contact with liquids containing formaldehyde.</p>
<b>Leave your body</b>	<p>Once in your body, formaldehyde is rapidly broken down into other chemicals.</p> <p>Most of these other chemicals quickly leave your body in the urine.</p> <p>Formaldehyde can also be converted to carbon dioxide and breathed out of the body.</p>

### 1.5 HOW CAN FORMALDEHYDE AFFECT MY HEALTH?

This section looks at studies concerning potential health effects in animal and human studies. Formaldehyde is a highly reactive molecule that can be directly irritating to tissues with which it comes into contact. Human and animal studies indicate that formaldehyde, at certain exposure levels, can be irritating to the upper respiratory tract and eyes with inhalation exposure, to the skin with dermal exposure, and to the gastrointestinal tract with oral exposure. Formaldehyde-induced noncancer and cancer effects appear to occur only at portals-of-entry (i.e., upper respiratory tract, gastrointestinal tract, and skin). Figure 1-1 illustrates the health effects of breathing formaldehyde in humans and laboratory animals and the range of air concentrations at

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which these effects were seen. Estimates of exposure levels posing minimal risk to humans (MRLs) are also presented in the figure. An MRL is an estimate of the daily human exposure that is likely to be safe over a certain period of exposure. MRLs are not intended to define clean-up or action levels, but are intended only to serve as a screening tool to help public health professionals decide where to look more closely. Therefore, MRLs are set at levels well below where effects have been observed. Figure 1-2 shows the health effects of formaldehyde ingestion in laboratory animals and the dose ranges at which these effects occur. Estimates of oral dose levels posing minimal risk to humans (MRLs) are also presented in Figure 1-2.

<p><b>Workers and residents</b></p> <ul style="list-style-type: none"> <li>• <b>Inhalation</b></li> </ul>	<p>The most common health problems in people exposed to formaldehyde include irritation of the eyes, nose, and throat.</p> <p>Formaldehyde may cause occupational asthma, but this seems to be rare.</p>
<p><b>Laboratory animals</b></p> <ul style="list-style-type: none"> <li>• <b>Inhalation</b></li>       <li>• <b>Oral</b></li> </ul>	<p>Animal studies have shown that inhalation of formaldehyde can result in irritation and damage to the lining of the nose and throat. High concentrations can also affect the lung.</p> <p>Impaired learning and changes in behavior have been observed in rats after high concentrations of formaldehyde.</p> <p>Stomach damage has been observed in rats exposed to high oral doses of formaldehyde.</p>
<p><b>Cancer</b></p>	<p>Some studies of humans exposed repeatedly to formaldehyde in workplace air found more cases of nose and throat cancer than expected. Animal studies of laboratory rats exposed for life to formaldehyde in air found that some rats developed nose cancer.</p> <p>The Department of Health and Human Services (DHHS) and the International Agency for Research on Cancer (IARC) have characterized formaldehyde as a human carcinogen based on studies of inhalation exposure in humans and laboratory animals.</p>

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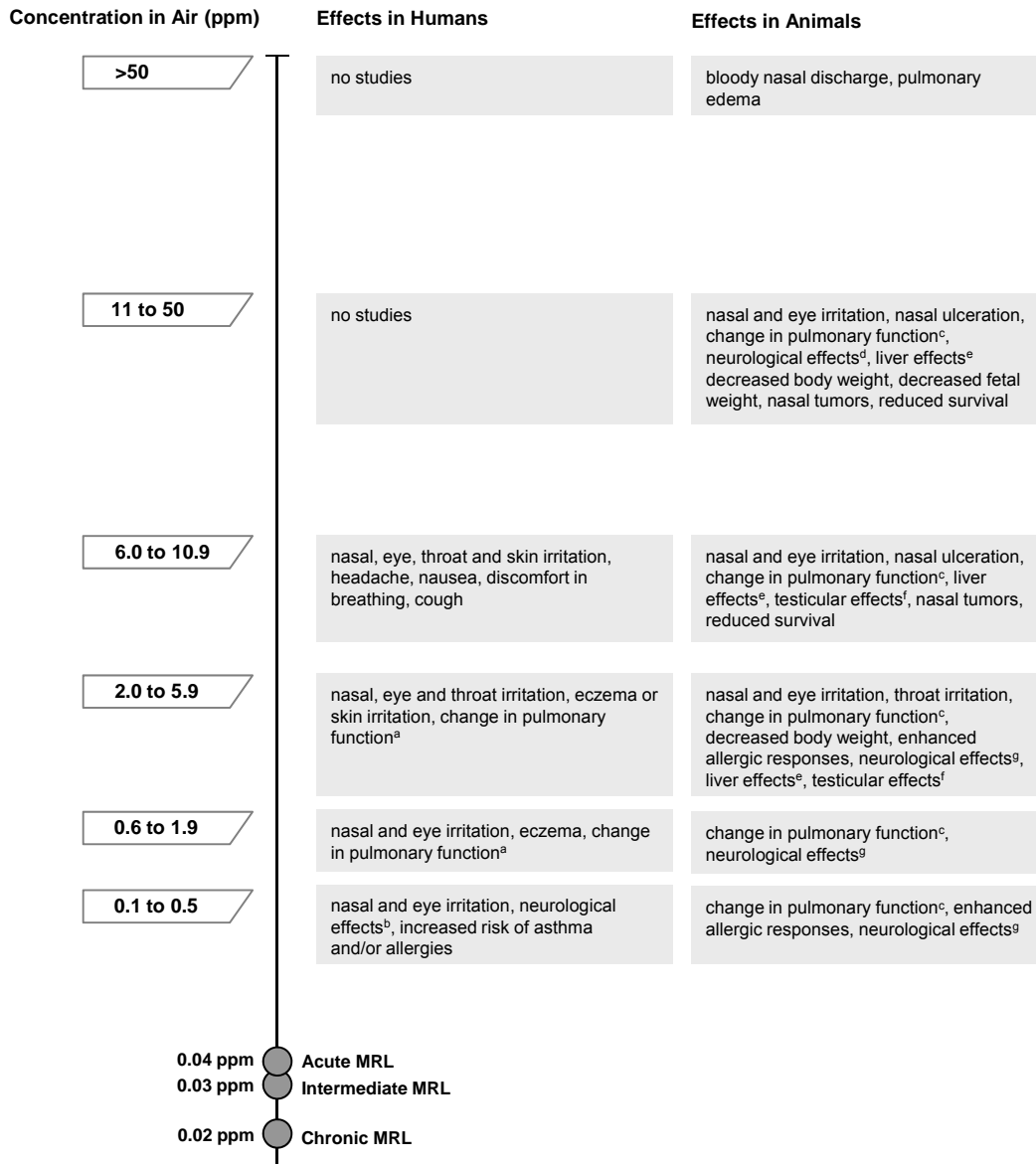
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**Figure 1-1. Health Effects of Breathing Formaldehyde**



<sup>a</sup>changes in pulmonary variables from spirometry testing (FEV, FVC)

<sup>b</sup>decreased performance on short-term memory tests

<sup>c</sup>decrease breathing rate and/or increased airway resistance

<sup>d</sup>listlessness, hunched appearance, uncoordinated movement, ataxia

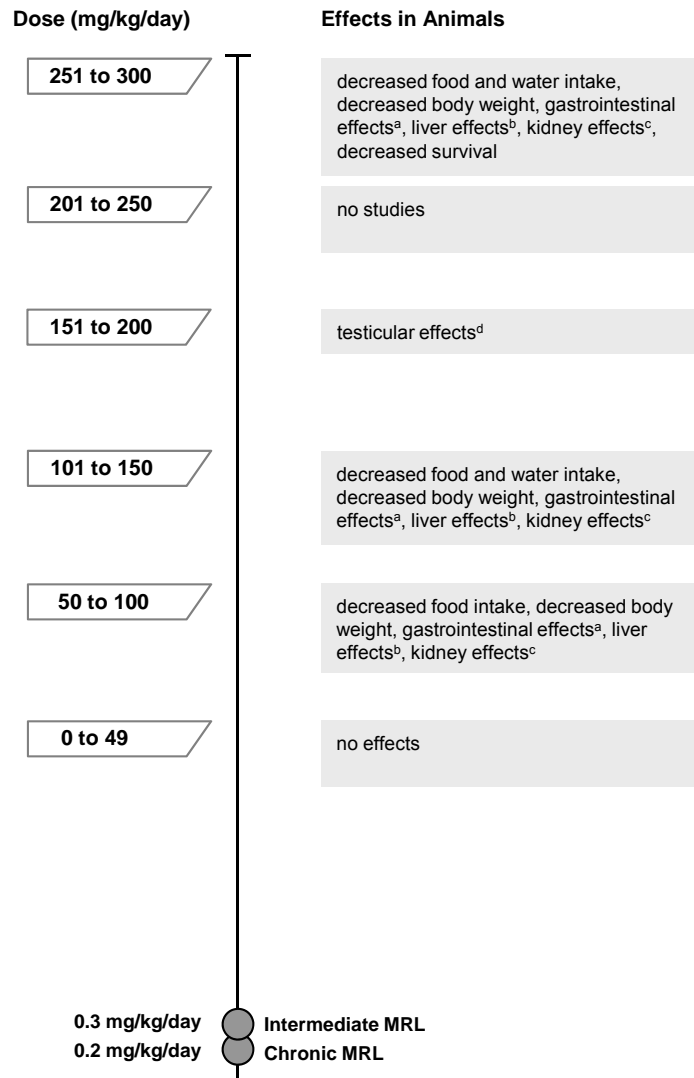
<sup>e</sup>altered serum biochemistry and/or liver histopathology

<sup>f</sup>decreased testicular weight, testicular atrophy, altered sperm motility/morphology, decreased serum testosterone, decreased diameter of seminiferous tubules

<sup>g</sup>decreased motor activity, altered open field behavior, impaired learning and memory

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**Figure 1-2. Health Effects of Ingesting Formaldehyde**



<sup>a</sup>erosions and ulcers, histopathological changes

<sup>b</sup>altered serum biochemistry and histopathology

<sup>c</sup>occult blood, changes in urine density and volume, kidney weight and histopathology

<sup>d</sup>altered sperm morphology





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### 1.6 HOW CAN FORMALDEHYDE AFFECT CHILDREN?

This section discusses potential health effects in humans from exposures during the period from conception to maturity at 18 years of age. Children are not small adults. They differ from adults in their exposures and may differ in their susceptibility to hazardous chemicals. Children's unique physiology and behavior can influence the extent of their exposure.

<b>Effects in children</b>	<p>A small number of studies have looked at the health effects of formaldehyde in children. It is very likely that breathing formaldehyde will result in nose and eye irritation (burning feeling, itchy, tearing, and sore throat). We do not know if the irritation would occur at lower concentrations in children than in adults.</p> <p>There is some evidence of asthma or asthma-like symptoms for children exposed to formaldehyde in homes.</p>
<b>Birth defects</b>	<p>Studies in animals suggest that formaldehyde will not cause birth defects in humans.</p>

### 1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO FORMALDEHYDE?

<b>Avoid tobacco smoke</b>	<p>Formaldehyde is a component of tobacco smoke.</p> <p>Avoid smoking in enclosed spaces such as inside the home or car in order to limit exposure to children and other family members.</p>
<b>Keep house ventilated</b>	<p>Formaldehyde is released into indoor air from construction materials and a variety of consumer products.</p> <ul style="list-style-type: none"><li>• Formaldehyde levels can be reduced by bringing fresh air into the home.</li><li>• Limit the use of pressed wood in homes or seal uncovered pressed wood products.</li><li>• Families should keep houses well ventilated by opening windows or using ventilation fans when levels are known to be high.</li></ul>

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<b>Wash new clothes</b>	Some permanent press fabrics emit formaldehyde.  • Washing these new clothes before wearing them will usually lower the amount of formaldehyde released from permanent press fabrics and reduce exposure to families.
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### 1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO FORMALDEHYDE?

Scientists use many tests to protect the public from harmful effects of toxic chemicals and to find ways for treating persons who have been harmed.

<b>Detecting exposure</b>	Formaldehyde cannot be reliably measured in blood, urine, or body tissues following exposure. Formaldehyde is produced in the body and would be present as a normal constituent in body tissues.
<b>Measuring exposure</b>	Antibodies to formaldehyde-bound proteins can be found in the blood of people exposed to formaldehyde; however, this test cannot be used to determine the extent of exposure or the kind of health effects that might develop from exposure.

### 1.9 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations *can* be enforced by law. The EPA, the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA) are some federal agencies that develop regulations for toxic substances. Recommendations provide valuable guidelines to protect public health, but *cannot* be enforced by law. The Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH) are two federal organizations that develop recommendations for toxic substances.

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Regulations and recommendations can be expressed as “not-to-exceed” levels, that is, levels of a toxic substance in air, water, soil, or food that do not exceed a critical value that is usually based on levels that affect animals; they are then adjusted to levels that will help protect humans.

Sometimes these not-to-exceed levels differ among federal organizations because they used different exposure times (an 8-hour workday or a 24-hour day), different animal studies, or other factors.

Recommendations and regulations are also updated periodically as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for formaldehyde include the following:

<b>Drinking water</b>	<p>The EPA has determined that lifetime exposure to 1 ppm formaldehyde in drinking water is not expected to cause any adverse effects.</p> <p>The EPA has also determined that exposure to formaldehyde in drinking water at concentrations of 10 parts per million (ppm) for 1 day or 5 ppm for 10 days is not expected to cause any adverse effects in a child.</p>
<b>Workplace air</b>	<p>OSHA set a legal limit of 0.75 ppm formaldehyde in air averaged over an 8-hour work day.</p> <p>The U.S. Department of Housing and Urban Development (HUD) set standards for formaldehyde emissions in manufactured housing of less than 0.2 ppm for plywood and 0.3 ppm for particle board. The HUD standards are designed to provide an ambient level of 0.4 ppm or less in manufactured housing.</p>

### 1.10 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department, or contact ATSDR at the address and phone number below.

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ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses that result from exposure to hazardous substances.

Toxicological profiles are also available on-line at [www.atsdr.cdc.gov](http://www.atsdr.cdc.gov) and on CD-ROM. You may request a copy of the ATSDR ToxProfiles™ CD-ROM by calling the toll-free information and technical assistance number at 1-800-CDCINFO (1-800-232-4636), by e-mail at [cdcinfo@cdc.gov](mailto:cdcinfo@cdc.gov), or by writing to:

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1600 Clifton Road NE  
Mailstop F-32  
Atlanta, GA 30333  
Fax: 1-770-488-4178

Organizations for-profit may request copies of final Toxicological Profiles from the following:

National Technical Information Service (NTIS)  
5285 Port Royal Road  
Springfield, VA 22161  
Phone: 1-800-553-6847 or 1-703-605-6000  
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