

XIV. TABLES AND FIGURES

TABLE XIV-1

PRODUCTION AND USE OF MAJOR PESTICIDES, 1975 ESTIMATES

Production (Range in Millions of Pounds Per Year)	Name of Pesticide	Use
>200	Creosote	Fungicide or wood preservative
100-200	Atrazine	Herbicide
	Coal tars	Fungicide or wood preservative
	Inorganic sulfurs	"
50-99	Toxaphene	Insecticide
	Carbaryl	"
	Pentachlorophenol	Fungicide or wood preservative
	Dichlorobenzene	Fumigant
30-49	DDT	Insecticide
	Methyl parathion	"
	Malathion	"
	2,4-D	Herbicide
	Inorganic coppers	Fungicide or wood preservative
15-29	Chlordane	Insecticide
	Parathion	"
	Propachlor	Herbicide
	Alachlor	"
	Chloramben (Amiben)	"
	Trifluralin	"
	MSMA	"
	Trichlorophenol	Fungicide or wood preservative
	Captan	"
	Methyl bromide	Fumigant
	Ethylene dibromide	"
5-14	Aldrin	Insecticide
	Methoxychlor	"
	Heptachlor	"
	Diazinon	"
	Disulfoton	"
	Phorate	"
	Monocrotophos	"
	Chlorpyrifos	"
	Simazine	Herbicide
	CDAA	"

TABLE XIV-1 (CONTINUED)

PRODUCTION AND USE OF MAJOR PESTICIDES, 1975 ESTIMATES

Production (Range in Millions of Pounds Per Year)	Name of Pesticide	Use
5-14	Propanil	Herbicide
	2,4,5-T	"
	DSMA	"
	Bromacil	"
	Didron	"
	Butylate	"
	EPTC	"
	TCA	"
	DEF	"
	Chromates	Fungicide or wood preservative
	Maneb	"
	Methane	"
	Benomyl	"
	Carbon tetrachloride	Fumigant
	Ethylene dichloride	"
	Naphthalene	"

Adapted from reference 7

TABLE XIV-2
PESTICIDE INDUSTRY STATISTICS, 1972

Type of Establishment	Number of Establishments	Pesticide Value of Shipment (Millions of Dollars)
Primary pesticide production		
Manufacturing (SIC 2869)	19	489.3
Formulating (SIC 2879)	388	867.0
Northeast	56	
North Central	89	
South	161	
West	82	
Subtotal (SIC's 2869, 2879)	407	1,356.3
Other establishments where pesticide manufacturing and formulation is a secondary industry (eg, SIC's 2842, 2821, 2834, 2819)		
	6,679	329.2
Total (all SIC's)	7,086	1,685.5

Adapted from reference 9

TABLE XIV-3

GEOGRAPHIC DISTRIBUTION OF TOTAL VALUE SHIPMENT, 1972

Region	Manufacturing		Formulating		Total	
	Value of Shipment (\$Million)	Percent of Total	Value of Shipment (\$Million)	Percent of Total	Value of Shipment (\$Million)	Percent of Total
Northeast	60.9	12	140.0	11	200.9	12
North Central	195.9	40	439.0	37	634.9	38
South	219.5	45	488.0	41	707.5	42
West	13.0	3	129.2	11	142.2	8
TOTAL	489.3	100	1,196.2	100	1,685.5	100

Adapted from reference 9

TABLE XIV-4

WORKERS POTENTIALLY EXPOSED IN THE
MANUFACTURE AND FORMULATION OF PESTICIDES, 1972

Type of Establishment	Number of Establishments	Number of Production Workers
Manufacturing (SIC 2869)	19	1,900
Formulation (SIC 2879)	388	6,800
Total (SIC 2869, 2879)	407	8,700
Other establishments where pesticide manufacturing and formulation is a secondary activity (eg, SIC's 2842, 2821, 2834, 2819)	6,679	355,300
Total (all SIC's)	7,086	364,000

Adapted from reference 9

TABLE XIV-5
DISTRIBUTION OF FORMULATION PLANT WORKERS

Size of Plant (Number of Employees)	Number of Plant Production Workers
1-19	1,000
20-95	2,100
100-499	1,600
>500	2,100
Total	6,800

Adapted from reference 9

TABLE XIV-6
PESTICIDE MASS POISONINGS

Kind of Accident	Pesticide Involved	Material Contaminated	Number Affected	Number Died	Location
Spillage during transport or storage	Endrin	Flour	159	0	Wales
	"	"	691	24	Qatar
	"	"	183	2	Saudi Arabia
	Dieldrin	Food	20	0	Shipboard
	Diazinon	Doughnut mix	20	0	USA
	Parathion	Wheat	360	102	India
	"	Barley	38	9	Malaya
	"	Flour	200	8	Egypt
	"	"	600	88	Columbia
	"	Sugar	300	17	Mexico
Accidental ingestions	"	Sheets	3	0	Canada
	Mevinphos	Plants	6	0	USA
	Hexachlorobenzene	Seed grain	>3,000	3-11%	Turkey
	Organic mercury	"	34	4	West Pakistan
	"	"	321	35	Iraq
Improper use	"	"	45	20	Guatemala
	Warfarin	Bait	14	2	Korea
	Toxaphene	Collards and chard	7	0	USA
	Nicotine	Mustard	11	0	USA
	Parathion	Used as treatment for body lice	>17	15	Iran
	Pentachlorophenol	Nursery linens	20	2	USA

Adapted from reference 73

TABLE XIV-7

 REPORTS OF OCCUPATIONAL DISEASE ATTRIBUTED TO PESTICIDES AND OTHER
 AGRICULTURAL CHEMICALS IN CALIFORNIA, 1973

Agricultural Chemical	Total	Agricul- ture	Manufac- turing	Construc- tion	Transporta- tion, Com- munication & Utilities	Trade	Struc- tural Pest Control	State & Local Govern- ment	Other and Unspec- ified
TOTAL	1,451	887	156	39	53	65	34	157	60
Organophosphorus Pesticides	260	182	32	--	9	10	7	14	6
Parathion	53	43	5	--	1	2	--	1	1
Systox	9	8	--	--	--	--	--	1	--
TEPP	3	2	--	--	--	1	--	--	--
Phosdrin	14	11	2	--	--	1	--	--	--
Malathion	13	6	1	--	1	1	--	2	2
Trithion	2	1	1	--	1	--	--	--	--
Thimet	2	2	--	--	--	--	--	--	--
Guthion	4	2	--	--	1	--	--	--	1
Other and unspecified	160	107	24	--	5	5	7	10	2
Halogenated Hydrocarbon Pesticides	105	44	20	--	4	5	11	17	4
Chlordane, lindane, kelthane	22	4	6	--	1	3	4	1	3
Endrin, aldrin, dieldrin, toxaphene	2	--	--	--	--	1	1	--	--
Methyl bromide	32	8	11	--	--	1	2	9	1
Other and unspecified	49	32	3	--	3	--	4	7	--
Lead and/or Arsenic Compounds	7	2	2	--	1	--	--	2	--
Herbicides (defoliant and weed killers)	208	96	14	4	12	12	--	53	17
Fertilizers	194	140	26	--	2	11	--	5	10
Organo-Mercury Compounds	5	--	5	--	--	--	--	--	--
Fungicides, Not Elsewhere Classified	55	25	8	11	7	1	--	--	3
Phenolic Compounds	57	12	13	15	6	1	3	4	3
Carbamates	37	36	--	--	--	1	--	--	--
Sulfur	50	43	2	--	2	1	1	1	--
Other Specified Agriculture Chemicals	70	16	13	--	2	6	4	26	3
Unspecified	403	291	21	9	8	17	8	35	14

Adapted from reference 17

TABLE XIV-8
SUSPECTED OCCUPATIONAL CARCINOGENS

Pesticide	Author, Ref	Species (Strain)	Sex	Dose and Route	Cancer Site	Statistical Significance
Aldrin/ Dieldrin	NIOSH, 2	(Numerous reports in literature)				
Bis (2-chloro-ethyl) ether	NCI, Bionetics, 4	Mouse (B6C3F1, B6AKF1)	M,F	100 mg/kg/d, 21 d oral, then 300 mg/kg/diet	Liver	P=0.01
			M,F	215 mg/kg sc on d 28	Reticulum cell	P=0.01
Bis (2-hydroxy-ethyl)-dithiocarbamic acid, potassium salt	NCI, Bionetics, 4	"	M,F	464 mg/kg/d, 21 d oral, then 1,112 ppm/diet	Liver	P=0.01
Ethylenebis-dithiocarbamic acid salts	Inference from Ethylene thiourea					
2-(p-tert-butylphenoxy)-isopropyl-2-chloroethyl sulfite	NCI, Bionetics, 4	"	M	464 mg/kg/d, 21 d oral, then 1,112 ppm/diet	Liver	P=0.05
			Oser and Oser, 194	Rat (FDRL)	M,F	400 ppm/diet
	Sternberg et al, 195	Dog (mongrel)	M,F	500 or 828-1,420 ppm/diet	Biliary system	
Captan	NCI, 197	Rat (Osborne-Mendel)	M,F	2,525 or 6,050 ppm/diet	Adrenal gland, thyroid	P=0.047 P=0.035
		Mouse (B6C3F1)	M	8,000 or 16,000 ppm/diet	Duodenum	P=0.008
		"	F	8,000 or 16,000 ppm/diet	"	P=0.022
Carbon tetrachloride	Reuber and Glover, 198	Rat (Osborne-Mendel; Japanese)	M	1.3 ml/kg of 50% solution 2x/wk, sc	Liver	
	Della Porter et al, 200	Hamster (Syrian)	M,F	0.0625-0.125 ml/kg, oral	"	

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TABLE XIV-8 (CONTINUED)
SUSPECTED OCCUPATIONAL CARCINOGENS

Pesticide	Author, Ref	Species (Strain)	Sex	Dose and Route	Cancer Site	Statistical Significance
Chloramben	NCI, 202	Mouse (B6C3F1)	F	10,000 or 20,000 ppm/diet	Liver	P<0.004
			M	10,000 or 20,000 ppm/diet	"	(P<0.029)
Chlordane	NCI, 203	"	M	158.9 or 56.2 ppm/diet	"	P<0.001
			F	30.1 or 63.8 ppm/diet	"	P<0.0001
			M	158.9 or 56.2 ppm/diet	Negative	
			F	30.1 or 63.8 ppm/diet		
Chlorobenzilate	NCI, Bionetics, 4	Mouse (B6C3F1, B6AKF1)	M,F	215 mg/kg/d, 21 d oral, then 603 ppm/diet	Liver	P=0.01
	NCI, 204	Mouse (B6C3F1)	M,F	3,200-7,846 ppm, diet	"	P=0.001
Chloroform	NCI, 199	Mouse (B6C3F1)	M	138 or 277 mg/kg/5x/wk, oral	Liver	P<0.001
			F	238 or 477 mg/kg/5x/wk, oral	"	P<0.001
			M	90 and 180 mg/kg, oral	Kidney	P=0.0016
DBCP	NCI, 206	Mouse (B6C3F1)	M	113 or 219 mg/kg/d 5x/wk, oral	Stomach	
			F	109 or 209 mg/kg/d 5x/wk, oral	"	
			F	15 or 29 mg/kg/d 5x/wk, oral	Mammaries, stomach	
DDT	NIOSH, 31	(Numerous reports in literature)				
p,p'-DDD	"	"		"		
o,p'-DDD	"	"		"		

TABLE XIV-8 (CONTINUED)
SUSPECTED OCCUPATIONAL CARCINOGENS

Pesticide	Author, Ref	Species (Strain)	Sex	Dose and Route	Cancer Site	Statistical Significance
EDB	Powers et al, 209, 210	Mouse (B6C3F1)	M,F	60 or 120 mg/kg/d 5x/wk, oral	Stomach	
		Rat (Osborne-Mendel)	M,F	40 or 80 mg/kg/d 5x/wk, oral	"	
Heptachlor	NCI, 211	Mouse (B6C3F1)	M	6.1-18 ppm/diet	Liver	P=0.001
			F	9-18 ppm/diet	"	P<0.001
		Rat (Osborne-Mendel)	M	38.9-77.9 ppm/diet	Negative	
			F	25.7-51.3 ppm/diet	"	
Kepone	NCI, 85	Mouse (B6C3F1)	M	20-23 ppm/diet	Liver	P<0.05
			F	20-40 ppm/diet	"	P<0.05
		Rat (Osborne-Mendel)	M	8-24 ppm/diet	"	P<0.05
			F	8-26 ppm/diet	"	P<0.05
Mirex	NCI, Bionetics, 4	Mouse (B6C3F1, B6AKF1)	M,F	10 mg/kg/d, 21 d oral, then 26 ppm/diet	Liver	P=0.01
			M,F	1,000 mg/kg sc on d 28	Liver, reticulum cells	P=0.01
	Ulland et al, 5	Rat (Charles River CD)	M,F	50 and 100 ppm/diet	Liver	
Nitrofen	NCI, 213	Rat (Osborne-Mendel)	F	1,300 or 2,600 ppm/ diet	Pancreas	P<0.001
		Mouse (B6C3F1)	M,F	2,348 or 4,696 ppm/ diet	Liver, hemangiosarcoma of liver	P<0.001 P=0.022 (high- dose male)

TABLE XIV-8 (CONTINUED)
SUSPECTED OCCUPATIONAL CARCINOGENS

Pesticide	Author, Ref	Species (Strain)	Sex	Dose and Route	Cancer Site	Statistical Significance
2-Nitropropane	NIOSH, 214	Rat (Sprague-Dawley)	M	207 ppm/d 5x/wk inhalation	Negative	
		Rat		300 ppm/119 hr, inhalation	Clear cell foci	
		Cat		328 ppm inhalation	Negative	
1,1,2,2-Tetrachloroethane	NCI, 215	Mouse (B6C3F1)	M,F	142 or 282 mg/kg/d, gavage	Liver	P<0.001
Tetrachloroethylene	NCI, 216	"	F	386 or 772 mg/kg/d, gavage	"	P<0.001
		"	M	536 or 1,072 mg/kg/d, gavage	"	P<0.001
Tetra-chlorvinphos	NCI, 217	"	M	8,000 or 16,000 ppm/diet	"	P<0.001
		"	F	8,000 or 16,000 ppm/diet	Neoplastic nodule	P=0.007
		Rat (Osborne-Mendel)	F	4,250 or 8,500 ppm/diet	Thyroid, adrenal	P=0.013, P=0.017
Trichloroethylene	NCI, 218	Mouse (B6C3F1)	M	2,339 mg/kg/d, 5x/wk oral or 1,169 mg/kg/d, 5x/wk oral	Liver	P<0.001
			"		"	P=0.004
			F	1,739 mg/kg/d, 5x/wk oral	"	P=0.008
Trifluralin	NCI, 220	"	F	2,740 or 5,192 ppm/diet	Liver	P<0.001
					Lung, stomach	P<0.036 Not significant

TABLE XIV-9

EXAMPLES OF PESTICIDES CONSIDERED BY NIOSH TO REQUIRE FURTHER CARCINOGENICITY TESTING

Pesticide	Author, Ref	Species (Strain)	Sex	Dose and Route	Cancer Site	Statistical Significance
Azobenzene	NCI, Bionetics, 4	Mouse (B6C3F1, B6AKF1)	M	21.5 mg/kg/d, 21 d oral then 56 mg/kg/diet	Site of Injection	P=0.01
			M,F	1,000 mg/kg sc on d 28	Negative	
Calcium cyanamide	"	Mouse (B6C3F1, B6AKF1)	M,F	100 mg/kg/d, 21 d oral, then 240 ppm/diet	Reticulum Cell	P=0.01
(2-chloroethyl) triethylammonium chloride (CCC)	"	"	M,F	21.5 mg/kg/d, 21 d oral, then 65 ppm/diet	Liver	P=0.01
Chloropicrin	NCI, 221	Mouse (B6C3F1)	M	66 mg/kg/d, gavage	Carcinoma, papilloma	Not statistically significant
CIPC	van Esch et al, 239	Mouse (Swiss)	F	15 mg single dose, oral	Papillomas	P<0.05
2,4-D	Hansen et al, 222	Rat (Osborne-Mendel)	M	1,250 mg/kg/diet	Various	P<0.05
	Arkhipov and Koslova, 223	Rat		Diet	Negative	
	NCI, Bionetics, 4	Mouse (B6C3F1, B6AKF1)	M,F	149 and 323 ppm/diet, 215 and 464 mg/kg injection	"	
		"	M,F	21.5 mg isooctyl ester/kg sc on d 7	Reticulum cells	P=0.01
Dimethoate	NCI, 225	Rat (Osborne-Mendel)	M,F	155-500 ppm/diet	Negative	
		Mouse (B6C3F1)	M,F	155-500 ppm/diet	"	
	Gibel et al, 224	Rat (Wistar)	M,F	5-30 mg/kg/d, oral	Spleen, liver various	
		"	M,F	15 mg/kg/d, im	Spleen, various	
		Mouse (AB)	M,F	Topical	Leukosis	

TABLE XIV-9 (CONTINUED)

EXAMPLES OF PESTICIDES CONSIDERED BY NIOSH TO REQUIRE FURTHER CARCINOGENICITY TESTING

Pesticide	Author, Ref	Species (Strain)	Sex	Dose and Route	Cancer Site	Statistical Significance
Dimethoxane	Hoch-Ligeti et al, 226	Rat (Wistar)	M *	1% solution in drinking water	Liver	
2,4-Dinitrotoluene	NCI, 227	Rat (Fischer 344)	M,F	0.008% and 0.02%, diet	Benign fibroma, benign mammary fibroadenoma	P=0.003 P=0.016
Diphenyl acetonitrile	NCI, Bionetics, 4	Mouse (B6C3F1, B6AKF1)	M,F	464 mg/kg sc on d 28	Reticulum cell	P=0.01
Endosulfan	" NCI, 228	Mouse (B6C3F1, B6AKF1) Mouse (B6C3F1) Rat (Osborne-Mendel)	M,F M,F M,F	1.0 mg/kg/d/21 d oral, then 3 ppm/diet 2.0-6.9 ppm, diet 223-952 ppm, diet	Lung Negative, early mortality "	P=0.05
Endrin	Treon et al, 229 Deichmann et al, 230	Rat (Carworth) Rat (Osborne-Mendel)	M,F M,F	1,5,25,50 or 100 ppm/diet 2,6 or 12 ppm/diet	Negative "	
Ethylan	NCI, Bionetics, 4	Mouse (B6C3F1, B6AKF1)	M,F	215 mg/kg/d, 21 d oral, then 815 ppm/diet	Liver	P=0.01
Ethylene oxide	Reyniers et al, 231 Van Duuren, 232 Walpole, 233	Mouse (ALBM-2) Mouse (Swiss-Millerton) Rat (Wistar)	F F F	Bedding 0.1 ml of 10% solution 3x/wk, skin painting 1 g/kg sc	Various Negative "	

TABLE XIV-9 (CONTINUED)

EXAMPLES OF PESTICIDES CONSIDERED BY NIOSH TO REQUIRE FURTHER CARCINOGENICITY TESTING

Pesticide	Author, Ref	Species (Strain)	Sex	Dose and Route	Cancer Site	Statistical Significance
HCCH	Nagasaki et al, 235,236	Mouse (dd)	M	600 ppm/diet	Liver	
	Goto et al, 237	Mouse (ICR-JCL)	M	600 ppm/diet	Liver nodules	
	Fitzhugh et al, 238	Rat (Wistar)	M,F	10-800 ppm/diet	Negative	
IPC	van Esch et al, 239	Mouse (Swiss)	M,F	15 mg/wk 10 wk oral	Papillomas	P<0.05
Lindane	NCI, 240	Mouse (B6C3F1)	M	80 ppm/diet	Liver	P=0.001
		"	M,F	80 ppm (female mice)-472 ppm/diet	Negative	
		Rat (Osborne-Mendel)	M,F	80 ppm (female mice)-472 ppm/diet	"	
	Nagasaki et al, 241	Mouse (dd)	M	100/500 ppm/diet	"	
	Fitzhugh et al, 238	Rat (Wistar)	M,F	5-1,600 ppm/diet	"	
	Thorpe and Walker, 242	Mouse (CF1)	M,F	400 ppm/diet	Liver	
	Goto et al, 237	Mouse (ICR-JCL)	M	300 ppm/diet	Liver nodules	
Mexacarbate	NCI, Bionetics, 4	Mouse (B6C3F1, B6AKF1)	M,F	4.64 mg/kg/d, 21 d oral, then 11 ppm/diet	Liver	P=0.05
PCNB	"	"	M,F	464 mg/kg/d 21 d oral, then 1,206 ppm/diet	"	P=0.01
	NCI, 243	Mouse (B6C3F1) Rat (Osborne-Mendel)	M,F M,F	14,635 ppm/diet	Negative	

TABLE XIV-9 (CONTINUED)

EXAMPLES OF PESTICIDES CONSIDERED BY NIOSH TO REQUIRE FURTHER CARCINOGENICITY TESTING

Pesticide	Author, Ref	Species (Strain)	Sex	Dose and Route	Cancer Site	Statistical Significance
Piperonyl butoxide	NCI, Bionetics, 4	Mouse (B6C3F1, B6AKF1)	M,F	100 mg/kg/d, 21 d oral, then 300 ppm/diet	Reticulum cell	P=0.05
Piperonyl sulfoxide	"	"	M,F	46.4 mg/kg/sc injection	"	P=0.05
			M,F	46.4 mg/kg/d, 21 d oral, then 111 ppm/diet	"	P=0.01
Sodium N,N-dimethyl dithiocarbamate (SDDC)	"	"	M,F	215 mg/kg/d, 21 d oral, then 692 ppm/diet	"	P=0.05
Strobane	"	"	M	4.64 mg/kg/d, 21 d oral then 11 ppm/diet	"	P=0.01
			M,F	4.64 mg/kg/d, 21 d oral then 11 ppm/diet	Reticulum cells	P=0.05
2,4,5-T	Muranyi-Kovacs et al, 245	Mouse (C3Hf)	F	100 mg/l drinking water for 2 mon then 80 ppm in diet	Various	P<0.01
	NCI, Bionetics, 4	Mouse (B6C3F1, B6AKF1)	M,F	diet, sc injection	"	
Thiourea	Fitzhugh and Nelson, 246	Rat (Albino)		100,250,500, 1,000 ppm/diet	Hepatic cell adenoma	
	Rosin and Rachmilewitz, 247	"	M,F	3,4,4 ml 10% solution 3x/wk im for 6 mon, then 0.2% solution in drinking water	Squamous-cell carcinoma, mixed-cell sarcoma	
	Gargus et al, 248	Mouse (ICR Swiss)		2,500 mg/kg single injection	Negative	
	Rosin and Unger, 249	Rat (Hebrew University)	M	0.2%/26 mon in drinking water	Myxomatous tumor of nose, epidermoid carcinomas of ear duct and orbit	

TABLE XIV-9 (CONTINUED)

EXAMPLES OF PESTICIDES CONSIDERED BY NIOSH TO REQUIRE FURTHER CARCINOGENICITY TESTING

Pesticide	Author, Ref	Species (Strain)	Sex	Dose and Route	Cancer Site	Statistical Significance
Trichlorfon	Gibel et al, 224	Rat (Wistar)	M,F	15 mg/kg/2x/wk oral	Spleen, various	
		"	M,F	15 mg/kg/2x/wk im	"	
		Mouse (AB)	M,F	Topical	Leukosis	
2,4,6-trichloro-phenol	NCI, Bionetics, 4	Mouse (B6C3F1, B6AKF1)	M,F	100 mg/kg/d, 21 d oral, then 260 ppm/ diet	Reticulum cell, liver	P=0.05

TABLE XIV-10

RESULTS OF MUTAGENICITY STUDIES WITH PESTICIDES

Pesticide	Test System*														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DDT		-	-	-	+		-	-							
Methyl parathion	+	+	+	+											
Dimethoate	+	+	+	+											
Dichlorvos (DDVP)	+	+	+	+		-	-	-							
Oxydemeton-methyl	+	+	+	+	+										
Monocrotophos	+	+	+	+											
Pentachlorophenol		-	-	+	-	+	-								
1,2-Dibromoethane		+	+	+	+	-	+								
Captan		+	+	+	-		+	+							
Folpet		+	+	+	-										
Ethylene dibromide									+	+	+				
Ethylene oxide			+		+				+	+		+	+	+	
Ethylene chlorohydrin											+	+			+
1,2-Dibromo-3-chloropropane											+				
Dicrotophos	+			+											

- 1 = liquid holding test, forward mutations to 5-MT resistance in *E. coli*
 2 = spot test, back mutation in *S. marcescens* and forward mutations in *E. coli*
 3 = liquid holding test, forward mutation to streptomycin resistance in *E. coli*
 4 = liquid holding test, mitotic gene conversion in *S. cerevisiae*
 5 = recessive lethal mutations in *D. melanogaster*
 6 = chromosome aberrations in human lymphocytes in vitro;
 7 = host-mediated assay, back mutation in *S. typhimurium* and *S. marcescens*;
 8 = dominant lethal test with mice;
 9 = *N. crassa*
 10 = *Tradescantia*
 11 = *S. typhimurium* (TA 1530)
 12 = *S. typhimurium* (TA 1535)
 13 = barley
 14 = *Drosophila*
 15 = *K. pneumoniae*

Adapted from references 257-261, 234

TABLE XIV-11

PESTICIDES DISPLAYING NO SIGNIFICANT CARCINOGENICITY IN ASSAYS WITH EXPERIMENTAL ANIMALS

Anthraquinone	Methyl chloroform
Antu	Methyl selenac
Atrazine	Methyl zimate
Bismate	Monochloroacetic acid
2-sec-Butyl-4,6-dinitrophenol	Mucochloric acid
Butyl zimate	Nabam
alpha-Chloralose	1-Naphthalene acetamide
Cumate	1-Naphthalene acetic acid
Dehydroacetic acid	1-Naphthyl-N-methyl carbamate
2,6-Dichloro-4-nitroaniline	Nickel dibutyl dithiocarbamate
alpha-(2,3-Dichlorophenoxy)-propionic acid	Noruron
alpha-(2,5-Dichlorophenoxy)-propionic acid	1,3,4,5,6,7,8,8-Octachloro-3a,4,7,7a-hexahydro-4,7-methano phthalen
2,4-Dichlorophenyl benzenesulfonate	Ovex
Dichlorvos	Pentachlorophenol
Dicryl	Phenothiazine
4-Dimethylamino-3,5-xyleneol	Phenylmercuric acetate
Dimethyldithiocarbamic acid-dimethylammonium salt	Picloram
Diuron	Propazine
Dodine	Propyl ethylbutylthiocarbamate
2-(2,4-DP)	Rotenone
Ethyl cadmate	Simazine
Folpet	Sulfads
Gibberellic acid	Tetradifon
Indole-3-acetic acid	Thiram
Isolan	2,2'-Thiobis(4,6-dichlorophenol)
Ledate	2,2'-Thiobis(4,6-dichlorophenol), disodium salt
Malathion	2,4,6-Trichlorophenol
Maleic hydrazide	2-(2,4,5-Trichlorophenoxy)-propionic acid
Maneb	Unads
Methoxychlor	

Adapted from references 4, 250-254

TABLE XIV-12

COMPOUNDS REVIEWED BY NIOSH WHICH HAVE BEEN TESTED FOR TERATOGENICITY

Compound	Investigator's Conclusion	"Teratogenic" Effect Dose	Number and Days of Doses Administered	Number of Animals Per Treated Dose (Animal/Route)	Incidence of Terata/Number of Fetuses		Fetal Abnormalities	Ref
		(mg/kg)			Control Group	Treated Group		
Parathion	All three	3.5	1, d 11	5 (rat/ip)	0/43*	1/28	Edema	262
Diclorovos	slightly	15.0		4 "	0/33*	3/41	Omphalocelic	
Diazinon	teratogenic	200		4 "	0/25*	1/6	Hydrocephalic	
		100		5 "	0/25*	1/6	Phalanx missing	
					0/25	1/6	Ectromelic-dilated renal Pelvis	
					0/26*	6/50		
Trichlorfon	Teratogenic	80	1, d 9 or 13	11 (rat/oral)	-	-	General edema	263
Phosmet	"	30	1, d 9	9 "	-	-	Hypognathia	
		30	1, d 13	8 "	-	-	Limb dislocation	
							Exencephaly	
							Non-closing eyelid	
Aldrin	Teratogenic	50	1, d 7,8,9	41 (hamster/oral)	1/155*	24/272*	Cleft palate	264
					0/155	20/272*	Cleft lip	
					0/155	1/272*	Fused rib	
Dieldrin	"	30	1, d 7,8,9	43 "	1/155	39/230*	Cleft palate	
					0/155	1/230*	"	
Endrin	"	5	1, d 7,8,9	39 "	1/155	16/148*	"	
					0/155	2/148*	Cleft lip	
					0/155	10/148*	Fused rib	

TABLE XIV-12 (CONTINUED)
 COMPOUNDS REVIEWED BY NIOSH WHICH HAVE BEEN TESTED FOR TERATOGENICITY

Compound	Investigator's Conclusion	"Teratogenic" Effect Dose (mg/kg)	Number and Days of Doses Administered	Number of Animals Per Treated Dose (Animal/Route)	Incidence of Terata/Number of Fetuses		Fetal Abnormalities	Ref
					Control Group	Treated Group		
Aldrin	Teratogenic	25	1,d 9	10 (mouse/oral)	0/70*	2/68*	Cleft palate	264
Dieldrin		15	1,d 9	"	0/70*	13/80*	Cleft palate	
Endrin		2.5	1,d 9	10 "	0/70*	5/82*	Cleft palate	
Captan		1,000	1,d 7,8	6 (hamster/oral)		8/35	Exencephaly; cranial pimple; cleft palate	267
		750	1,d 6-10 or 6-8	5 "	7/1536	10/73	Exencephaly; cranial pimple; fused ribs	
		600		1 "		4/52	Fused ribs; limb defects	
		500		5 "		5/109	Exencephaly; fused ribs; cranial pimple; limb defects;	
		300		5 "		9/11	curved tail tail Exencephaly; fused ribs	

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TABLE XIV-12 (CONTINUED)

COMPOUNDS REVIEWED BY NIOSH WHICH HAVE BEEN TESTED FOR TERATOGENICITY

Compound	Investigator's Conclusion	"Teratogenic" Effect Dose (mg/kg)	Number and Days of Doses Administered	Number of Animals Per Treated Dose (Animal/Route)	Incidence of Terata/Number of Fetuses		Fetal Abnormalities	Ref
					Control Group	Treated Group		
Thiram (in DMSO)	Teratogenic	250 250	1,d 7 1,d 8	3 (hamster/ oral)	0/1053	1/16	Cranial nipple Shortened mandible/maxilla Fused ribs Limb defect Umbilical hernia	265
					3/1083	1/16		
					1/1083	4/6		
					2/1083	1/6		
					0/1083	1/16		
Thiram (in CMC)	"	250 250	1,7 1,8	11 (hamster/ oral)	0/1083	1/79	Cranial nipple Shortened maxilla/mandible Fused ribs Short/curved tail Umbilical hernia	
					3/1083	4/79		
					1/1083	4/79		
					1/1083	6/79		
					0/1083	7/79		
Diquat	-	7	1,d 6-14	-- (rat/ip)	--	--	Retarded sternum and oxicle growth	266
Paraquat	-	6.5	1,d 6	-- "	--	--	Cartilage malformations	

*Calculated figure

TABLE XIV-12 (CONTINUED)

COMPOUNDS REVIEWED BY NIOSH WHICH HAVE BEEN TESTED FOR TERATOGENICITY

Compound	Investigator's Conclusion	"Teratogenic" Effect Dose (mg/kg)	Number and Days of Doses Administered	Number of Animals Per Treated Dose (Animal/Route)	Incidence of Terata/ Number of Fetuses		Fetal Abnormalities	Ref
					Control Group	Treated Group		
Folpet	-	1,000	1, d 7, 8	1 (Hamster/ oral)		3/7	Fused rib; short/curved tail	267
		900	1, d 6-10 or 6-8	3 "		5/25	Exencephaly; fused rib; cranial pimple	
		800		3 "		1/66	Limb defect	
		700		6 "	7/1536	2/56	Short/curved tail; fused rib	
		600		9 "		8/74	Exencephaly; fused rib; limb defect	
		500		10 "		3/91	Exencephaly; limb defect; cleft palate; short tail	
Captafol	-	500	1, d 8	13 "		15/132	Exencephaly; cranial pimple	267
		400	1, d 6-10 or 6-8	8 "	7/1536	14/61	Exencephaly; fused ribs; short tail	
		300		6 "		1/63	Limb defect	
		200		15 "		4/145	Cleft palate; umbilical hernia; short/curved tail	
2,4,5-T	Terato- genic	300	1, d 12, 13	20 (mouse/ oral)	6/995	39/340	Cleft palate	267

TABLE XIV-12 (CONTINUED)

COMPOUNDS REVIEWED BY NIOSH WHICH HAVE BEEN TESTED FOR TERATOGENICITY

Compound	Investigator's Conclusion	"Teratogenic" Effect Dose (mg/kg)	Number and Days of Doses Administered	Number of Animals Per Treated Dose (Animal/Route)	Incidence of Terata/ Number of Fetuses		Fetal Abnormalities	Ref
					Control Group	Treated Group		
2,4,5-T	Teratogenic	113	1, d 6-14	18 (mouse/sc)	41/4176*	174/79*	Cleft palate	269
+ DMSO	"		d 6-15	14 "	4/496	27/97*	"	
+ Dioxin	"	113	d 9-17	10 "	0/106*	20/36*	"	
2,4,5-T	"	113	1, d 6-14	12 (mouse/oral)	0/227*	13/58*	"	
+ Dioxin	"	113	d 6-15	7 "	0/106*	20/37*	"	
2,4,5-T	"	113	1, d 6-14	12 (mouse/oral)	0/227*	13/58*	"	
+ Dioxin	"	113	d 6-15	7 "	0/106*	20/37*	"	
2,4,5-T	"	46.4	1, d 10-15	6 (rats/oral)	0/122*	0/16*	No cleft palate	
+ Dioxin	"							
2,4,5-T + 2.9 ppm Dioxin	"	100	1, d 6-10	6 (hamster/oral)	0/975	4/77	Eye abnormalities; cleft palate; ectopic heart	270
2,4,5-T, no detectible Dioxin	"	100	1, d 6-10	8 "	0/975	7/38	Delayed head ossification; limb deformity	

TABLE XIV-13

EXAMPLES OF ADVERSE REPRODUCTIVE EFFECTS DUE TO PESTICIDES

Pesticide	Species	Dose/Concentration	Effect	Ref
Kepone	Mouse	5-37.5 ppm/diet	Decreased size and number of litters	271
	"	10-37.5 ppm/diet	Decreased size, number and survival of litters	
Mirex	Rat	0.2-50 mg/injected once	LH inhibition and decreased ovulation	273
Aldrin	Dog	0.15-03 mg/kg/d, oral	Delayed estrus, inability to mate, decreased mammary development, frequent stillbirths, low offspring survival	274, 275
Aldrin & p,p'-DDT	"	0.15 mg/kg aldrin plus 6 mg/kg p,p'-DDT/d, oral	Delayed estrus, decreased mammary development, frequent stillbirths, low offspring survival	274, 275
p,p'-DDT	"	12 mg/kg/d, oral	Delayed estrus, inability to mate, decreased mammary development, frequent stillbirths, low offspring survival	274, 275
Technical DDT	Mouse	12.5-50 mg/kg, oral	Reduced testosterone uptake by prostate	276
Dieldrin	"	1.25-5 mg/kg, oral	"	276
2,4,5-T	"	6.25-25 mg/kg, oral	"	276
Carbaryl	Rat	14 mg/kg/d, diet	Estrus prolonged, sperm motility reduced, disturbed spermatogenesis, ovary disturbances	277
Heptachlor	"	6 mg/kg/diet	Decreased litter size, increased perinatal litter mortality	278
Crufomate	"	Dipped, 2 d before or 10 d after mating	Decreased number of litters	279

TABLE XIV-14

ORGANOPHOSPHORUS INSECTICIDES SUSPECTED OF DELAYED NEUROTOXICITY
BASED ON EXPERIMENTAL EVIDENCE IN CHICKENS

Compound	Dose, Route	Ref
Haloxon	3 x 200 mg/kg, oral	285
EPN*	40 mg/kg, sc	287
	60 mg/kg, sc	286
	40 mg/kg, sc	99
DEF	7 x 100 mg/kg, ip	288
	200 mg/kg, sc	99
Merphos	10 x 100 mg/kg, ip	288
	600 mg/kg, sc	99
Carbophenothion*	640 mg/kg, sc	99
	2 x 500 mg/kg, sc	**
DMPA	50 mg/kg, ip	289

*Not delayed but irreversible

**MK Johnson, written communication, May 1978

TABLE XIV-15
GENERAL CLASSIFICATION OF TOXIC MATERIALS

LD50 (oral administration) Values	Toxicity Designation
<5 mg/kg	Super toxic
>5 to 50 mg/kg	Extremely toxic
>50 to 500 mg/kg	Very toxic
>500 to 5,000 mg/kg	Moderately toxic
>5,000 to 15,000 mg/kg	Slightly toxic
>15,000 mg/kg	Practically nontoxic

Adapted from reference 333

TABLE XIV-16
EPA CLASSIFICATION

Hazard Indicators	Toxicity Categories			
	I	II	III	IV
Oral LD50	Up to and including 50 mg/kg	From 50 thru 500 mg/kg	From 500 thru 5,000 mg/kg	>5,000 mg/kg
Inhalation LC50	Up to and including .2 mg/l	From .2 thru 2 mg/l	From 2 thru 20 mg/l	>20 mg/l
Dermal LD50	Up to and including 200 mg/kg	From 200 thru 2,000	From 2,000 thru 20,000	>20,000
Eye effects	Corrosive; corneal opacity not reversi- ble within 7 d	Corneal opacity reversible within 7 d; irritation persisting for 7 d	No corneal opacity; irritation reversible within 7 d	No irritation
Skin effects	Corrosive	Severe irritation at 72 hr	Moderate irritation at 72 hr	Mild or slight irrita- tion at 72 hr

Adapted from 40 CFR 162

TABLE XIV-17

DOT CLASSIFICATION CRITERIA FOR CLASS A AND B POISONS

	Dose	Species	Observation Period
LD50 (oral) mg/kg	50	White rat	48 hr
LC50 (inhalation) mg/l	2	"	48 hr
LD50 (dermal) mg/kg	200	Rabbit	24 hr

Adapted from 49 CFR 173.343

TABLE XIV-18
CLASSIFICATION PROPOSED TO WHO, 1972

Class I

(a) Oral LD50 (rat) <200 mg/kg;

OR

(b) Formulation containing any concentration of an active ingredient with oral LD50 (rat) \leq 25 mg/kg.

Class II

Not in Class I(a) and $200 \text{ mg/kg} \leq \text{oral LD50 (rat)} \leq 2,000 \text{ mg/kg}$

Class III

Not in Class I(a) and $2000 \text{ mg/kg} \leq \text{oral LD50 (rat)} \leq 5,000 \text{ mg/kg}$

Class IV

Oral LD50 (rat) > 5000 mg/kg but no active ingredient with oral LD50 (rat) \leq 200 mg/kg

Adapted from reference 336

TABLE XIV-12

WHO CLASSIFICATION, 1975

LD50 (rat) mg/kg	Extremely Hazardous	Highly Hazardous	Moderately Hazardous	Slightly Hazardous
Oral				
Solids	≤ 5	5-50	50-500	> 500
Liquids	≤ 20	20-200	200-2,000	>2,000
Dermal				
Solids	≤ 10	10-100	100-1,000	>1,000
Liquids	≤ 40	40-400	400-4,000	>4,000

Adapted from reference 337

TABLE XIV-20
RUSSIAN CLASSIFICATION

	I Extremely Toxic	II Highly Toxic	III Moderately Toxic	IV Slightly Toxic
LD50 (oral) mg/kg	<15	15-150	<151-1,500	>1,500
LD50 (inhalation) mg/l	<.5	.5-5	< 5-50	> 50
LD50 (dermal) mg/kg	<100	100-500	<500-2,500	>2,500

Adapted from reference 338

TABLE XIV-21
BULGARIAN CLASSIFICATION

	Extremely Hazardous	Very Hazardous	Moderately Hazardous	Slightly Hazardous
LD50 (rat) oral mg	< 50	0-100	100-1,000	>1,000
LD50 (rat) dermal mg/kg	<100	0-500	500-2,000	2,000
Inhalation toxicity LC50 for rat 4 hrs exposure	<200 mg/m ³ . The concentration of saturation is higher or equal to the toxic one; provokes heavy acute poisonings	<100 mg/m ³ . The con- centration of saturation is higher than the threshold one; provokes poisonings	1,000-5,000 mg/m ³ . The concentration of saturation causes slight effect and is about the threshold one	>5,000 mg/m ³ . The concentration of saturation provokes no effect
Elasterogenic effect	Proved cancerogenic (sic) for people. Strong cancerogens (sic) for test animals	Slight cancerogenic (sic) for test animals. Effect in less than 20% of the animals with max. un toxic doses. Suspected cancerogen (sic)	No cancerogenic (sic) effect	No cancerogenic (sic) effect
Teratogenic effect	Proved or suspected teratogenicity (sic) in humans, repro- ducible in exp. animals. Teratogenic activity at levels similar to that of human exposure	Strong teratogens: affect more than 50% of the off- springs at doses not toxic to the mother. Polytropic adverse effects. Active in several animal species	Proved teratogenicity (sic) for one species only, affects single or single organ or system, effective dose above 1/10 LD50	No teratogenicity (sic)
Embryotoxicity	Is not recorded in the assessment	Selective embryotoxicity. Manifests with doses not toxic for the mother	Moderate embryo- toxicity. Manifests with doses toxic for the mother	No embryotoxic effect

Adapted from reference 337

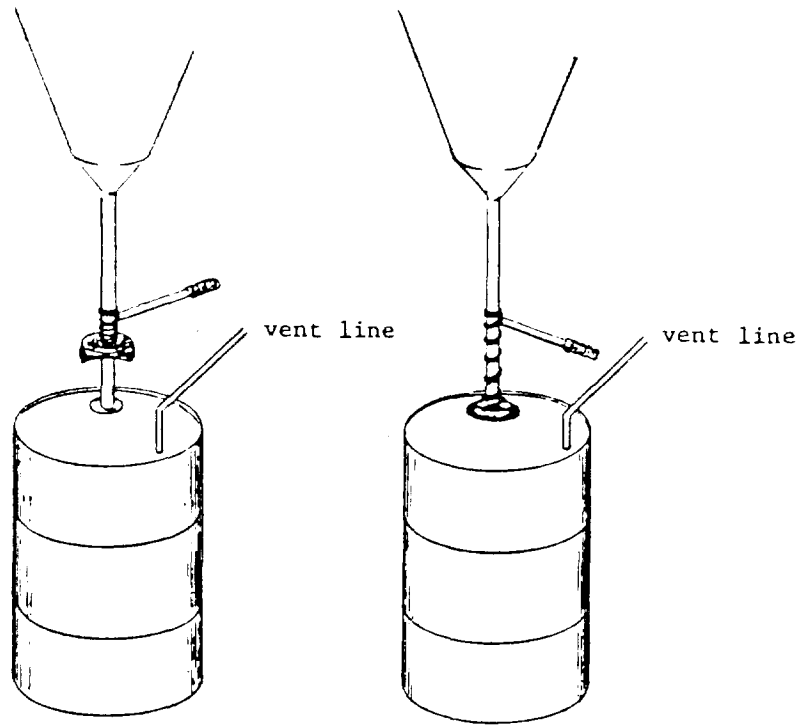
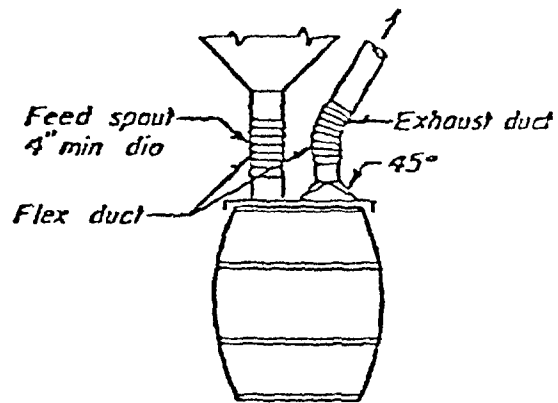


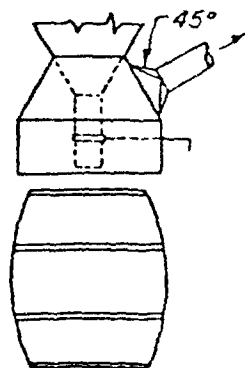
FIGURE XIV-1
SPRING-LOADED RUBBER COLLAR AND VENT LINE FOR DRUM FILLING



Adapted from reference 343

FIGURE XIV-2

EXAMPLE OF LOCAL EXHAUST SYSTEM FOR DRUM AND BARREL FILLING



Adapted from reference 343

FIGURE XIV-3

EXAMPLE OF LOCAL EXHAUST SYSTEM FOR DRUM AND BARREL FILLING

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