

# OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR NITROGLYCERIN AND ETHYLENE GLYCOL DINITRATE

## INTRODUCTION

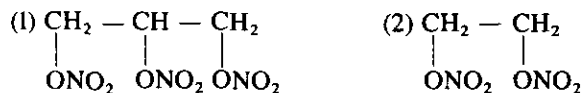
This guideline summarizes pertinent information about nitroglycerin (NG) and ethylene glycol dinitrate (EGDN) for workers, employers, and occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; therefore, readers are advised to regard these recommendations as general guidelines.

## SUBSTANCE IDENTIFICATION

Data in the following section are presented for (1) nitroglycerin and (2) ethylene glycol dinitrate.

• **Formula:** (1)  $C_3H_5N_3O_9$  (2)  $C_2H_4N_2O_6$

• **Structure:**



• **Synonyms:** (1) Anginine, blasting gelatin, blasting oil, glonoin, glycerol trinitrate, glyceryl nitrate, glyceryl trinitrate, GTN, myocon, NG, niglycon, niong, nitric acid triester of glycerol, nitrine-TDC, nitroglycerol, nitroglycyn, nitrol; (2) Dinitrolycol, EGDN, ethanediol dinitrate, ethylene dinitrate, ethylene nitrate, glycol dinitrate, nitroglycol

• **Identifiers:** (1) CAS 55-63-0; RTECS QX2100000; DOT not assigned; (2) CAS 628-96-6; RTECS KW5600000; DOT not assigned

• **Appearance and odor:** (1) Pale yellow, slightly sweet smelling oil; (2) yellowish liquid with no odor

## CHEMICAL AND PHYSICAL PROPERTIES

Data in the following section are presented for (1) nitroglycerin and (2) ethylene glycol dinitrate. If not specified, data apply to both compounds.

• **Physical data**

1. Molecular weight: (1) 227.11; (2) 152.08
2. Boiling point (at 760 mmHg): (1) 256°C (493°F); (2) 197-200°C (387-392°F)

3. Explosive point: (1) 270°C (518°F); (2) 114°C (237°F)
4. Specific gravity (water = 1): (1) 1.6; (2) 1.49
5. Vapor density: (1) 7.8 (air = 1 at boiling point of NG); (2) 5.24 (air = 1 at boiling point of EGDN)
6. Melting point: (1) 13.1°C (55.1°F); (2) -22.3°C (-9°F)
7. Vapor pressure at 20°C (68°F): (1) 0.00012-0.011 mmHg; (2) 0.04 mmHg
8. (1) Slightly soluble in water; (2) insoluble in water

• **Reactivity**

1. Incompatibilities: Contact with acids, heat, or mechanical shock may result in explosion.
2. Hazardous decomposition products: Toxic vapors and gases (e.g., oxides of nitrogen and carbon monoxide) may be released in an explosion involving NG or EGDN.

• **Flammability**

1. Flash point: Explodes
2. Autoignition temperature: (1) 270.4°C (518°F); (2) 195°C (383°F)
3. Class A Explosive (29 CFR 1910.109), Flammability Rating 2 (NFPA)

• **Warning properties**

Evaluation of warning properties for respirator selection: Based on lack of information on odor threshold and eye irritation levels, NG and EGDN should be considered to have poor warning properties.

## EXPOSURE LIMITS

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for NG and EGDN is 0.2 parts of NG or EGDN per million parts of air (ppm) [2 milligrams of NG or 1 milligram of EGDN per cubic meter of air ( $\text{mg}/\text{m}^3$ )] as a ceiling concentration which shall at no time be exceeded (Skin). The notation "Skin" refers to the potential contribution to overall exposure by the cutaneous route including the mucous membranes and eyes. The National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL) for NG or EGDN alone or for mixtures of the two substances is 0.1  $\text{mg}/\text{m}^3$  as a ceiling concentration determined in any 20-minute sampling period. The American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV®) for NG or EGDN is

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Public Health Service Centers for Disease Control  
National Institute for Occupational Safety and Health  
Division of Standards Development and Technology Transfer

0.05 ppm (0.5 mg/m<sup>3</sup> NG or 0.3 mg/m<sup>3</sup> EGDN) as a time-weighted average concentration (TWA) for a normal 8-hour workday and a 40-hour workweek (Skin) (Table 1).

**Table 1.—Occupational exposure limits for nitroglycerin and ethylene glycol dinitrate**

	Exposure limits	
	ppm	mg/m <sup>3</sup>
OSHA PEL		
NG ceiling (Skin)*	0.2	2
EGDN ceiling (Skin)†	0.2	1
NIOSH REL		
Ceiling (20 min)	—	0.1
ACGIH TLV®		
NG TWA (Skin)	0.05	0.5
EGDN TWA (Skin)	0.05	0.3

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

† If the atmospheric concentration of EGDN exceeds 0.02 ppm, personal protection may be necessary to avoid headache.

## HEALTH HAZARD INFORMATION

### • Routes of exposure

NG and EGDN may cause adverse health effects following exposure via inhalation, ingestion, or dermal contact.

### • Summary of toxicology

1. *Effects on animals:* Subchronic inhalation of EGDN by mice caused lethargy, skin damage, muscle spasms, and death due to circulatory and respiratory paralysis. In cats, subchronic or chronic inhalation or dermal administration of EGDN caused severe anemia, decreased appetite, seizures, hemorrhage of internal organs, and death. Chronic oral administration of NG to rats produced cancer of the liver. NIOSH will continue to monitor the research regarding NG to determine whether the collective evidence justifies controlling this chemical as a carcinogen.

2. *Effects on humans:* Acute inhalation or dermal exposure of workers to NG and EGDN has caused decreased systolic, diastolic, and pulse blood pressures due to vascular dilation. Chronic exposure to NG and EGDN has caused damage to the heart and reduced tolerance to alcohol. Chronic exposure to NG and EGDN, or to NG alone, followed by a brief or extended period away from exposure, has been associated with an increased incidence of sudden death.

### • Signs and symptoms of exposure

1. *Short-term (acute):* Exposure to NG and EGDN can cause severe headache, dizziness, nausea, and heart palpitations.

2. *Long-term (chronic):* Exposure to NG and EGDN can cause severe chest pain (angina pectoris), which frequently occurs during brief periods away from work. Skin sensitization can also occur.

## RECOMMENDED MEDICAL PRACTICES

### • Medical surveillance program

Workers with potential exposures to chemical hazards should be monitored in a systematic program of medical surveillance

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

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

### • Preplacement medical evaluation

Prior to placing a worker in a job with a potential for exposure to NG or EGDN, the physician should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the skin and nervous, cardiovascular, and hematopoietic (blood-cell-forming) systems.

A preplacement medical evaluation is recommended in order to detect and assess preexisting or concurrent conditions which may be aggravated or result in increased risk when a worker is exposed to NG or EGDN at or below the NIOSH REL. The examining physician should consider the probable frequency, intensity, and duration of exposure, as well as the nature and degree of the condition, in placing such a worker. Such conditions, which should not be regarded as absolute contraindications to job placement, include a history and physical or other findings suggestive of cardiovascular disease, especially coronary artery disease. The physician should obtain baseline values for electrocardiographic studies appropriate for the age and medical history of the worker.

### • Periodic medical screening and/or biologic monitoring

Occupational health interviews and physical examinations should be performed at regular intervals. Additional examinations may be necessary should a worker develop symptoms that may be attributed to exposure to NG or EGDN. The interviews, examinations, and appropriate medical screening and/or biologic monitoring tests should be directed at identifying an excessive decrease or adverse trend in the physiologic function of the skin and nervous, hematopoietic, and cardiovascular sys-

tems as compared to the baseline status of the individual worker or to expected values for a suitable reference population.

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

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

- **Sentinel health events**

1. Acute SHE's include methemoglobinemia.
2. Delayed-onset SHE's include methemoglobinemia and chest pain (angina pectoris).

## MONITORING AND MEASUREMENT PROCEDURES

- **Ceiling concentration evaluation**

Measurements to determine worker exposure should be taken during periods of maximum expected airborne concentrations of NG and EGDN. Each measurement to determine the NIOSH REL (ceiling exposure) in the worker's breathing zone (air that most nearly represents that inhaled by the worker) should consist of a 20-minute sample or a series of consecutive samples that total 20 minutes. A minimum of three measurements should be taken during one workshift, and the highest of all measurements taken is an estimate of the worker's exposure. If the periods of maximum exposure are not clearly defined, a statistical procedure which can be used as a peak exposure detection strategy is given in the *Occupational Exposure Sampling Strategy Manual*.

- **Method**

Sampling and analysis may be performed by collecting NG and EGDN vapors with tenax solid sorbent tubes followed by desorption with ethanol and analysis by gas chromatography. Detector tubes or other direct-reading devices calibrated to measure NG and EGDN may also be used if available. A detailed sampling and analytical method for NG and EGDN may be found in the *NIOSH Manual of Analytical Methods* (method number 2507).

## PERSONAL PROTECTIVE EQUIPMENT

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

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

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

## SANITATION

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

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

Skin that becomes contaminated with NG or EGDN should be promptly washed with soap and water.

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

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

## COMMON OPERATIONS AND CONTROLS

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

**Table 2.—Operations and methods of control for nitroglycerin and ethylene glycol dinitrate**

Operations	Controls
During formulation and filling operations in the manufacture of industrial explosives and propellants	Process enclosure, local exhaust ventilation, temperature control, personal protective equipment
During the synthesis and handling of NG or EGDN; during the handling of industrial explosives	Process enclosure, local exhaust ventilation, temperature control, personal protective equipment
During the preparation and handling of dosage forms including tablets and solutions in the manufacture of pharmaceuticals	Process enclosure, local exhaust ventilation

## EMERGENCY FIRST AID PROCEDURES

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

#### • Eye exposure

Where there is any possibility of a worker's eyes being exposed to NG or EGDN, an eye-wash fountain should be provided within the immediate work area for emergency use.

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

#### • Skin exposure

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

If NG or EGDN gets on the skin, wash it immediately with soap and water. If NG or EGDN penetrates the clothing, remove the clothing immediately and wash the skin with soap and water. Get medical attention promptly.

#### • Rescue

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

## SPILLS AND LEAKS

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

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

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities of liquids containing NG or EGDN, absorb on sponges or paper towels kept in a sodium carbonate solution. Remove paper towels to a secure outdoor location for burning.
4. Large quantities of liquids containing NG or EGDN may be washed with water into holding tanks where NG and EGDN can be separated. NG and EGDN should not be allowed to enter a confined space such as a sewer because of the possibility of an explosion.
5. If in solid form, NG and EGDN may be collected using non-sparking tools and removed to a secure, outdoor location for burning.

## WASTE REMOVAL AND DISPOSAL

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

## RESPIRATORY PROTECTION

It must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should

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

In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including selection of the correct respirators, requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly. Only respirators that have been approved by the Mine Safety and Health Administration (MSHA, formerly Mining Enforcement and Safety Administration) and by NIOSH should be used. **Remember! Air-purifying respirators will not protect from oxygen-deficient atmospheres.**

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

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**Table 3.—Respiratory protection for nitroglycerin and ethylene glycol dinitrate**

Condition	Minimum respiratory protection*†
Concentration:	
Less than or equal to 0.2 ppm	Any supplied-air respirator (substance reported to cause eye irritation or damage—may require eye protection)
	Any self-contained breathing apparatus (substance reported to cause eye irritation or damage—may require eye protection)
Less than or equal to 0.5 ppm	Any supplied-air respirator operated in a continuous flow mode (substance reported to cause eye irritation or damage—may require eye protection)
Less than or equal to 2 ppm	Any self-contained breathing apparatus with a full facepiece
	Any supplied-air respirator with a full facepiece
Less than or equal to 20 ppm	Any supplied-air respirator with a half-mask and operated in a pressure-demand or other positive pressure mode (substance reported to cause eye irritation or damage—may require eye protection)
Less than or equal to 40 ppm	Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode
Planned or emergency entry into environments containing unknown concentrations or levels above 40 ppm	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
	Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Firefighting	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
Escape only	Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister having a high-efficiency particulate filter
	Any appropriate escape-type self-contained breathing apparatus

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

† The respiratory protection listed for any given condition is the minimum required to meet the NIOSH REL of 0.1 mg/m<sup>3</sup> (ceiling).