

## APPENDIX C

### OCCUPATIONAL EXPOSURES TO THE GLYCOL ETHERS BY WORKSITE OR PROCESS

Table C-1.—Occupational exposures by worksite or process

Glycol ether	Worksite or process	Reference *	Number and type of samples	Concentration	
				Range (ppm)	Average (ppm)
EGEE	Leather dyeing	Gill 1977	1 BZ <sup>†</sup>	ND <sup>‡</sup>	ND
	Spray painting	Lee 1982	2 BZ	both 25	25
	Painting (brush and spray)	Love and Donohue 1983	8 BZ	ND-128	22
		Sparer et al. 1988	90 BZ	0-21.5	2.6
	Manufacture of solid state circuits	Gunter 1985	6 BZ	ND-96	17
Hospital housekeeping	Apol and Cone 1983	3 BZ	<0.2	<0.2	

(Continued)

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See footnotes at end of table.

Table C-1 (Continued).—Occupational exposures by worksite or process

Glycol ether	Worksite or process	Reference	Number and type of samples	Concentration	
				Range (ppm)	Average (ppm)
EGEE (Cont'd)	Construction of plastic and wood boats	Crandall and Hartle 1983	7 BZ	0.2-1.1	1.1
	Printing	Burroughs 1979	16 BZ 5 area <sup>§</sup>	<2.4-<49 <3.0-<17	<14 <5.9
	Ceramic shell production	Ratcliffe et al. 1986	10 BZ 8 area	ND-24 10-17	Not presented Not presented
EGEEA	Painting, molding, inspection	Gunter and Lucas 1974	21 BZ	<0.4-20	2.4
	Spray painting	Hervin and Thoburn 1975	22 BZ	13-4,657	543
			20 area	11-1,262	191
		Gunter et al. 1980	6 BZ	ND	ND
			1 area	ND	ND
		Hartle 1980	3 BZ	5.7-14	8.8
			6 area	0.3-3.4	2.2
	Apol 1976	8 BZ	ND-5	1.3	
		2 area	ND	ND	
	Chrostek and Levine 1981	8 BZ	0.5-8.1	3.3	

Paint compounding and mixing	Gilles 1977	24 BZ 4 area	ND-1.0 ND	0.11 ND
Degreasing	Johnson and Boxer 1983	2 BZ 2 area	Trace Trace	Trace Trace
Manufacture of solid state circuits	Gunter 1985	14 BZ	ND-1.3	0.2
Mixing and application of epoxy-type paint	Cohen and Maier 1973	15 BZ	0.83-98	27
Graphic arts department	McLouth and Gorman 1980	5 area	ND	ND
Silk-screening	Boiano 1983	7 BZ 6 BZ	1.2-3.8 0.5-4.0	2.3 2.6
Construction of plastic and wood boats	Crandall and Hartle 1983	7 BZ	0.4-2.7	1.1
Coatings processes	Bryant 1978	4 area 6 BZ 6 area	ND-0.6 ND-1.6 ND	0.2 0.5 ND
Spray painting and curing operations	McQuilken 1980	2 BZ 1 area	4.6-8.9 24	6.8 24

(Continued)

Table C-1 (Continued).—Occupational exposures by worksite or process

Glycol ether	Worksite or process	Reference	Number and type of samples	Concentration	
				Range (ppm)	Average (ppm)
EGME	Degreasing and paint stripping	Hervin et al. 1974	24 BZ	ND	ND
	Painting, molding, inspection	Gunter and Lucas 1974	35 BZ	<0.8-5	1.4
	Painting (brush and spray)	Love and Donohue 1983	1 BZ	15	15
		Sparer et al. 1988	81 BZ	0-5.6	0.8
	Coating of paper and fabric with resin	Ramos and Lucas 1973	9 BZ	ND-11	4.1
			8 area	0.7-9.0	5.0
Press room and reel room	Markel and Moody 1982	5 BZ	ND-0.5	0.4	
		3 area	ND-0.4	0.2	
EGMEA	Photo etching	Levy 1976	1 BZ	37	37

\* See References beginning on page 262.

† Breathing zone sample.

\* Not detectable.

§ Immediate work area sample(s).

**Table C-2.—Long-term sampling results for 2-methoxyethanol (2-ME),  
2-ethoxyethanol (2-EE), and 2-ethoxyethyl acetate (2-EEA)\***

Industry	Glycol ether(s) sampled	No. of samples	Samples below limit of detection		Concentration range (ppm) <sup>†</sup>
			No.	Percent	
Aerospace	2-ME	8	8	100	all ≤0.27 <sup>‡</sup>
	2-EE	5	5	100	all ≤0.22 <sup>‡</sup>
	2-EEA	15	15	100	all ≤0.23 <sup>‡</sup>
Electronics	2-EEA	8	8	100	all ≤0.02 <sup>§</sup>
Airlines	2-EEA	13	0	0	0.29-2.69
Coating mfg.	2-EEA	6	0	0	0.07 <sup>**</sup> -0.35
Automotive	2-EEA	12	10	80	≤0.02 <sup>§</sup> -0.05 <sup>**</sup>
Fuel distribution	2-ME	10	3	34	≤0.03 <sup>§</sup> -0.34
Paperboard mfg.	2-ME	9	6	66	≤0.04 <sup>§</sup> -1.06
Glycol ether mfg.	2-EEA	31	25	81	≤0.02 <sup>§</sup> -0.44
Summary	2-ME	27	17	63	≤0.02 <sup>§</sup> -1.06
	2-EE	5	5	100	all ≤0.22 <sup>‡</sup>
	2-EEA	85	58	68	≤0.02 <sup>§</sup> -2.69
Total		117	80	60	≤0.02 <sup>§</sup> -2.69

\* Adapted from Piacitelli et al. [1989].

<sup>†</sup> Samples were not time-weighted to 8-hr concentrations.

<sup>‡</sup> Laboratory analysis was below limit of detection (0.03 mg/sample).

<sup>§</sup> Laboratory analysis was below limit of detection (0.01 mg/sample).

<sup>\*\*</sup> Laboratory analysis was below limit of quantitation (0.03 mg/sample).

**Table C-3.—Distribution of ethylene glycol ethers among the various industrial operations as detected in air samples\***

Operation	Number of air samples	Number of glycol ethers detected			
		EGME	EGMEA	EGEE	EGEEA
Printing	94	0	2	76	61
Painting	81	4	0	19	66
Car repair	20	10	1	0	9
Various	67	0	12	11	38
Total	262	14	15	106	174

\*Table taken from Veulemans et al. [1987b].

**Table C-4.—Concentration (ppm) of ethylene glycol ethers used in various industrial operations\***

Operation		EGME	EGMEA	EGEE	EGEEA
Printing	G.M. <sup>†</sup>	---	0.9	2.6	3.04
	Range	---	0.8-0.9	0.18-47.9	0.06-34.6
Painting	G.M.	9.8	---	2.5	1.8
	Range	1.75-42.8	---	0.37-55.3	0.22-14.6
Car repair	G.M.	2.47	0.48	---	1.7
	Range	1.8-5.0	---	---	0.28-7.8
Various	G.M.	---	2.4	4.5	1.8
	Range	---	0.08-29.9	0.82-332	0.11-151.8

\*Table adapted from Veulemans et al. [1987].

<sup>†</sup>Data are geometric means.

## APPENDIX D

### MATERIAL SAFETY DATA SHEET

The following sections describe the information that must be supplied for each product or material in the appropriate blocks of the Material Safety Data Sheet (MSDS).

To facilitate filing and retrieval, insert the product designation in the block in the upper left corner of the first page. Print in upper case letters as large as possible. The MSDS should be printed to read upright with the sheet turned sideways. For the product designation, use the name or code that appears on the label or the name by which the product is sold or known by workers. The relative numerical hazard ratings and key statements are those determined by the rules in Chapter V, Part B, of the NIOSH publication entitled *A Recommended Standard: An Identification System for Occupationally Hazardous Materials* [NIOSH 1974b]. The company identification may be printed in the upper right corner if desired.

#### D.1 SECTION I. PRODUCTION IDENTIFICATION

Insert the manufacturer's name, address, and regular and emergency telephone numbers (including area code) in the appropriate blocks of Section I. The company listed should be a source of detailed backup information on the hazards of the material(s) covered by the MSDS. The listing of suppliers or wholesale distributors is discouraged. The trade name should be the product designation or common name associated with the material. The synonyms are those commonly used for the product, especially formal chemical nomenclature. Every known chemical designation or competitor's trade name need not be listed.

#### D.2 SECTION II. HAZARDOUS INGREDIENTS

The "materials" listed in Section II shall be those substances that are part of the hazardous product covered by the MSDS and that individually meet any of the criteria defining a hazardous material. Thus, one component of a multicomponent product might be listed because of its toxicity, another component because of its flammability, and a third component for both its toxicity and its reactivity. Note that a MSDS for a single component product must have the name of the material repeated in this section to avoid giving the impression that there are no hazardous ingredients.

List chemical substances according to their complete name derived from a recognized system of nomenclature. Where possible, avoid using common names and general class names such

as “aromatic amine,” “safety solvent,” or “aliphatic hydrocarbon” when the specific name is known.

The “%” may be the approximate percentage by weight or volume (indicate basis) that each hazardous ingredient of the mixture bears to the whole mixture. This may be indicated as a range or maximum amount (i.e., 10% to 40% vol. or 10% max. wt.) to avoid disclosure of trade secrets.

State toxic hazard data in terms of concentration, mode of exposure or test, and animal used (e.g., 100 ppm LC<sub>50</sub>-rat, 25 mg/kg LD<sub>50</sub>-skin-rabbit, 75 ppm LC man, permissible exposure from 29 CFR 1910.1000) or, if not available, from other sources such as NIOSH RELs and publications of the American Conference of Governmental Industrial Hygienists (ACGIH) or the American National Standards Institute, Inc. (ANSI). Flashpoint, shock sensitivity, or similar descriptive data may be used to indicate flammability, reactivity, or similar hazardous properties of the material.

### **D.3 SECTION III. PHYSICAL DATA**

The data in Section III should be for the total mixture. Include the boiling point and melting point in degrees Fahrenheit (Celsius in parenthesis); vapor pressure, in conventional millimeters of mercury (mm Hg); vapor density of gas or vapor (air = 1); solubility in water, in parts/hundred parts of water by weight; specific gravity (water = 1); percent volatiles (indicated if by weight or volume) at 70°F (21.1°C); evaporation rate for liquids or sublimable solids, relative to butyl acetate; and appearance and odor. These data are useful for the control of toxic substances. Boiling point, vapor density, percent volatiles, vapor pressure, and evaporation are useful for designing proper ventilation equipment. This information is also useful for designing and deploying adequate fire and spill containment equipment. The appearance and odor may facilitate identification of substances stored in improperly marked containers or spilled substances.

### **D.4 SECTION IV. FIRE AND EXPLOSION DATA**

Section IV should contain complete fire and explosion data for the product. Include flashpoint and autoignition temperature in degrees Fahrenheit (Celsius in parentheses), flammable limits in percent by volume in air, suitable extinguishing media or materials, special fire-fighting procedures, and unusual fire and explosion hazard information. If the product presents no fire hazard, insert “NO FIRE HAZARD” on the line labeled “Extinguishing Media.”

### **D.5 SECTION V. HEALTH HAZARD INFORMATION**

For the “Health Hazard Data” line, use a combined estimate of the hazard of the total product. This can be expressed as a TWA concentration, as a permissible exposure, or by some other indication of an acceptable standard. Other data are acceptable, such as lowest LD<sub>50</sub> if multiple components are involved.



Under “Routes of Exposure,” comments in each category should reflect the potential hazard from absorption by the route in question. Indicate the severity of the effect and the basis for the statement, if possible. The basis might be animal studies, analogy with similar products, or human experiences. Comments such as “yes” or “possible” are not helpful. Typical comments might be:

Skin Contact—single short contact, no adverse effects likely; prolonged or repeated contact, possibly mild irritation.

Eye Contact—some pain and mild transient irritation; no corneal scarring.

Write “Emergency and First Aid Procedures” in lay language. The procedure should primarily represent first-aid treatment that could be provided by paramedical personnel or individuals trained in first aid.

Include in the “Notes to Physician” section any special medical information of assistance to an attending physician, e.g, required or recommended preplacement and periodic medical examinations, diagnostic procedures, and medical management of overexposed workers.

## **D.6 SECTION VI. REACTIVITY DATA**

The comments in Section VI relate to safe storage and handling of hazardous, unstable substances. Be sure to highlight instability or incompatibility to common substances or circumstances, such as water, direct sunlight, steel or copper piping, acids, alkalies, etc. Include in “Hazardous Decomposition Products” those products released under fire conditions. Also include dangerous products produced by aging, such as peroxides in the case of some ethers. Where applicable, indicate shelf life.

## **D.7 SECTION VII. SPILL OR LEAK PROCEDURES**

List detailed procedures for cleanup and disposal; place emphasis on precautions to be taken to protect workers assigned to cleanup detail. Describe specific neutralizing chemicals or procedures in detail. Disposal methods should be explicit including proper labeling of containers holding residues and ultimate disposal methods such as “sanitary landfill” or “incineration.” Warnings such as “comply with local, State and Federal antipollution ordinances” are proper but not sufficient. Identify specific procedures.

## **D.8 SECTION VIII. SPECIAL PROTECTIONS INFORMATION**

Section VIII requires specific information concerning ventilation requirements and personal protective equipment. Statements such as “yes,” “no,” or “if necessary” are not informative. Specify the type and preferred methods of ventilation. Specify the type and NIOSH or Mine Safety and Health Administration approval class (e.g., supplied air or organic vapor canister for respirators). Specify the type and materials of construction for protective equipment.

## **D.9 SECTION IX. SPECIAL PRECAUTIONS**

“Precautionary Statements” shall consist of the label statements selected for use on the container or placard. Insert in this section additional information on any aspect of safety or health not covered in other sections. The lower block can contain references to published guides or in-house procedures for handling and storage. Department of Transportation markings and classifications and other freight, handling, or storage requirements and environmental controls can be noted.

## **D.10 SIGNATURE AND FILING**

Finally, enter the name and address of the responsible person who completed the MSDS and the date of completion. This will facilitate correcting errors and identifying a source of additional information.

File the MSDS in a location readily accessible to workers exposed to the hazardous substance. The MSDS can be used as a training aid and as the basis for discussion during safety meetings and training of new workers. Its purpose is to assist management by directing attention to the need for specific control engineering, work practices, and protective measures that will ensure safe handling and use of the material. The MSDS will aid the safety and health staff in planning a safe and healthful work environment and in suggesting appropriate emergency procedures and sources of help in the event of harmful exposure of workers.

# MATERIAL SAFETY DATA SHEET

## Sections I – III


# MATERIAL SAFETY DATA SHEET

I PRODUCT IDENTIFICATION		
<b>MANUFACTURER'S NAME</b>	<b>REGULAR TELEPHONE NO.</b> <b>EMERGENCY TELEPHONE NO</b>	
<b>ADDRESS</b>		
<b>TRADE NAME</b>		
<b>SYNONYMS</b>		
II HAZARDOUS INGREDIENTS		
MATERIAL OR COMPONENT	%	HAZARD DATA
III PHYSICAL DATA		
<b>BOILING POINT, 760 MM HG</b>		<b>MELTING POINT</b>
<b>SPECIFIC GRAVITY (H<sub>2</sub>O=1)</b>		<b>VAPOR PRESSURE</b>
<b>VAPOR DENSITY (AIR=1)</b>		<b>SOLUBILITY IN H<sub>2</sub>O % BY WT</b>
<b>% VOLATILES BY VOL</b>		<b>EVAPORATION RATE (BUTYL ACETATE=1)</b>
<b>APPEARANCE AND ODOR</b>		

## MATERIAL SAFETY DATA SHEET (Continued)

### Sections IV – V

<b>IV FIRE AND EXPLOSION DATA</b>				
FLASH POINT (TEST METHOD)		AUTOIGNITION TEMPERATURE		
FLAMMABLE LIMITS IN AIR, % BY VOL.		LOWER		UPPER
EXTINGUISHING MEDIA				
SPECIAL FIRE FIGHTING PROCEDURES				
UNUSUAL FIRE AND EXPLOSION HAZARD				
<b>V HEALTH HAZARD INFORMATION</b>				
<b>HEALTH HAZARD DATA</b>				
<b>ROUTES OF EXPOSURE</b>				
INHALATION				
SKIN CONTACT				
SKIN ABSORPTION				
EYE CONTACT				
INGESTION				
<b>EFFECTS OF OVEREXPOSURE</b>				
ACUTE OVEREXPOSURE				
CHRONIC OVEREXPOSURE				
<b>EMERGENCY AND FIRST AID PROCEDURES</b>				
EYES				
SKIN:				
INHALATION:				
INGESTION:				
<b>NOTES TO PHYSICIAN</b>				

**MATERIAL SAFETY DATA SHEET (Continued)****Sections VI – VIII**

<b>VI REACTIVITY DATA</b>
CONDITIONS CONTRIBUTING TO INSTABILITY
INCOMPATIBILITY
HAZARDOUS DECOMPOSITION PRODUCTS
CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION
<b>VII SPILL OR LEAK PROCEDURES</b>
STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED
NEUTRALIZING CHEMICALS
WASTE DISPOSAL METHOD
<b>VIII SPECIAL PROTECTION INFORMATION</b>
VENTILATION REQUIREMENTS
SPECIFIC PERSONAL PROTECTIVE EQUIPMENT
RESPIRATORY (SPECIFY IN DETAIL)
EYE
GLOVES
OTHER CLOTHING AND EQUIPMENT

**MATERIAL SAFETY DATA SHEET (Continued)**

**Section IX**

<b>IX SPECIAL PRECAUTIONS</b>	
<b>PRECAUTIONARY STATEMENTS</b>	
<b>OTHER HANDLING AND STORAGE REQUIREMENTS</b>	

PREPARED BY \_\_\_\_\_

ADDRESS \_\_\_\_\_

DATE \_\_\_\_\_