

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR CARBARYL

INTRODUCTION

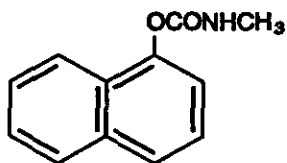
This guideline summarizes pertinent information about carbaryl for workers and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether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

Sevin, 1-naphthyl n-methylcarbamate, alpha-naphthyl n-methylcarbamate, methylcarbamic acid-1-naphthyl ester

• Identifiers

1. CAS No.: 63-25-2

2. RTECS No.: FC5950000

3. DOT UN: 2757 55

4. DOT label: None

• Appearance and odor

Carbaryl is an odorless white, gray, or colorless solid. This substance is a carbamate pesticide.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 201.22

2. Boiling point (760 mm Hg): Decomposes

3. Specific gravity (water = 1): 1.23 at 20°C (68°F)

4. Vapor density: Not applicable

5. Melting point: 142°C (287.6°F)

6. Vapor pressure at 25°C (77°F): <0.00004 mm Hg

7. Solubility: Nearly insoluble in water; moderately soluble in dimethylformamide, acetone, isophorone, and cyclohexanone.

8. Evaporation rate: Not applicable

• Reactivity

1. Conditions contributing to instability: Unstable above 70°C (148°F); hydrolyzes in alkalies

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2. Incompatibilities: Contact of carbaryl with strong oxidizers may cause fires and explosions. Carbaryl is also incompatible with strongly alkaline pesticides.

3. Hazardous decomposition products: Toxic gases and vapors (such as oxides of nitrogen, methylamine, and carbon monoxide) may be released in a fire involving carbaryl.

4. Special precautions: None

• Flammability

The National Fire Protection Association has not assigned a flammability rating to carbaryl. This substance is not flammable, although other constituents of carbaryl formulations may be flammable or 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 carbaryl should be fought upwind and 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. Containers of carbaryl formulations may explode in the heat of the fire and should be moved from the fire area if it is possible to do so safely. If this is not possible, cool containers from the sides with water until well after the fire is out. Stay away from the ends of containers. Personnel should withdraw immediately if they hear a rising sound from a venting safety device or if a container becomes discolored as a result of fire. Dikes should be used to contain fire-control water for later disposal. Firefighters should wear a full set of protective clothing and self-contained breathing apparatus when fighting fires involving carbaryl. Chemical protective clothing that is specifically recommended for carbaryl may not provide thermal protection unless so stated by the clothing manufacturer. Structural firefighters' protective clothing is not effective against fires involving carbaryl.

EXPOSURE LIMITS

• OSHA PEL

The current Occupational Safety and Health Administration

(OSHA) permissible exposure limit (PEL) for carbaryl is 5 mg/m³ as an 8-hr time-weighted average (TWA) concentration [29 CFR 1910.1000, Table Z-1].

• NIOSH REL

The National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL) for carbaryl is 5 mg/m³ as a TWA for up to a 10-hr workday and a 40-hr workweek [NIOSH 1992a].

• ACGIH TLV

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned carbaryl a threshold limit value (TLV) of 5 mg/m³ as a TWA for a normal 8-hr workday and a 40-hr workweek [ACGIH 1993].

• Rationale for limits

The OSHA and ACGIH limits are based on the risk of teratogenic, systemic, and other effects associated with exposure to carbaryl, and the NIOSH limit is based on the risk of central nervous system and reproductive effects associated with exposure to carbaryl.

HEALTH HAZARD INFORMATION

• Routes of exposure

Exposure to carbaryl can occur through inhalation, eye and skin contact, percutaneous absorption, and ingestion.

• Summary of toxicology

1. *Effects on Animals:* Carbaryl inhibits cholinesterase enzyme activity in the central, autonomic, and peripheral nervous systems. This chemical was mildly irritating to exposed rabbit eyes and severely irritating to rabbit skin following a 24-hr contact period [NIOSH 1992b]. Guinea pigs showed a weak skin sensitization reaction to carbaryl [Carpenter et al. 1961]. The dermal LD₅₀ is 4,000 mg/kg for rats and 2,000 mg/kg for rabbits [NIOSH 1992b]. Goats acutely drenched with carbaryl developed anorexia, diarrhea, dullness, weakness, frothing, nasal discharge, recumbency, and death. Histopathology of necropsied tissues revealed hyperemia of the CNS, heart, liver, and kidney plus myocardial and neuronal degeneration [NLM 1992]. The lowest reported oral LD₅₀ for mice is 128 mg/kg, and for rats it is 230 mg/kg [NIOSH 1992b]. Dogs were given a single

oral dose of carbaryl (250, 375, or 500 mg/kg); animals in the two higher dose groups showed signs of nervous system stimulation: lacrimation, excessive salivation, muscular twitching, incoordination, vomiting, defecation, and urination [Carpenter et al. 1961]. In the dogs given 375 mg/kg carbaryl, red blood cell cholinesterase activity was depressed by 24% to 33% [Carpenter et al. 1961]. Rats that received doses ranging from 7 to 70 mg/kg for up to 12 months developed marked functional and structural changes of the pituitary gland plus impairment of thyroid and gonadal function [IARC 1976]. Long-term exposure of pigs resulted in the induction of a progressive structural neuromyopathy that was not acutely reversible with atropine [NIOSH 1992b]. Male rats exposed to 200 mg/kg three times a week for 13 weeks did not develop adverse reproductive effects, but doses of 70 mg/kg (dosing schedule undefined) for 1 year caused reduced sperm motility and alterations in spermatogenesis [NIOSH 1992b]. Female rats exposed to a total dose of 1,370 mg/kg over 39 weeks developed menstrual cycle changes, and exposure of other rats to 5,475 mg/kg over 52 weeks caused uterine, cervix, vaginal, ovarian, and fallopian tube alterations [NIOSH 1992b]. Carbaryl has not been shown to be teratogenic at doses below those causing maternal toxicity [Proctor et al. 1988]. Carbaryl is a mutagen in a wide variety of in vitro and in vivo tests [NIOSH 1992b]. Based on a review of the results of carcinogenicity bioassays in mice and rats, the International Agency for Research on Cancer (IARC) has concluded that the evidence for the carcinogenicity of this substance in animals is inadequate [IARC 1987].

2. *Effects on Humans:* Carbaryl causes reversible cholinesterase inhibition in humans; this effect causes acetylcholine to accumulate at synapses in the nervous system, at neuromuscular junctions of the skeletal and smooth muscles, and in the secretory glands. In two separate incidents, a liquid insecticide (carbaryl/dimethoate mixture) was splashed into a person's eyes, causing transient injury to the corneal epithelium and swelling of the lids [NIOSH 1992b]. Dermal application of carbaryl to the forearm resulted in urinary excretion of 74% of the dose applied [IARC 1976]. A single oral dose of 250 mg carbaryl (approximately 2.8 mg/kg) caused the sudden onset of abdominal pain followed by profuse sweating, lethargy, and vomiting in an adult man; after treatment, this individual recovered completely. An individual who had consumed 21 g of carbaryl (500 mg/kg) recovered from acute cholinesterase inhibi-

tion but suffered weakness of the arms and legs and had electrophysiologic findings consistent with a diagnosis of peripheral neuropathy [NIOSH 1992b]. A 75-year-old man who had excessive long-term exposure to carbaryl recovered from cholinesterase inhibition when removed from exposure, but sleep apnea and peripheral neuropathy appeared as late clinical features [NIOSH 1992b]. A group of 59 workers exposed for 19 months to carbaryl concentrations ranging from 0.23 to 31 mg/m³ showed no overt signs or symptoms of carbamate poisoning, although their red blood cell cholinesterase activity was slightly depressed [Proctor et al. 1988]. Testicular dysfunction and abnormalities in the shape of sperm have been reported in carbaryl-exposed workers [Schrag and Dixon 1985; Wyrobek et al. 1980, 1981].

• **Signs and symptoms of exposure**

1. *Acute exposure:* Carbaryl-induced cholinesterase inhibition can cause nausea, vomiting, abdominal cramps, and diarrhea; excessive sweating and salivation; lethargy and weakness; runny nose and a sensation of tightness in the chest; contracted pupils, blurred vision, tearing, and pain in the eyes; loss of coordination, tremors, and slurring of speech; increasingly difficult respiration, convulsions, and coma. If the poisoning is severe, death from respiratory failure may follow.
2. *Chronic exposure:* Carbaryl has induced headache, memory loss, anorexia, weight loss, proximal muscle weakness, fasciculations, cramps, sleep apnea, and peripheral neuropathy.

• **Emergency procedures**

WARNING!
Seek immediate medical attention for severely affected victims or for 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 carbaryl 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 having the victim touch the back of the throat with a finger until productive vomiting ceases. Do *not* give syrup of ipecac because of possible onset of respiratory depression and seizures.

—Do *not* induce vomiting if carbaryl 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 use of carbaryl as a molluscicide, acaricide, and insecticide (for fruits, vegetables, cotton, tobacco, ornamental trees, livestock, poultry, and pets) may result in worker exposure to this chemical.

The following methods are effective in controlling worker exposures to carbaryl, 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) period-

ically 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 carbaryl, 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 red blood cell cholinesterase activity.

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 carbaryl 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 and other findings consistent with cholinesterase inhibition.

- **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 carbaryl exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of carbaryl on red blood cell cholinesterase activity. 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. A pre-exposure blood cholinesterase concentration should be obtained for each worker so that the postexposure concentration may be expressed as a percentage of that subject's normal cholinesterase activity. A postexposure blood cholinesterase concentration that is less than 70% of

normal is considered indicative of excessive exposure to carbaryl. Although the relationship between airborne concentrations of carbaryl and urinary concentrations of 1-naphthal has not been established, urinary concentrations of 1-naphthal in excess of 4 mg/liter urine may reflect overexposure to carbaryl.

- **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 carbaryl is determined by an OSHA versatile sampler (OVS-2) containing two sections of XAD-2 resin (270/140-mg sections, 20/60 mesh) and a glass fiber filter. Sampling tubes can be obtained from OSHA's Salt Lake City Analytical Laboratory. Samples are collected at a maximum flow rate of 1 liter/min until a maximum air volume of 60 liters is collected. The samples are extracted with acetonitrile. Analysis is conducted by high performance liquid chromatography using an ultraviolet detector. The limit of detection for this procedure is 0.08 mg/m³. This method is described in Method No. 63, OSHA Laboratory In-House Methods File [OSHA 1989].

PERSONAL HYGIENE

If carbaryl contacts the skin, workers should flush the affected areas immediately with plenty of water for 15 min and then wash with soap and water.

Clothing contaminated with carbaryl 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 carbaryl, particularly its potential to cause cholinesterase inhibition.

A worker who handles carbaryl 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 carbaryl or a solution containing carbaryl is handled, processed, or stored.

STORAGE

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

SPILLS AND LEAKS

In the event of a spill or leak involving carbaryl, 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.
2. Notify safety personnel.
3. Ventilate the area of the spill or leak.
4. For small dry spills, use a clean shovel and gently place the material into a clean, dry container, creating as little dust as possible; cover and remove the container from the spill area.
5. Absorb small liquid spills with sand or other non-combustible absorbent material and place the material in a covered container for later disposal.
6. For large liquid spills, build dikes far ahead of the spill to contain the carbaryl for later reclamation or disposal.

SPECIAL REQUIREMENTS

U.S. 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

Carbaryl 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

A hazardous substance release is defined by EPA as any spilling, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of hazardous substances into the environment (including the abandonment or discarding of contaminated containers). In the event of a release that is above the reportable quantity for that chemical, employers are required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [40 CFR 355.40] to notify the proper Federal authorities.

The reportable quantity for carbaryl is 100 lb. If an amount equal to or greater than this quantity is released within a 24-hr period in a manner that will expose persons outside the facility, employers are required to do the following:

—Notify the National Response Center *immediately* at (800) 424-8802 or at (202) 426-2675 in Washington, D.C. [40 CFR 302.6].

—Notify the emergency response commission of the State likely to be affected by the release [40 CFR 355.40].

—Notify the community emergency coordinator of the local emergency planning committee (or relevant local emergency response personnel) of any area likely to be affected by the release [40 CFR 355.40].

• Community right-to-know requirements

Employers who own or operate facilities in SIC codes 20 to 39, who employ 10 or more workers, and who manufacture 25,000 lb or more or otherwise use 10,000 lb or more of carbaryl per calendar year are required by EPA to submit a Toxic Chemical Release Inventory Form (Form R) to EPA reporting the amount of carbaryl 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 carbaryl 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 carbaryl 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 (impervious gloves, full-body coveralls, and impervious footwear) should be worn to prevent repeated or prolonged skin contact with carbaryl. 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. The following materials have been recommended for use against permeation by carbaryl and may provide protection for more than 4 but fewer than 8 hr: natural rubber, neoprene, nitrile rubber, and polyvinyl chloride.

If carbaryl 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 carbaryl might contact the eyes (e.g., through splashes of carbaryl-containing formulations). Eyewash fountains and emergency showers should be available within the immediate work area whenever the potential exists for eye or skin contact with carbaryl. Contact lenses should not be worn if the potential exists for carbaryl exposure.

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