

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR CYCLONITE

INTRODUCTION

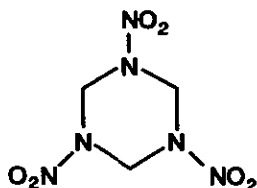
This guideline summarizes pertinent information about cyclonite for workers and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether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

RDX; trimethylene trinitramine; cyclotrimethylenetrinitramine; cyclotrimethylenetrinitramine; hexahydro-1,3,5-trinitro-s-triazine; Hexogen 5W; Hexolite; PBX(AF) 108; sym-trimethylenetrinitramine; trinitro-cyclotrimethylene triamine; 1,3,5-trinitro-1,3,5-triazacyclohexane

• Identifiers

1. CAS No.: 121-82-4
2. RTECS No.: XY9450000
3. DOT UN: 0072 (wetted with not <25% water, by weight, or desensitized with not <10% phlegmatizer, by weight); 0072 (wetted with not <15 percent water, by weight); 0483 (desensitized)
4. DOT label: Explosive A, corrosive

• Appearance and odor

Cyclonite is a white, crystalline powder that is a powerful high explosive. It is also used occasionally as a rodenticide.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 222.26
2. Boiling point: Data not available
3. Specific gravity (water = 1): 1.82 at 20°C (68°F)
4. Vapor density: Data not available
5. Melting point: 205° to 206°C (401° to 402.8°F)
6. Vapor pressure: 0.0004 mm Hg at 110°C (230°F)
7. Solubility: Insoluble in water, alcohol, benzene, car-

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

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Education and Information Division

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bon tetrachloride, and carbon disulfide; slightly soluble in ethyl acetate, methanol, ether, and toluene; soluble in acetone

8. Evaporation rate: Data not available

Reactivity

1. Conditions contributing to instability: Shock or heat
2. Incompatibilities: Contact with mercury fulminate detonates cyclonite, and contact with combustibles or strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases (such as the oxides of nitrogen) may be released in a fire involving cyclonite.
4. Special precautions: Cyclonite is one of the most powerful explosives in use today. It must be stored in an explosives magazine and be handled accordingly.

Flammability

The National Fire Protection Association has not assigned a flammability rating to cyclonite; however, this substance is a dangerous explosion hazard.

1. Flash point: Explodes
2. Autoignition temperature: Data not available
3. Flammable limits in air: Data not available
4. Extinguishant: Evacuate the area if cyclonite or materials in the vicinity of cyclonite catch fire. This material is a high explosive and must be handled accordingly. The Fire Department should be called immediately if cyclonite is on fire or materials near this substance catch fire.

Fires involving cyclonite should be fought upwind from the maximum distance possible. Isolate the hazard area and deny access to unnecessary personnel. Firefighters should wear a full set of protective clothing and self-contained breathing apparatus when fighting fires involving cyclonite.

EXPOSURE LIMITS

OSHA PEL

The Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure

limit (PEL) for cyclonite [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 1.5 mg/m³ as a TWA for up to a 10-hr workday and a 40-hr workweek and 3 mg/m³ as a short-term exposure limit (STEL), both with a "Skin" notation. A STEL is a 15-min TWA exposure that should not be exceeded at any time during a workday [NIOSH 1992].

• ACGIH TLV

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned cyclonite a threshold limit value (TLV) of 1.5 mg/m³ as a TWA for a normal 8-hr workday and a 40-hr workweek. The ACGIH also assigns a "Skin" notation to cyclonite [ACGIH 1993].

• Rationale for limits

The NIOSH and ACGIH limits are based on the risk of central nervous system effects associated with exposure to cyclonite.

HEALTH HAZARD INFORMATION

• Routes of exposure

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

• Summary of toxicology

1. *Effects on Animals:* In animals, cyclonite is toxic to the central nervous system. The oral LD₅₀s in the rat and mouse are 100 mg/kg and 59 mg/kg, respectively; before death, these animals lost weight, became increasingly irritable, and had frequent convulsions. At autopsy, the animals showed lung and gastrointestinal tract congestion [NIOSH 1993; Clayton and Clayton 1981]. Others report an oral LD₅₀ of approximately 200 mg/kg in rats [ACGIH 1991]. Seven dogs given 50 mg cyclonite/day, 6 days/week for 6 weeks showed no blood changes and did not develop methemoglobinemia; however, they became excited and irritable, had hyperactive reflexes, and convulsed and collapsed within 1 week of the onset of dosing. At autopsy, no microscopic pathology was seen [Clayton and Clayton 1981; ACGIH 1991]. The low-

est oral dose of cyclonite reported to cause developmental toxicity in the rat is 3 g/kg; 20 mg/kg cyclonite administered on days 6 to 15 of gestation caused fetotoxicity [NIOSH 1993].

2. *Effects on Humans:* In humans, cyclonite is toxic to the central nervous system. Epileptiform seizures have occurred either without warning or after a few days of insomnia, restlessness, and irritability in workers manufacturing cyclonite explosives. The seizures were most frequent in persons inhaling cyclonite-laden dust; the postconvulsive interval was characterized by temporary amnesia, malaise, fatigue, and weakness, but recovery was eventually complete [Clayton and Clayton 1981; ACGIH 1991]. Workers in a large cyclonite manufacturing plant who handled the material in the moist state did not convulse or show other signs of cyclonite poisoning, but they did develop primary irritant and sensitization dermatitis, particularly of the face and eyelids; these skin conditions are believed to have been caused by unidentified intermediates used in the manufacturing process. Patch tests confirmed that cyclonite had not caused the irritation [Clayton and Clayton 1981]. Five workers convulsed or lost consciousness after handling cyclonite in a dusty atmosphere. These workers developed headaches, nausea, vomiting, or unconsciousness either at work or later at home; unconsciousness lasted several minutes to 24 hr and was accompanied by varying degrees of stupor, nausea, vomiting, and weakness. The workers recovered completely, but two of the men became ill again when they were re-exposed to cyclonite [Clayton and Clayton 1981].

• Signs and symptoms of exposure

1. *Acute exposure:* The signs and symptoms of acute overexposure to cyclonite include headache; irritability; fatigue; weakness; tremors; nausea; dizziness; vomiting; insomnia; unconsciousness; and seizures.
2. *Chronic exposure:* Continued low-level exposure to cyclonite can cause irritability, sleeplessness, and seizures. Cyclonite may cause skin sensitization; if sensitization occurs, very low future exposures can cause itching, the development of a skin rash, and hives.

• Emergency Procedures

WARNING!
Exposed victims may die!
**Transport immediately to emergency
medical facility!**

Keep unconscious victims warm and on their sides to avoid choking if vomiting occurs. *Immediately* initiate the following emergency procedures, continuing them as appropriate en route to the emergency medical facility:

1. *Eye exposure:* *Immediately and thoroughly* flush the eyes with large amounts of water for at least 15 min, occasionally lifting the upper and lower eyelids.
2. *Skin exposure:* Irritation may result from exposure to particulates or concentrated solutions, vapors, mists, or aerosols of cyclonite. Cyclonite can be absorbed through the skin in lethal amounts! *Immediately* remove contaminated clothing and *thoroughly* wash contaminated skin with soap and water for at least 15 min.
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 victim's lips and perform cardiopulmonary resuscitation (CPR); if breathing is difficult, give oxygen.

4. *Ingestion exposure:* Take the following steps if cyclonite 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* 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 cyclonite and result in worker exposures to this substance:

—Manufacture, handling, and use of cyclonite explosives, munitions, and solid propellants

—Manufacture, formulation, and application of cyclonite-containing rodenticides

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

—Process enclosure

—Local exhaust ventilation

—General dilution ventilation

—Personal protective equipment

Good sources of information on 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 cyclonite, the examining 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 central nervous system and skin.

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 cyclonite at or below the prescribed exposure limit. The examining physician 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 skin allergies or findings consistent with diseases of the central nervous system or 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 cyclonite exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of cyclonite on the central nervous system or 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 cyclonite.

- **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 to determine the worker's medical status at the end of his or her employment. 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 cyclonite is determined by using a glass fiber filter (37 mm). Samples are collected at a recommended flow rate of 1.0 liter/min until a recommended air volume of 120 liters is collected. Analysis is conducted by high performance liquid chromatography using ultraviolet detection. This method is included in the OSHA Laboratory In-House Methods File [OSHA 1989].

PERSONAL HYGIENE

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

Clothing contaminated with cyclonite 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 cyclonite.

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

STORAGE

Cyclonite should be stored in a permanent explosives magazine. Detached storage is required. Containers of cyclonite should be protected from shock, friction, and physical damage and should be separated from initiator explosives, strong oxidizers, combustibles, shock, heat, sparks, and open flame. Because containers that formerly contained cyclonite may still hold product residues, they should be handled appropriately.

SPILLS

In the event of a spill involving cyclonite, 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:

1. Do not touch the spilled material.
2. Notify safety personnel.
3. Remove all sources of heat and ignition.
4. Ventilate the area of the spill.
5. Use nonsparking tools for cleanup.
6. Cover the spill with soda ash and spray the area with water. Use a shovel to place the spilled material into a closed container for later 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**

Cyclonite 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 cyclonite; there is no reportable quantity for this substance.

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

Employers are not required by Section 313 of SARA to submit a Toxic Chemical Release Inventory Form (Form R) to EPA reporting the amount of cyclonite 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 cyclonite 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 cyclonite 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 any skin contact with cyclonite. 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 cyclonite 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 cyclonite.

If cyclonite is dissolved in water or 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 cyclonite might contact the eyes (e.g., through dust particles). Eyewash fountains and emergency showers should be available within the immediate work area whenever the potential exists for eye or skin contact with cyclonite. Contact lenses should not be worn if the potential exists for cyclonite exposure.

REFERENCES CITED

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