

NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND
SUPPORTING DOCUMENTATION FOR

*** ETHYLENE GLYCOL DINITRATE AND/OR NITROGLYCERIN ***

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for ETHYLENE GLYCOL DINITRATE AND/OR NITROGLYCERIN

The basic text of this document contains the draft technical standard approved by the Joint Review Committee of the NIOSH/OSHA Standards Completion Program and the supporting documentation for the substance ETHYLENE GLYCOL DINITRATE AND/OR NITROGLYCERIN.

The SCP draft technical standards are recommendations to the Department of Labor for its consideration in rulemaking and have no legal status until final rules have been promulgated by that agency. This draft standard is provided for your information only.

The References and Sources, Respirator Table Documentation and Use/Exposure and Control Documentation are the working documents used by the various SCP working groups during the development of the draft technical standard and serve as the technical foundation for the standard. The classification for each substance and the regulatory statements were derived following a decision logic established for the various sections of the standard.

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(a) Definitions. (1) "Permissible exposure" means exposure of employees to airborne concentrations of ethylene glycol dinitrate and nitroglycerin not in excess of 0.2 parts per million (ppm) (1 milligram per cubic meter (mg/M3)) averaged over any fifteen-minute period during an eight-hour work shift, as stated in § 1910.1000, Table Z-1.

(2) "Action level" means one half of the permissible exposure for ethylene glycol dinitrate and nitroglycerin.

(b) Exposure determination and measurement. (1) Each employer who has a place of employment in which ethylene glycol dinitrate and nitroglycerin are released into the workplace air shall determine if any employee may be exposed to airborne concentrations of ethylene glycol dinitrate and nitroglycerin at or above the action level. The determination shall be made each time there is a change in increase in airborne concentrations of ethylene glycol dinitrate and nitroglycerin.

(2) A written record of the determination shall be made and it shall contain at least the following information:

(i) Any information, observations, or calculations which may indicate employee exposure to ethylene glycol dinitrate or nitroglycerin;

(ii) Any measurements of ethylene glycol dinitrate or nitroglycerin taken;

(iii) Any employee complaints of symptoms which may be attributable to exposure to ethylene glycol dinitrate or nitroglycerin; and

(iv) Date of determination, work being performed at the time, location within work site, name, and social security number of each employee considered.

(3) If the employer determines that any employee may be exposed to ethylene glycol dinitrate and nitroglycerin at or above the action level, the exposure of the employee in each work operation who is believed to have the greatest exposure shall be measured. The exposure measurement shall be representative of the maximum exposure of the employee during an eight-hour work shift.

(4) If the exposure measurement taken pursuant to paragraph (b)(3) of this section reveals employee exposure to ethylene glycol dinitrate and nitroglycerin at or above the action level, the employer shall:

(i) Identify all employees who may be exposed at or above the action level; and

(ii) Measure the exposure of the employees so identified.

(5) If an employee exposure measurement reveals that an employee is exposed to ethylene glycol dinitrate and nitroglycerin at or above the action level, but not above the permissible exposure, the exposure of that employee shall be measured at least every two months.

(6) If an employee exposure measurement reveals that an employee is exposed to ethylene glycol dinitrate and nitroglycerin above the permissible exposure, the employer shall:

(i) Measure the exposure monthly of the employee so exposed;

(ii) Institute control measures as required by paragraph (d) of this section; and

(iii) Individually notify, in writing, within five days, every employee who is found to be exposed to ethylene glycol dinitrate and nitroglycerin above the permissible exposure. The employee shall also be notified of the corrective action being taken to reduce the exposure to at or below the permissible exposure.

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(7) If two consecutive employee exposure measurements taken at least one week apart reveal that the employee is exposed to ethylene glycol dinitrate and nitroglycerin below the action level, the employer may terminate measurement for the employee.

(8) For purposes of this paragraph, employee exposure is that which would occur if the employee were not using a respirator.

(c) Methods of Measurement. (1) An employee's exposure shall be obtained by any combination of short term samples which represents the employee's actual exposure averaged over the time periods appropriate to the permissible exposure (See Appendix B (IV) of this section).

(2) The method of measurement shall have an accuracy, to a confidence level of 95 percent, of not less than that given in Table 1.

Table 1

Concentration	Required Accuracy
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Above permissible exposure	$\pm 25\%$
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At or below permissible exposure	
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and above the action level	$\pm 35\%$
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At or below the action level	$\pm 50\%$
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(d) Compliance. (1) No employee shall be exposed to ethylene glycol dinitrate or nitroglycerin above the permissible exposure as defined in paragraph (a)(1) of this section.

(2) Employee exposures to airborne concentrations of ethylene glycol dinitrate or nitroglycerin shall be controlled to at or below the permissible exposure by engineering and work practice controls:

(i) Engineering and work practice controls shall be instituted to reduce exposures to at or below the permissible exposure, except to the extent that such controls are not technically feasible.

(ii) Wherever engineering and work practice controls are not sufficient to reduce exposures to at or below the permissible exposure, they shall nonetheless be used to reduce exposure to the lowest level feasible and shall be supplemented by respirators in accordance with paragraph (d)(4) of this section.

(3) Engineering controls. When mechanical ventilation is used to control exposure, measurements which demonstrate system effectiveness, for example, air velocity, static pressure, or air volume, shall be made at least every three months. Measurements of system effectiveness shall also be made within five days of any change in production, process, or control which might result in an increase in airborne concentrations of ethylene glycol dinitrate or nitroglycerin.

(4) Compliance with the permissible exposure shall not be achieved by the use of respirators except:

(i) During the time period necessary to install or implement engineering or work practice controls; or

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- (ii) In work situations in which engineering and work practice controls are technically not feasible; or
- (iii) To supplement engineering and work practice controls when such controls fail to reduce airborne concentrations of ethylene glycol dinitrate or nitroglycerin to at or below the permissible exposure; or
- (iv) For operations which require entry into tanks or closed vessels; or
- (v) In emergencies.
- (5) Where respirators are needed and permitted under this paragraph to reduce employee exposure, the employer shall select and provide the appropriate respirator from Table 2 and shall ensure that the employee uses the respirator provided.

TABLE 2 RESPIRATORY PROTECTION FOR ETHYLENE GLYCOL DINITRATE AND/OR NITROGLYCERIN

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Vapor Concentration	
2 ppm or less	Any supplied-air respirator. Any self-contained breathing apparatus.
10 ppm or less	Any supplied-air respirator with a full facepiece, helmet or hood. Any self-contained breathing apparatus with a full facepiece.
80 ppm or less	A Type C supplied-air respirator operated in pressure - demand or other positive pressure or continuous-flow mode.
Greater than 80 ppm or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied - air respirator with a full facepiece operated in pressure - demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors and particulates. Any escape self-contained breathing apparatus.

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(6) Respirators shall be approved by the Mining Enforcement and Safety Administration (formerly Bureau of Mines) or by the National Institute for Occupational Safety and Health under the provisions of 30 CFR Part 11.

(7) The employer shall institute a respiratory protection program in accordance with § 1910.134(b), (d), (e), and (f).

(e) Fire and safety. (1) The employer shall familiarize himself with the information contained in the Substance Technical Guidelines (Appendix B of this section) for ethylene glycol dinitrate and nitroglycerin.

(2) For the purpose of compliance with § 1910.109, ethylene glycol dinitrate and nitroglycerin are classified as Class A explosives.

(3) Sources of ignition such as smoking or open flames are prohibited where ethylene glycol dinitrate or nitroglycerin are used, handled or stored.

(4) Ethylene glycol dinitrate and nitroglycerin shall be stored so as not to come in contact with acids.

(f) Personal protective equipment. (1) Employers shall provide and ensure that employees use impervious clothing, gloves, face shields (eight-inch minimum) and other appropriate protective clothing necessary to prevent any possibility of skin contact with liquid ethylene glycol dinitrate or liquid nitroglycerin. Face shields shall comply with § 1910.133 (a)(2), (a)(4), (a)(5), and (a)(6).

(2) Employers shall ensure that employees whose clothing has had any possibility of being contaminated with liquid ethylene glycol dinitrate or liquid nitroglycerin change into uncontaminated clothing before leaving the work premises.

(3) Employers shall ensure that clothing which has had any possibility of being contaminated with liquid ethylene glycol dinitrate or liquid nitroglycerin is placed in closed containers for storage until it can be discarded or until the employer provides for the removal of the substance from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the substance, the employer shall inform the person performing the operation of the hazardous properties of ethylene glycol dinitrate and nitroglycerin.

(4) Where there is any possibility of exposure of an employee's body to liquid ethylene glycol dinitrate or liquid nitroglycerin, employers shall provide facilities for quick drenching of the body within the immediate work area for emergency use.

(5) Employers shall ensure that non-impervious clothing which becomes contaminated with ethylene glycol dinitrate or nitroglycerin be removed immediately and not reworn until the substance is removed from the clothing.

(6) Employers shall ensure that clothing which becomes wet with liquid ethylene glycol dinitrate or liquid nitroglycerin be removed immediately and not reworn until the substance is removed from the clothing.

(7) Employers shall provide and ensure that employees use safety goggles (cup-cover type dust and splash safety goggles) which comply with § 1910.133(a)(2)-(a)(6) where liquid ethylene glycol dinitrate or liquid nitroglycerin may contact the eyes.

(g) Spills and disposal. (1) In the event that liquid ethylene glycol dinitrate or liquid nitroglycerin are spilled the employer shall immediately eliminate potential sources of ignition, provide available ventilation and then clean up the spill.

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(2) Liquid ethylene glycol dinitrate or liquid nitroglycerin shall not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.

(h) Sanitation. (1) Employers shall ensure that employees whose skin becomes contaminated with ethylene glycol dinitrate or nitroglycerin immediately wash or shower with soap or mild detergent and water to remove the substance from the skin.

(2) Employers shall ensure that all employees subject to skin contact with liquid ethylene glycol dinitrate or liquid nitroglycerin wash with soap or mild detergent and water any areas of the body which may have contacted these substances at the end of each work day.

(3) Employers shall ensure that employees do not eat or smoke in areas where liquid ethylene glycol dinitrate or liquid nitroglycerin are handled, processed or stored.

(4) Employers shall ensure that employees who handle liquid ethylene glycol dinitrate or liquid nitroglycerin wash their hands thoroughly with soap or mild detergent and water before eating, smoking or using toilet facilities.

(i) Training and information. (1) Each employer who has a workplace in which ethylene glycol dinitrate and/or nitroglycerin are present shall keep a copy of this regulation with Appendixes A, B and C at the workplace. This material shall be made readily available to affected employees.

(2) Each employer who has employees exposed to ethylene glycol dinitrate or nitroglycerin above the action level or employees who may have skin or eye contact with liquid ethylene glycol dinitrate or nitroglycerin, or employees who work where ethylene glycol dinitrate or nitroglycerin present a potential fire or explosion hazard, shall annually:

(i) Inform affected employees of the information contained in the Substance Safety Data Sheet for ethylene glycol dinitrate and nitroglycerin (Appendix A of this section);

(ii) Advise affected employees as to the signs and symptoms of exposure to ethylene glycol dinitrate and nitroglycerin.

(iii) Instruct affected employees to advise the employer of the development of signs and symptoms of exposure to ethylene glycol dinitrate and nitroglycerin which are listed in Appendix A of the section; and

(iv) Provide training to ensure that employees understand the precautions of safe use, emergency procedures, and the correct use of protective equipment relative to ethylene glycol dinitrate and nitroglycerin.

(j) Medical surveillance. (1) The employer shall provide medical procedures as required by this paragraph. All medical procedures shall be performed by or under the supervision of a physician at no cost to the employee.

(2) Preplacement medical examination. The employer shall make available to each employee who is exposed, or will be exposed, to liquid ethylene glycol dinitrate or nitroglycerin or airborne concentrations of ethylene glycol dinitrate or nitroglycerin at or above the action level a preplacement medical examination which must include the following:

(i) A medical history and physical examination with emphasis on the heart, blood, liver, and kidneys;

(ii) A complete blood count to include at least red and white cell count, a differential smear, hemoglobin and hematocrit;

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(iii) Electrocardiogram.

(3) Periodic medical examination. The employer shall make available to each employee exposed to liquid ethylene glycol dinitrate or nitroglycerin or airborne concentrations of ethylene glycol dinitrate or nitroglycerin at or above the action level, twelve months from the date of the employee's first exposure, and every twelve months thereafter, a periodic medical examination which must include the following:

(i) A medical history and physical examination with emphasis on the heart, blood, liver and kidneys;

(ii) A complete blood count to include at least red and white cell count, a differential smear, hemoglobin and hematocrit;

(iii) Electrocardiogram.

(4) Alternative medical procedures. If the examining physician chooses to use alternative medical procedures to those specified in paragraphs (j)(2) and (j)(3) of this section, the employer may accept such alternative medical procedures as meeting the requirements of this section provided that the employer:

(i) Obtains a statement from the examining physician setting forth the alternative medical procedures, the rationale for substitution, and evidence that they will be equally effective;

(ii) Informs each exposed worker of the fact that alternative medical procedures to those required in paragraphs (j)(2) and (j)(3) of this section are to be made available.

(5) Interim medical examination. The employer shall provide an interim medical examination including a methemoglobin determination for the employee if the employee informs the employer of any of the signs or symptoms of exposure to ethylene glycol dinitrate or nitroglycerin which are listed in Appendix A which the employee suspects are caused by exposure to ethylene glycol dinitrate or nitroglycerin.

(6) Informing the physician. The employer shall provide to the physician performing any medical examination required by this section the following information:

(i) A copy of this regulation with Appendixes A, B, and C for ethylene glycol dinitrate or nitroglycerin;

(ii) A description of the affected employee's duties as they relate to his exposure to ethylene glycol dinitrate or nitroglycerin;

(iii) A description of any personal protective equipment and respirators required to be used;

(iv) The results of any measurements which may indicate the affected employee's exposure;

(v) The affected employee's anticipated exposure level; and

(vi) Upon request of the physician, any available information from previous medical examinations of the affected employee.

(7) Where a medical examination is required by paragraphs (j)(2), (j)(3), or (j)(5) of this section, following such examination the employer shall obtain from the examining physician a written opinion which conforms with paragraph (j)(8) of this section.

(8) Physician's written opinion. i) The physician's written opinion shall be a signed statement by the examining physician specifically stating:

(A) Whether the employee has any detected medical condition which would place the employee at increased risk of material impairment of the

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employee's health from exposure to ethylene glycol dinitrate or nitroglycerin or would directly or indirectly aggravate any detected medical condition;

(B) Any recommended limitations upon the employee's exposure to ethylene glycol dinitrate or nitroglycerin, including limitations upon the use of personal protective equipment and respirators;

(C) That the employee has been informed by the physician of any detected medical conditions which require further medical examination or treatment.

(ii) The physician's written opinion shall not reveal specific medical findings or diagnoses unrelated to exposure to ethylene glycol dinitrate or nitroglycerin.

(iii) The employer shall provide the employee with a copy of the physician's written opinion.

(9) results of tests. Where a preplacement or periodic medical examination is required by paragraphs (j)(2) or (j)(3) of this section, following such examination the employer shall obtain from the examining physician:

(i) A recording of the results of the blood tests and electrocardiogram;

(ii) Where alternative medical procedures have been performed in accordance with paragraph (j)(4) of this section, a recording of such alternative procedures.

(10) No employee shall be exposed to ethylene glycol dinitrate or nitroglycerin in such a way as would put the employee at increased risk of material impairment of his health from such exposure. This determination may be based on the physician's written opinion.

(11) No medical procedure which would be performed pursuant to paragraphs (j)(2) or (j)(3) of this section need be performed if records of a previous such procedure performed within the past six months are acceptable to the examining physician.

(12) If an employee refuses any required medical examination, the employer shall inform the employee of the possible health consequences of such refusal and obtain a signed statement from the employee indicating that the employee understands the risk involved by refusal to be examined.

(k) Recordkeeping. (1) Exposure determination. (i) The employer shall keep an accurate record of all determinations required to be made pursuant to paragraph (b)(1) of this section.

(ii) This record shall include the written determination required in paragraph (b)(2) of this section.

(iii) This record shall be maintained until replaced by a more recent record.

(2) Exposure measurements. (i) The employer shall keep an accurate record of all measurements taken to determine employee exposure to ethylene glycol dinitrate or nitroglycerin.

(ii) This record shall include:

(A) The date of measurement;

(B) Operations involving exposure to ethylene glycol dinitrate or nitroglycerin which are being monitored;

(C) Sampling and analytical method used and evidence of their accuracy;

(D) Number, duration, and results of samples taken; and

(E) Name, social security number and exposure of the employee monitored.

(iii) This record shall be maintained until replaced by a more recent record but in no event for less than one year.

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(3) Mechanical ventilation. (i) When mechanical ventilation is used as an engineering control, the employer shall maintain an accurate record of the measurements demonstrating the effectiveness of such ventilation required by paragraph (d)(3) of this section.

(ii) This record shall include:

- (A) Date of measurement;
- (B) Type of measurement taken;
- (C) Result of measurement.

(iii) These records shall be maintained for at least one year.

(4) Employee training and information. (i) The employer shall keep an accurate record of all employee training and information required by paragraph (i) of this section.

(ii) This record shall include:

- (A) Date of training;
- (B) Name and social security number of employee trained;
- (C) Content or scope of training provided.

(iii) This record shall be maintained until replaced by a more recent record.

(5) Medical surveillance. (i) The employer shall keep an accurate record of employee medical surveillance required by paragraph (j) of this section.

(ii) This record shall include:

- (A) The name and social security number of the employee;
- (B) Results of tests required by paragraph (j)(2) and (j)(3) of this section and results of any tests conducted pursuant to paragraphs (j)(4) of this section;

(C) Any employee medical complaints relative to exposure to ethylene glycol dinitrate or nitroglycerin;

(D) A copy of information provided to the physician pursuant to paragraph (j)(6)(ii), (iii), (iv), (v), and (vi) of this section.

(E) Physician's written opinion; and

(F) A signed statement of any refusal to be examined.

(iii) This record shall be maintained for the duration of and for five years after termination of the employment of the affected employee.

(6) Access to records. (i) All records required to be maintained by this section shall be made available upon request to authorized representatives of the Assistant Secretary of Labor for Occupational Safety and Health and the Director of the National Institute for Occupational Safety and Health.

(ii) Each employee or former employee shall have access to the exposure determination and exposure measurement records required to be maintained by this section which indicate his own exposure to ethylene glycol dinitrate or nitroglycerin.

(iii) Employee medical records required to be maintained by this section shall be made available upon written request to a physician designated by the employee or former employee.

(1) Employee observation of measurement. (1) The employer shall give each employee or his representative an opportunity to observe any measurement of his exposure to ethylene glycol dinitrate or nitroglycerin which is conducted pursuant to this section.

(2) When observation of measurement of employee exposure to ethylene glycol dinitrate or nitroglycerin requires entry into an area where the use

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of personal protective devices, including respirators, is required, the observer shall be provided with and required to use such equipment and comply with all other applicable safety procedures.

(3) Without interfering with the measurement, observers shall be entitled to:

- (i) Receive an explanation of the measurement procedure.
- (ii) Visually observe all steps related to the measurement of the airborne concentration of ethylene glycol dinitrate or nitroglycerin that are being performed at the place of exposure; and
- (iii) Record the results obtained.

NOTE: The information contained in the following appendixes is advisory in nature and is not intended, by itself, to create any additional obligations not otherwise imposed or detract from any existing obligation.

APPENDIX A

SUBSTANCE SAFETY DATA SHEET

FOR ETHYLENE GLYCOL DINITRATE AND NITROGLYCERIN

I. SUBSTANCE IDENTIFICATION

- A. Substance: Ethylene glycol dinitrate and nitroglycerin
- B. Permissible Exposure: 0.2 part of ethylene glycol dinitrate or nitroglycerin per million parts of air (ppm) (1 milligram of ethylene glycol dinitrate and nitroglycerin per cubic meter of air (mg/M3)) shall not be exceeded during any fifteen minute period during an eight-hour work shift.
- C. Appearance and Odor: Ethylene glycol dinitrate: Colorless to yellow odorless oily liquid; nitroglycerin: Colorless to yellow odorless oily liquid. It can be a solid at temperatures below 13 C (55 F).

II. HEALTH HAZARD DATA

- A. Ways in which the chemical affects your body: Ethylene glycol dinitrate and nitroglycerin can affect your body if you inhale them or if they come in contact with your eyes or if you swallow them. They may enter your body through your skin.
- B. Effects of Overexposure:
 - 1. Exposure: Exposure to small amounts of ethylene glycol dinitrate and nitroglycerin by skin exposure, inhalation or swallowing can cause severe throbbing headaches. With larger exposures, dizziness, nausea, vomiting, abdominal pain, a blue coloration of the skin and lips, pounding of the heart, delirium and drowsiness may

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occur. Effects may be made worse by ingestion of alcohol. A temporary tolerance to headache may develop but this is lost after a few days without exposure. On rare occasions, a worker may have anginal pains of the heart a few days after discontinuing repeated daily exposure. Sudden death has also been reported from cardiac arrest under these circumstances.

2. Reporting Signs and Symptoms: You should inform your employer if you develop any signs or symptoms and suspect that they are caused by exposure to ethylene glycol dinitrate or nitroglycerin.

III. EMERGENCY FIRST AID PROCEDURES

- A. Eye Exposure: If ethylene glycol dinitrate or nitroglycerin get into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.
- B. Skin Exposure: If ethylene glycol dinitrate or nitroglycerin get on your skin, immediately wash the contaminated skin using soap or mild detergent and water. If ethylene glycol dinitrate or nitroglycerin penetrate through your clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Get medical attention immediately.
- C. Breathing: If you or any other person breathes in large amounts of ethylene glycol dinitrate or nitroglycerin move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.
- D. Swallowing: When ethylene glycol dinitrate or nitroglycerin have been swallowed, give the person large amounts of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Get medical attention immediately.
- E. Rescue: Move affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty yourself. Understand your emergency rescue procedures and know the locations of the equipment before the need arises.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

- A. Respirators: Respirators are not the best way to control exposure to ethylene glycol dinitrate and nitroglycerin. You can only be required to wear them for routine use if your employer is in the process of installing controls or control measures prove inadequate. You may be required to wear respirators for non-routine activities or in emergencies. If respirators are worn, they must have a Mining Enforcement and Safety Administration (MESA) or National Institute for Occupational Safety and Health (NIOSH) approval label.

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(Older respirators may have a Bureau of Mines approval label.) For effective protection, respirators must fit your face and head snugly. Respirators should not be loosened or removed in work situations where their use is required. If you experience difficulty breathing while wearing a respirator, tell your employer.

- B. Protective Clothing: You must wear impervious clothing, gloves, face shield or other appropriate protective clothing to prevent any possibility of skin contact with ethylene glycol dinitrate or nitroglycerin. Replace or repair impervious clothing that has developed leaks.
- C. Eye Protection: You must wear splash-proof safety goggles where liquid ethylene glycol dinitrate or liquid nitroglycerin may contact your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

- A. Ethylene glycol dinitrate and nitroglycerin are explosives. These substances may detonate if exposed to heat or shock.
- B. Ethylene glycol dinitrate and nitroglycerin must be stored in tightly closed containers in a cool, well ventilated area away from heat and acids.
- C. Sources of ignition such as smoking and open flames are prohibited wherever ethylene glycol dinitrate or nitroglycerin are handled, used or stored.
- D. You must use non-sparking tools when opening or closing metal containers of ethylene glycol dinitrate or nitroglycerin, and containers must be bonded and grounded when pouring or transferring liquid ethylene glycol dinitrate and nitroglycerin.
- E. If your work clothing has had any possibility of becoming contaminated with ethylene glycol dinitrate or nitroglycerin, you must change into uncontaminated clothing before leaving the work premises.
- F. You must immediately remove any non-impervious clothing that becomes contaminated with ethylene glycol dinitrate or nitroglycerin and this clothing must not be reworn until the ethylene glycol dinitrate and nitroglycerin is removed from the clothing.
- G. Clothing wet with liquid ethylene glycol dinitrate or liquid nitroglycerin can be easily detonated by heat or shock. You must immediately remove this clothing and it must not be reworn until the ethylene glycol dinitrate and nitroglycerin is removed from the clothing.
- H. If your skin becomes contaminated with ethylene glycol dinitrate or nitroglycerin, you must immediately wash with soap or mild detergent and water to remove the ethylene glycol dinitrate and nitroglycerin from your skin.
- I. If you are subject to skin contact with ethylene glycol dinitrate or nitroglycerin, at the end of each work day you must wash with soap or mild detergent and water any areas of your body that may have contacted ethylene glycol dinitrate or nitroglycerin.

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- J. You must not eat or smoke in areas where ethylene glycol dinitrate or nitroglycerin is handled, processed or stored.
- K. If you handle ethylene glycol dinitrate or nitroglycerin, you must wash your hands thoroughly with soap or mild detergent and water before eating, smoking or using toilet facilities.
- L. Fire extinguishers and quick drenching facilities, where provided, must be readily available and you should know where they are and how to operate them.
- M. Ask your supervisor where ethylene glycol dinitrate and nitroglycerin is used in your work area and for any additional safety and health rules.

VI. ACCESS TO INFORMATION

- A. Each year your employer is required to inform you of the information contained in this Substance Safety Data Sheet for ethylene glycol dinitrate and nitroglycerin. In addition, your employer must instruct you in the safe use of ethylene glycol dinitrate and nitroglycerin, emergency procedures, and the correct use of protective equipment.
- B. Your employer is required to determine whether you are being exposed to ethylene glycol dinitrate and nitroglycerin. You or your representative have the right to observe employee exposure measurements and to record the results obtained. If your employer determines that you are being overexposed, he is required to inform you of the exposure and the actions which are being taken to reduce your exposure.
- C. Your employer is required to keep records of your exposure and medical examinations. Your employer is required to keep exposure data for at least one year and to keep medical data during your employment, and for a period of five years following your termination of employment. Your employer is required to make the exposure data available to you upon your request. Your employer is also required to release your medical records to your physician upon your written request.
- D. Your employer must give you a copy of the physicians written opinion for any physical examination required by this standard.

APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES

FOR ETHYLENE GLYCOL DINITRATE AND NITROGLYCERIN

I. PHYSICAL AND CHEMICAL DATA (Ethylene glycol dinitrate)

- A. Substance Identification
 - 1. Synonyms: Glycol dinitrate; nitroglycol; dinitro-glycol; GDN
 - 2. Formula: $C_2H_4(NO_3)_2$

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3. Molecular weight: 152.1

B. Physical Data

1. Boiling point (760 mm Hg): Explodes at 114 C (237 F)
2. Specific gravity (water = 1): 1.4
3. Vapor density (air = 1 at boiling point of ethylene glycol dinitrate): Not applicable
4. Melting point: -23 C (-9 F)
5. Vapor pressure at 20 C (68 F): 0.05 mm Hg
6. Solubility in water, % by weight at 20 C (68 F): 0.52
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Colorless to yellow odorless oily liquid

II. PHYSICAL AND CHEMICAL DATA (Nitroglycerin)

A. Substance Identification

1. Synonyms: Glyceryl trinitrate
2. Formula: $C_3H_5(NO_3)_3$
3. Molecular weight: 227.1

B. Physical Data

1. Boiling point (760 mm Hg): Explodes at 145 C (293 F)
2. Specific gravity (water = 1): 1.6
3. Vapor density (air = 1 at boiling point of nitroglycerin): Not applicable
4. Melting point: 13 C (55 F)
5. Vapor pressure at 20 C (68 F): 0.0015 mm Hg
6. Solubility in water, % by weight at 20 C (68 F): 0.17
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Colorless to yellow odorless oily liquid. It can be a solid at temperatures below 13 C (55 F).

III. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: Explodes
2. Autoignition temperature: Ethylene glycol dinitrate: 195 C (383 F); Nitroglycerin: 270 C (518 F)
3. Impact sensitivity (minimum fall of a 2 kg weight to cause at least one explosion in ten trials): Nitroglycerin 15 cm; Ethylene glycol dinitrate 56 cm.
4. Explosion temperature (temperature required to cause explosion in 5 seconds): Nitroglycerin 222 C (431 F); Ethylene glycol dinitrate 257 C (495 F).
5. Flammable limits in air, % by volume: Not applicable
6. Extinguishing media: None
7. Special fire-fighting procedures: When ethylene glycol dinitrate and nitroglycerin are involved in a fire, the area should be evacuated. Fires involving ethylene glycol dinitrate or nitroglycerin should be fought only from an explosion-resistant location because of the possibility of detonation of ethylene glycol dinitrate and nitroglycerin.
8. Unusual fire and explosion hazards: Ethylene glycol dinitrate and nitroglycerin are explosive liquids. Ethylene glycol dinitrate and nitroglycerin may be

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detonated easily by shock or heat. All ignition sources must be controlled where ethylene glycol dinitrate or nitroglycerin are used, handled or stored.

9. For purposes of conforming with the requirements of 29 CFR 1910.109, ethylene glycol dinitrate and nitroglycerin are classified as Class A explosives.

B. Reactivity

1. Conditions contributing to instability: Ethylene glycol dinitrate and nitroglycerin may explode when subject to shock or temperatures above 50 C (122 F).
2. Incompatibilities: Contact with acids will cause decomposition and development of pressure.
3. Hazardous decomposition products: Toxic gases and vapors (such as oxides of nitrogen and carbon monoxide) may be released when ethylene glycol dinitrate and nitroglycerin explode.
4. Special precautions: Liquid ethylene glycol dinitrate and nitroglycerin will attack some forms of plastics, rubber and coatings.

IV. SPILL, LEAK, AND DISPOSAL PROCEDURES

- A. If ethylene glycol dinitrate or nitroglycerin 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, hydrolize and absorb on dry sand or similar material. Ethylene glycol dinitrate and nitroglycerin must not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.
- B. Persons not wearing protective equipment should be restricted from areas of spills or leaks until cleanup has been completed.
- C. Waste disposal methods: Small quantities of ethylene glycol dinitrate or nitroglycerin may be disposed by burning carefully in a safe, secluded location.

V. MONITORING AND MEASUREMENT PROCEDURES

- A. EXPOSURE ABOVE THE ACTION LEVEL: Measurements taken for the purpose of determining employee exposure under this section are best taken such that the average eight-hour exposure may be determined from a single eight-hour sample or two four-hour samples. Several short time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). Sampling and analyses may be performed by instruments such as detector tubes certified by NIOSH under 42 CFR part 84, portable direct-reading instruments, dosimeters, or gas and vapor adsorption tubes with subsequent chemical analyses. The method of measurement must determine the concentration of nickel carbonyl to plus or minus 35%.

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- B. EXPOSURE ABOVE THE PERMISSIBLE EXPOSURE: The monitoring and measurements under this section should be essentially the same as described under paragraph IV. A. Laboratories performing chemical analyses should be accredited in Industrial Hygiene Chemistry by the American Industrial Hygiene Association. The method of measurement must determine the concentration of nickel carbonyl to plus or minus 25%.
- C. METHODS: Methods meeting these accuracy requirements are available from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161 under the title "NIOSH Analytical Methods for Set P" (Order number XXXXXXXXXX).
- D. QUALIFIED PERSONS: Since many of the duties relating to employee protection are dependent on the results of monitoring and measuring procedures, employers should assure that the evaluation of employee exposures is performed by a competent industrial hygienist or other technically qualified person.

VI. MISCELLANEOUS PRECAUTIONS

- A. Store ethylene glycol dinitrate and nitroglycerin in accordance with 29 CFR 1910.109.
- B. Non-sparking tools must be used to open and close metal ethylene glycol dinitrate or nitroglycerin containers. These containers must be effectively grounded and bonded prior to pouring.
- C. Employers should advise employees of all areas and operations where exposure to ethylene glycol dinitrate or nitroglycerin could occur.

VII. COMMON OPERATIONS

Common operations in which exposure to ethylene glycol dinitrate and nitroglycerin is likely to occur are: During their use in the manufacture and use of high explosives, propellants, and pharmaceuticals.

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation; skin absorption.

II. TOXICOLOGY

Absorption of ethylene glycol dinitrate (EGDN) or nitroglycerin (NG), whether from inhalation of the vapor or absorption of the liquid through the skin, causes vasodilatation and on cessation of exposure, rebound vasoconstriction with angina and possible myocardial damage and cardiac arrest. They may also produce low levels of methemoglobin and the formation of Heinz bodies in erythrocytes. EGDN is absorbed through the skin more rapidly than NG and produces a greater methemoglobin and Heinz body response in animals; chronic poisoning in animals results in anemia

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and mild degenerative changes in the heart, liver, and kidneys. In humans, the cardiovascular effects predominate; mild intoxication from EGDN or NG results in a characteristic intense throbbing headache, presumably due to cerebral vasodilatation, often associated with dizziness and nausea, and occasionally with vomiting and abdominal pain; more severe exposure also causes hypotension, flushing, palpitation, methemoglobinemia, delirium, and depression of the central nervous system. Aggravation of these symptoms after alcohol ingestion has been observed. Upon repeated exposure, a temporary tolerance to headache develops but is usually lost after a few days without exposure. On occasions a worker may have an attack of angina pectoris a few days after cessation of repeated exposures to EGDN, a manifestation of cardiac ischemia; sudden death due to unheralded cardiac arrest has also been reported under these circumstances. Volunteers exposed to the vapor of a mixture of EGDN and NG at a concentration of NG of 2 mg/M3 in an explosives magazine suffered headache and fall in blood pressure within 3 minutes of exposure; a mean concentration of NG of 0.7 mg/M3 for 25 minutes also produced lowered blood pressure and slight headache. Workers intermittently exposed (2 or 3 times a week for an unspecified time period) to NG vapor at concentrations of 0.03 to 0.11 ppm complained of headache; complaints ceased when concentrations were reduced to below 0.01 ppm. Eye effects from contact with the liquid have not been reported. Mild skin irritation and possible skin sensitization from exposure to NG have been reported..

III. SIGNS AND SYMPTOMS

Intense throbbing headache; dizziness; nausea, vomiting, abdominal pain; hypotension, flushing, palpitation; methemoglobinemia; delirium, depression of central nervous system; angina pectoris on cessation of exposure with possible sudden death; skin irritation; by analogy to effects caused in animals there may be anemia and mild injury to the liver and kidneys.

IV. SPECIAL TESTS

None in common usage.

V. TREATMENT

Remove from exposure. Immediately flush eyes with water and wash skin with soap or mild detergent and water. Remove all contaminated clothing. If swallowed and the person is conscious, induce vomiting. Give artificial resuscitation and administer oxygen if indicated.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Ethylene glycol dinitrate and/or nitroglycerin cause systemic vasodilatation; the most frequent complaint is intense headache described as throbbing. Angina pectoris has occurred a few days

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after removal from exposure with myocardial damage and death. Consumption of alcohol aggravates the toxic effects. Skin absorption is known to occur. It is important that the physician become familiar with plant operating conditions in which exposure to ethylene glycol dinitrate and/or nitroglycerin occurs. Those with skin disease may not tolerate the wearing of protective clothing and those with chronic respiratory disease may not tolerate the wearing of negative pressure respirators.

B. PREPLACEMENT

The following medical procedures must be made available to each employee who is exposed to ethylene glycol dinitrate and/or nitroglycerin:

1. A complete history and physical examination -- The purpose is to detect preexisting conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Persons with a history of cardiovascular disease or anemia would be expected to be at increased risk from exposure. Examination of the cardiovascular system, blood, liver, and kidneys should be stressed. The skin should be examined for evidence of chronic disorders.
2. A complete blood count -- Ethylene glycol dinitrate and/or nitroglycerin has been shown to cause anemia in animals. A complete blood count must be performed including a red cell count, a white cell count, a differential count of a stained smear, as well as hemoglobin and hematocrit. Observe for Heinz bodies.
3. Electrocardiogram -- Ethylene glycol dinitrate and/or nitroglycerin have been reported to cause angina and sudden cardiac deaths. Those with preexisting heart disease may be at increased risk.

C. PERIODIC EXAMINATIONS

The above medical examinations are to be repeated on an annual basis. Methemoglobin determinations shall be performed if overexposure is suspected or signs and symptoms of toxicity occur.

VII. REFERENCES

1. American Conference of Governmental Industrial Hygienists: "Ethylene Glycol Dinitrate and/or Nitroglycerin," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, pp. 110-111.
2. Hygienic Guide Series: "Ethylene Glycol Dinitrate," American Industrial Hygiene Association Journal, 27:574-577, 1966.

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3. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 1590, 2094-2096.
4. Hygienic Guide Series: "Nitroglycerin," American Industrial Hygiene Association Journal, 21:99-100, 1960.
5. Carmichael, P. and J. Lieben: "Sudden Death in Explosives Workers," Archives of Environmental Health, 7:424-439, 1963.
6. Trainor, D.C. and R.C. Jones: "Headaches in Explosive Magazine Workers," Archives of Environmental Health, 12:231-234, 1966.
7. Fredrick, W.G., et al: Annual Report, Bureau of Industrial Hygiene, Detroit Department of Health, Detroit, Michigan, 1961, p. 2.
8. Einert, C.E., et al: "Exposure to Mixtures of Nitroglycerin and Ethylene Glycol Dinitrate," American Industrial Hygiene Association Journal, 24:435-447, 1963.
9. Grant, W. Morton: Toxicology of the Eye (2d ed.), Charles C. Thomas, Springfield, Illinois, 1974, pp. 755, 1079-1080.
10. International Labour Office: Encyclopaedia of Occupational Health and Safety, Vol. II, I-Z, McGraw Hill Book Company, New York, 1974, pp. 947-949.
11. Lange, R.L., et al: "Nonatheromatous Ischemic Heart Disease following Withdrawal from Chronic Industrial Nitroglycerin Exposure," Circulation, 46:666-678, 1972.

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REFERENCES AND SOURCES
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1910.1000

- (f) Personal Protective Equipment, and, (h) Sanitation
Eye: American Industrial Hygiene Association, "Hygienic Guide Series;" Grant, "Toxicology of the Eye"
Skin: Gleason, Gosselin, Hodge, Smith, "Clinical Toxicology of Commercial Products;" Patty, "Industrial Hygiene and Toxicology;" Hamilton and Hardy, "Industrial Toxicology;" International Labour Office, "Encyclopedia of Occupational Health and Safety;" Johnston, "Glycols;" American Industrial Hygiene Association, "Hygienic Guide Series;" Sax, "Dangerous Properties of Industrial Materials;" Von Oettingen, "Poisoning"
Ingestion: Von Oettingen, "Poisoning;" International Labour Office, "Encyclopedia of Occupational Health and Safety;" Christensen and Luginbyhl, "NIOSH Toxic Substances List;" Sax, "Dangerous Properties of Industrial Materials"

COMMENTS

Eye - Classification: 2 and 6
Output statement numbers: 10 and 12 combined
Exceptions: None

The Hygienic Guide Series states, "published reports of the effect of liquid ethylene glycol dinitrate (EGDN) on the eye have not been found. However, the toxicity of the material by other routes indicates the prudence of the use of chemical workers' goggles if eye contact with the liquid is likely."

According to Grant, "the effects of nitroglycerin (NG) on the eye have not been well documented, but observations made fifty years ago are commonly quoted." However, these accounts give systemic effects, rather than effects of direct splashing of liquid NG on the eyes.

A literature search for both EGDN and NG failed to produce any specific data concerning direct contact with either compound on the eye. Because of the recommendation of the AIHA, however, it is concluded to be "prudent" to assign classifications of 2 and 6 to EGDN and a classification of 2 to NG.

Skin - Classifications: 1 and 5
Output statement numbers: 1, 5a, 6, 8a, 14g, 14i, 15, 20a, 21
Exceptions: See below

According to Gleason, EGDN is "more acutely toxic than NG" and "in animals it is more rapidly absorbed through the skin." Patty reports, "it is more toxic for cats and rabbits and produces a greater methemoglobin and Heinz body response."

In man, Patty notes that the "cardiovascular effects overshadow all others," and adds, "acute exposure in man results in headache, nausea, vomiting, hypotension, and tachycardia. The much quoted reports of sudden deaths in explosives workers that have been attributed to exposure to ethylene glycol dinitrate have never been explained satisfactorily. Blood pressure abnormalities (presumably hypotension) have been observed in appreciable numbers of men engaged in the production of

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dynamite, with exposures to both ethylene glycol dinitrate and nitroglycerin."

Hamilton and Hardy report that evidence of cardiovascular effects caused by EGDN and NG may be "associated with sudden death in explosives workers." Diagnosis of these workers has usually been "acute myocardial (sic) infraction," often with no coronary arterial diseases or occlusions. Literature reviews suggest this occurs after "one or two days absence from exposure. Hamilton and Hardy further add, however, "epidemiological evidence for causal association between exposure and sudden death is impressive, though circumstantial."

The ILO notes that a "period of exposure, which often varies between 6 and 10 years, 'results in this' sudden death phenomena," and death is so rapid that it is not possible to examine a victim during an attack.

Johnston states, "chronic poisoning involves anemia, irreversible red blood cell changes, fatty changes in heart muscles, liver and kidney, and hyperplasia of the bone marrow. Human fatalities that resulted suddenly twenty-four to forty - eight hours after exposures have not been adequately explained."

The Hygienic Guide Series says that EGDN "is absorbed through the skin in toxic amounts - more readily than NG. The minimum dose, applied as a 1% solution in alcohol, which causes headaches in man was reported as 18 - 35 mg."

According to Sax, NG "can be absorbed through uninjured skin and may produce eruptions on the palms and intra-digital spaces of the hands." Von Oettingen further notes that these eruptions are "similar to those of poison ivy poisoning" and may "ulcerate under the nails and finger tips and are slow to heal."

Other symptoms of absorption through the skin according to Von Oettingen, are "flushing of the face and neck, and throbbing headache." These symptoms are sometimes associated with "decrease in blood pressure, nausea, vomiting and diarrhea the heart at first may be increased, but later slowed. The symptoms usually occur after 'few minutes' exposure. Severe exposure may result in "weakness and prostration, occasionally methemoglobinemia, jaundice, edema of the legs and injury to the kidneys."

Patty, in a comprehensive discussion of NG skin absorption reports, "in view of the skin absorption and low vapor pressure, skin exposures are particularly significant. Absorption of relatively small amounts results in an intense throbbing headache, often associated with nausea, and occasionally with vomiting and abdominal pain. Larger amounts may result in hypotension, depression, confusion, occasionally delirium, methemoglobinemia, and cyanosis. A temporary tolerance to headache develops from repeated exposure but this is usually lost after a few days without exposure. Workers have utilized this phenomenon by placing a small amount of nitroglycerin in their hat bands to ensure continued absorption and to prevent 'Monday headache.' Fatalities from industrial

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intoxication are uncommon. Medical studies of explosives workers with combined nitroglycerin and ethylene glycol dinitrate exposures have not given evidence of chronic intoxication or injury despite the occurrence of transient symptoms."

EGDN has a vapor pressure of 0.05 mm Hg at 20 degrees C. It is 0.52% soluble in water and explodes when subjected to heat or impact. The temperature at which it explodes is circa 237 degrees F.

NG has a melting point of 55 degrees F, a vapor pressure of 0.0015 mm Hg at 20 degrees C, and a solubility in water of 0.17%. It also is shock sensitive and can explode at a temperature of 293 degrees F.

The Hygienic Guide Series data indicate that EGDN is very readily absorbed through the skin. To prevent any of the acute and chronic effects discussed above, it is concluded necessary to assign this substance a classification of 1 and to specify statements 5a and 15 because of its low vapor pressure.

The data available for NG indicate that not only can it be absorbed through the skin but it can also cause slow healing local effects. Though it is indicated that the substance is absorbed more slowly than EGDN, it is indicated that relatively small amounts of this compound can also cause the cited effects. Thus, classifications of 1 and 5 are concluded to be appropriate for NG.

Because of the shock sensitivity of both of these explosives, statement 21 is specified to insure that only clothing which becomes wet is immediately removed. Also, due to the extreme shock sensitivity the solid material would have, it is not handled or used in this state and, therefore, only the liquid substance has been addressed.

Ingestion - Classification: 1 and 5

Output statement numbers: 19, 20a

Exceptions: None

According to Von Oettingen, the toxic symptoms resulting from acute exposure to EGDN are "essentially the same as those experienced with nitroglycerin, namely: headache, nausea, vomiting, lowering of blood pressure, tachycardia, hyper-hydrosis, cyanosis due to methemoglobinemia, and dyspnea upon exertion. Several cases of sudden death have been reported in workers exposed to this material."

The ILO, however, states cases of sudden death have also been reported in workers in contact with nitroglycerin, however, "death has usually been attributed to the action of EGDN mixed with nitroglycerin in the manufacture of dynamite." The ILO further notes that ingestion of large amounts of NG "usually causes fatal collapse."

The NIOSH Toxic Substances List gives the oral rat LD50 as 616 mg/kg for EGDN, and the oral rat LDLO for nitroglycerin as 80 mg/kg.

Sax rates EGDN as moderately toxic and nitroglycerin as highly toxic.

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Given the very low vapor pressures of these compounds and the possible effects of very small doses, classifications of 1 and 5 are concluded to be warranted.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

National Fire Protection Association, "Fire Protection Guide on Hazardous Materials," 5th edition, 1975 (NFPA)

E. I. duPont de Nemours and Co., Material Safety Data Sheet, "Nitro-glycerin - Sensitized Nitrate" (duP)

"Lange's Handbook of Chemistry," 11th edition (Lange)

Kirk-Othmer, "Encyclopedia of Chemical Technology," 2nd edition, Vol. I, p. 602, 605 (K - O)

American Industrial Hygiene Journal, November 1966, p. 584 (AIHJ)

Sources of data items used:

- I. A. 1. Synonyms: NFPA 325M, Lange, K-O
2. Formula: NFPA 325M
3. Molecular weight: Lange
- B. 1. Boiling point: Lange, K-O; (CRC Handbook reports higher values)
2. Specific gravity: K-O, NFPA 325M
3. Vapor density: Not applicable
4. Melting point: K-O
5. Vapor pressure: K-O
6. Solubility in water: K-O
7. Evaporation rate: Not applicable
8. Appearance and odor: AIHA
- II. A. 1. Flash point: NFPA 325M
2. Autoignition temperature: K-O, NFPA 325M
3. Impact Sensitivity: K-O
4. Explosion Temperature: K-O
5. Flammable limits: Not applicable
6. Extinguishing media: duP
7. Special fire fighting procedures: duP
8. Unusual fire and explosion hazards: duP
- B. 1. Conditions contributing to instability: K-O
2. Incompatibilities: duP
3. Hazardous decomposition products: ADL
4. Special precautions: ADL
- III. A. Steps if released or spilled: duP
C. Waste disposal method: K-O, duP
- V. Miscellaneous precautions: duP, K-O

USE/EXPOSURE AND CONTROL DOCUMENT

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Bresler, R. R., "Nitroglycerin Reactions Among Pharmaceutical Workers," Industrial Medicine and Surgery, 18:519 - 523, 1949 (Bresler)

Carmichael, P. and Lieben, J., "Sudden Death in Explosive Workers,"

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"Ethylene Glycol Dinitrate," American Conference of Government Industrial Hygienists, Hygienic Guide Series, November - December 1966 (Hygienic Guides)

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- Trainor, D. C. and Jones, R. C., "Headaches in Explosive Magazine Workers," Archives of Environmental Health, 12:231 - 234, 1966 (Trainor)
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References for Specific Use/Exposure

1. Yee, Carmichael
2. K-O
3. Edgewood, K-O
4. Hunter, Trainor, Weiner
5. Bresler, K-O

References for Specific Control Methods

1. Hygienic Guides, Yee, ILO
2. Hygienic Guides
3. Hygienic Guides, Edgewood
4. Hygienic Guides
5. Bresler

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RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Ethylene glycol dinitrate and/or nitroglycerin

D. O. L. STANDARD: 0.2 ppm shall not be exceeded

WARNING PROPERTIES:

Odor Threshold: There is no quantitative information available concerning the odor threshold of ethylene glycol dinitrate and/or nitroglycerin.

Eye Irritation Level: Ethylene glycol dinitrate and nitroglycerin are not known to be an eye irritants.

Evaluation of Warning Properties: Since there is no quantitative information available relating warning properties to air concentrations of ethylene glycol dinitrate and/or nitroglycerin, this material is treated as a substance with poor warning properties. Gas sorbent respiratory equipment is not permitted. This substance is also considered to be a shock sensitive material for which sorbent type respirators should not be used.

IDLH: 80 ppm

Basis for IDLH Value: There are no acute inhalation toxicity data available upon which to base the IDLH concentration for ethylene glycol dinitrate and/or nitroglycerin (EGDN and/or NG). The chosen IDLH, therefore, is based upon chronic toxicity data concerning the physiological response of animals to EGDN. According to Patty rats and guinea pigs survived "6 months' exposure to 500 ug/liter (80 ppm) with the only effect being slight drowsiness and some Heinz body formation." Although Patty states that EGDN is more toxic for cats and rabbits, 80 ppm is still probably a conservative IDLH concentration, since cats given 2-hour daily exposures to 21 ppm EGDN for 100 days exhibited only marked blood changes.

Other Toxicological Information: Patty reports that ethylene glycol dinitrate (EGDN) "is absorbed through the skin, the lungs, and the gastrointestinal tract. Van Oettingen has summarized the toxicity data in his review of nitrate esters (Table 16). It causes hypotension, methemoglobinemia and Heinz body formation. Inhalation of the low level of 2 ppm, 2 hours a day, for 1000 days by cats caused transient blood changes and 21 ppm for the same period resulted in

RESPONSE TO ETHYLENE GLYCOL DINITRATE

Species	Dose	Route	Response
Cat	100 mg/kg	Subcutaneous	Certain fatal dose
Rabbit	400 mg/kg	Subcutaneous	Certain fatal dose
Cat	60 mg/kg	Subcutaneous	45% methemoglobin, Heinz bodies
Rabbit	12.5 mg/kg		Hypotension
Cat	21 ppm X 1000	Inhalation	Marked blood changes only
Cat	2 ppm X 1000	Inhalation	Temporary blood changes
Man	1.8 - 3.5 cc. of 1% solution	Skin	Minimal dose for headache

marked blood changes. Rats and guinea pigs are quite tolerant, surviving 6 months' exposure to 500 ug/liter (80 ppm) with the only effect being slight drowsiness and some Heinz body formation. Chronic

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poisoning in animals is associated with anemia as well as methemoglobinemia and Heinz body formation. Ethylene glycol dinitrate is absorbed through the skin more rapidly than nitroglycerin. It is more toxic for cats and rabbits and produces a greater methemoglobin and Heinz body response . . .

"Acute exposure in man results in headache, nausea, vomiting, hypotension, and tachycardia."

Concerning the physiological response to nitroglycerin, Patty states that "nitroglycerin is absorbed through the skin, lungs, and mucous membranes. In view of the skin absorption and low vapor pressure, skin exposures are particularly significant. Absorption of relatively small amounts results in an intense throbbing headache, often associated with nausea, and occasionally with vomiting and abdominal pain. Larger amounts may result in hypotension, depression, confusion, occasionally delirium, methemoglobinemia and cyanosis. Aggravation of these symptoms and the occurrence of maniacal manifestations after alcohol ingestion have been repeatedly observed. A temporary tolerance to headache develops from repeated exposures but this is usually lost after a few days without exposure . . . Fatalities from industrial intoxication are uncommon. Medical studies of explosives workers with combined nitroglycerin and ethylene glycol dinitrate exposures have not given evidence of chronic intoxication of injury despite the occurrence of transient symptoms. An extensive study of 276 workers with long exposure to nitroglycerin and ethylene glycol dinitrate in three Swedish explosives factories gave no evidence of permanent deterioration in health. The average air concentrations of nitroglycerin-ethylene glycol dinitrate for most operations were below 5 mg/cu meter, usually 2 to 4 mg/cu meter. In the group with exposures to concentrations generally below 3 mg/cu meter, symptoms such as fatigue and alcohol intolerance were less frequent but there was little difference in the frequency of headaches. Headache and fatigue were the predominant symptoms. Vomiting, dyspnea, and alcohol intolerance were less frequent and chest pain was least frequent. The occurrence of 'anginoid crises' or other acute heart emergencies has not been thoroughly substantiated but the suggestive reports point to the need for further documentation of this important possibility."

Patty states that at 0.5 ppm (5 mg/cu meter), "headaches and other symptoms will occur . . . but chronic injury is unlikely. Skin absorption is probably important and careful attention is required to reduce this exposure."

The Documentation of TLV's state that "on present knowledge the limit for each separately should be equal to the limit of the combined EGDN and NG, namely 0.2 ppm. Because of the type of risk involved, this limit should represent a ceiling 'C' value, not to be exceeded . . . A ceiling TLV of 0.02 ppm for NG and EGDN combined for intermittent exposures only is recommended to prevent blood pressure lowering and headaches."

LFL: EGDN and NG are explosive

VAPOR PRESSURE AT 20 C: EGDN: 0.05 mm Hg; NG: 0.0015 mm Hg

SATURATED CONCENTRATION AT 20 C: EGDN: 66 ppm; NG: 2 ppm

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USE/EXPOSURE AND CONTROL DOCUMENT
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	Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1.	Inhalation of vapor and skin contact with liquid and dust during formulation and filling operations in manufacture of industrial explosives (including dynamite, cordite, and blasting gelatin)	A,D	Process enclosure; local exhaust ventilation; temperature control; personal protective equipment (respiratory protective devices, gloves, goggles, protective clothing)
2.	Inhalation of vapor and skin contact with liquid during synthesis and handling of substance	A,D	Process enclosure; local exhaust ventilation; temperature control; personal protective equipment (respiratory protective devices, gloves, goggles, protective clothing)
3.	Inhalation of vapor and skin contact with liquid and dust during formulation and filling operations in manufacture of propellants (including rocket and small-arm propellants for military use)	A,D	Process enclosure; local exhaust ventilation; temperature control; personal protective equipment (respiratory protective devices, gloves, goggles, protective clothing)
4.	Inhalation of vapor and dust and skin contact with liquid and dust during handling of industrial explosives (including loading operations at magazines and preparation of charges for firing in mining and construction)	A,D	Process enclosure; local exhaust ventilation; temperature control; personal protective equipment (respiratory protective devices, gloves, goggles)
5.	Inhalation of vapor and dust and skin contact with liquid and dust during preparation and handling of dosage forms (including tablets and solutions) in pharmaceuticals manufacture	A,D	Process enclosure; local exhaust ventilation

A -- Inhalation

B -- Skin contact resulting in

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for ETHYLENE GLYCOL DINITRATE AND/OR NITROGLYCERIN

- localized irritation
- C -- Ingestion
- D -- Skin contact resulting in
absorption and subsequent
systemic poisoning