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Provisional Peer-Reviewed Toxicity Values for

Propylene Glycol Monoethyl Ether

(Alpha Isomer [CASRN 52125-53-8] and
Beta Isomer [CASRN 1569-02-4])

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COMMONLY USED ABBREVIATIONS AND ACRONYMS

α2u-g	alpha 2u-globulin
ACGIH	American Conference of Governmental Industrial Hygienists
AIC	Akaike's information criterion
ALD	approximate lethal dosage
ALT	alanine aminotransferase
AST	aspartate aminotransferase
atm	atmosphere
ATSDR	Agency for Toxic Substances and Disease Registry
BMD	benchmark dose
BMDL	benchmark dose lower confidence limit
BMDS	Benchmark Dose Software
BMR	benchmark response
BUN	blood urea nitrogen
BW	body weight
CA	chromosomal aberration
CAS	Chemical Abstracts Service
CASRN	Chemical Abstracts Service Registry Number
CBI	covalent binding index
CHO	Chinese hamster ovary (cell line cells)
CL	confidence limit
CNS	central nervous system
CPN	chronic progressive nephropathy
CYP450	cytochrome P450
DAF	dosimetric adjustment factor
DEN	diethylnitrosamine
DMSO	dimethylsulfoxide
DNA	deoxyribonucleic acid
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
FEV1	forced expiratory volume of 1 second
GD	gestation day
GDH	glutamate dehydrogenase
GGT	γ-glutamyl transferase
GSH	glutathione
GST	glutathione-S-transferase
Hb/g-A	animal blood-gas partition coefficient
Hb/g-H	human blood-gas partition coefficient
HEC	human equivalent concentration
HED	human equivalent dose
i.p.	intraperitoneal
IRIS	Integrated Risk Information System
IVF	in vitro fertilization
LC_{50}	median lethal concentration
LD_{50}	median lethal dose
LOAEL	lowest-observed-adverse-effect level
MN	micronuclei
MNPCE	micronucleated polychromatic erythrocyte
MOA	mode-of-action
MTD	maximum tolerated dose
NAG	N-acetyl-β-D-glucosaminidase
NCEA	National Center for Environmental Assessment
NCI	National Cancer Institute
NOAEL	no-observed-adverse-effect level
NTP	National Toxicology Program
NZW	New Zealand White (rabbit breed)
OCT	ornithine carbamoyl transferase
ORD	Office of Research and Development
PBPK	physiologically based pharmacokinetic
PCNA	proliferating cell nuclear antigen
PND	postnatal day
POD	point of departure
$POD_{[ADJ]}$	duration-adjusted POD
QSAR	quantitative structure-activity relationship
RBC	red blood cell
RDS	replicative DNA synthesis
RfC	inhalation reference concentration
RfD	oral reference dose
RGDR	regional gas dose ratio
RNA	ribonucleic acid
SAR	structure activity relationship
SCE	sister chromatid exchange
SD	standard deviation
SDH	sorbitol dehydrogenase
SE	standard error
SGOT	glutamic oxaloacetic transaminase, also known as AST
SGPT	glutamic pyruvic transaminase, also known as ALT
SSD	systemic scleroderma
TCA	trichloroacetic acid
TCE	trichloroethylene
TWA	time-weighted average
UF	uncertainty factor
UF_A	interspecies uncertainty factor
UF_H	intraspecies uncertainty factor
UF_S	subchronic-to-chronic uncertainty factor
UF_D	database uncertainty factor
U.S.	United States of America
WBC	white blood cell

PROVISIONAL PEER-REVIEWED TOXICITY VALUES FOR PROPYLENE GLYCOL MONOETHYL ETHER

(Alpha Isomer [CASRN 52125-53-8] and Beta Isomer [CASRN 1569-02-4])

BACKGROUND

A Provisional Peer-Reviewed Toxicity Value (PPRTV) is defined as a toxicity value derived for use in the Superfund Program. PPRTVs are derived after a review of the relevant scientific literature using established Agency guidance on human health toxicity value derivations. All PPRTV assessments receive internal review by a standing panel of National Center for Environment Assessment (NCEA) scientists and an independent external peer review by three scientific experts.

The purpose of this document is to provide support for the hazard and dose-response assessment pertaining to chronic and subchronic exposures to substances of concern, to present the major conclusions reached in the hazard identification and derivation of the PPRTVs, and to characterize the overall confidence in these conclusions and toxicity values. It is not intended to be a comprehensive treatise on the chemical or toxicological nature of this substance.

The PPRTV review process provides needed toxicity values in a quick turnaround timeframe while maintaining scientific quality. PPRTV assessments are updated approximately on a 5-year cycle for new data or methodologies that might impact the toxicity values or characterization of potential for adverse human health effects and are revised as appropriate. It is important to utilize the PPRTV database (http://hhpprtv.ornl.gov) to obtain the current information available. When a final Integrated Risk Information System (IRIS) assessment is made publicly available on the Internet (http://www.epa.gov/iris), the respective PPRTVs are removed from the database.

DISCLAIMERS

The PPRTV document provides toxicity values and information about the adverse effects of the chemical and the evidence on which the value is based, including the strengths and limitations of the data. All users are advised to review the information provided in this document to ensure that the PPRTV used is appropriate for the types of exposures and circumstances at the site in question and the risk management decision that would be supported by the risk assessment.

Other U.S. Environmental Protection Agency (EPA) programs or external parties who may choose to use PPRTVs are advised that Superfund resources will not generally be used to respond to challenges, if any, of PPRTVs used in a context outside of the Superfund program.

QUESTIONS REGARDING PPRTVs

Questions regarding the contents and appropriate use of this PPRTV assessment should be directed to the EPA Office of Research and Development's National Center for Environmental Assessment, Superfund Health Risk Technical Support Center (513-569-7300).

INTRODUCTION

Propylene glycol monoethyl ether (alpha isomer [CASRN 52125-53-8] and beta isomer [CASRN 1569-02-4]) is a clear colorless liquid used to make lacquers, paints, leather finishes, wood stains, furniture polishes, inks, polyglycol ethers, and cleaning products. It is also used as an antifreeze, solvent, adhesive additive, as well as in agrochemical formulations and nail care products (ChemIDplus, 2014). The molecular formula of both propylene glycol monoethyl ether isomers is $C_5H_{12}O_2$ (see Figure 1). A list of physicochemical properties of the propylene glycol monoethyl ether isomers is provided in Table 1.

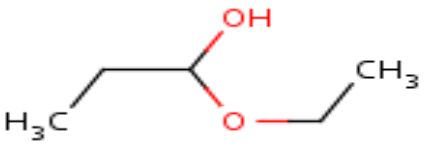
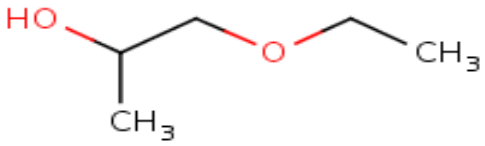
Alpha Isomer (CASRN 52125-53-8)	Beta Isomer (CASRN 1569-02-4)
	

Figure 1. Chemical Structures of Propylene Glycol Monoethyl Ether Isomers

Table 1. Physicochemical Properties of Propylene Glycol Monoethyl Ether Isomers[a]

Property (unit)	Value	
	Alpha Isomer (CASRN 52125-53-8)	Beta Isomer (CASRN 1569-02-4)
Boiling point (°C)	ND	131
Melting point (°C)	ND	ND
Density (g/cm^3 at 20°C)	ND	ND
pH (unitless)	ND	ND
Relative vapor density (air = 1)	ND	ND
Vapor pressure (mm Hg at 25°C)	2.42	3.86
Solubility in water (mg/L at 25°C)	3.66×10^5	3.66×10^5
LogP (octanol-water)	NV	NV
Molecular weight (g/mol)	104.15	104.15
Henry's law constant (atm-m^3/mol)	7.38×10^{-8}	7.38×10^{-8}

[a]ChemIDplus (2014).
ND = no data; NV = no value.

Table 2 provides a summary of available toxicity values for propylene glycol monoethyl ether from the U.S. EPA and other regulatory agencies or organizations.

Table 2. Summary of Available Toxicity Values for Propylene Glycol Monoethyl Ether Isomers (Alpha Isomer [CASRN 52125-53-8][a] and Beta Isomer [CASRN 1569-02-4][b])

Source/Parameter[c,d]	Value (Applicability)	Notes	Reference	Date Accessed
Noncancer				
ACGIH	NV[a,b]	NA	ACGIH (2013)	NA
ATSDR	NV[a,b]	NA	ATSDR (2013)	NA
Cal/EPA	NV[a,b]	NA	Cal/EPA (2014a)	9-9-2014[d]
NIOSH	NV[a,b]	NA	NIOSH (2010)	NA
OSHA	NV[a,b]	NA	OSHA (2011, 2006)	NA
IRIS	NV[a,b]	NA	U.S. EPA	9-9-2014
Drinking water	NV[a,b]	NA	U.S. EPA (2012)	NA
HEAST	NV[a]	NA	U.S. EPA (2011)	NA
	[b]Chronic RfD = 7×10^{-1} mg/kg-day [b]Subchronic RfD = 7×10^{0} mg/kg-day	The critical effect is decreased weight gain in rats for both the chronic and subchronic RfDs (Smyth and Carpenter, 1948).	U.S. EPA (2011)	
HEA	NV[a]	NA	U.S. EPA (1984)	NA
	[b]AIS = 476 mg/kg-day [b]AIC = 47.6 mg/kg-day	Based on the incidence of reduced growth and kidney changes in rats (Smyth and Carpenter, 1948).	U.S. EPA (1984)	
CARA HEEP	NV[a,b]	NA	U.S. EPA (1994)	NA
WHO	NV[a,b]	NA	WHO	9-9-2014
Cancer				
IRIS	NV[a,b]	NA	U.S. EPA	9-9-2014
HEAST/WOE	NV[a,b]	NA	U.S. EPA (2011)	NA
IARC	NV[a,b]	NA	IARC (2013)	NA
NTP	NV[a,b]	NA	NTP (2011)	NA

Table 2. Summary of Available Toxicity Values for Propylene Glycol Monoethyl Ether Isomers (Alpha Isomer [CASRN 52125-53-8][a] and Beta Isomer [CASRN 1569-02-4][b])

Source/Parameter[c,d]	Value (Applicability)	Notes	Reference	Date Accessed
Cal/EPA	NV[a,b]	NA	Cal/EPA (2014b, 2009)	NA

[a]Alpha isomer of propylene glycol monoethyl ether
[b]Beta isomer of propylene glycol monoethyl ether
[c]Sources: ACGIH = American Conference of Governmental Industrial Hygienists; ATSDR = Agency for Toxic Substances and Disease Registry; Cal/EPA = California Environmental Protection Agency; CARA = Chemical Assessments and Related Activities; HEA = Health Effects Assessment; HEAST = Health Effects Assessment Summary Tables; HEEP = Health and Environmental Effects Profile; IARC = International Agency for Research on Cancer; IRIS = Integrated Risk Information System; NIOSH = National Institute for Occupational Safety and Health; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration; WHO = World Health Organization.
[d]The Cal/EPA Office of Environmental Health Hazard Assessment (OEHHA) Toxicity Criteria Database (http://oehha.ca.gov/tcdb/index.asp) was also reviewed and found to contain no information on propylene glycol monoethyl ether.

AIC = acceptable intake chronic; AIS = acceptable intake subchronic; IDLH = immediately dangerous to life or health; NA = not applicable; NSRL = no significant risk level; NV = not available; PEL = permissible exposure level; REL = recommended exposure level; RfD = oral reference dose TLV = threshold limit value; TWA = time weighted average; WOE = cancer weight of evidence.

Literature searches were conducted on sources published from 1900 through August 2014 for studies relevant to the derivation of provisional toxicity values for propylene glycol monoethyl ether (alpha isomer [CASRN 52125-53-8] and beta isomer [CASRN 1569-02-4]). The following databases were searched by chemical name, synonyms, or CASRN: ACGIH, ANEUPL, ATSDR, BIOSIS, Cal/EPA, CCRIS, CDAT, ChemIDplus, CIS, CRISP, DART, EMIC, EPIDEM, ETICBACK, FEDRIP, GENE-TOX, HAPAB, HERO, HMTC, HSDB, IARC, INCHEM IPCS, IPA, ITER, IUCLID, LactMed, NIOSH, NTIS, NTP, OSHA, OPP/RED, PESTAB, PPBIB, PPRTV, PubMed (toxicology subset), RISKLINE, RTECS, TOXLINE, TRI, U.S. EPA IRIS, U.S. EPA HEAST, U.S. EPA HEEP, U.S. EPA OW, and U.S. EPA TSCATS/TSCATS2. The following databases were searched for toxicity values or exposure limits: ACGIH, ATSDR, Cal/EPA, U.S. EPA IRIS, U.S. EPA HEAST, U.S. EPA HEEP, U.S. EPA OW, U.S. EPA TSCATS/TSCATS2, NIOSH, NTP, OSHA, and RTECS.

REVIEW OF POTENTIALLY RELEVANT DATA (NONCANCER AND CANCER)

The available data on both isomers of propylene glycol monoethyl ether primarily focus on their physicochemical properties. No repeated-dose toxicity studies via the oral or inhalation route of exposure are available in humans or laboratory animals for the alpha isomer of propylene glycol monoethyl ether. For the beta isomer of propylene glycol monoethyl ether, the only relevant study that warrants any consideration for derivation of provisional references doses (p-RfDs) is an oral range-finding study by Smyth and Carpenter (1948). In this study, propylene glycol monoethyl ether was administered in the drinking water to groups of Sherman rats (5/sex/dose) at doses of 0 (control), 160, 680, or 2,140 mg/kg-day for 30 days. Body weight, appetite, and morbidity were measured, and microscopic analysis of the adrenals, upper intestine, kidney, liver, and spleen were performed (although the time at which these measurements were conducted was not reported, it was assumed to have been at study termination). Appetite was judged on the basis of water consumption (in mL). Reduced appetite and reduced growth at 2,140 mg/kg-day were reported by the study authors (sex of rats affected was not specified). Although propylene glycol monoethyl ether-induced "kidney changes" were mentioned in the U.S. EPA (1984) Health Effects Assessment (HEA), no such changes were mentioned in the original Smyth and Carpenter (1948) study report. No details regarding the examination or observation of other toxicological endpoints were provided in the study.

Oral toxicity values have been previously derived using the Smyth and Carpenter (1948) range-finding study (U.S. EPA, 2011, 1984; see Table 2). However, the HEA (U.S. EPA, 1984) document reported that the Smyth and Carpenter (1948) study is only marginally adequate for risk assessment purposes, as this study utilized a relatively small number of animals, and hematology, serum biochemistry, urinalysis, organ weights, and detailed histopathology were not reported. Thus, the Smyth and Carpenter (1948) study does not comprehensively evaluate sufficient toxicological endpoints, and is not considered adequate for use in the derivation of any p-RfD values by current standards.

No toxicity information is available regarding inhalation exposure of humans or animals to the beta isomer of propylene glycol monoethyl ether.

DERIVATION OF PROVISIONAL VALUES

DERIVATION OF ORAL REFERENCE DOSES

Feasibility of Deriving Subchronic and Chronic p-RfDs

No subchronic-duration, chronic-duration, developmental toxicity, reproductive toxicity, or carcinogenicity studies on the alpha isomer of propylene glycol monoethyl ether via the oral route were identified. For the beta isomer of propylene glycol monoethyl ether, only a 30-day oral range-finding study (Smyth and Carpenter, 1948) in Sherman rats is available. However, as stated above, this study is not considered adequate for use in the derivation of any p-RfD values by current standards. Thus, an attempt was made to use a computational toxicological surrogate approach to identify surrogate chemicals for both isomers of propylene glycol monoethyl ether (see Wang et al., 2012 for details on this established methodology). For the alpha isomer of propylene glycol monoethyl ether, no suitable analogs with >50% structural similarity and possessing repeated-dose toxicity values were identified using the ChemIDplus database. For the beta isomer of propylene glycol monoethyl ether, two putative structural analogs (1-methoxy-2-hydroxypropane [or propylene glycol monomethyl ether; CASRN 107-98-2] and propylene glycol [CASRN 57-55-6]) with >50% structural similarity and possessing repeated-dose toxicity values were identified using the ChemIDplus database. Although subchronic and chronic p-RfDs are available in a PPRTV assessment of propylene glycol (U.S. EPA, 2008), these p-RfDs are based on hematological endpoints observed in male Wistar rats following 5 weeks of oral administration in drinking water (Vaille et al., 1971). Thus, when compared to the beta isomer of propylene glycol monoethyl ether, it cannot be determined whether the 1-methoxy-2-hydroxypropane and propylene glycol structural analogs share similar target organs of toxicity or toxicity endpoints following oral exposure. Additionally, due to the general lack of information on the physicochemical properties of the alpha and beta isomers of propylene glycol monoethyl ether (see Table 1), it is difficult to analyze for comparability with those of the two putative structural analogs (see Appendix A; note known differences in solubility and vapor pressure). Finally, no metabolism information is available for either of the propylene glycol monoethyl ether isomers. Taken together, a computational toxicological surrogate approach based on the established Wang et al. (2012) methodology is not feasible for either isomer of propylene glycol monoethyl ether; therefore, no p-RfDs are derived in this PPRTV assessment.

DERIVATION OF INHALATION REFERENCE CONCENTRATIONS

Feasibility of Deriving Subchronic and Chronic Provisional Reference Concentrations (p-RfCs)

Although a chronic inhalation reference concentration (RfC) is available on IRIS for the 1-methoxy-2-hydroxypropane structural analog to the beta isomer of propylene glycol monoethyl ether (U.S. EPA, 1995), no short-term-duration, subchronic-duration, chronic-duration, developmental toxicity, reproductive toxicity, or carcinogenicity studies on either the alpha or beta isomers of propylene glycol monoethyl ether via the inhalation route were available for comparative toxicity analysis. Thus, application of a computational toxicological surrogate approach in the derivation of p-RfCs is precluded in this PPRTV assessment.

CANCER WEIGHT-OF-EVIDENCE (WOE) DESCRIPTOR

Limitations in the available data preclude development of a WOE descriptor for both isomers of propylene glycol monoethyl ether.

MODE-OF-ACTION (MOA) DISCUSSION

Limitations in the available data preclude determination of a MOA discussion for both isomers of propylene glycol monoethyl ether.

APPENDIX A. PHYSICOCHEMICAL PROPERTIES OF PUTATIVE STRUCTURAL ANALOGS TO PROPYLENE GLYCOL MONOETHYL ETHER ISOMERS

Physicochemical Properties of Putative Structural Analogs to Propylene Glycol Monoethyl Ether Isomers[a]

Property (unit)	Value	
	1-Methoxy-2-Hydroxypropane (CASRN 107-98-2)	**Propylene Glycol (CASRN 57-55-6)**
Boiling point (°C)	119	187.6
Melting point (°C)	-1.42×10^{2}	-6.00×10^{1}
Density (g/cm^3 at 20°C)	ND	ND
pH (unitless)	ND	ND
Relative vapor density (air = 1)	ND	ND
Vapor pressure (mm Hg at 25°C)	12.5	0.129
Solubility in water (mg/L at 25°C)	1.00×10^{6}	1.00×10^{6}
LogP (octanol-water)	–0.490	–0.92
Molecular weight (g/mol)	90.12	76.09
Henry's law constant ($atm\text{-}m^3/mol$)	9.20×10^{-7}	1.29×10^{-8}

[a]ChemIDplus (2014).
ND = no data.

APPENDIX B. REFERENCES

ACGIH (American Conference of Governmental Industrial Hygienists). (2013). 2013 TLVs and BEIs. Based on documentation of the threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH.

ATSDR (Agency for Toxic Substances and Disease Registry). (2013). Minimal risk levels (MRLs) for hazardous substances. Atlanta, GA: Agency for Toxic Substances and Disease Registry (ATSDR). Retrieved from http://www.atsdr.cdc.gov/mrls/index.asp

Cal/EPA (California Environmental Protection Agency). (2009). Appendix A: Hot spots unit risk and cancer potency values. Sacramento, CA: Office of Environmental Health Hazard Assessment. http://www.oehha.ca.gov/air/hot_spots/2009/AppendixA.pdf

Cal/EPA (California Environmental Protection Agency). (2014a). All OEHHA acute, 8-hour and chronic reference exposure levels (chRELs) as of June 2014. Sacramento, CA: Office of Health Hazard Assessment. http://www.oehha.ca.gov/air/allrels.html

Cal/EPA (California Environmental Protection Agency). (2014b). Chemicals known to the state to cause cancer or reproductive toxicity June 6, 2014. (Proposition 65 list). Sacramento, CA: California Environmental Protection Agency, Office of Environmental Health Hazard Assessment. http://oehha.ca.gov/prop65/prop65_list/files/P65single060614.pdf

Cal/EPA (California Environmental Protection Agency). OEHHA toxicity criteria database. Sacramento, CA: Office of Environmental Health Hazard Assessment. http://www.oehha.ca.gov/tcdb/

ChemIDplus. (2014). Propylene glycol monoethyl ether [Database]. Bethesda, MD: National Institutes of Health, National Library of Medcine. Retrieved from http://toxnet.nlm.nih.gov/

IARC (International Agency for Research on Cancer). (2013). Bitumens and bitumen emissions, and some N- and S-heterocyclic polycyclic aromatic hydrocarbons. IARC monographs on the evaluation of carcinogenic risks to humans, vol 103. Geneva, Switzerland: WHO. http://monographs.iarc.fr/ENG/Monographs/vol103/mono103.pdf

NIOSH (National Institute for Occupational Safety and Health). (2010). NIOSH pocket guide to chemical hazards. Index of chemical abstracts service registry numbers (CAS No.). Atlanta, GA: Center for Disease Control and Prevention, U.S. Department of Health, Education and Welfare. http://www.cdc.gov/niosh/npg/npgdcas.html

NTP (National Toxicology Program). (2011). Report on carcinogens: Twelfth edition (12th ed.). Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health. http://ntp.niehs.nih.gov/ntp/roc/twelfth/roc12.pdf

OSHA (Occupational Safety & Health Administration). (2006). Table Z-1 limits for air contaminants. Occupational Safety and Health Administration. http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992

OSHA (Occupational Safety & Health Administration). (2011). Air contaminants: occupational safety and health standards for shipyard employment, subpart Z, toxic and hazardous substances. (OSHA Standard 1915.1000). Washington, DC: U.S. Department of Labor. http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10286

Smyth, HF, Jr; Carpenter, CP. (1948). Further experience with the range finding test in the industrial toxicology laboratory. J Ind Hyg Toxicol 30: 63-68.

U.S. EPA (U.S. Environmental Protection Agency). (1984). Health effects assessment for glycol ethers [EPA Report]. (EPA/540/1-86/052). Cincinnati, OH: U.S. Environmental Protection Agency, Environmental Criteria and Assessment Office. http://www.ntis.gov/search/product.aspx?ABBR=PB86134632

U.S. EPA (U.S. Environmental Protection Agency). (1994). Chemical assessments and related activities (CARA) [EPA Report]. (600/R-94/904; OHEA-I-127). Washington, DC: U.S. Environmental Protection Agency, Office of Health and Environmental Assessment. http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=60001G8L.txt

U.S. EPA (U.S. Environmental Protection Agency). (1995). IRIS summary for propylene glycol monomethyl ether (PGME) (CASRN 107-98-2). Washington, DC: U.S. Environmental Protection Agency, Integrated Risk Information System. http://www.epa.gov/iris/subst/0404.htm

U.S. EPA (U.S. Environmental Protection Agency). (2008). Provisional peer reviewed toxicity values for propylene glycol (CASRN 57-55-6) [EPA Report]. Cincinnati, OH: U.S. Environmental Protection Agency, National Center for Environmental Assessment.

U.S. EPA (U.S. Environmental Protection Agency). (2011). Health effects assessment summary tables (HEAST). Washington, DC: U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. http://epa-heast.ornl.gov/

U.S. EPA (U.S. Environmental Protection Agency). (2012). 2012 Edition of the drinking water standards and health advisories. (EPA/822/S-12/001). Washington, DC: Office of Water. http://water.epa.gov/action/advisories/drinking/upload/dwstandards2012.pdf

U.S. EPA (U.S. Environmental Protection Agency). Integrated risk information system (IRIS) [Database]. Washington, DC: U.S. Environmental Protection Agency, Integrated Risk Information System. Retrieved from http://www.epa.gov/iris/

Vaille, C; Debray, C; Rozé, C; Souchard, M; Martin, E. (1971). [Hyperglycemic action of propylene glycol]. Ann Pharm Fr 29: 577-582.

Wang, NC; Zhao, QJ; Wesselkamper, SC; Lambert, JC; Petersen, D; Hess-Wilson, JK. (2012). Application of computational toxicological approaches in human health risk assessment. I. A tiered surrogate approach. Regul Toxicol Pharmacol 63: 10-19. http://dx.doi.org/10.1016/j.yrtph.2012.02.006

WHO (World Health Organization). Online catalog for the Environmental Health Criteria Series. Available online at http://www.who.int/ipcs/publications/ehc/en/