

XII. TABLES AND FIGURES

TABLE XII-1

SELECTED PROPERTIES OF ETHYLENE DICHLORIDE

Chemical Abstract's serial number	000107062		
Synonyms	1,2-Dichloroethane Ethylene dichloride Ethylene chloride		
Molecular formula	CH <sub>2</sub> Cl-CH <sub>2</sub> Cl		
Formula weight	98.96		
Boiling point	83.4 C (182 F) (760 mm Hg)		
Melting point	-35.4 C (-31.7 F)		
Vapor density	3.42 (air = 1)		
Specific gravity	1.253 (20 C), (water = 1.000 at 4 C)		
Solubility	0.81g/100g water at 20 C; soluble in ethyl ether, ethyl alcohol, benzene, acetone		
Density of saturated air	1.27 (air = 1)		
Concentration of saturated air	11.5% by volume at 25 C		
Flammable (explosive) limits	6.2 to 15.9% by volume in air		
Flash point	18.3 C (65 F) (open cup) 13.0 C (55.4 F) (closed cup)		
Autoignition temperature	413 C (775 F)		
Vapor pressure	Temp F	Temp C	mm Hg
	50	10	40
	68	20	68
	77	25	85
	86	30	100
	104	40	160
Conversion factors, (25 C 760 mm Hg)	1 mg/liter = 1 g/cu m = 247 ppm 1 ppm = 4.05 mg/cu m = 4.05 µg/liter		

Adapted from references 1,5,6,7

TABLE XII-2

## SIGNS AND SYMPTOMS FOLLOWING FATAL ETHYLENE DICHLORIDE INGESTION

Author	Patient Data	Amount Consumed	Onset of Symptoms	Progression of Signs and Symptoms
Hueper & Smith 1935 [46]	63-year-old man	2 oz	2 hrs	Nausea; faintness; vomiting; dazed; cyanotic; dilated pupils; coarse rales; weak, rapid pulse; dark brown liquid stools; increased cyanosis; pulse and heart sounds absent; dyspnea; death 22 hours after ingestion.
Ienistea & Mezincesco 1943 [8]	30-year-old man	Unknown		Staggering; nausea; vomiting; shivering; stupor; temporary recovery; resumed vomiting; unconsciousness; death 42 hours after ingestion.
Keyzer [47]	1-1/2-year-old boy	1 sip		Extreme weakness; comatose; vomiting; death the next day.
Meurs 1944 [48]	1-1/2-year-old boy	Unknown		Coma; anuria; pneumonia.
Noetzel 1944 [49]	Man	About 82 ml mixed with coffee and beer		Intoxicated; vomiting; diarrhea; unconsciousness; dyspnea; death 6 hours after ingestion.
Bloch 1946 [50]	52-year-old man	Unknown; maybe on several occasions		Inattentive; sleepy; excitement; unconsciousness; rapid, irregular breathing; cyanosis; completely dilated pupils; light pulse; heart and respiratory failure; lung edema; death at least 10 hours after ingestion.

TABLE XII-2 (CONTINUED)

## SIGNS AND SYMPTOMS FOLLOWING FATAL ETHYLENE DICHLORIDE INGESTION

Author	Patient Data	Amount Consumed	Onset of Symptoms	Progression of Signs and Symptoms
Hulst 1946 [51]	43-year-old man, alcoholic	4 drinks diluted with orange juice		Unconsciousness; death 8 hours after ingestion.
[51] (cont'd)	43-year-old man, alcoholic	4 drinks diluted with orange juice		Confusion; deep sleepiness; unconsciousness; vomiting with blood; death 24 hours after ingestion.
Stuhlert [52]	Man	Unknown		Violent vomiting; painful visceral cramps; extreme weakness; pale, cyanotic; weak, rapid pulse; weak heart sounds; rales; dyspnea; increased cyanosis and dyspnea, and weakening pulse; death 20 hours after ingestion.
	Man	Unknown		Violent vomiting; cyanosis; diarrhea; rapid pulse; rales; circulatory failure and death 39 hours after ingestion.
Roubal [53]	55-year-old man, asthmatic	20 ml		Epigastric pain; extreme dizziness; sleeplessness; vomiting; slow pulse; death 24 hours after ingestion.
	16-year-old man	50 ml		Vomiting; epigastric pain; fourth day: muscle spasms, hiccups, pulse 108, no eye- lid response to light; death 91 hours after ingestion.

TABLE XII-2 (CONTINUED)

## SIGNS AND SYMPTOMS FOLLOWING FATAL ETHYLENE DICHLORIDE INGESTION

Author	Patient Data	Amount Consumed	Onset of Symptoms	Progression of Signs and Symptoms
Lochhead & Close [54]	50-year-old man	30 ml	30 minutes	Unconsciousness; vomiting, cyanosis; dilated, fixed pupils; pulmonary edema, extreme dyspnea; death 10 hours after ingestion.
Flotow [55]	Man	About 20 ml	1 hr	Collapse; repeated vomiting; after 12 hours blue lips, difficulty breathing; death 13 hours after ingestion.
	Man	About 20 ml		Death within 12 hours of ingestion.
Garrison & Leadingham [56]	30-year-old man	40 ml		Slight cough; reddened conjunctivae; shock; weak, rapid pulse (100); regained consciousness after 3 hours; hyperactivity alternating with semicomatose condition; death 28 hours after ingestion.
Hubbs & Prusmack [57]	Man		2 hours	Violently ill; shock; cyanosis; pulmonary edema; light coma; vomiting and diarrhea; low blood pressure; severe albuminuria; death at 19 hours after ingestion.
Durwald [58]	2-year-old boy		2 hours	Violent vomiting; 20 hours after ingestion, restlessness, tonic-clonic cramps; during cramps death occurred approx 21 hours after ingestion.

TABLE XII-2 (CONTINUED)

## SIGNS AND SYMPTOMS FOLLOWING FATAL ETHYLENE DICHLORIDE INGESTION

Author	Patient Data	Amount Consumed	Onset of Symptoms	Progression of Signs and Symptoms
Weiss [59]	79-year-old man	1 sip		Vomiting; weakness; pale, cyanotic; scarcely conscious; vagueness; rapid, regular pulse (136); blood pressure not measurable; died 40 hours after ingestion with heart and circulatory failure.
	2-year-old boy	1 sip		Vomiting; diarrhea; tonic spasms; increasing loss of consciousness; dyspnea; impaired circulation; death 20 hours after ingestion.
Reinfried [60]	23-year-old man	1 sip	1 hour	Dizziness; nausea; unconsciousness; vomiting; cyanosis; no pupil reaction; no corneal reflex; difficult breathing; strong motor unrest; death after 8 hours due to respiratory and circulatory failure.
Freundt et al [61]	63-year-old man	1 or 2 sips		Shortly after ingestion unconscious; soon regained consciousness, strong vomiting; period of improvement; 10.5 hours after ingestion unconscious; blood pressure falling; 14 hours after ingestion death resulting from circulatory failure.
Kaira [62]	3 men, 19-27 years old	70, 80, and 100 ml	Few minutes	Vomiting; weakness; dizziness; lost consciousness; deaths occurred 5-8 hours after ingestion.

TABLE XII-2 (CONTINUED)

## SIGNS AND SYMPTOMS FOLLOWING FATAL ETHYLENE DICHLORIDE INGESTION

Author	Patient Data	Amount Consumed	Onset of Symptoms	Progression of Signs and Symptoms
Secchi et al [63]	80-year-old	50 ml		Elevated serum enzymes--LDH, SGOT, SGPT, alkaline phosphatase, glutamic dehydrogenase, RNAase; death a few hours after ingestion.
Martin et al [64]	57-year-old man	40 ml		Somnolence; vomiting; sinus tachycardia (100); ventricular extrasystoles; return of consciousness 14 hours after ingestion; dyspnea; loss of blood pressure; cardiac arrest; death 24 hours after ingestion.
Schonborn et al [65]	18-year-old man	50 ml	1 hour	Somnolent; cyanotic; 4 hours later foul smelling diarrhea; 5.5 hours later shock of circulatory system; death after 17 hours in irreversible shock.
Yodaiken & Babcock [66]	14-year-old boy	15 ml		Within 2 hours severe headache; staggering; lethargy; periodic vomiting; blood pressure drop; oliguric; increasingly dyspneic, somnolent and oliguric; ecchymoses; sinus bradycardia; cardiac arrest; pulmonary edema; refractory hypotension; death on 6th day.

TABLE XII-2 (CONTINUED)

## SIGNS AND SYMPTOMS FOLLOWING FATAL ETHYLENE DICHLORIDE INGESTION

Author	Patient Data	Amount Consumed	Onset of Symptoms	Progression of Signs and Symptoms
Morozov [67]	Man	Several mouthfuls	30 minutes	Vertigo; nausea; vomiting; heart sounds slightly muffled; tachycardia; 17.5 hours later headache; pain in substernal region; cyanotic; rapid, weak pulse; scattered dry rales in lungs; decreased blood pressure; vomiting with bile; liquid stools; subconjunctival hemorrhage; oliguric, paranephric hemorrhage; 5th day pulmonary edema; loss of consciousness, and death 3 hours later.
Bogoyavlenski et al [70]	32-year-old man	8 ml	Immediate	Burning sensation in mouth, throat, stomach; drank milk and vomited; weakness; speech retardation; lethargic; asthenic; cold sweat; heart sounds muffled; weak and rapid pulse; 22 hours after ingestion excitation, restlessness, delirium, face flushed, coarse, systolic murmur, respiratory depression, circulatory weakness, anuria, then death 56 hours after ingestion.

TABLE XII-2 (CONTINUED)

## SIGNS AND SYMPTOMS FOLLOWING FATAL ETHYLENE DICHLORIDE INGESTION

Author	Patient Data	Amount Consumed	Onset of Symptoms	Progression of Signs and Symptoms
[70]	27-year-old man	Half glass	2.5 hours	Unconsciousness; vomiting of dark vomitus; regained consciousness after 12 hours, burning sensation in digestive tract; dyspnea; nausea; cyanosis; respiratory rate 32/minute; moist rales in lungs; heart sounds muffled; pulse 102; extrasystoles; anuria; death 19 hours after ingestion.
Agranovich [72]	26-year-old man	"Large quantity"		Vomiting; unconsciousness; regained consciousness 3 hours later; cyanosis; almost no pulse; loss of consciousness again and death 12 hours after ingestion.
	32-year-old man	Glass		Vomiting, weakness, stomach pains; admitted to hospital on 3rd day with cyanosis, restlessness, tongue coated, dry; frequent liquid stools with blood; abdomen painful on palpation; liver enlarged, dry and moist rales; rapid, weak pulse; anuria; increasing cyanosis; unconsciousness and death on 3rd day after ingestion.
Bryzhin [73]	4 males 20-29 years old	150-200 ml	3-4 hours	Symptoms not reported; deaths 10, 15, 33, and 35 hours after ingestions.



TABLE XII-3

## ETHYLENE DICHLORIDE IN AN AIRCRAFT FACTORY BY OPERATION

Concentration			Gluing		Drying		Other		All		Cumulative
Range µg/l	Mid point µg/l	ppm	No.*	% Total Worktime	No.*	% Total Worktime	No.*	% Total Worktime	No.*	% Total Worktime	%
11-20	15	3.7	0		1	0.05	9	7.09	10	7.14	7.14
21-30	25	6.2	5	0.81	13	0.63	9	7.09	27	8.53	15.67
31-40	35	8.6	3	0.49	17	0.83	16	12.61	36	13.93	29.60
41-50	45	11.1	3	0.49	16	0.78	25	19.70	44	20.97	50.57
51-60	55	13.6	9	1.46	27	1.31	18	14.19	54	16.96	67.53
61-70	65	16.1	9	1.46	27	1.32	8	6.30	44	9.08	76.61
71-80	75	18.5	10	1.63	13	0.63	7	5.52	30	7.78	84.39
81-90	85	21.0	11	1.79	13	0.63	0		24	2.42	86.81
91-100	95	23.5	7	1.14	9	0.44	0		16	1.58	88.39
101-110	105	25.9	8	1.30	5	0.24	0		13	1.54	89.93
111-120	115	28.4	4	0.65	1	0.05	0		5	0.70	90.63
121-130	125	30.9	9	1.46	3	0.15	0		12	1.61	92.24
131-140	135	33.3	4	0.65	4	0.19	0		8	0.84	93.06
141-150	145	35.8	4	0.65	2	0.10	0		6	0.75	93.83
151-160	155	38.3	7	1.14	0		0		7	1.14	94.97
161-170	165	40.8	3	0.49	3	0.15	0		6	0.64	95.61
171-180	175	43.2	3	0.49	0		0		3	0.49	96.10
181-190	185	45.7	7	1.14	0		0		7	1.14	97.24
191-200	195	48.2	13	2.11	0		0		13	2.11	99.35
201-210	205	50.6	4	0.65	0		0		4	0.65	100.00
totals			123	20.00	154	7.50	92	72.50	369	100.00	
TWA, µg/liter				114.5		66.1		44.4		60.05	
TWA, ppm				28.3		16.3		11.0		14.8	

Derived from Kozik [105]

\*No. = number of samples

TABLE XII-4

ETHYLENE DICHLORIDE INHALATION  
EXPOSURES AND EFFECTS IN ANIMALS

Author	Concentration ppm	Exposure Variables	Effects
Loscalzo et al [115]	Not reported	Administered until death of animal	Rabbits: Progressive decrease of blood pressure and devel- opment of respiratory paralysis.
Spencer et al [108]	-	-	Mice: LC50(0.25 hr) = 20,000 ppm LC50(0.53 hr) = 12,000 ppm LC50(2.73 hr) = 3,000 ppm LC50(7.20 hr) = 1,000 ppm
Andreuzzi and Capodaglio [117]	4,800 (70% ethylene dichloride, 30% carbon tetrachloride)	Through face mask	Rabbits: Substantial ECG changes in repolarization phase, decreased arterial pressure, increased venous pressure.
Lioia and Elmino [110]	3,000	4 hours	Rabbits: Slight hemato- logic and bone marrow changes.
[110 & 111]	3,000	2 hr/day 5 days/wk 1 week	Rabbits: Marked progressive anemic responses with changes in blood parameters and bone marrow, reduction of leuko- lipid levels, no changes in peroxidase or deoxyribo- nucleosides.
Lioia and Fondacaro [112]	3,000	2 hr/day 5 days/wk 1 week	Rabbits: Impairment of liver function determined by serum protein electrophoresis, BSP retention, colloidal lability test and decreased in albumin- globulin ratios.
Guarino et al [113]	3,000	4 hours	Rabbits: Hemorrhagic liver and kidney damage.

TABLE XII-4 (CONTINUED)

ETHYLENE DICHLORIDE INHALATION  
EXPOSURES AND EFFECTS IN ANIMALS

Author	Concentration ppm	Exposure Variables	Effects
Guarino et al [113]	3,000	2 hr/day 5 days/wk 1 week	Rabbits: liver and kidney degeneration with necrotic changes.
Lioia et al [114]	3,000	4 hr single & 2 hr/day 5 days/wk 1 week	Rabbits: Severe damage of kidneys and impaired kidney function especially degeneration of the renal tubules.
Heppel et al [106]	3,000	7 hours	Lethal for various animal species, all animals showed narcosis, lacrimation and dyspnea; pulmonary congestion, fatty degeneration of liver and kidneys; necrosis of adrenal cortex.
Heppel et al [106]	1,500	7 hr/day 6 days	Lethal for most animals of 4 species. Similar findings as in animals at 3,000 ppm.
Heppel et al [107]	1,000	7 hr/day 2 days	Death within 20 days for 5 species, pulmonary congestion, renal tubular degeneration, fatty liver degeneration, occasional hemorrhage of the adrenal cortex, and myocardial degeneration.
Hofmann et al [109]	500	6 hr/day 5 days/week 17 weeks	Various species, high mortality, cats and dogs heart dilations and lung hyperemia, rats lipid nephrosis and fat accumulation in adrenal glands.
Heppel et al [107]	400	7 hr/day 5 days/week 17 days	High mortality in five species, slight fatty degeneration of the liver and kidney and diffuse myocarditis.

TABLE XII-4 (CONTINUED)

ETHYLENE DICHLORIDE INHALATION  
EXPOSURES AND EFFECTS IN ANIMALS

Author	Concentration ppm	Exposure Variables	Effects
Spencer et al [108]	400	7 hr/day 5 days/week 5 weeks	Various species high mortality, rapid loss of body weight, increased weight of liver and kidneys, fatty liver degeneration, degeneration of renal tubular epithelium.
Heppel et al [107]	200	7 hr/day 5 days/week	Increased mortality in five species, loss of weight, crusting about the eyes, mild pulmonary congestion, calcification of adrenal medulla and fat droplets in liver and myocardium.
Spencer et al [108]	200	7 hr/day 5 days/wk 180 days	Various species, loss of body weight, slight liver degeneration.
Heppel et al [107]	100	7 hr/day 5 days/wk 4 months	Successful breeding in rats, no abnormal findings at autopsy.
Spencer et al [108]	100	7 hr/day 5 days/wk 226 days	Various species, in guinea pigs, loss of body weight and increased liver weights.
Hofmann et al [109]	100	6 hr/day 5 days/week 17 weeks	Various experimental animals no effect, decreased growth rate in cats.

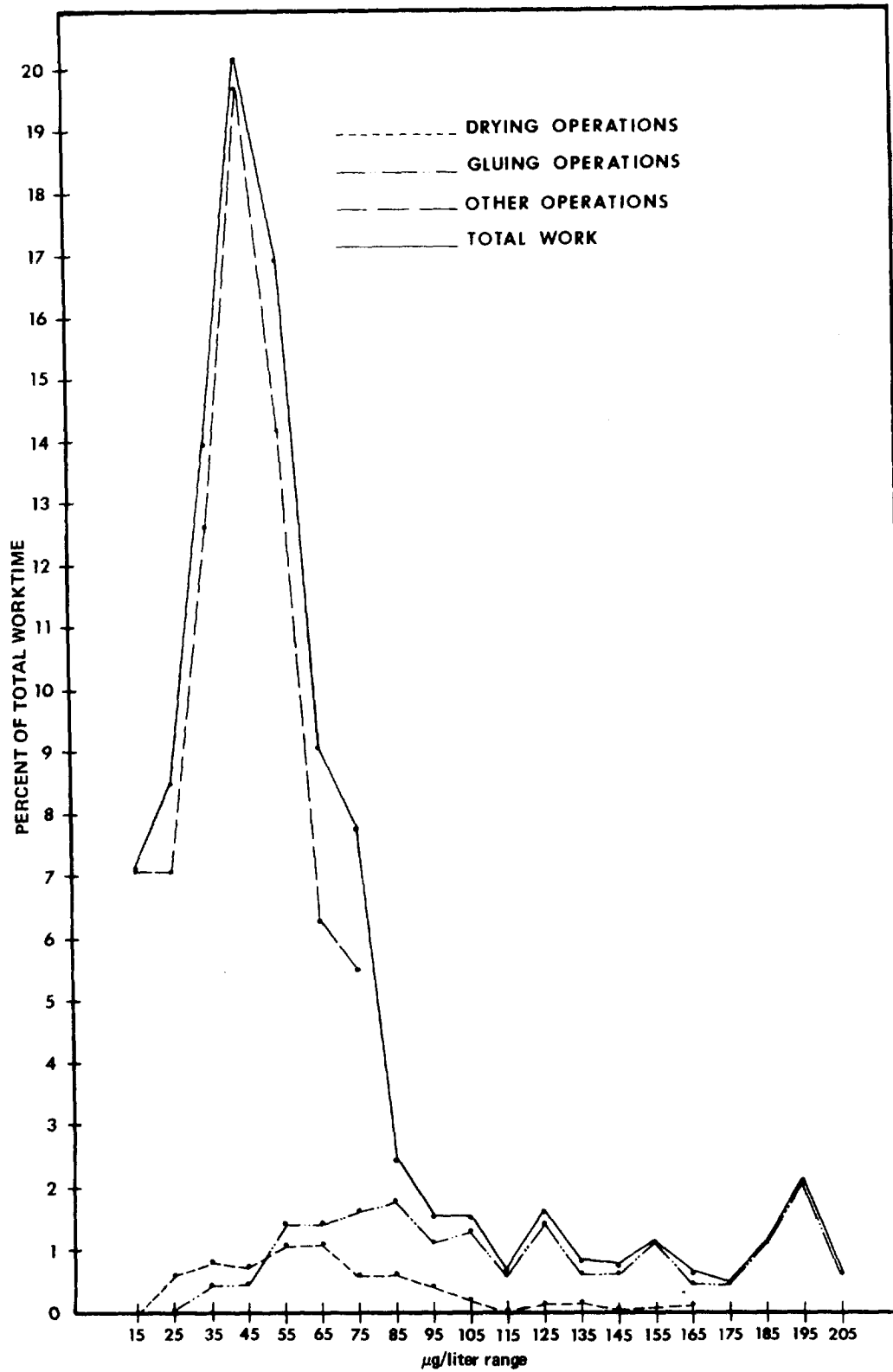


FIGURE XII-1. Relative Frequency of Ethylene Dichloride Concentrations in an Aircraft Factory (Derived from Kozik [105])

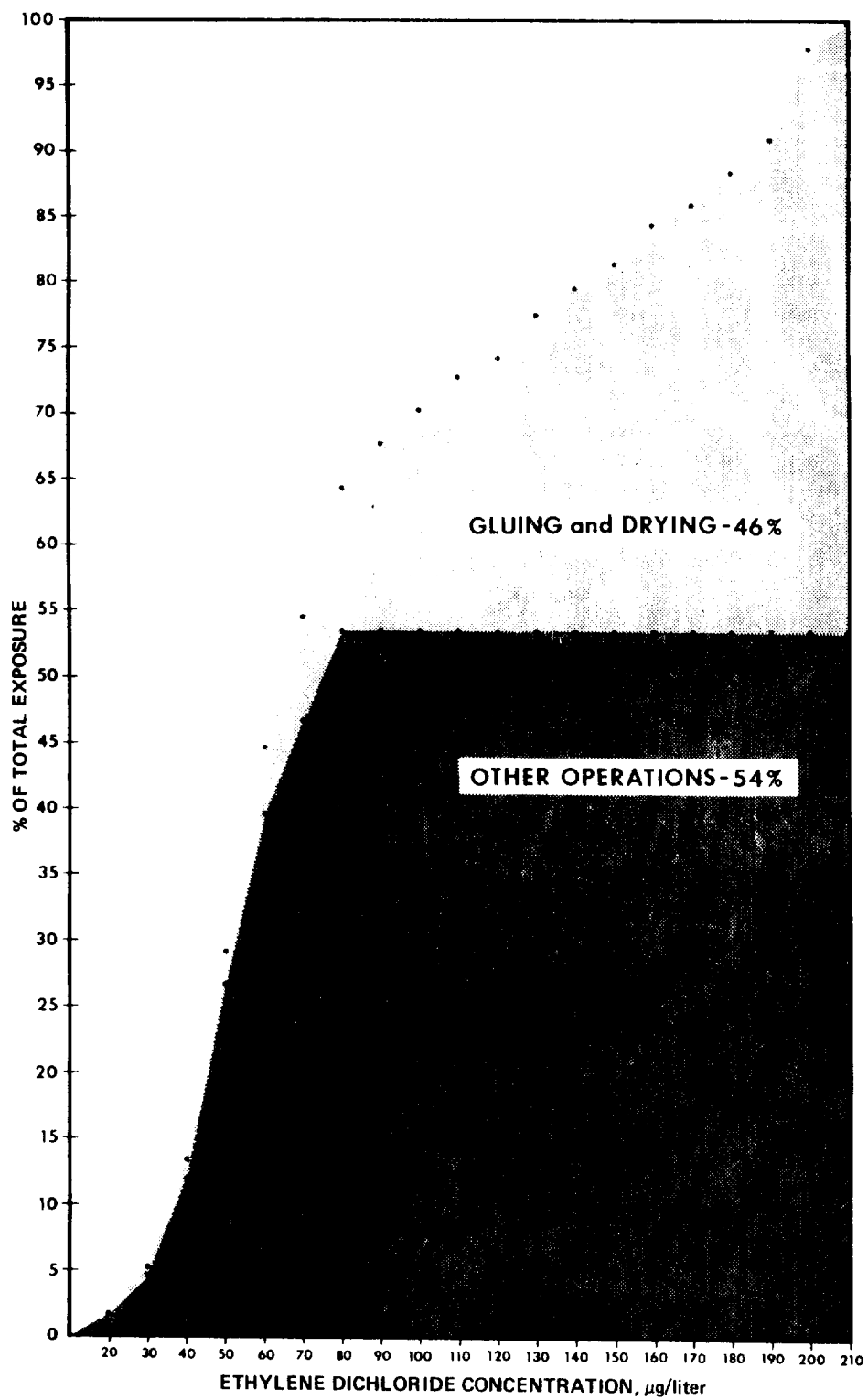


FIGURE XII-2. Percentage of Total Exposure Associated with 2 Operations in an Aircraft Factory (Derived from Kozik [105])

