

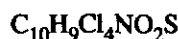
OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR CAPTAFOL

INTRODUCTION

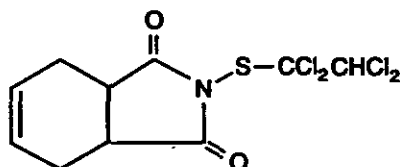
This guideline summarizes pertinent information about captafol for workers and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether new information is available.

SUBSTANCE IDENTIFICATION

• Formula



• Structure



• Synonyms

Difolatan; Captofol; Sanspor; Sulfonimide; 3a,4,7,7a-tetrahydro-2-((1,1,2,2-tetrachloroethyl)thio)-1-H-isoin-dole-1,3(2H)-dione; Alfloc 7020; Difosan; Folcid; Haipen 50; N-((1,1,2,2-tetrachloroethyl)sulfonyl)-cis-4-cyclohexene-1,2-dicarboximide; Nalco 7046; Ortho 5865; Proxel EF; cis-N-((1,1,2,2-tetrachloroethyl)thio)-4-cyclo-hexene-1,2-dicarboximide

• Identifiers

1. CAS No.: 2425-06-1
2. RTECS No.: GW4900000
3. DOT UN: None
4. DOT label: None

• Appearance and odor

Captafol is a noncombustible, white, crystalline substance with a characteristic odor. It is available commercially in the form of a liquid or wettable powder.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 349.06
2. Boiling point (760 mm Hg): Data not available
3. Specific gravity (water = 1): Data not available
4. Vapor density: Not applicable
5. Melting point: 160° to 161°C (320° to 321.8°F) (decomposes)
6. Vapor pressure at 20°C (68°F): Data not available
7. Solubility: Insoluble in water; slightly soluble in acetone and most organic solvents; freely soluble in toluene.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
Education and Information Division

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

8. Evaporation rate: Not applicable

- **Reactivity**

1. Conditions contributing to instability: Strongly alkaline conditions

2. Incompatibilities: Contact of captafol with acids or acid vapors may cause violent reactions.

3. Hazardous decomposition products: Toxic gases (such as chlorine and oxides of nitrogen and sulfur) may be released in a fire involving captafol.

4. Special precautions: None

- **Flammability**

The National Fire Protection Association has not assigned a flammability rating to captafol; this substance is not combustible.

1. Flash point: Not applicable

2. Autoignition temperature: Not applicable

3. Flammable limits in air: Not applicable

4. Extinguishant: Use an extinguishant that is suitable for the materials involved in the surrounding fire.

Fires involving captafol should be fought upwind from the maximum distance possible. Isolate the hazard area and deny access to unnecessary personnel. Emergency personnel should stay out of low areas and ventilate closed spaces before entering. Firefighters should wear a full set of protective clothing and self-contained breathing apparatus when fighting fires involving captafol.

EXPOSURE LIMITS

- **OSHA PEL**

The Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure limit (PEL) for captafol [29 CFR 1910.1000, Table Z-1].

- **NIOSH REL**

The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) of 0.1 mg/m³ as a TWA for up to a

10-hr workday and a 40-hr workweek. The NIOSH REL also bears a "Skin" notation, which indicates that the cutaneous route of exposure (including mucous membranes and eyes) contributes to overall exposure. However, captafol has been designated as a potential occupational carcinogen and exposure should be limited to the lowest feasible concentration [NIOSH 1992].

- **ACGIH TLV**

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned captafol a threshold limit value (TLV) of 0.1 mg/m³ as a TWA for a normal 8-hr workday and a 40-hr workweek with a "Skin" notation [ACGIH 1993].

- **Rationale for limits**

The ACGIH limit is based on the sensitization effects associated with exposure to captafol.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Exposure to captafol can occur through inhalation, eye or skin contact, and ingestion.

- **Summary of toxicology**

1. *Effects on Animals:* Captafol is a liver and kidney toxicant; it also has fetotoxic and teratogenic effects in experimental animals. When instilled into rabbits' eyes it caused irritation of the conjunctiva and iris that lasted 21 days [ACGIH 1991]. Moderate skin irritation resulted when rabbits were dermally exposed to captafol for 72 hr [ACGIH 1991]. The dermal LD₅₀ in the rabbit is 9 g/kg while it is <15 g/kg for the 80% wettable powder [NLM 1991; ACGIH 1991]. Rat oral LD₅₀s range from 2.5 to 6.8 g/kg [ACGIH 1991]. Dogs given 100 or 300 mg/kg captafol (route not specified) in a 2-yr study developed mild anemia and showed growth deficiency; the livers and kidneys of these animals and those given 30 mg/kg were slightly enlarged but showed no functional abnormalities [Hayes 1982]. Captafol is fetotoxic and/or teratogenic in rats, rabbits, and hamsters by the oral or peritoneal routes of exposure [NIOSH 1991; NLM 1991]. Captafol is also an experimental mutagen: it was positive in one in vivo and several in vitro tests [NLM 1991]. In a 2-yr cancer bioassay, rats were fed captafol at dietary levels of 250, 500,

1,500, or 5,000 ppm. Animals in the two highest dose groups did not grow normally and had enlarged livers; mortality was increased in animals dosed at the highest level. On microscopic examination, the livers and kidneys of animals given 1,500 or 5,000 ppm captafol showed kidney and pronounced degenerative liver changes, although there was no evidence of tumors [Hayes 1982; Clayton and Clayton 1981]. A second chronic study has confirmed captafol to be a carcinogen in treated mice [ACGIH 1991].

2. *Effects on Humans:* In humans, captafol is an irritant and sensitizer of the skin and upper respiratory system. Reactions to acute overexposure to captafol may be severe; sensitized workers develop wheezing and bronchitis [Clayton and Clayton 1981]. A 1969 survey of Japanese farmers reported a 25% incidence of occupational dermatitis in these workers; those farmers who had developed acute contact dermatitis had been engaged in the application of captafol and had developed red and swollen eyelids and dermatitis that was aggravated by light (phototoxic dermatitis). The skin eruptions typically appeared 1 to 3 days after contact and usually disappeared within a week after the cessation of exposure [Hayes 1982]. In one study, 23% of agricultural workers exposed to captafol reported episodes that suggested occupationally induced dermatitis [NLM 1991]. Another study reports that many of the captafol-exposed workers who had developed skin rash also showed signs of systemic toxicity: hypertension, anemia, decreased liver function, decreased excretion of urinary protein and urobilinogen, and depressed cholinesterase activity [Hayes 1982; ACGIH 1991]. Ingestion of large quantities have caused vomiting and diarrhea [NLM 1991].

• **Signs and symptoms of exposure**

1. *Acute exposure:* Captafol can induce wheezing, bronchitis, coughing, redness and tearing of the eyes, red and swollen eyelids, and reddened and blistered skin.
2. *Chronic exposure:* The signs and symptoms of chronic exposure to captafol may include raised, itching, reddened, and blistered eruptions of the skin, asthmatic wheezing, hypertension, anemia, and decreased red blood cell cholinesterase activity and elevated liver function.

• **Emergency procedures**

WARNING!
Seek immediate medical attention for severely affected victims or victims with signs and symptoms of toxicity or irritation!

Keep unconscious victims warm and on their sides to avoid choking if vomiting occurs. Initiate the following emergency procedures:

1. *Eye exposure:* Irritation may result. **Immediately and thoroughly** flush the eyes with large amounts of water, occasionally lifting the upper and lower eyelids.
2. *Skin exposure:* Irritation may result. **Immediately and thoroughly** wash contaminated skin with soap and water.
3. *Inhalation exposure:* Move the victim to fresh air **immediately**. Have the victim blow his or her nose, or use a soft tissue to remove particulates or residues from the nostrils.

If the victim is not breathing, clean any chemical contamination from the victim's lips and perform cardiopulmonary resuscitation (CPR); if breathing is difficult, give oxygen.

4. *Ingestion exposure:* Take the following steps if captafol or any material containing it is ingested:

—Have the victim rinse the contaminated mouth cavity several times with a fluid such as water.

—Have the victim drink a glass (8 oz) of fluid such as water.

—Induce vomiting by giving syrup of ipecac as directed on the package. If ipecac is unavailable, have the victim touch the back of the throat with a finger until productive vomiting ceases. Do *not* use syrup of ipecac if large amounts of captafol are ingested.

—Do *not* induce vomiting if captafol has been mixed with a petroleum distillate such as kerosene or diesel fuel.

—Do *not* force an unconscious or convulsing person to drink fluid or to vomit.

5. *Rescue*: Remove an incapacitated worker from further exposure and implement appropriate emergency procedures (e.g., those listed on the material safety data sheet required by OSHA's hazard communication standard [29 CFR 1910.1200]). All workers should be familiar with emergency procedures and the location and proper use of emergency equipment.

EXPOSURE SOURCES AND CONTROL METHODS

The following operations may involve captafol and may result in worker exposures to this substance:

- Manufacture of captafol or captafol mixtures
- Formulation of captafol-containing fungicides
- Application of captafol-containing fungicides to tomatoes, potatoes, coffee plants, logs, and wood products

The following methods are effective in controlling worker exposures to captafol, depending on the feasibility of implementation:

- Process enclosure
- Local exhaust ventilation
- General dilution ventilation
- Personal protective equipment

Good sources of information about control methods are as follows:

1. ACGIH [1992]. *Industrial ventilation—a manual of recommended practice*. 21st ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
2. Burton DJ [1986]. *Industrial ventilation—a self study companion*. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

3. Alden JL, Kane JM [1982]. *Design of industrial ventilation systems*. New York, NY: Industrial Press, Inc.

4. Wadden RA, Scheff PA [1987]. *Engineering design for control of workplace hazards*. New York, NY: McGraw-Hill.

5. Plog BA [1988]. *Fundamentals of industrial hygiene*. Chicago, IL: National Safety Council.

MEDICAL MONITORING

Workers who may be exposed to chemical hazards should be monitored in a systematic program of medical surveillance that is intended to prevent occupational injury and disease. The program should include education of employers and workers about work-related hazards, early detection of adverse health effects, and referral of workers for diagnosis and treatment. The occurrence of disease 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 monitoring program is intended to supplement, not replace, such measures. To place workers effectively and to detect and control work-related health effects, medical evaluations should be performed (1) before job placement, (2) periodically during the term of employment, and (3) at the time of job transfer or termination.

• Preplacement medical evaluation

Before a worker is placed in a job with a potential for exposure to captafol, a licensed health care professional 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 respiratory system and skin. Medical monitoring for respiratory disease should be conducted using the principles and methods recommended by the American Thoracic Society [ATS 1987].

A preplacement medical evaluation is recommended to detect and assess medical conditions that may be aggravated or may result in increased risk when a worker is exposed to captafol at or below the prescribed exposure limit. The licensed health care professional should consider the probable frequency, intensity, and duration of

exposure as well as the nature and degree of any applicable medical condition. Such conditions (which should not be regarded as absolute contraindications to job placement) include a history of allergies and other findings consistent with diseases of the respiratory system and skin.

- **Periodic medical examinations and biological monitoring**

Occupational health interviews and physical examinations should be performed at regular intervals during the employment period, as mandated by any applicable Federal, State, or local standard. Where no standard exists and the hazard is minimal, evaluations should be conducted every 3 to 5 years or as frequently as recommended by an experienced occupational health physician. Additional examinations may be necessary if a worker develops symptoms attributable to captafol exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of captafol on the respiratory system and skin. Current health status should be compared with the baseline health status of the individual worker or with expected values for a suitable reference population.

Biological monitoring involves sampling and analyzing body tissues or fluids to provide an index of exposure to a toxic substance or metabolite. No biological monitoring test acceptable for routine use has yet been developed for captafol.

- **Medical examinations recommended at the time of job transfer or termination**

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic or laboratory tests that 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 with those expected for a suitable reference population.

WORKPLACE MONITORING AND MEASUREMENT

A worker's exposure to airborne captafol is determined by using an OSHA Versatile Sampler (OVS-2) with a 13-mm tube (270/140 mg sections, 20/60 mesh) that has a glass fiber filter enclosed. Samples are collected at a recommended flow rate of 1.0 liter/min until a recommended air volume of 240 liters is collected. Analysis is conducted by

gas chromatography using an electron capture detector. This method is included in the OSHA Laboratory In-House Methods File [OSHA 1989]

PERSONAL HYGIENE

If captafol contacts the skin, workers should immediately wash the affected areas with soap and water.

Clothing contaminated with captafol should be removed immediately, and provisions should be made for safely removing this chemical from these articles. Persons laundering the clothes should be informed of the hazardous properties of captafol, particularly its potential to cause skin sensitization.

A worker who handles captafol should thoroughly wash hands, forearms, and face with soap and water before eating, using tobacco products, using toilet facilities, or applying cosmetics.

Workers should not eat, drink, use tobacco products, or apply cosmetics in areas where captafol or a solution containing captafol is handled, processed, or stored.

STORAGE

Captafol should be stored in a cool, dry, well-ventilated area in tightly sealed containers that are labeled in accordance with OSHA's hazard communication standard [29 CFR 1910.1200]. Containers of captafol should be protected from physical damage and should be stored separately from acids, acid fumes, strong oxidizers, heat, sparks, and open flame. Because containers that formerly contained captafol may still hold product residues, they should be handled appropriately.

SPILLS AND LEAKS

In the event of a spill or leak involving captafol, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup is complete. The following steps should be undertaken following a spill or leak:

1. Do not touch the spilled material; stop the leak if it is possible to do so without risk.
2. Notify safety personnel.
3. Remove all sources of heat and ignition.

4. Ventilate the area of the spill or leak.
5. For small dry spills, collect material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in an approved facility.
6. If captafol is in liquid or slurry form, absorb it with vermiculite, dry sand, earth, or a similar method.

SPECIAL REQUIREMENTS

Environmental Protection Agency (EPA) requirements for emergency planning, reportable quantities of hazardous releases, community right-to-know, and hazardous waste management may change over time. Users are therefore advised to determine periodically whether new information is available.

- **Emergency planning requirements**

Captafol is not subject to EPA emergency planning requirements under the Superfund Amendments and Reauthorization Act (SARA) [42 USC 11022].

- **Reportable quantity requirements for hazardous releases**

Employers are not required by the emergency release notification provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [40 CFR 355.40] to notify the National Response Center of an accidental release of captafol; there is no reportable quantity for this substance.

- **Community right-to-know requirements**

Employers are not required by Section 313 of the SARA to submit a Toxic Chemical Release Inventory Form (Form R) to EPA reporting the amount of captafol emitted or released from their facility annually.

- **Hazardous waste management requirements**

EPA considers a waste to be hazardous if it exhibits any of the following characteristics: ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.21-261.24. Although captafol is not specifically listed as a hazardous waste under the Resource Conservation and Recovery Act (RCRA) [40 USC 6901 et seq.], EPA requires employers to treat waste as hazardous if it exhibits any of the characteristics discussed above.

Providing detailed information about the removal and disposal of specific chemicals is beyond the scope of this guideline. The U.S. Department of Transportation, EPA, and State and local regulations should be followed to ensure that removal, transport, and disposal of this substance are conducted in accordance with existing regulations. To be certain that chemical waste disposal meets EPA regulatory requirements, employers should address any questions to the RCRA hotline at (800) 424-9346 or at (202) 382-3000 in Washington, D.C. In addition, relevant State and local authorities should be contacted for information about their requirements for waste removal and disposal.

RESPIRATORY PROTECTION

- **Conditions for respirator use**

Good industrial hygiene practice requires that engineering controls be used where feasible to reduce workplace concentrations of hazardous materials to the prescribed exposure limit. However, some situations may require the use of respirators to control exposure. Respirators must be worn if the ambient concentration of captafol exceeds prescribed exposure limits. Respirators may be used (1) before engineering controls have been installed, (2) during work operations such as maintenance or repair activities that involve unknown exposures, (3) during operations that require entry into tanks or closed vessels, and (4) during emergencies. Workers should use only respirators that have been approved by NIOSH and the Mine Safety and Health Administration (MSHA).

- **Respiratory protection program**

Employers should institute a complete respiratory protection program that, at a minimum, complies with the requirements of OSHA's respiratory protection standard [29 CFR 1910.134]. Such a program must include respirator selection, an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, respirator fit testing, periodic workplace monitoring, and regular respirator maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program (including selection of the correct respirator) requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly. For additional information about the selection and use of respirators and about the medical screening of respirator users, consult the *NIOSH Respirator Decision Logic* [NIOSH 1987b] and the *NIOSH Guide to Industrial Respiratory Protection* [NIOSH 1987a].

PERSONAL PROTECTIVE EQUIPMENT

Protective clothing should be worn to prevent skin contact with captafol. Chemical protective clothing should be selected on the basis of available performance data, manufacturers' recommendations, and evaluation of the clothing under actual conditions of use. No reports have been published on the resistance of various protective clothing materials to captafol permeation. If permeability data are not readily available, protective clothing manufacturers should be requested to provide information on the best chemical protective clothing for workers to wear when they are exposed to captafol.

If captafol is dissolved in an organic solvent, the permeation properties of both the solvent and the mixture must be considered when selecting personal protective equipment and clothing.

Safety glasses, goggles, or face shields should be worn during operations in which captafol might contact the eyes (e.g., through dust particles or splashes of solution). Eyewash fountains and emergency showers should be available within the immediate work area whenever the potential exists for eye or skin contact with captafol.

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