

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR CRESOL, ALL ISOMERS

INTRODUCTION

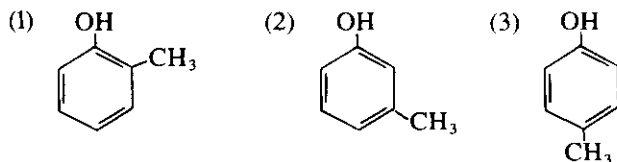
This guideline summarizes pertinent information about the three isomers of cresol (ortho-, meta-, and para-cresol) for workers, employers, and occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; therefore, readers are advised to regard these recommendations as general guidelines. Throughout this guideline, the term "cresol" refers to any of the three isomers.

SUBSTANCE IDENTIFICATION

Data in the following section are presented for the three isomers of cresol: (1) ortho; (2) meta; (3) para. If unspecified, data apply to all three isomers.

• **Formula:** C₇H₈O

• **Structure:**



• **Synonyms:** (1) o-Cresol; 2-cresol; o-cresylic acid; 1-hydroxy-2-methylbenzene; o-hydroxy toluene; (2) m-Cresol; 3-cresol; m-cresylic acid; 1-hydroxy-3-methylbenzene; m-hydroxy toluene; 3-hydroxy toluene; (3) p-Cresol; 4-cresol; p-cresylic acid; 1-hydroxy-4-methylbenzene; p-hydroxy toluene; 4-hydroxy toluene

• **Identifiers:** (1) CAS 95-48-7; RTECS G06300000; DOT 2076; (2) CAS 108-39-4; RTECS G06125000; DOT 2076; (3) CAS 106-44-5; RTECS G06475000; DOT 2076; DOT label required for all isomers: "Poison"

• **Appearance and odor:** Colorless crystals or liquid with an odor like phenol or creosote

CHEMICAL AND PHYSICAL PROPERTIES

Data in the following section are presented for the three isomers of cresol: (1) ortho; (2) meta; (3) para. If unspecified, data apply to all three isomers.

• Physical data

1. Molecular weight: 108.13
2. Boiling point (at 760 mmHg): (1) 191°C (376°F); (2) 202.7°C (397°F); (3) 201.9°C (395°F)
3. Specific gravity (water = 1): (1) 1.048; (2) 1.034; (3) 1.035
4. Vapor density (air = 1 at boiling point of cresol): 3.72
5. Melting point: (1) 30.9°C (87.8°F); (2) 12.0°C (49°F); (3) 34.8°C (95°F)
6. Vapor pressure at 25°C (77°F): (1) 0.25 mmHg; (2) 0.15 mmHg; (3) 0.11 mmHg
7. Solubility in water, g/100 g water at 25°C (77°F): (1) 2.5; (2) 2.2; (3) 1.9
8. Evaporation rate (butyl acetate = 1): (1) 0.025; (2) 0.015; (3) 0.011
9. Saturation concentration in air (approximate) at 25°C (77°F): (1) 0.03% (300 ppm); (2) 0.02% (200 ppm); (3) 0.014% (140 ppm)
10. Ionization potential: (1) 8.93 eV; (2) 8.98 eV; (3) 8.97 eV

• Reactivity

1. Incompatibilities: Strong oxidizing agents, alkalis, and heat.
2. Hazardous decomposition products: Toxic vapors and gases (e.g., carbon monoxide and formaldehyde) may be released in a fire involving cresol.
3. Caution: Liquid cresol will attack some forms of plastics, coatings, and rubber.

• Flammability

1. Flash point: (1) 81.1°C (178°F) (closed cup); (2) 86.1°C (187°F) (closed cup); (3) 86.1°C (187°F) (closed cup)
2. Autoignition temperature: (1) 559°C (1040°F); (2) 626°C (1158°F); (3) 559°C (1040°F)
3. Flammable limits in air, % by volume: (1) Lower, 1.4 at 149°C (300°F); upper, not available; (2) lower, 1.1 at 150°C (302°F); upper, not available; (3) lower, 1.1 at 150°C (302°F); upper, not available
4. Extinguishant: Dry chemical, foam, or carbon dioxide
5. Class IIIA Combustible Liquid (29 CFR 1910.106), Flammability Rating 2 (NFPA)

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health
Division of Standards Development and Technology Transfer

• Warning properties

1. Odor threshold: Less than 1 ppm
2. Evaluation of warning properties for respirator selection: Because of its odor, cresol can be detected below the National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL); thus, cresol is treated as a chemical with adequate warning properties.

EXPOSURE LIMITS

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for cresol is 5 parts of cresol per million parts of air (ppm) [22 milligrams of cresol per cubic meter of air (mg/m³)] as a time-weighted average (TWA) concentration over an 8-hour workshift (Skin). The notation "Skin" refers to the potential contribution to overall exposure by the cutaneous route including mucous membranes and eyes. The NIOSH REL is 2.3 ppm (10 mg/m³) as a TWA for up to a 10-hour workshift, 40-hour workweek. The American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV[®]) is 5 ppm (22 mg/m³) (Skin) as a TWA for a normal 8-hour workday and a 40-hour workweek (Table 1).

Table 1.—Occupational exposure limits for cresol (all isomers)

| | Exposure limits | |
|-----------------------------------|-----------------|-------------------|
| | ppm | mg/m ³ |
| OSHA PEL TWA (Skin)* | 5 | 22 |
| NIOSH REL TWA | 2.3 | 10 |
| ACGIH TLV [®] TWA (Skin) | 5 | 22 |

* (Skin): Potential contribution to overall exposure by the cutaneous route including mucous membranes and eyes.

HEALTH HAZARD INFORMATION

• Routes of exposure

Cresol may cause adverse health effects following exposure via inhalation, ingestion, or dermal or eye contact.

• Summary of toxicology

1. *Effects on animals*: In rats and rabbits, acute dermal absorption of cresol caused tremors, convulsions, fluid in the lungs, liver injury, and kidney inflammation; oral administration caused gastrointestinal tract inflammation, pneumonia, injury to the liver and kidneys, convulsions, and coma. Chronic inhalation of cresol by rats and mice produced inflammation and fluid accumulation in the airways, damage to the bone marrow, and degeneration of cells in the brain.
2. *Effects on humans*: Acute exposure to cresol has caused alterations in brain function and death due to respiratory failure. Repeated exposure by any route has produced nervous disor-

ers, fluid in the lungs, and death due to severe damage to the liver, kidneys, pancreas, or spleen.

• Signs and symptoms of exposure

1. *Short-term (acute)*: Exposure to cresol can cause muscular weakness, nausea, vomiting, abdominal pain, headache, dizziness, dimness of vision, ringing in the ears, weak pulse, rapid and labored breathing, fainting, and mental confusion and depression. Skin irritation and burns can also occur. Eye contact with cresol can cause extensive damage and blindness.
2. *Long-term (chronic)*: Exposure to cresol can cause difficulty in swallowing, vomiting, salivation, loss of appetite, and diarrhea. Skin eruptions, rash, and dermatitis can also occur.

RECOMMENDED MEDICAL PRACTICES

• Medical surveillance program

Workers with potential exposures to chemical hazards should be monitored in a systematic program of medical surveillance intended to prevent or control occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety and health, earliest possible detection of adverse health effects, and referral of workers for diagnostic confirmation and treatment. The occurrence of disease (a "sentinel health event," SHE) or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical surveillance program is intended to supplement, not replace, such measures.

A medical surveillance program should include systematic collection and epidemiologic analysis of relevant environmental and biologic monitoring, medical screening, morbidity, and mortality data. This analysis may provide information about the relatedness of adverse health effects and occupational exposure that cannot be discerned from results in individual workers. Sensitivity, specificity, and predictive values of biologic monitoring and medical screening tests should be evaluated on an industry-wide basis prior to application in any given worker group. Intrinsic to a surveillance program is the dissemination of summary data to those who need to know, including employers, occupational health professionals, potentially exposed workers, and regulatory and public health agencies.

• Preplacement medical evaluation

Prior to placing a worker in a job with a potential for exposure to cresol, the physician should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the eyes, skin, liver, kidneys, and respiratory and central nervous systems. Medical surveillance for respiratory disease should be conducted by using the principles and methods recommended by NIOSH and the American Thoracic Society (ATS).

A preplacement medical evaluation is recommended in order to detect and assess preexisting or concurrent conditions which may be aggravated or result in increased risk when a worker is exposed to cresol at or below the NIOSH REL. The examining physician should consider the probable frequency, intensity, and duration of exposure, as well as the nature and degree of the condition, in placing such a worker. Such conditions, which should not be regarded as absolute contraindications to job placement, include historical and physical or laboratory findings consistent with chronic diseases of the skin or liver. In addition to the medical interview and physical examination, the means to identify these conditions may include serologic screening tests of liver function and markers for hepatitis A or B infection.

- **Periodic medical screening and/or biologic monitoring**

Occupational health interviews and physical examinations should be performed at regular intervals. Additional examinations may be necessary should a worker report symptoms that may be attributed to exposure to cresol. The interviews, examinations, and appropriate medical screening and/or biologic monitoring tests should be directed at identifying an excessive decrease or adverse trend in the integrity or physiologic function of the eyes, skin, liver, kidneys, and respiratory and central nervous systems as compared to the baseline status of the individual worker or to expected values for a suitable reference population. Liver function tests should be used and interpreted according to standardized epidemiologic procedures and evaluation criteria.

The following tests should be used and interpreted according to standardized procedures and evaluation criteria recommended by NIOSH and ATS: standardized questionnaires and tests of lung function.

- **Medical practices recommended at time of job transfer or termination**

The medical, environmental, and occupational history interviews, the physical examination, the selected physiologic and laboratory tests which were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared to those expected for a suitable reference population. Because occupational exposure to cresol may cause diseases of prolonged induction-latency, the need for medical surveillance may extend well beyond termination of employment.

- **Sentinel health events**

Acute and delayed-onset SHE's include toxic hepatitis.

MONITORING AND MEASUREMENT PROCEDURES

- **TWA exposure evaluation**

Measurements to determine worker exposure to cresol should be taken so that the TWA exposure is based on a single entire workshift sample or an appropriate number of consecutive samples collected during the entire workshift. Under certain conditions, it may be appropriate to collect several short-term interval samples (up to 30 minutes each) to determine the aver-

age exposure level. Air samples should be taken in the worker's breathing zone (air that most nearly represents that inhaled by the worker).

- **Method**

Sampling and analysis may be performed by collecting cresol with silica gel tubes followed by desorption with acetone and analysis by gas chromatography. Detector tubes or other direct-reading devices calibrated to measure cresol may also be used if available. A detailed sampling and analytical method for cresol may be found in the *NIOSH Manual of Analytical Methods* (method number 2001).

PERSONAL PROTECTIVE EQUIPMENT

Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions.

Workers should be provided with and required to use CPC, gloves, face shields (8-inch minimum), and other appropriate protective clothing necessary to prevent skin contact with cresol.

Workers should be provided with and required to use dust- and splash-proof safety goggles where cresol may come in contact with the eyes.

SANITATION

Clothing which is contaminated with cresol should be removed immediately and placed in closed containers for storage until it can be discarded or until provision is made for the removal of cresol from the clothing. If the clothing is to be laundered or cleaned, the person performing the operation should be informed of cresol's hazardous properties.

Change and shower rooms should be provided with separate locker facilities for street and work clothes.

Skin that becomes contaminated with cresol should be promptly washed with soap and water.

The storage, preparation, dispensing, or consumption of food or beverages, the storage or application of cosmetics, the storage or smoking of tobacco or other smoking materials, or the storage or use of products for chewing should be prohibited in work areas.

Workers who handle cresol should wash their faces, hands, and forearms thoroughly with soap and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

Common operations in which exposure to cresol may occur and control methods which may be effective in each case are listed in Table 2.

Table 2.—Operations and methods of control for cresol

| Operations | Controls |
|---|--|
| During use in the manufacture of antiseptics and disinfectants, phosphate esters, antioxidants, resins, herbicides, perfumes, explosives, and photographic developers | Process enclosure, general dilution ventilation, personal protective equipment |
| During use as a solvent and as an engine and metal cleaner; during use in the textile industry | Process enclosure, general dilution ventilation, personal protective equipment |

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, remove the victim from further exposure, send for medical assistance, and initiate emergency procedures.

• Eye exposure

Where there is any possibility of a worker's eyes being exposed to cresol, an eyewash fountain should be provided within the immediate work area for emergency use.

If cresol gets into the eyes, flush them immediately with large amounts of water for 15 minutes, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

• Skin exposure

Where there is any possibility of a worker's body being exposed to cresol, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

If cresol gets on the skin, wash it immediately with soap and water. If cresol penetrates the clothing, remove the clothing immediately and wash the skin with soap and water.

• Rescue

If a worker has been incapacitated, move the affected worker from the hazardous exposure. Put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILLS AND LEAKS

Workers not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

If cresol is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.

3. For small quantities of liquids containing cresol, absorb on paper towels and place in an appropriate container. Place towels in a safe place such as a fume hood for evaporation. Allow sufficient time for evaporation of the vapors so that the hood ductwork is free from cresol vapors. Burn the paper in a suitable location away from combustible materials.

4. Large quantities of liquids containing cresol may be absorbed in vermiculite, dry sand, earth, or a similar material and placed in an appropriate container. Cresol should not be allowed to enter a confined space such as a sewer because of the possibility of an explosion.

5. Liquids containing cresol may be collected by vacuuming with an appropriate system. If a vacuum system is used, there should be no sources of ignition in the vicinity of the spill, and flashback prevention devices should be provided.

WASTE REMOVAL AND DISPOSAL

U.S. Environmental Protection Agency, Department of Transportation, and/or state and local regulations shall be followed to assure that removal, transport, and disposal are in accordance with existing regulations.

RESPIRATORY PROTECTION

It must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or minimizing exposure during routine operations. However, there are some exceptions for which respirators may be used to control exposure: when engineering and work practice controls are not technically feasible, when engineering controls are in the process of being installed, or during emergencies and certain maintenance operations, including those requiring confined-space entry (Table 3).

In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards, 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including selection of the correct respirators, requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly.

Only respirators that have been approved by the Mine Safety and Health Administration (MSHA, formerly Mining Enforcement and Safety Administration) and by NIOSH should be used. **Remember! Air-purifying respirators will not protect from oxygen-deficient atmospheres.**

For each level of respiratory protection, only those respirators that have the minimum required protection factor and meet other use restrictions are listed. All respirators that have higher protection factors may also be used.

BIBLIOGRAPHY

- American Conference of Governmental Industrial Hygienists: "Cresol," *Documentation of the Threshold Limit Values and Biological Exposure Indices* (5th ed.), Cincinnati, 1986.
- American Conference of Governmental Industrial Hygienists: *TLVs® Threshold Limit Values and Biological Exposure Indices for 1987-88*, Cincinnati, 1987.
- American Industrial Hygiene Association: "Cresol" (rev. 1978), *Hygienic Guide Series*, Detroit, 1978.
- American Lung Association of San Diego and Imperial Counties: "Taking the Occupational History," *Annals of Internal Medicine*, 99:641-651, November 1983.
- Clayton, G.D., and Clayton, F.E. (eds.): *Toxicology*, Vol. IIA of *Patty's Industrial Hygiene and Toxicology* (3rd rev. ed.), John Wiley & Sons, Inc., New York, 1981.
- *Code of Federal Regulations*, U.S. Department of Labor, Occupational Safety and Health Administration, 29 CFR 1910.106, 1910.134, 1910.1000, OSHA 2206, revised July 1, 1986.
- *Code of Federal Regulations*, U.S. Department of Transportation, 49 CFR 172.101, Transportation 49, revised October 1, 1982.
- Finkel, A.J. (ed.): *Hamilton and Hardy's Industrial Toxicology* (4th ed.), John Wright—PSG Inc., Boston, 1983.
- Goldman, R.H., and Peters, J.M.: "The Occupational and Environmental Health History," *Journal of the American Medical Association*, 246:2831-2836, 1981.
- Grant, W.M.: *Toxicology of the Eye* (2nd ed.), Charles C. Thomas, Springfield, Illinois, 1974.
- Halperin, W.E., Ratcliffe, J., Frazier, T.M., Wilson, L., Becker, S.P., and Shulte, P.A.: "Medical Screening in the Workplace: Proposed Principles," *Journal of Occupational Medicine*, 28(8):547-552, 1986.
- Hankinson, J.L.: "Pulmonary Function Testing in the Screening of Workers: Guidelines for Instrumentation, Performance, and Interpretation," *Journal of Occupational Medicine*, 28(10):1081-1092, 1986.
- Hawley, G.G.: *The Condensed Chemical Dictionary* (10th ed.), Litton Educational Publishing, Inc., New York, 1981.
- Leidel, N.A., Busch, K.A., and Lynch, J.R.: *Occupational Exposure Sampling Strategy Manual*, U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-173, Cincinnati, 1977.
- Levy, B.S., and Wegman, D.H. (eds.): *Occupational Health: Recognizing and Preventing Work-Related Disease*, Little, Brown and Company, Boston, 1983.
- Mark, H.F., Othmer, D.F., Overberger, C.G., Seaborg, G.T., Grayson, M., and Eckroth, D. (eds.): *Kirk-Othmer Encyclopedia of Chemical Technology* (3rd ed.), John Wiley & Sons, Inc., New York, 1981.
- National Fire Protection Association: *National Fire Codes®* (Vol. 13), Quincy, Massachusetts, 1983.
- National Institute for Occupational Safety and Health: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control: *Criteria for a Recommended Standard. . . Occupational Exposure to Cresol*, DHEW (NIOSH) Publication No. 78-133, Cincinnati, 1978.
- National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control: *NIOSH Manual of Analytical Methods* (3rd ed., Vol. 1), Eller, P.M. (ed.), DHHS (NIOSH) Publication No. 84-100, Cincinnati, 1984.
- National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control: *Registry of Toxic Effects of Chemical Substances* (Microfiche Edition), Sweet, D.V., and Lewis, R.J. (eds.), Cincinnati, April 1985.
- Proctor, N.H., and Hughes, J.P.: *Chemical Hazards of the Workplace*, J.B. Lippincott Company, Philadelphia, 1978.
- Rom, W.N. (ed.): *Environmental and Occupational Medicine*, Little, Brown and Company, Boston, 1983.
- Rothstein, M.A.: *Medical Screening of Workers*, Bureau of National Affairs, Washington, DC, 1984.
- Rutstein, D.D., Mullan, R.J., Frazier, T.M., Halperin, W.E., Melius, J.M., and Sestito, J.P.: "Sentinel Health Events (Occupational): A Basis for Physician Recognition and Public Health Surveillance," *American Journal of Public Health*, 73:1054-1062, 1983.
- Scientific Assembly on Environmental and Occupational Health: "Evaluation of Impairment/Disability Secondary to Respiratory Disease," *American Review of Respiratory Diseases*, 126:945-951, 1982.
- Scientific Assembly on Environmental and Occupational Health: "Surveillance for Respiratory Hazards in the Occupational Setting," *American Review of Respiratory Diseases*, 126:952-956, 1982.

Table 3.—Respiratory protection for cresol (all isomers)

| Condition | Minimum respiratory protection*† |
|--|---|
| Concentration: | |
| Less than or equal to 23 ppm | <p>Any chemical cartridge respirator with organic vapor cartridge(s) in combination with a dust and mist filter</p> <p>Any supplied-air respirator</p> <p>Any self-contained breathing apparatus</p> |
| Less than or equal to 57.5 ppm | <p>Any supplied-air respirator operated in a continuous flow mode</p> <p>Any powered air-purifying respirator with organic vapor cartridge(s) in combination with a dust and mist filter</p> |
| Less than or equal to 115 ppm | <p>Any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter</p> <p>Any supplied-air respirator with a full facepiece</p> <p>Any self-contained breathing apparatus with a full facepiece</p> <p>Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister having a high-efficiency particulate filter</p> <p>Any powered air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter (substance reported to cause eye irritation or damage—may require eye protection)</p> <p>Any supplied-air respirator with a tight-fitting facepiece operated in a continuous flow mode (substance reported to cause eye damage—may require eye protection)</p> |
| Less than or equal to 250 ppm | <p>Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode</p> |
| Planned or emergency entry into environments containing unknown concentrations or levels above 250 ppm | <p>Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode</p> <p>Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode</p> |
| Firefighting | <p>Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode</p> |
| Escape only | <p>Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister having a high-efficiency particulate filter</p> <p>Any appropriate escape-type self-contained breathing apparatus</p> |

* Only NIOSH/MSHA-approved equipment should be used.

†The respiratory protection listed for any given condition is the minimum required to meet the NIOSH REL of 2.3 ppm (10 mg/m³) (TWA).