



# Criteria For A Recommended Standard

**Occupational Exposure to  
Ethylene Glycol Monomethyl Ether,  
Ethylene Glycol Monoethyl Ether,  
and Their Acetates**



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Public Health Service  
Centers for Disease Control  
National Institute for Occupational Safety and Health



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National Institute for Occupational Safety and Health  
Division of Standards Development and Technology Transfer  
Cincinnati, Ohio

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## FOREWORD

The purpose of the Occupational Safety and Health Act of 1970 (Public Law 91-596) is to assure safe and healthful working conditions for every working person and to preserve our human resources. The Act authorizes the National Institute for Occupational Safety and Health (NIOSH) to develop and recommend occupational safety and health standards and to develop criteria that will ensure that no worker will suffer diminished health, functional capacity, or life expectancy as a result of his or her work experience.

Through criteria documents, NIOSH communicates recommended standards to regulatory agencies, including the Occupational Safety and Health Administration (OSHA) and the Mine Safety and Health Administration (MSHA). In addition, NIOSH distributes these documents to health professionals in academia, industry, organized labor, public interest groups, and other appropriate government agencies. Criteria documents provide the scientific basis for the occupational safety and health standards. These documents generally contain a critical review of the scientific and technical information available on the prevalence of hazards, the existence of safety and health risks, and the adequacy of control methods.

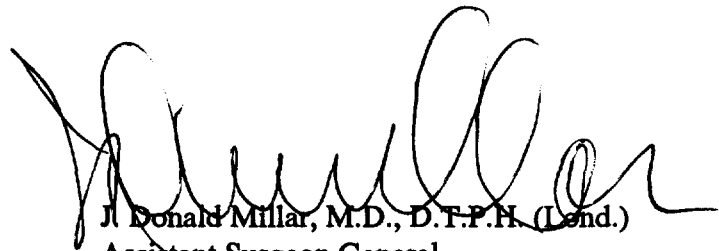
This criteria document reviews available information about the health risks for workers engaged in the manufacture and use of ethylene glycol monomethyl ether (EGME), ethylene glycol monoethyl ether (EGEE), and their acetates, ethylene glycol monomethyl ether acetate (EGMEA) and ethylene glycol monoethyl ether acetate (EGEEA). Evidence from case reports clearly establishes the risk of adverse effects on the blood, central nervous and hematopoietic systems, liver, and kidneys. The results of studies in animals have demonstrated dose-related embryotoxicity and other reproductive effects in several species of animals exposed to EGME, EGEE, and their acetates by different routes of administration. Of particular concern are studies in which exposure of pregnant animals to airborne concentrations of EGME or EGEE at or below their current OSHA permissible exposure limits (PELs) led to increased incidences of malformations, growth retardation, and embryonic death. Concern was also caused by testicular atrophy and infertility resulting from exposure of male animals to airborne concentrations of EGME or EGEE at or below their PELs.

A known metabolism precedes the reproductive and developmental toxicity of EGME and EGEE in animals. Because the same metabolic pathways exist in humans, NIOSH considers it prudent to assume that humans and animals are similarly subject to the reproductive and developmental effects of these chemicals. EGMEA and EGEEA have the same potential for reproductive and developmental effects as the parent compounds because they are metabolized to EGME and EGEE, respectively.

Because limited data are available from studies in humans, NIOSH bases its recommended exposure limits (RELs) for EGME, EGEE, and their acetates on data from studies in animals. The data were adjusted to allow for uncertainties in the extrapolation from animals to humans. NIOSH recommends that worker exposure to EGME and EGMEA in the workplace be limited to 0.1 part per million parts of air (0.1 ppm) (0.3 mg EGME/m<sup>3</sup> and 0.5 mg

EGMEA/m<sup>3</sup>) as a time-weighted average for up to 10 hr/day during a 40-hr workweek (10-hr TWA). Exposure to EGEE and EGEEA in the workplace shall be limited to 0.5 ppm (1.8 mg/m<sup>3</sup> for EGEE and 2.7 mg/m<sup>3</sup> for EGEEA) as a 10-hr TWA. Exposure to these glycol ethers shall be reduced using state-of-the-art engineering controls and work practices. Dermal contact is prohibited because EGME, EGEE, and their acetates are readily absorbed through the skin.

The Institute takes sole responsibility for the conclusions and recommendations presented in this document. All reviewers' comments are being sent with this document to OSHA and MSHA for consideration in standard setting.

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## ABSTRACT

This document examines the occupational health risks associated with exposure to ethylene glycol monomethyl ether (EGME), ethylene glycol monoethyl ether (EGEE), and their acetates, ethylene glycol monomethyl ether acetate (EGMEA) and ethylene glycol monoethyl ether acetate (EGEEA). Criteria are also provided for eliminating or minimizing the risks encountered by workers during the manufacture and use of these glycol ethers.

These glycol ethers adversely affect the blood, central nervous and hematopoietic systems, liver, and kidneys. Studies in animals have demonstrated dose-related malformations, growth retardation, and embryonic death in the offspring of pregnant animals exposed to airborne concentrations of EGME or EGEE at or below their current Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs). In addition, testicular atrophy and infertility occurred in male animals exposed to airborne concentrations of EGME or EGEE at or below their current PELs. EGMEA and EGEEA have the same potential for reproductive and developmental effects as the parent compounds because they are metabolized to EGME and EGEE, respectively.

The National Institute for Occupational Safety and Health (NIOSH) therefore recommends that exposure to EGME and EGMEA in the workplace be limited to 0.1 part per million parts of air (0.1 ppm) ( $0.3 \text{ mg EGME/m}^3$  and  $0.5 \text{ mg EGMEA/m}^3$ ) as a time-weighted average for up to 10 hr/day during a 40-hr workweek (10-hr TWA).

NIOSH also recommends that exposure to EGEE and EGEEA be limited to 0.5 ppm ( $1.8 \text{ mg EGEE/m}^3$  and  $2.7 \text{ mg EGEEA/m}^3$ ) as a 10-hr TWA. Exposure to these glycol ethers shall be reduced using state-of-the-art engineering controls and work practices. Dermal contact is prohibited because EGME, EGEE, and their acetates are readily absorbed through the skin.

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## ABBREVIATIONS

ABP	androgen binding protein
ACGIH	American Conference of Governmental Industrial Hygienists
Ach	acetylcholine
ADH	alcohol dehydrogenase
Cal OSHA	California Occupational Safety and Health Administration
CAS	Chemical Abstracts Service
cc	cubic centimeter
CFR	Code of Federal Regulations
CHO	Chinese hamster ovary
CK	creatinine kinase
cm	centimeter
CNS	central nervous system
CY	cyclophosphamide
DA	dopamine
DEGBE	diethylene glycol butyl ether
DEGME	diethylene glycol monomethyl ether
DPGME	dipropylene glycol monomethyl ether
DTH	delayed type hypersensitivity
EAA	ethoxyacetic acid
EC <sub>50</sub>	concentration that allowed 50% of the seeded cells to form colonies
EGEE	ethylene glycol monoethyl ether
EGEEA	ethylene glycol monoethyl ether acetate
EGME	ethylene glycol monomethyl ether
EGMEA	ethylene glycol monomethyl ether acetate
EMH	extramedullary hemopoiesis
FSH	follicle-stimulating hormone
g	gram
g.d.	gestation day

Hb	hemoglobin
Hct	hematocrit
HPLC	high performance liquid chromatography
5-HT	5-hydroxytryptamine
IDLH	immediately dangerous to life and health
IgG	immunoglobulin G
i.p.	intraperitoneal
i.v.	intravenous
kcal	kilocalorie
kg	kilogram
KLH	keyhole limpet hemocyanin
LC <sub>50</sub>	lethal concentration for 50% of the animals
LD <sub>50</sub>	lethal dose for 50% of the animals
LDH	lactate dehydrogenase
LH	luteinizing hormone
LOAEL	lowest observable adverse effect level
m	meter
MAA	methoxyacetic acid
M.A.C.	maximum allowable concentration
MCHb	mean corpuscular (cell) hemoglobin
MCHC	mean cell hemoglobin concentrations
MCV	mean corpuscular (cell) volume
MEK	methylethyl ketone
mg	milligram
MIBK	methyl isobutyl ketone
min	minute
ml	milliliter
mM	millimolar
mmol	millimole
4-MP	4-methylpyrazole
MSDS	material safety data sheet
MSHA	Mine Safety and Health Administration
NAD	nicotinamide adenine
NADPH	nicotinamide adenine diphosphate

NE	norepinephrine
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NOAEL	no observable adverse effect level
NOES	National Occupational Exposure Survey
NTP	National Toxicology Program
OSHA	Occupational Safety and Health Administration
PCV	packed cell volume
PEL	permissible exposure limit
ppe	personal protective equipment
ppm	parts per million
RBC	red blood cell or erythrocyte
REL	recommended exposure limit
RTECS	Registry of Toxic Effects of Chemical Substances
s.c.	subcutaneous
SRBC	sheep erythrocyte
STEL	short-term exposure limit
TDI	toluene diisocyanate
TLV	threshold limit value
TNP-LPS	trinitrophenyl-lipopolysaccharide
TWA	time-weighted average
UCC	Union Carbide Corporation
UDS	unscheduled DNA synthesis
μmol	micromole
v/v	volume to volume
WBC	white blood cell
wk	week

## GLOSSARY

**Biological monitoring:** The measurement and evaluation of hazardous substances or their metabolites in the body tissues, fluids, or exhaled air of exposed workers.

**Developmental toxicity:** Any adverse effects on normal growth, development, or acquisition of organ function in (1) the conceptus of a pregnant woman exposed to a chemical or physical agent, or (2) an immature (prepubertal) individual exposed to a chemical or physical agent.

**Lowest observable adverse effect level (LOAEL):** The lowest concentration of a chemical or physical agent that produces an observable adverse health effect in exposed animals or workers.

**No observable adverse effect level (NOAEL):** The concentration of a chemical or physical agent that produces no observable adverse health effect in exposed animals or workers.

**Recommended exposure limit (REL):** An occupational exposure limit recommended by NIOSH as being protective of worker health and safety over a working lifetime; the REL is used in combination with engineering and work practice controls, exposure and medical monitoring, labeling, posting, worker training, and personal protective equipment. The REL is frequently expressed as a time-weighted average (TWA) exposure for up to 10 hr/day during a 40-hr workweek. The REL may also be expressed as (1) a short-term exposure limit (STEL) that should never be exceeded and is to be determined in a specified sampling time (usually 15 min), or (2) a ceiling limit (C) that should never be exceeded even instantaneously unless specified over a given time period.

**Reproductive hazard:** Any chemical or physical agent capable of causing an adverse effect on reproduction.

**Reproductive toxicity:** Any adverse effects on gametogenesis, fecundity, or sexual functions (e.g., libido, menstrual cyclicity, potency) that result when a postpubertal individual of either sex is exposed to certain chemical or physical agents.

**Skin:** The notation “skin” indicates that airborne or direct exposure by the cutaneous route (including mucous membranes and eyes) contributes to overall exposure.

**Time-weighted average (10-hr TWA):** An airborne concentration of a chemical or physical agent in the worker’s breathing zone for up to 10 hr/day during a 40-hr workweek.

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