

A P P E N D I X A

OSHA Permissible Exposure Limits

APPENDIX A.1: GENERAL TABLE OF PELs

LIMITS FOR AIR CONTAMINANTS

The permissible exposure levels (PELs) are 8-hour time-weighted averages (TWAs) unless otherwise noted; (C) designation denotes a ceiling limit. Concentrations are to be determined from breathing-zone air samples.

Substance	CAS No. ^a	permissible exposure level		Skin
		ppm ^b	mg/m ^{3c}	
Acetaldehyde	75-07-0	200	360	
Acetic acid	64-19-7	10	25	
Acetic anhydride	108-24-7	5	20	
Acetone	67-64-1	1000	2400	
Acetonitrile	75-05-8	40	70	
2-Acetylaminofluorine; see 1910.1014	53-96-3			
Acetylene dichloride; see 1,2-Dichloroethylene				
Acetylene tetrabromide	79-27-6	1	14	
Acrolein	107-02-8	0.1	0.25	
Acrylamide	79-06-1		0.3	X
Acrylonitrile; see 1910.1045	107-13-1			
Aldrin	309-00-2		0.25	X
Allyl alcohol	107-18-6	2	5	X
Allyl chloride	107-05-1	1	3	
Allyl glycidyl ether (AGE)	106-92-3	(C) 10	(C) 45	
Allyl propyl disulfide	2179-59-1	2	12	

Substance	CAS No. ^a	permissible exposure level		Skin
		ppm ^b	mg/m ^{3c}	
α -Alumina	1344-28-1			
Total dust			15	
Respirable fraction			5	
Aluminum metal (as Al)	7429-90-5			
Total dust			15	
Respirable fraction			5	
4-Aminodiphenyl; see 1910.1011	92-67-1			
2-Aminoethanol; see Ethanolamine				
2-Aminopyridine	504-29-0	0.5	2	
Ammonia	7664-41-7	50	35	
Ammonium sulfamate	7773-06-0			
Total dust			15	
Respirable fraction			5	
<i>n</i> -Amyl acetate	628-63-7	100	525	
<i>sec</i> -Amyl acetate	626-38-0	125	650	
Aniline and homologs	62-53-3	5	19	X
Anisidine (<i>o</i> -, <i>p</i> -isomers)	29191-52-4		0.5	X
Antimony and compounds (as Sb)	7440-36-0		0.5	
ANTU (α = naphthylthiourea)	86-88-4		0.3	
Arsenic, inorganic compounds (as As); see 1910.1018	7440-38-2		10 $\mu\text{g}/\text{m}^3$	
Arsenic, organic compounds (as As)	7440-38-2		0.5	
Arsine	7784-42-1	0.05	0.2	
Asbestos; see 1910.1001 for construction, see 1926.1101	varies with compound			
Azinphos-methyl	86-50-0		0.2	X
Barium, soluble compounds (as Ba)	7440-39-3		0.5	
Barium sulfate	7727-43-7			
Total dust			15	
Respirable fraction			5	
Benomyl	17804-35-2			
Total dust			15	
Respirable fraction			5	
Benzene; see 1910.1028 See Appendix A.2 for the limits applicable in the operations or sectors excluded in 1910.1028 ^d	71-43-2			
Benzidine; see	1910.1010	92-87-5		
Benzo (<i>a</i>) pyrene; see Coal tar pitch volatiles				
<i>p</i> -Benzoquinone; see Quinone				
Benzoyl peroxide	94-36-0	5		
Benzyl chloride	100-44-7	1	5	
Beryllium and beryllium compounds (as Be)	7440-41-7		See Appendix A.2	

518 Appendix A OSHA Permissible Exposure Limits

Substance	CAS No. ^a	permissible exposure level		Skin
		ppm ^b	mg/m ^{3c}	
Biphenyl; see Diphenyl				
Bismuth telluride				
Undoped	1304-82-1			
Total dust			15	
Respirable fraction			5	
Boron oxide	1303-86-2			
Total dust			15	
Boron trifluoride	7637-07-2	(C)1	(C)3	
Bromine	7726-95-6	0.1	0.7	
Bromoform	75-25-2	0.5	5	X
Butadiene (1,3-Butadiene) see 1910.1051;1910.19	106-99-0	1-5 ppm STEL		
Butanethiol; see Butyl mercaptan				
2-Butanone (methyl ethyl ketone)	78-93-3	200	590	
2-Butoxyethanol	111-76-2	50	240	X
<i>n</i> -Butyl-acetate	123-86-4	150	710	
<i>sec</i> -Butyl acetate	105-46-4	200	950	
<i>tert</i> -Butyl-acetate	540-88-5	200	950	
<i>n</i> -Butyl alcohol	71-36-3	100	300	
<i>sec</i> -Butyl alcohol	78-92-2	150	450	
<i>tert</i> -Butyl alcohol	75-65-0	100	300	
Butylamine	109-73-9	(C) 5	(C) 15	X
<i>tert</i> -Butyl chromate [as CrO ₃]	1189-85-1		(C) 0.1	X
<i>n</i> -Butyl glycidyl ether (BGE)	2426-08-6	50	270	
Butyl mercaptan	109-79-5	10	35	
<i>p-tert</i> -Butyltoluene	98-51-1	10	60	
Cadmium (as Cd); see 1910.1027	7440-43-9			
Calcium carbonate	1317-65-3			
Total dust			15	
Respirable fraction			5	
Calcium hydroxide	1305-62-0			
Total dust			15	
Respirable fraction			5	
Calcium oxide	1305-78-8		5	
Calcium silicate	1344-95-2			
Total dust			15	
Respirable fraction			5	
Calcium sulfate	7778-18-9			
Total dust			15	
Respirable fraction			5	
Camphor, synthetic	76-22-2		2	
Carbaryl (Sevin)	63-25-2		5	
Carbon black	1333-86-4		3.5	
Carbon dioxide	124-38-9	5000	9000	
Carbon disulfide	75-15-0			

See Appendix A.2

Substance	CAS No. ^a	permissible exposure level		Skin
		ppm ^b	mg/m ^{3c}	
Carbon monoxide	630-08-0	50	55	
Carbon tetrachloride	56-23-5		See Appendix A.2	
Cellulose	9004-34-6			
Total dust			15	
Respirable fraction			5	
Chlordane	57-74-9		0.5	X
Chlorinated camphene	8001-35-2		0.5	X
Chlorinated diphenyl oxide	55720-99-5		0.5	
Chlorine	7782-50-5	(C) 1	(C) 3	
Chlorine dioxide	10049-04-4	0.1	0.3	
Chlorine trifluoride	7790-91-2	(C) 0.1	(C) 0.4	
Chloroacetaldehyde	107-20-0	(C) 1	(C) 3	
α -Chloroacetophenone (phenacyl chloride)	532-27-4	0.05	0.3	
Chlorobenzene	108-90-7	75	350	
<i>o</i> -Chlorobenzylidene malononitrile	2698-41-1	0.05	0.4	
Chlorobromomethane	74-97-5	200	1050	
2-Chloro-1,3-butadiene; see β -Chloroprene				
Chlorodiphenyl (42% Chlorine) (PCB)	53469-21-9		1	X
Chlorodiphenyl (54% Chlorine) (PCB)	11097-69-1		0.5	X
1-Chloro-2,3-epoxypropane; see Epichlorohydrin				
2-Chloroethanol; see Ethylene chlorohydrin				
Chloroethylene; see Vinyl chloride				
Chloroform (trichloromethane)	67-66-3	(C) 50	(C) 240	
bis (Chloromethyl) ether; see 1910.1008	542-88-1			
Chloromethyl methyl ether; see 1910.1006	107-30-2			
1-Chloro-1-nitropropane	600-25-9	20	100	
Chloropicrin	76-06-2	0.1	0.7	
β -Chloroprene	126-99-8	25	90	X
2-Chloro-6 (trichloromethyl) pyridine	1929-82-4			
Total dust			15	
Respirable fraction			5	
Chromic acid and chromates [as CrO (III)]	varies with compound		See Appendix A.2	
Chromium (II) compounds (as Cr)	7440-47-3		0.5	
Chromium (III) compounds (as Cr)	7440-47-3		0.5	
Chromium metal and insoluble salts (as Cr)	7440-47-3		1	
Chrysene; see Coal tar pitch volatiles				
Clopidol	2971-90-6			
Total dust			15	

Substance	CAS No. ^a	permissible exposure level		Skin
		ppm ^b	mg/m ^{3c}	
Respirable fraction			5	
Coal dust (less than 5% SiO ₂), respirable fraction			See Appendix A.3	
Coal dust (greater than or equal to 5% SiO ₂), respirable fraction			See Appendix A.3	
Coal tar pitch volatiles (benzene soluble fraction), anthracene, BaP, phenanthrene, acridine, chrysene, pyrene	65966-93-2		0.2	
Cobalt metal, dust, and fume (as Co)	7440-48-4		0.1	
Coke oven emissions; see 1910.1029			150 µg/m ³	
Copper	7440-50-8			
Fume (as Cu)			0.1	
Dusts and mists (as Cu)			1	
Cotton dust ^c ; see 1910.1043 in cotton gin; see 1910.1046			200–750 µg/m ³	
Crag herbicide (Sesone)	136-78-7			
Total dust			15	
Respirable fraction			5	
Cresol, all isomers	1319-77-3	5	22	X
Crotonaldehyde	123-73-9	2	6	
	4170-30-3			
Cumene	98-82-8	50	245	X
Cyanides (as CN)	varies with compound	5		
Cyclohexane	110-82-7	300	1050	
Cyclohexanol	108-93-0	50	200	
Cyclohexanone	108-94-1	50	200	
Cyclohexene	110-83-8	300	1015	
Cyclopentadiene	542-92-7	75	200	
2,4-D (Dichlorophen oxyacetic acid)	94-75-7		10	
Decaborane	17702-41-9	0.05	0.3	X
Demeton (Systox)	8065-48-3		0.1	X
Diacetone alcohol (4-Hydroxy-4-methyl 2-pentanone)	123-42-2	50	240	
1,2-Diaminoethane; see Ethylenediamine				
Diazomethane	334-88-3	0.2	0.4	
Diborane	19287-45-7	0.1	0.1	
1,2-Dibromo-3-chloropropane (DBCP); see 1910.1044	96-12-8	1 ppb (parts per billion)		
1,2-Dibromoethane; see Ethylene dibromide				
Dibutyl phosphate	107-66-4	1	5	
Dibutyl phthalate	84-74-2		5	
o-Dichlorobenzene	95-50-1	(C) 50	(C) 300	

Substance	CAS No. ^a	permissible exposure level		Skin
		ppm ^b	mg/m ^{3c}	
p-Dichlorobenzene	106-46-7	75	450	
3,3'-Dichlorobenzidine; see 1910.1007	91-94-1			
Dichlorodifluoromethane	75-71-8	1000	4950	
1,3-Dichloro-5, 5-dimethyl hydantoin	118-52-5		0.2	
Dichlorodiphenyltrichloroethane (DDT)	50-29-3		1	X
1,1-Dichloroethane	75-34-3	100	400	
1,2-Dichloroethane; see Ethylene dichloride				
1,2-Dichloroethylene	540-59-0	200	790	
Dichloroethyl ether	111-44-4	(C)15	(C)90	X
Dichloromethane; see Methylene chloride				
Dichloromonofluoromethane	75-43-4	1000	4200	
1,1-Dichloro-1-nitroethane	594-72-9	(C) 10	(C) 60	
1,2-Dichloropropane; see Propylene dichloride				
Dichlorotetrafluoroethane	76-14-2	1000	7000	
Dichlorvos (DDVP)	62-73-7		1	X
Dicyclopentadienyl iron Total dust	102-54-5		15	
Respirable fraction			5	
Dieldrin	60-57-1		0.25	X
Diethylamine	109-89-7	25	75	
2-Diethylaminoethanol	100-37-8	10	50	X
Diethyl ether; see Ethyl ether				
Difluorodibromomethane	75-61-6	100	860	
Diglycidyl ether (DGE)	2238-07-5	(C) 0.5	(C) 2.8	
Dihydroxybenzene; see Hydroquinone				
Diisobutyl ketone	108-83-8	50	290	
Diisopropylamine	108-18-9	5	20	X
4-Dimethylaminoazobenzene; see 1910.1015	60-11-7			
Dimethoxymethane; see Methylal				
Dimethyl acetamide	127-19-5	10	35	X
Dimethylamine	124-40-3	10	18	
Dimethylaminobenzene; see Xylidine				
Dimethylaniline (<i>N,N</i> -Dimethylaniline)	121-69-7	5	25	X
Dimethylbenzene; see Xylene				
Dimethyl-1,2-dibromo-2, 2-dichloroethylphosphate	300-76-5	3		
Dimethylformamide 2,6-Dimethyl- 4-heptanone; see Diisobutyl ketone	68-12-2	10	30	X

522 Appendix A OSHA Permissible Exposure Limits

Substance	CAS No. ^a	permissible exposure level		Skin
		ppm ^b	mg/m ^{3c}	
1,1-Dimethylhydrazine	57-14-7	0.5	1	X
Dimethylphthalate	131-11-3		5	
Dimethyl sulfate	77-78-1	1	5	X
Dinitrobenzene (all isomers)			1	X
ortho	528-29-0			
meta	99-65-0			
para	100-25-4			
Dinitro- <i>o</i> -cresol	534-52-1		0.2	X
Dinitrotoluene	25321-14-6		1.5	X
Dioxane (Diethylene dioxide)	123-91-1	100	360	X
Diphenyl (biphenyl)	92-52-4	0.2	1	
Diphenylmethane diisocyanate; see Methylene bisphenyl isocyanate				
Dipropylene glycol methyl ether	34590-94-8	100	600	X
Di- <i>sec</i> octyl phthalate (Di-(2-ethylhexyl) phthalate)	117-81-7		5	
Emery	12415-34-8			
Total dust			15	
Respirable fraction			5	
Endrin	72-20-8		0.1	X
Epichlorohydrin	106-89-8	5	19	X
EPN 1,2-Epoxypropane; see Propylene oxide 2,3-Epoxy-1-propanol; see Glycidol	2104-64-5		0.5	X
Ethanethiol; see Ethyl mercaptan				
Ethanolamine	141-43-5	3	6	
2-Ethoxyethanol (cellosolve)	110-80-5	200	740	X
2-Ethoxyethyl acetate (cellosolve acetate)	111-15-9	100	540	X
Ethyl acetate	141-78-6	400	1400	
Ethyl acrylate	140-88-5	25	100	X
Ethyl alcohol (ethanol)	64-17-5	1000	1900	
Ethylamine	75-04-7	10		18
Ethyl amyl ketone (5-Methyl-3- heptanone)	541-85-5	25	130	
Ethyl benzene	100-41-4	100	435	
Ethyl bromide	74-96-4	200	890	
Ethyl butyl ketone (3-heptanone)	106-35-4	50	230	
Ethyl chloride	75-00-3	1000	2600	
Ethyl ether	60-29-7	400	1200	
Ethyl formate	109-94-4	100	300	
Ethyl mercaptan	75-08-1	(C) 10	(C) 25	
Ethyl silicate	78-10-4	100	850	
Ethylene chlorohydrin	107-07-3	5	16	X
Ethylenediamine	107-15-3	10	25	

Substance	CAS No. ^a	permissible exposure level		Skin
		ppm ^b	mg/m ^{3c}	
Ethylene dibromide	106-93-4		See Appendix A.2	
Ethylene dichloride (1,2-Dichloroethane)	107-06-2		See Appendix A.2	
Ethylene glycol dinitrate	628-96-6	(C) 0.2	(C) 1	X
Ethylene glycol methyl acetate; see Methyl cellosolve acetate				
Ethyleneimine see 1910.1012	151-56-4			
Ethylene oxide; see 1910.1047	75-21-8	1		
Ethylidene chloride; see 1,1-Dichloroethane				
N-Ethylmorpholine	100-74-3	20	94	X
Ferbam	14484-64-1			
Total dust			15	
Ferrovandium dust	12604-58-9		1	
Fluorides (as F)		See Appendix A.2	2.5	
Fluorine	7782-41-4	0.1	0.2	
Fluorotrichloromethane (trichlorofluoromethane)	75-69-4	1000	5600	
Formaldehyde; see 1910.1048	50-00-0	1		
Formic acid	64-18-6	5	9	
Furfural	98-01-1	5	20	X
Furfuryl alcohol	98-00-0	50	200	
Glycerin (mist)	56-81-5			
Total dust			15	
Respirable fraction			5	
Glycidol	556-52-5	50	150	
Glycol monoethyl ether; see 2-Ethoxyethanol				
Grain dust (oat, wheat barley)			10	
Graphite, natural respirable dust	7782-42-5		See Appendix A.3	
Graphite, synthetic				
Total dust			15	
Respirable fraction			5	
Guthion; see Azinphos methyl				
Gypsum	13397-24-5			
Total dust			15	
Respirable fraction			5	
Hafnium	7440-58-6		0.5	
Heptachlor	76-44-8		0.5	X
Heptane (<i>n</i> -Heptane)	142-82-5	500	2000	
Hexachloroethane	67-72-1	1	10	X
Hexachloronaphthalene	1335-87-1		0.2	X
<i>n</i> -Hexane	110-54-3	500	1800	
2-Hexanone (Methyl <i>n</i> -butyl ketone)	591-78-6	100	410	
Hexone (Methyl isobutyl ketone)	108-10-1	100	410	

524 Appendix A OSHA Permissible Exposure Limits

Substance	CAS No. ^a	permissible exposure level		Skin
		ppm ^b	mg/m ^{3c}	
sec-Hexyl acetate	108-84-9	50	300	
Hydrazine	302-01-2	1	1.3	X
Hydrogen bromide	10035-10-6	3	10	
Hydrogen chloride	7647-01-0	(C) 5	(C) 7	
Hydrogen cyanide	74-90-8	10	11	X
Hydrogen fluoride (as F)	7664-39-3		See Appendix A.2	
Hydrogen peroxide	7722-84-1	1	1.4	
Hydrogen selenide (as Se)	7783-07-5	0.05	0.2	
Hydrogen sulfide	7783-06-4		See Appendix A.2	
Hydroquinone	123-31-9	2		
Iodine	7553-56-2	(C) 0.1	(C) 1	
Iron oxide fume	1309-37-1		10	
Isomyl acetate	123-92-2	100	525	
Isomyl alcohol (primary and secondary)	123-51-3	100	360	
Isobutyl acetate	110-19-0	150	700	
Isobutyl alcohol	78-83-1	100	300	
Isophorone	78-59-1	25	140	
Isopropyl acetate	108-21-4	250	950	
Isopropyl alcohol	67-63-0	400	980	
Isopropylamine	75-31-0	5	12	
Isopropyl ether	108-20-3	500	2100	
Isopropyl glycidyl ether (IGE)	4016-14-2	50	240	
Kaolin	1332-58-7			
Total dust			15	
Respirable fraction			5	
Ketene	463-51-4	0.5	0.9	
Lead inorganic (as Pb); see 1910.1025 (for General Industry) or 1926.62 (for Construction)	7439-92-1		50 µg/m ³	
Limestone	1317-65-3			
Total dust			15	
Respirable fraction			5	
Lindane	58-89-9		0.5	X
Lithium hydride	7580-67-8		0.025	
LPG (Liquefied petroleum gas)	68476-85-7	1000	1800	
Magnesite	546-93-0			
Total dust			15	
Respirable fraction			5	
Magnesium oxide fume	1309-48-4			
Total particulate			15	
Malathion	121-75-5			
Total dust			15	X
Maleic anhydride	108-31-6	0.25	1	
Manganese compounds (as Mn)	7439-96-5		(C) 5	

Substance	CAS No. ^a	permissible exposure level		Skin
		ppm ^b	mg/m ^{3c}	
Manganese fume (as Mn)	7439-96-5		(C) 5	
Marble	1317-65-3			
Total dust			15	
Respirable fraction			5	
Mercury (aryl and inorganic) (as Hg)	7439-97-6		See Appendix A.2	
Mercury (organo) alkyl compounds (as Hg)	7439-97-6		See Appendix A.2	
Mercury (vapor) (as Hg)	7439-97-6		See Appendix A.2	
Mesityl oxide	141-79-7	25	100	
Methanethiol; see Methyl mercaptan				
Methoxychlor	72-43-5			
Total dust			15	
2-Methoxyethanol;(methyl cellosolve)	109-86-4	25	80	X
2-Methoxyethyl acetate (methyl cellosolve acetate)	110-49-6	25	120	X
Methyl acetate	79-20-9	200	610	
Methyl acetylene (propyne)	74-99-7	1000	1650	
Methyl acetylene propadiene mixture (MAPP)		1000	1800	
Methyl acrylate	96-33-3	10	35	X
Methylal (dimethoxymethane)	109-87-5	1000	3100	
Methyl alcohol	67-56-1	200	260	
Methylamine	74-89-5	10	12	
Methyl amyl alcohol; see Methyl isobutyl carbinol				
Methyl <i>n</i> -amyl ketone	110-43-0	100	465	
Methyl bromide	74-83-9	(C) 20	(C) 80	X
Methyl butyl ketone; see 2-Hexanone				
Methyl cellosolve; see 2-Methoxyethanol				
Methyl cellosolve acetate; see 2-Methoxyethyl acetate				
Methyl chloride	74-87-3		See Appendix A.2	
Methyl chloroform (1,1,1-Trichloroethane)	71-55-6	350	1900	
Methylcyclohexane	108-87-2	500	2000	
Methylcyclohexanol	25639-42-3	100	470	
<i>o</i> -Methylcyclohexanone	583-60-8	100	460	X
Methylene chloride	75-09-2		See Appendix A.2	
Methyl ethyl ketone (MEK); see 2-Butanone				
Methyl formate	107-31-3	100	250	
Methyl hydrazine (monomethyl hydrazine)	60-34-4	(C) 0.2	(C) 0.35	X
Methyl iodide	74-88-4	5	28	X
Methyl isoamyl ketone	110-12-3	100	475	

526 Appendix A OSHA Permissible Exposure Limits

Substance	CAS No. ^a	permissible exposure level		Skin
		ppm ^b	mg/m ^{3c}	
Methyl isobutyl carbinol	108-11-2	25	100	X
Methyl isobutyl ketone; see Hexone				
Methyl isocyanate	624-83-9	0.02	0.05	X
Methyl mercaptan	74-93-1	(C) 10	(C) 20	
Methyl methacrylate	80-62-6	100	410	
Methyl propyl ketone; see 2-Pentanone				
α -Methyl styrene	98-83-9	(C) 100	(C) 480	
Methylene bisphenyl isocyanate (MDI)	101-68-8	(C) 0.02	(C) 0.2	
Mica; see Silicates				
Molybdenum (as Mo)	7439-98-7			
Soluble compounds			5	
Insoluble compounds				
Total dust				
Monomethyl aniline	100-61-8	2	15	
Monomethyl hydrazine; see Methyl hydrazine			9	X
Morpholine	110-91-8	20		
Naphtha (coal tar)	8030-30-6	100	70	X
Naphthalene	91-20-3	10	400	
α -Naphthylamine; see 1910.1004	134-32-7		50	
β -Naphthylamine; see 1910.1009	91-59-8			
Nickel carbonyl (as Ni)	13463-39-3	0.001	0.007	
Nickel, metal and insoluble compounds (as Ni)	7440-02-0		1	
Nickel, soluble compounds (as Ni)	7440-02-0		1	
Nicotine	54-11-5		0.5	X
Nitric acid	7697-37-2	2	5	
Nitric oxide	10102-43-9	25	30	
<i>p</i> -Nitroaniline	100-01-6	1	6	X
Nitrobenzene	98-95-3	1	5	X
<i>p</i> -Nitrochlorobenzene	100-00-5		1	X
4-Nitrobiphenyl; see 1910.1003	92-93-3			
Nitroethane	79-24-3	100	310	
Nitrogen dioxide	10102-44-0	(C) 5	(C) 9	
Nitrogen trifluoride	7783-54-2	10	29	
Nitroglycerin	55-63-0	(C) 0.2	(C) 2	X
Nitromethane	75-52-5	100	250	
1-Nitropropane	108-03-2	25	90	
2-Nitropropane	79-46-9	25	90	
<i>N</i> -Nitrosodimethylamine; see 1910.1016				
Nitrotoluene (all isomers)		5	30	X
<i>o</i> -isomer	88-72-2			
<i>m</i> -isomer	99-08-1			
<i>p</i> -isomer	99-99-0			

Substance	CAS No. ^a	permissible exposure level		Skin
		ppm ^b	mg/m ^{3c}	
Nitrotrichloromethane; see Chloropicrin				
Octachloronaphthalene	2234-13-1		0.1	X
Octane	111-65-9	500	2350	
Oil mist, mineral	8012-95-1		5	
Osmium tetroxide (as Os)	20816-12-0		0.002	
Oxalic acid	144-62-7		1	
Oxygen difluoride	7783-41-7	0.05	0.1	
Ozone	10028-15-6	0.1	0.2	
Paraquat, respirable dust	4685-14-7 1910-42-5 2074-50-2		0.5	X
Parathion	56-38-2		0.1	X
Particulates not otherwise regulated (PNOR) ^f				
Total dust			15	
Respirable fraction			5	
PCB; see Chlorodiphenyl (42% and 54% chlorine)				
Pentaborane	19624-22-7	0.005	0.01	
Pentachloronaphthalene	1321-64-8		0.5	X
Pentachlorophenol	87-86-5		0.5	X
Pentaerythritol	115-77-5			
Total dust			15	
Respirable fraction			5	
Pentane	109-66-0	1000	2950	
2-Pentanone (Methyl propyl ketone)	107-87-9	200	700	
Perchloroethylene (tetrachloroethylene)	127-18-4		See Appendix A.2	
Perchloromethyl mercaptan	594-42-3	0.1	0.8	
Perchloryl fluoride	7616-94-6	3	13.5	
Perlite	93763-70-3			
Total dust			15	
Respirable fraction			5	
Petroleum distillates (naphtha) (rubber solvent)		500	2000	
Phenol	108-95-2	5	19	X
<i>p</i> -Phenylene diamine	106-50-3		0.1	X
Phenyl ether, vapor	101-84-8	1	7	
Phenyl ether-biphenyl mixture, vapor		1	7	
Phenylethylene; see Styrene				
Phenyl glycidyl ether (PGE)	122-60-1	10	60	
Phenylhydrazine	100-63-0	5	22	X
Phosdrin (Mevinphos)	7786-34-7		0.1	X
Phosgene (carbonyl chloride)	75-44-5	0.1	0.4	

Substance	CAS No. ^a	permissible exposure level		Skin
		ppm ^b	mg/m ^{3c}	
Phosphine	7803-51-2	0.3	0.4	
Phosphoric acid	7664-38-2		1	
Phosphorus (yellow)	7723-14-0		0.1	
Phosphorus pentachloride	10026-13-8		1	
Phosphorus pentasulfide	1314-80-3		1	
Phosphorus trichloride	7719-12-2	0.5	3	
Phthalic anhydride	85-44-9	2	12	
Picloram	1918-02-1			
Total dust			15	
Respirable fraction			5	
Picric acid	88-89-1		0.1	X
Pindone (2-Pivalyl-1,3-indandione)	83-26-1		0.1	
Plaster of paris	26499-65-0			
Total dust			15	
Respirable fraction			5	
Platinum (as Pt)	7440-06-4			
Metal				
Soluble Salts			0.002	
Portland cement	65997-15-1			
Total dust			15	
Respirable fraction			5	
Propane	74-98-6	1000	1800	
beta-Propriolactone; see 1910.1013	57-57-8			
<i>n</i> -Propyl acetate	109-60-4	200	840	
<i>n</i> -Propyl alcohol	71-23-8	200	500	
<i>n</i> -Propyl nitrate	627-13-4	25	110	
Propylene dichloride	78-87-5	75	350	
Propylene imine	75-55-8	2	5	X
Propylene oxide	75-56-9	100	240	
Propyne; see Methyl acetylene				
Pyrethrum	8003-34-7		5	
Pyridine	110-86-1	5	15	
Quinone	106-51-4	0.1	0.4	
RDX; see Cyclonite				
Rhodium (as Rh), metal fume and insoluble compounds	7440-16-6		0.1	
Rhodium (as Rh), soluble compounds	7440-16-6		0.001	
Ronnel	299-84-3		15	
Rotenone	83-79-4		5	
Rouge				
Total dust			15	
Respirable fraction			5	
Selenium compounds (as Se)	7782-49-2		0.2	
Selenium hexafluoride (as Se)	7783-79-1	0.05	0.4	

Substance	CAS No. ^a	permissible exposure level		Skin
		ppm ^b	mg/m ^{3c}	
Silica, amorphous, diatomaceous earth, containing less than 1% crystalline silica	61790-53-2		See Appendix A.3	
Silica, amorphous, precipitated and gel	112926-00-8		See Appendix A.3	
Silica, crystalline cristobalite, respirable dust	14464-46-1		See Appendix A.3	
Silica, crystalline quartz, respirable dust	14808-60-7		See Appendix A.3	
Silica, crystalline tripoli (as quartz), respirable dust	1317-95-9		See Appendix A.3	
Silica, crystalline tridymite, respirable dust	15468-32-3		See Appendix A.3	
Silica, fused, respirable dust	60676-86-0		See Appendix A.3	
Silicates (less than 1% crystalline silica)			See Appendix A.3	
Mica (respirable dust)	12001-26-2		See Appendix A.3	
Soapstone, total dust			See Appendix A.3	
Soapstone, respirable dust			See Appendix A.3	
Talc (containing asbestos): use asbestos limit: see 29 CFR 1910.1001			See Appendix A.3	
Talc (containing no asbestos), respirable dust	14807-96-6		See Appendix A.3	
Tremolite, asbestiform; see 1910.1001				
Silicon	7440-21-3			
Total dust			15	
Respirable fraction			5	
Silicon carbide	409-21-2			
Total dust			15	
Respirable fraction			5	
Silver, metal and soluble compounds (as Ag)	7440-22-4		0.01	
Soapstone; see Silicates				
Sodium fluoroacetate	62-74-8		0.05	X
Sodium hydroxide	1310-73-2		2	
Starch	9005-25-8			
Total dust			15	
Respirable fraction			5	
Stibine	7803-52-3	0.1	0.5	
Stoddard solvent	8052-41-3	500	2900	
Strychnine	57-24-9		0.15	
Styrene	100-42-5		See Appendix A.2	
Sucrose	57-50-1			
Total dust			15	
Respirable fraction			5	
Sulfur dioxide	7446-09-5	5	13	

530 Appendix A OSHA Permissible Exposure Limits

Substance	CAS No. ^a	permissible exposure level		Skin
		ppm ^b	mg/m ^{3c}	
Sulfur hexafluoride	2551-62-4	1000	6000	
Sulfuric acid	7664-93-9		1	
Sulfur monochloride	10025-67-9	1	6	
Sulfur pentafluoride	5714-22-7	0.025	0.25	
Sulfuryl fluoride	2699-79-8	5	20	
Systox; see Demeton 2,4,5-T (2,4,5-trichlorophenoxyacetic acid)	93-76-5		10	
Talc; see Silicates				
Tantalum, metal and oxide dust	7440-25-7		5	
TEDP (Sulfotep)	3689-24-5		0.2	X
Tellurium and compounds (as Te)	13494-80-9		0.1	
Tellurium hexafluoride (as Te)	7783-80-4	0.02	0.2	
Temephos	3383-96-8			
Total dust			15	
Respirable fraction			5	
TEPP (Tetraethyl pyrophosphate)	107-49-3		0.05	X
Terphenylis	26140-60-3	(C) 1	(C) 9	
1,1,1,2-Tetrachloro-2,2-difluoroethane	76-11-9	500	4170	
1,1,2,2-Tetrachloro-1,2-difluoroethane	76-12-0	500	4170	
1,1,2,2-Tetrachloroethane	79-34-5	5	35	X
Tetrachoroethylene; see Perchloroethylene				
Tetrachloromethane; see Carbon tetrachloride				
Tetrachloronaphthalene	1335-88-2		2	X
Tetraethyl lead (as Pb)	78-00-2		0.075	X
Tetrahydrofuran	109-99-9	200	590	
Tetramethyl lead, (as Pb)	75-74-1		0.075	X
Tetramethyl succinonitrile	3333-52-6	0.5	3	X
Tetranitromethane	509-14-8	1	8	
Tetryl (2,4,6-Trinitro-phenylmethylnit- ramine)	479-45-8		1.5	X
Thallium, soluble compounds (as TI)	7440-28-0		0.1	X
4,4'-Thiobis (6- <i>tert</i> , Butyl- <i>m</i> -cresol)	96-69-5			
Total dust			15	
Respirable fraction			5	
Thiram	137-26-8		5	
Tin, inorganic compounds (except oxides) (as Sn)	7440-31-5		2	
Tin, organic compounds (as Sn)	7440-31-5		0.1	
Titanium dioxide	13463-67-7			
Total dust			15	
Toluene	108-88-3		See Appendix A.2	
Toluene-2,4-diisocyanate (TDI)	584-84-9	(C) 0.02	(C) 0.14	

Substance	CAS No. ^a	permissible exposure level		Skin
		ppm ^b	mg/m ^{3c}	
<i>o</i> -Toluidine	95-53-4	5	22	X
Toxaphene; see Chlorinated camphene				
Tremolite; see Silicates				
Tributyl phosphate	126-73-8		5	
1,1,1-Trichloroethane; see Methyl chloroform				
1,1,2-Trichloroethane	79-00-5	10	45	X
Trichloroethylene	79-01-6		See Appendix A.2	
Trichloromethane; see Chloroform				
Trichloronaphthalene	1321-65-9		5	X
1,2,3-Trichloropropane	96-18-4	50	300	
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	1000	7600	
Triethylamine	121-44-8	25	100	
Trifluorobromomethane	75-63-8	1000	6100	
2,4,6-Trinitrophenyl; see Picric acid				
2,4,6-Trinitrophenylmethyl nitramine; see Tetryl				
2,4,6-Trinitrotoluene (TNT)	118-96-7		1.5	X
Triorthocresyl phosphate	78-30-8		0.1	
Triphenyl phosphate	115-86-6		3	
Turpentine	8006-64-2	100	560	
Uranium (as U)	7440-61-1			
Soluble compounds			0.05	
Insoluble compounds			0.05	
Vanadium	1314-62-1			
Respirable dust (as V ₂ O ₅)			(C) 0.5	
Fume (as V ₂ O ₅)			(C) 0.1	
Vegetable oil mist				
Total dust			15	
Respirable fraction			5	
Vinyl benzene; see Styrene				
Vinyl chloride; see 1910.1017	75-01-4			
Vinyl cyanide; see Acrylonitrile				
Vinyl toluene	25013-15-4	100	480	
Warfarin	81-81-2		0.1	
Xylenes (<i>o</i> -, <i>m</i> -, <i>p</i> -isomers)	1330-20-7	100	435	
Xylidine	1300-73-8	5	25	X
Yttrium	7440-65-5		1	
Zinc chloride fume	7646-85-7		1	
Zinc oxide fume	1314-13-2		5	
Zinc oxide	1314-13-2			
Total dust			15	
Respirable fraction			5	
Zinc stearate	557-05-1			

Substance	CAS No. ^a	permissible exposure level		Skin
		ppm ^b	mg/m ^{3c}	
Total dust			15	
Respirable fraction			5	
Zirconium compounds (as Zr)	7440-67-7		5	

^aThe CAS number is for information only. Enforcement is based on the substance name. For an entry covering more than one metal compound measured as the metal, the CAS number for the metal is given, not CAS numbers for the individual compounds.

^bParts of vapor or gas per million parts of contaminated air by volume at 25 °C and 760 torr.

^cMilligrams of substance per cubic meter of air. When entry is in this column only, the value is exact; when listed with a ppm entry, it is approximate.

^dThe final benzene standard in 1910.1028 applies to all occupational exposures to benzene except in some circumstances the distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures; for the excepted subsegments, the benzene limits in Appendix A.2 apply. See 1910.1028 for specific circumstances.

^eThis 8-hour TWA applies to respirable dust as measured by a vertical elutriator cotton dust sampler or equivalent instrument. The time-weighted average applies to the cotton waste-processing operations of waste recycling (sorting, blending, cleaning, and willowing) and garnetting. See also 1910.1043 for cotton dust limits applicable to other sectors.

^fAll inert or nuisance dusts, whether mineral, inorganic, or organic, not listed specifically by substance name are covered by the "Particulates Not Otherwise Regulated" (PNOR) limit, which is the same as the inert or nuisance dust limit of Appendix A.3.

Source: Code of Federal Regulations 29 CFR 1910.1000. 54 FR 36767, Sept. 5, 1989; 54 FR 41244, Oct. 6, 1989; 55 FR 3724, Feb. 5, 1990; 55 FR 12819, Apr. 6, 1990; 55 FR 19259, May 9, 1990; 55 FR 46950, Nov. 8, 1990; 57 FR 29204, July 1, 1992; 57 FR 42388, Sept. 14, 1992; 58 FR 35340, June 30, 1993.; 61 FR 56746, Nov. 4, 1996.

APPENDIX A.2: PELs AND STELs FOR SOME SPECIALIZED MATERIALS

Substance	8-hour time-weighted average	Acceptable ceiling concentration	Acceptable maximum peak above the acceptable ceiling concentration for an 8-hour shift	
			Concentration	Maximum duration
Benzene ^a (Z3740-1969)	10 ppm	25 ppm	50 ppm	10 minutes
Beryllium and beryllium compounds (Z3729-1970)	0.2 µg/m ³		2 µg/m ³	15 minutes
Cadmium dust ^b (Z375-1970)	0.2 mg/m ³	0.6 mg/m ³		
Cadmium fume ^b (Z375-1970)	0.1 mg/m ³	0.3 mg/m ³		
Carbon disulfide (Z373-1968)	20 ppm	30 ppm	100 ppm	30 minutes
Carbon tetrachloride (Z3717-1967)	10 ppm	25 ppm	200 ppm	5 minutes in any 4 hours
Chromic acid and chromates (Z37-7-1971)		1 mg/10 m ³		
Ethylene dibromide (Z3731-1970)	20 ppm	30 ppm	50 ppm	5 minutes

Substance	8-hour time-weighted average	Acceptable ceiling concentration	Acceptable maximum peak above the acceptable ceiling concentration for an 8-hour shift	
			Concentration	Maximum duration
Ethylene dichloride (Z3721-1969)	50 ppm	100 ppm	200 ppm	5 minutes in any 3 hours
Fluoride as dust (Z3728-1969)	2.5 mg/m ³			
Formaldehyde: see 1910.1048				
Hydrogen fluoride (Z3728-1969)	3 ppm			
Hydrogen sulfide (Z372-1966)		20 ppm	50 ppm	10 minutes once only, if no other measurable exposure occurs
Mercury (Z378-1971)		1 mg/10m ³		
Methyl chloride (Z3718-1969)	100 ppm	200 ppm	300 ppm	5 minutes in any 3 hours
Methylene chloride: see 1910.1052	25 ppm		125 ppm	15 minutes in any 3 hours
Organo (alkyl) mercury (Z3730-1969)	0.01 mg/m ³	0.04 mg/m ³		
Styrene (Z3715-1969)	100 ppm	200 ppm	600 ppm	5 minutes in any 3 hours
Tetrachloroethylene (Z3722-1967)	100 ppm	200 ppm	300 ppm	5 minutes in any 3 hours
Toluene (Z3712-1967)	200 ppm	300 ppm	500 ppm	10 minutes
Trichloroethylene (Z3719-1967)	100 ppm	200 ppm	300 ppm	5 minutes in any 2 hours

^aThis standard applies to the industry segments exempt from the 1-ppm 8-hour TWA and 5-ppm STEL of the benzene standard at 1910.1028.

^bThis standard applies to any operations or sectors for which the cadmium standard, 1910.1027, is stayed or otherwise not in effect.

Source: Code of Federal Regulations 29 CFR 1910.1000, 57 FR 42388, Sept. 14, 1992; 58 FR 21781, Apr. 23, 1993; 58 FR 35340, June 30, 1993; 62 FR 1493, Jan. 10, 1997.

APPENDIX A.3: PELs FOR MINERAL DUSTS

Substance	mppcf ^a	mg/m ³
Silica		
Crystalline		
Quartz (respirable)	$\frac{250^b}{\%SiO_2 + 5}$	$\frac{10 \text{ mg/m}^3^d}{\%SiO_2 + 2}$
Quartz (total dust)		$\frac{80 \text{ mg/m}^3}{\%SiO_2 + 2}$

Cristobalite: Use $\frac{1}{2}$ the value calculated from the count or mass formulas for quartz

Substance	mppcf ^a	mg/m ³
Tridymite: Use $\frac{1}{2}$ the value calculated from the formulas for quartz		
Amorphous, including natural diatomaceous earth	20	
Silicates (less than 1% crystalline silica)		
Mica	20	
Soapstone	20	
Talc (not containing asbestos)	20 ^c	
Talc (containing asbestos). Use asbestos limit		
Tremolite, asbestiform (see 29 CFR 1910.1001)		
Portland cement	50	
Graphite (natural)	15	
Coal Dust ^e		
Respirable fraction less than 5% SiO ₂	$\frac{2.4 \text{ mg/m}^3}{\% \text{SiO}_2 + 2}$	
Respirable fraction greater than 5% SiO ₂	$\frac{10 \text{ mg/m}^3}{\% \text{SiO}_2 + 2}$	
Inert or nuisance dust ^d		
Respirable fraction	15	5 mg/m ³
Total dust	50	15 mg/m ³

Note: Conversion factors – mppcf \times 35.3 = million particles per cubic meter = particles per cc.

^aMillions of particles per cubic foot of air, based on impinger samples counted by light-field techniques.

^bThe percentage of crystalline silica in the formula is the amount determined from airborne samples, except in those instances in which other methods have been shown to be applicable.

^cContaining less than 1% quartz; if 1% quartz or more, use the quartz limit.

^dAll inert or nuisance dusts, whether mineral, inorganic, or organic, not listed specifically by substance name are covered by this limit, which is the same as the "Particulates not Otherwise Regulated" (PNOR) limit in the table of Appendix A.1.

^eBoth concentration and percent quartz for the application of this limit are to be determined from the fraction passing a size selector with the following characteristics:

Aerodynamic diameter (unit density sphere)	% passing selector
2	90
2.5	75
3.5	50
5.0	25
10	0

The measurements under this note refer to the use of an AEC (now NRC) instrument. The respirable fraction of coal dust is determined with an MRE: the figure corresponding to that of 2.4 mg/m³ in the table for coal dust is 4.5 mg/m³.

A P P E N D I X B

Medical Treatment

- Treatment of **INFECTION**
- Application of **ANTISEPTICS** during second or subsequent visit of medical personnel
- Treatment of **SECOND- OR THIRD-DEGREE BURN(S)**
- Application of **SUTURES** (stitches)
- Removal of **FOREIGN BODIES EMBEDDED IN EYE**
- Removal of **FOREIGN BODIES** from wound if procedure is **COMPLICATED** because of depth of embedment, size, or location
- Use of **PRESCRIPTION MEDICATIONS** (except a single dose administered on first visit for minor injury or discomfort)
- Use of hot or cold **SOAKING THERAPY** during second or subsequent visit to medical personnel
- Application of hot or cold **COMPRESS(ES)** during second or subsequent visit to medical personnel
- **CUTTING AWAY DEAD SKIN** (surgical debridement)
- Application of **HEAT THERAPY** during second or subsequent visit to medical personnel
- Use of **WHIRLPOOL BATH THERAPY** during second or subsequent visit to medical personnel
- **POSITIVE X-RAY DIAGNOSIS** (fractures, broken bones, etc.)
- **ADMISSION TO A HOSPITAL** or equivalent medical facility for treatment

Source: Recordkeeping, 1978.

A P P E N D I X C

First-Aid Treatment

- Application of **BANDAGE(S)** during first visit to medical personnel
- Application of **BUTTERFLY ADHESIVE DRESSING(S)** or **STERISTRIP(S)** in lieu of sutures
- Use of **ELASTIC BANDAGE(S)** during first visit to medical personnel
- Removal of **FOREIGN BODIES NOT EMBEDDED IN EYE** if only irrigation is required
- Removal of **FOREIGN BODIES** from wound if procedure is **UNCOMPLICATED**, and is, for example, by tweezers or other simple technique
- Using a **NON-PRESCRIPTION** medication at **NON-PRESCRIPTION STRENGTH** (For medications available in both prescription and non-prescription form, a recommendation by a physician or other licensed health care professional to use a non-prescription medication at prescription strength is considered medical treatment for recordkeeping purposes)
- **SOAKING THERAPY** on initial visit to medical personnel or removal of bandages by **SOAKING**
- Application of hot or cold **COMPRESS(ES)** during first visit to medical personnel
- Using **MASSAGES** (physical therapy or chiropractic treatment are considered medical treatment for recordkeeping purposes)
- Using any non-rigid means of support, such as elastic bandages, wraps, non-rigid back belts, etc.
- Application of **HEAT THERAPY** during first visit to medical personnel
- **OBSERVATION** of injury during visit to medical personnel
- Cleaning, flushing, or soaking wounds on the skin surface
- Using temporary immobilization devices while transporting an accident victim (splints, slings, neck collars, or back boards)
- Drilling a fingernail or toenail to relieve pressure, or draining fluids from blisters
- Using eye patches
- Drinking fluids for relief of heat stress.

The following procedure, by itself, is not considered medical treatment:

- Administration of TETANUS SHOT(S) or BOOSTER(S). However, these shots are often given in conjunction with the more serious injuries; consequently, injuries requiring tetanus shots may be recordable for other reasons.

Source: Code of Federal Regulations 1904.7(b)(5)(i)(C)

A P P E N D I X D

Classification of Medical Treatment

OCCUPATIONAL SKIN DISEASES OR DISORDERS

Examples: Contact dermatitis, eczema, or rash caused by primary irritants and sensitizers or poisonous plants; oil acne; chrome ulcers; chemical burns or inflammations; etc.

DUST DISEASES OF THE LUNGS (PNEUMOCONIOSES)

Examples: Silicosis, asbestosis and other asbestos-related diseases, coal worker's pneumoconiosis, byssinosis, siderosis, and pneumoconioses.

RESPIRATORY CONDITIONS DUE TO TOXIC AGENTS

Examples: Pneumonitis, pharyngitis, rhinitis, or acute congestion due to chemicals, dusts, gases, or fumes; farmer's lung; etc.

POISONING (SYSTEMIC EFFECT OF TOXIC MATERIALS)

Examples: Poisoning by lead, mercury, cadmium, arsenic, or other metals; poisoning by carbon monoxide, hydrogen sulfide, or other gases; poisoning by benzol, carbon tetrachloride, or other organic solvents; poisoning by insecticide sprays such as parathion or lead arsenate; poisoning by other chemicals such as formaldehyde, plastics, or resins, etc.

DISORDERS DUE TO PHYSICAL AGENTS (OTHER THAN TOXIC MATERIALS)

Examples: Heatstroke, sunstroke, heat exhaustion, and other effects of environmental heat; freezing, frostbite, and effects of exposure to low temperatures; caisson disease; effects of ionizing radiation (isotopes, X-rays, radium); effects of nonionizing radiation (welding flash, ultraviolet rays, microwaves, sunburn); etc.

DISORDERS ASSOCIATED WITH REPEATED TRAUMA

Examples: Noise-induced hearing loss; synovitis, tenosynovitis, and bursitis; Raynaud's phenomena; and other conditions due to repeated motion, vibration, or pressure.

ALL OTHER OCCUPATIONAL ILLNESSES

Examples: Anthrax, brucellosis, infectious hepatitis, malignant and benign tumor, food poisoning, histoplasmosis, coccidioidomycosis, etc.

A P P E N D I X E

Highly Hazardous Chemicals, Toxics, and Reactives

This appendix contains a list of toxic and reactive highly hazardous chemicals that present a potential for a catastrophic event at or above the threshold quantity. List is current as of January 1, 2009 (OSHA Standard 29 CFR 1910.119, APP.A).

Chemical name	CAS ^a	TQ ^b
Acetaldehyde	75-07-0	2500
Acrolein (2-propenal)	107-02-8	150
Acrylyl chloride	814-68-6	250
Alkylaluminums	Varies	5000
Allyl chloride	107-05-1	1000
Allylamine	107-11-9	1000
Ammonia, anhydrous	7664-41-7	10,000
Ammonia solutions (greater than 44% ammonia by weight)	7664-41-7	15,000
Ammonium perchlorate	7790-98-9	7500
Ammonium permanganate	7787-36-2	7500
Arsine (also called arsenic hydride)	7784-42-1	100
Bis (chloromethyl) ether	542-88-1	100
Boron trichloride	10294-34-5	2500
Boron trifluoride	7637-07-2	250
Bromine	7726-95-6	1500
Bromine chloride	13863-41-7	1500
Bromine pentafluoride	7789-30-2	2500
Bromine trifluoride	7787-71-5	15,000
3-Bromopropyne (also called propargyl bromide)	106-96-7	100
Butyl hydroperoxide (tertiary)	75-91-2	5000
Butyl perbenzoate (tertiary)	614-45-9	7500
Carbonyl chloride (see Phosgene)	75-44-5	100
Carbonyl fluoride	353-50-4	2500

Chemical name	CAS ^a	TQ ^b
Cellulose nitrate (concentration greater than 12.6% nitrogen)	9004-70-0	2500
Chlorine	7782-50-5	1500
Chlorine dioxide	10049-04-4	1000
Chlorine pentafluoride	13637-63-3	1000
Chlorine trifluoride	7790-91-2	1000
Chlorodiethylaluminum (also called diethylaluminum chloride)	96-10-6	5000
1-Chloro-2,4-dinitrobenzene	97-00-7	5000
Chloromethyl methyl ether	107-30-2	500
Chloropicrin	76-06-2	500
Chloropicrin and methyl bromide mixture	None	1500
Chloropicrin and methyl chloride mixture	None	1500
Cumene hydroperoxide	80-15-9	5000
Cyanogen	460-19-5	2500
Cyanogen chloride	506-77-4	500
Cyanuric fluoride	675-14-9	100
Diacetyl peroxide (concentration greater than 70%)	110-22-5	5000
Diazomethane	334-88-3	500
Dibenzoyl peroxide	94-36-0	7500
Diborane	19287-45-7	100
Dibutyl peroxide (tertiary)	110-05-4	5000
Dichloroacetylene	7572-29-4	250
Dichlorosilane	4109-96-0	2500
Diethylzinc	557-20-0	10,000
Diisopropyl peroxydicarbonate	105-64-6	7500
Dilauroyl peroxide	105-74-8	7500
Dimethyldichlorosilane	75-78-5	1000
1,1-Dimethylhydrazine	57-14-7	1000
Dimethylamine, anhydrous	124-40-3	2500
2,4-Dinitroaniline	97-02-9	5000
Ethyl methyl ketone peroxide (also methyl ethyl ketone peroxide; concentration greater than 60%)	1338-23-4	5000
Ethyl nitrite	109-95-5	5000
Ethylamine	75-04-7	7500
Ethylene fluorohydrin	371-62-0	100
Ethylene oxide	75-21-8	5000
Ethyleneimine	151-56-4	1000
Fluorine	7782-41-4	1000
Formaldehyde (formalin)	50-00-0	1000
Furan	110-00-9	500
Hexafluoroacetone	684-16-2	5000
Hydrochloric acid, anhydrous	7647-01-0	5000
Hydrofluoric acid, anhydrous	7664-39-3	1000
Hydrogen bromide	10035-10-6	5000
Hydrogen chloride	7647-01-0	5000
Hydrogen cyanide, anhydrous	74-90-8	1000

Chemical name	CAS ^a	TQ ^b
Hydrogen fluoride	7664-39-3	1000
Hydrogen peroxide (52% by weight or greater)	7722-84-1	7500
Hydrogen selenide	7783-07-5	150
Hydrogen sulfide	7783-06-4	1500
Hydroxylamine	7803-49-8	2500
Iron, pentacarbonyl	13463-40-6	250
Isopropylamine	75-31-0	5000
Ketene	463-51-4	100
Methacrylaldehyde	78-85-3	1000
Methacryloyl chloride	920-46-7	150
Methacryloyloxyethyl isocyanate	30674-80-7	100
Methyl acrylonitrile	126-98-7	250
Methylamine, anhydrous	74-89-5	1000
Methyl bromide	74-83-9	2500
Methyl chloride	74-87-3	15,000
Methyl chloroformate	79-22-1	500
Methyl ethyl ketone peroxide (concentration greater than 60%)	1338-23-4	5000
Methyl fluoroacetate	453-18-9	100
Methyl fluorosulfate	421-20-5	100
Methyl hydrazine	60-34-4	100
Methyl iodide	74-88-4	7500
Methyl isocyanate	624-83-9	250
Methyl mercaptan	74-93-1	5000
Methyl vinyl ketone	79-84-4	100
Methyltrichlorosilane	75-79-6	500
Nickel carbonyl (nickel tetracarbonyl)	13463-39-3	150
Nitric acid (94.5% by weight or greater)	7697-37-2	500
Nitric oxide	10102-43-9	250
Nitroaniline (paranitroaniline)	100-01-6	5000
Nitrogen dioxide	10102-44-0	250
Nitrogen oxides (NO; NO ₂ ; N ₂ O ₄ ; N ₂ O ₅)	10102-44-0	250
Nitrogen tetroxide (also called nitrogen peroxide)	10544-72-6	250
Nitrogen trifluoride	7783-54-2	5000
Nitrogen trioxide	10544-73-7	250
Nitromethane	75-52-5	2500
Oleum (65 to 80% by weight; also called fuming sulfuric acid)	8014-94-7	1000
Osmium tetroxide	20816-12-0	100
Oxygen difluoride (fluorine monoxide)	7783-41-7	100
Ozone	10028-15-6	100
Pentaborane	19624-22-7	100
Peracetic acid (concentration greater than 60% acetic acid; also called peroxyacetic acid)	79-21-0	1000
Perchloric acid (concentration greater than 60% by weight)	7601-90-3	5000
Perchloromethyl mercaptan	594-42-3	150
Perchloryl fluoride	7616-94-6	5000

Chemical name	CAS ^a	TQ ^b
Peroxyacetic acid (concentration greater than 60% acetic acid; also called peracetic acid)	79-21-0	1000
Phosgene (also called carbonyl chloride)	75-44-5	100
Phosphine (hydrogen phosphide)	7803-51-2	100
Phosphorus oxychloride (also called phosphoryl chloride)	10025-87-3	1000
Phosphorus trichloride	7719-12-2	1000
Phosphoryl chloride (also called phosphorus oxychloride)	10025-87-3	1000
Propargyl bromide	106-96-7	100
Propyl nitrate	627-3-4	2500
Sarin	107-44-8	100
Selenium hexafluoride	7783-79-1	1000
Stibine (antimony hydride)	7803-52-3	500
Sulfur dioxide (liquid)	7446-09-5	1000
Sulfur pentafluoride	5714-22-7	250
Sulfur tetrafluoride	7783-60-0	250
Sulfur trioxide (also called sulfuric anhydride)	7446-11-9	1000
Sulfuric anhydride (also called sulfur trioxide)	7446-11-9	1000
Tellurium hexafluoride	7783-80-4	250
Tetrafluoroethylene	116-14-3	5000
Tetrafluorohydrazine	10036-47-2	5000
Tetramethyl lead	75-74-1	1000
Thionyl chloride	7719-09-7	250
Trichloro (chloromethyl) silane	1558-25-4	100
Trichloro (dichlorophenyl) silane	27137-85-5	2500
Trichlorosilane	10025-78-2	5000
Trifluorochloroethylene	79-38-9	10,000
Trimethoxysilane	2487-90-3	1500

^aChemical Abstracts Service number.

^bThreshold quantity in pounds (amount necessary to be covered by this standard). OSHA Std 1910.119, Appendix A. 57 FR 7847, Mar. 4, 1992.

A P P E N D I X F

**North American Industry
Classification System
(NAICS) Code**

PRINCIPAL MANUFACTURING CATEGORIES

NAICS 3-digit Subsector Code	Description
212	Mining
221	Utilities
311	Food manufacturing
312	Beverage and tobacco product manufacturing
313	Textile mills
314	Textile product mills
315	Apparel manufacturing
316	Leather and allied product manufacturing
321	Wood product manufacturing
322	Paper manufacturing
323	Printing and related support activities
324	Petroleum and coal products manufacturing
325	Chemical manufacturing
326	Plastics and rubber products manufacturing
327	Nonmetallic mineral product manufacturing
331	Primary metal manufacturing
332	Fabricated metal product manufacturing
333	Machinery manufacturing
334	Computer and electronic product manufacturing
335	Electrical equipment, appliance, and component manufacturing
336	Transportation equipment manufacturing
337	Furniture and related product manufacturing
339	Miscellaneous manufacturing
424	Merchant wholesalers, nondurable goods
425	Wholesale electronic markets and agent brokers
511	Publishing
512	Publishing
519	Publishing
562	Hazardous waste
Misc. Mfg Codes	Includes some of the 6-digit NAICS numbers in the categories of: 1119, 1133, 2111, 4883, 5417, and 8114. Make sure to look up the full 6-digit NAICS number
Federal Facilities	All required to report regardless of NAICS

PARTIALLY EXEMPT INDUSTRIES

Employers classified in the following NAICS 4-Digit Industry Groups are not required to keep general OSHA injury and illness records unless asked by OSHA, the Bureau of Labor Statistics (BLS), or an authorized state agency. Fatalities or workplace incidents that result in the hospitalization of three or more employees must still be reported.

NAICS Code and Industry Description							
4412	Other motor vehicle dealers	5151	Radio and television broadcasting	5412	Accounting, tax preparation, bookkeeping, and payroll services	6213	Offices of other health practitioners
4431	Electronics and appliance stores	5172	Wireless telecommunications carriers (except satellite)	5413	Architectural, engineering, and related services	6214	Outpatient care centers
4461	Health and personal care stores	5173	Telecommunications resellers	5414	Specialized design services	6215	Medical and diagnostic laboratories
4471	Gasoline stations	5179	Other telecommunications	5415	Computer systems design and related services	6244	Child day care services
4481	Clothing stores	5181	Internet service providers and web search portals	5416	Management, scientific, and technical consulting services	7114	Agents and managers for artists, athletes, entertainers, and other public figures
4482	Shoe stores	5182	Data processing, hosting, and related services	5417	Scientific research and development services	7115	Independent artists, writers, and performers
4483	Jewelry, luggage, and leather goods stores	5191	Other information services	5418	Advertising and related services	7213	Rooming and boarding houses
4511	Sporting goods, hobby, and musical instrument stores	5211	Monetary authorities-central bank	5511	Management of companies and enterprises	7221	Full-service restaurants
4512	Book, periodical, and music stores	5221	Depository credit intermediation	5611	Office administrative services	7222	Limited-service eating places
4531	Florists	5222	Nondepository credit intermediation	5614	Business support services	7224	Drinking places (alcoholic beverages)

NAICS Code and Industry Description							
4532	Office supplies, stationery, and gift stores	5223	Activities related to credit intermediation	5615	Travel arrangement and reservation services	8112	Electronic and precision equipment repair and maintenance
4812	Nonscheduled air transportation	5231	Securities and commodity contracts intermediation and brokerage	5616	Investigation and security services	8114	Personal and household goods repair and maintenance
4861	Pipeline transportation of crude oil	5232	Securities and commodity exchanges	6111	Elementary and secondary schools	8121	Personal care services
4862	Pipeline transportation of natural gas	5239	Other financial investment activities	6112	Junior colleges	8122	Death care services
4869	Other pipeline transportation	5241	Insurance carriers	6113	Colleges, universities, and professional schools	8131	Religious organizations
4879	Scenic and sightseeing transportation, other	5242	Agencies, brokerages, and other insurance related activities	6114	Business schools and computer and management training	8132	Grantmaking and giving services
4885	Freight transportation arrangement	5251	Insurance and employee benefit funds	6115	Technical and trade schools	8133	Social advocacy organizations
5111	Newspaper, periodical, book, and directory publishers	5259	Other investment pools and funds	6116	Other schools and instruction	8134	Civic and social organizations
5112	Software publishers	5312	Offices of real estate agents and brokers	6117	Educational support services	8139	Business, professional, labor, political, and similar organizations
5121	Motion picture and video industries	5331	Lessors of nonfinancial intangible assets (except copyrighted works)	6211	Office of physicians		
5122	Sound recording industries	5411	Legal services	6212	Offices of dentists		

A P P E N D I X G

States Having Federally Approved¹ State Plans for Occupational Safety and Health Standards and Enforcement

Alaska	New Jersey ²
Arizona	New Mexico
California	New York ²
Connecticut ²	North Carolina
Hawaii	Oregon
Illinois ²	South Carolina
Indiana	Tennessee
Iowa	Utah
Kentucky	Vermont
Maryland	Virginia
Maine ²	Washington
Michigan	Wyoming
Minnesota	Also, Puerto Rico and the
Nevada	Virgin Islands

¹Approved by authority of Section 18.b of Public Law 91-596. The list is current as of October 2017.

²The Connecticut, Illinois, Maine, New Jersey, New York, and the Virgin Islands plans cover the public sector only (state, local government, and municipal employees only). The federal OSHA agency covers enforcement for private sector employees in these six State Plans.

Bibliography

- 2016 Liberty Mutual Workplace Safety Index*. Hopkinton, MA: Liberty Mutual Research Institute for Safety, 2016.
- “\$10 Million awarded to family of plant worker killed by a robot,” *The Citizen*, Ottawa. August 11, 1983.
- Accident Facts*. Itasca IL: National Safety Council, 1993.
- Active Shooter How to Respond*. Washington, D.C.: U.S. Department of Homeland Security, October, 2008.
- Active Shooter Recommendations and Analysis for Risk Mitigation*, New York City Police Department, 2012 Edition.
- Adding Inequality to Injury: The Costs of Failing to Protect Workers on the Job*, U.S. Department of Labor (OSHA) June, 2015.
- AFI 91–202. *The US Air Force Mishap Prevention Program*, U.S. Air Force, 2016.
- AFI 91–204. *Safety Investigations and Reports*. U.S. Air Force, 1995.
- “Alabama auto parts supplier to Kia and Hyundai, staffing agencies face \$2.5M in fines after robot fatally crushes young bride-to-be,” U.S. Department of Labor (OSHA), OSHA News Release—Region 4, December, 2016.
- ANSI/IESNA RP-7-01 Standard*, Illumination Engineering Society of North America, New York, NY, 2001.
- Applications Manual for the Revised NIOSH Lifting Equation*. Cincinnati, OH: U.S. Department of Health and Human Services, January, 1994.
- Arc Welding and Gas Welding and Cutting: Safety and Health* (NIOSH 78–138). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1978.
- Arkansas Assigned Risk Rates for 2016*, National Council on Compensation Insurance, 2016.
- Arkansas Workers’ Compensation Laws and Rules of the Commission* (rev. ed.). Little Rock, AR: Workers’ Compensation Commission, June 1986.
- Asfahl, C. Ray, *Robots and Manufacturing Automation* (2nd ed.), New York: John Wiley & Sons, Inc. 1992.
- Asfahl, C. Ray, ed., *OSHA Standards Digest, General Industry Edition*, Fayetteville, AR: New Century Media, 2006.
- Asfahl, C. Ray, ed., *OSHA Standards Digest, Construction Edition*, Fayetteville, AR: New Century Media, 2008.
- Asfahl, C. Ray and Erica R. Asfahl, “Job-Made Guardrails: Are They Strong Enough?” *Occupational Health & Safety*, March, 2007, Vol. 76, No. 3.
- Auto and Home Supply Stores: Health and Safety Guide* (NIOSH 76–113). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1975.
- Avers, Laura, “A Bridge Builder’s Worst Nightmare,” *Ohio Monitor*, July–August 1993, Vol. 65, No. 3, p. 16.
- “Back Belts,” *NIOSH FACT*, www.cdc.gov/niosh/backfs.html, August 31, 2002.
- Barciela, Susana, “Working Column,” *Miami Herald*, March 21, 1994.

- Barnett, Ralph L., "Foot Controls: Riding the Pedal," *Safety Brief*, July 1997, Vol. 12, No. 4.
- Bischoff, Kenneth B. and Robert J. Lutz, "Pharmacokinetics and Risk Assessment," course description, *Continuing Education*. New York: American Institute of Chemical Engineers, 1992, p. 45.
- Bland, Jay, ed., *The Welding Environment*. Miami, FL: American Welding Society, 1973.
- Bloodborne Pathogens Final Standard: Summary of Key Provisions*, Fact Sheet OSHA 92-46. Washington, DC: U.S. Department of Labor, August 5, 1992.
- BLS—Bureau of Labor and Statistics Census of Fatal Occupational Injuries Summary, 2014
- Brace, Tony, and Anthony Vetri, "Ergonomic Investments: A Plant-Level Exploratory Analysis," *Professional Safety*, February 2009, Vol. 54, No. 2.
- "Brake Monitoring," *Manufacturing Engineering*, February 1976.
- Briscoe, G. J., *Risk Management Guide*, DOE 76-45, SSDC-11, revision 1. Idaho Falls, ID: EG&G Idaho, Inc., 1982.
- CDC—Center for Disease Control Statistics on HIV as of June, 2016
- Chaffin, D., and K. Park, "Biomechanical Evaluation of Two Methods of Manual Load Lifting," *AIIE Transactions*, June 1974, Vol. 6, No. 2.
- Chapnik, Elissa-Beth, and Clifford M. Gross, "Evaluation, Office Improvements Can Reduce VDT Operator Problems," *Occupational Health and Safety*, July 1987, Vol. 56, No. 7.
- Chemistry Laboratory Safety Library* (5th ed.). Boston: National Fire Protection Association, 1975.
- Chicken Processing Plant Fires Hamlet, North Carolina and North Little Rock, Arkansas*, United States Fire Administration and the Federal Emergency Management Agency, U.S. Fire Administration/Technical Report Series. June, 1991.
- Christensen, Herbert E., et al., eds., *Registry of Toxic Effects of Chemical Substances* (1975 ed.). Rockville, MD: U.S. Department of Health, Education, and Welfare (NIOSH), 1975.
- Christensen, Herbert E., et al., eds., *Suspected Carcinogens*. Rockville, MD: U.S. Department of Health, Education, and Welfare (NIOSH), 1975.
- Claussen, Loretta, "Religious Rights? Balancing worker safety and religious freedom," *Safety + Health*, November 2008, Vol. 178, No. 5.
- "Cleaning up the environment," *U.S. News and World Report*, March 25, 1991, p. 45.
- "Color Detector Tubes and Direct Reading Gas Detection Instruments," *SKC Bulletin 9206*, June 1, 1992.
- A Common Goal*. Little Rock, AR: Arkansas Department of Labor, 1975.
- "Compensating Workers for Permanent Partial Disabilities," *Social Security Bulletin*, Vol. 65, No. 4, May, 2005.
- "Computer Chips and Miscarriages" column. *Occupational Hazards*, December 1992, Vol. 54, No. 12.
- Concepts and Techniques of Machine Safeguarding* (OSHA 3067). Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration, 1980.
- Concrete Collapse, "U.S. Department of Labor's OSHA cites Denver concrete contractor following accident injuring 13 employees," OSHA 08-46-DEN, January 9, 2008.
- Concrete Products and Industry: Health and Safety Guide* (NIOSH 75-163). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1975.
- Construction and Related Machinery Manufacturers: Health and Safety Guide* (NIOSH 78-103). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1977.

- Construction Industry OSHA Safety and Health Standards* (29 CFR 1926/1910: OSHA 2207) (rev.). Washington, DC: Department of Labor, Occupational Safety and Health Administration, 1979.
- Construction vs. Manufacturing 1974–94*, U.S. Department of Labor Washington, DC: Department of Labor, 1996.
- Cost of Government Regulation Study. Chicago: Arthur Andersen, 1979.
- Cote, Arthur E., "History of Fire Protection Engineering," *Fire Protection Engineering*, Fall, 2008
- Covan, John M., *Electric Hazards Control Manual*, Little Rock, AR: Arkansas Department of Labor, 1977.
- Cranes: A Guide to Good Work Practices for Operators* (NIOSH 78–192). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1978.
- Crites, Thomas R., "Reconsidering the Costs and Benefits of a Formal Safety Program," *Professional Safety*, December 1995, Vol. 40, No. 12, p. 28.
- Cross, Rich, "EPA's Tank Rule: A Compliance Nightmare for Motor Carriers," *Commercial Carrier Journal*, November 1988.
- Dear, Joseph A., "The Rate of Injuries and Illnesses in Construction." Speech to the Northwest Indiana Business Roundtable, March 23, 1995.
- DeGross, Lola, "Deadline to Submit Comments on OSHA Draft Guidelines on Night Retail Violence Extended Again" Release USDL: 96–437. Washington, DC: U.S. Department of Labor News, October 17, 1996.
- Dickie, D. E., *Crane Handbook*. Toronto: Construction Safety Association of Ontario, 1975.
- Douglass, Cynthia, "Indoor Air Quality Act of 1991," Congressional Testimony. Washington, DC: U.S. House of Representatives, Committee on Science, Space, and Technology, Subcommittee on Environment, February 7, 1992.
- Draeger Tube Handbook*. Pittsburgh, PA: National Draeger, 1992.
- Drug Testing Monitor* (brochure). Washington, DC: Traffic World, 1989.
- Eckhardt, Robert, "The Safety Professional in the Corporate Social Structure," *Professional Safety*, May 1993, Vol. 38, No. 5, p. 31.
- Elements of Ergonomics Programs*, Washington, DC: Department of Labor, Occupational Safety and Health Administration, March 1997.
- Employer payment for Personal Protective Equipment*, Final Rule, U.S. Department of Labor, November 2007.
- Engineering Control of Welding Fumes* (NIOSH 75–115). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1975.
- "Everything You Wanted to Know about OSHA," Little Rock Area OSHA Office, Little Rock, AR. Presented by David Trigg on January 31, 2009.
- Fabricated Structural Metal Products Industry: Health and Safety Guide* (NIOSH 78–100). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1977.
- Facts on Aligning the Hazard Communication Standard to the GHS*, U.S. Department of Labor (OSHA). <https://www.osha.gov/as/opa/facts-hcs-ghs.html>. Accessed August, 2016.
- Fatal Facts*, No. 36. Washington, DC: U.S. Department of Labor, 1988.
- Federal Register, Docket Number OSHA-2008-0031 — "Clarification of Remedy for Violation of Requirements To Provide Personal Protective Equipment and Train Employees," September 18, 2008.

- Federal Register, Docket Number. OSHA-2009-0023- "Combustible Dust; Advance notice of proposed rulemaking," October 21, 2009.
- Federal Register*, OSHA Standard 29 CFR 1910.146, with preamble, 58 FR 4549, January 14, 1993.
- Feldman, Marye C., and James B. Bramson, "What Is the Cost of Compliance," *Journal of the American Dental Association*, June 1994, Vol. 125, p. 682.
- Felsenthal, Edward, "Out of Hand: Is It an Epidemic or Largely a Fad? The Debate Over Repetitive-Stress Injury Heats Up." *Wall Street Journal*, February 18, 1994, Vol. 223, No. 35.
- Fiberglass Layup and Sprayup* (NIOSH 76-158). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1976.
- "Final Rule Issued to Improve Tracking of Workplace Injuries and Illnesses," U.S. Department of Labor (OSHA), <https://www.osha.gov/recordkeeping/finalrule/>. Accessed June, 2017.
- Fire Protection Handbook* (15th ed.). Quincy, MA: National Fire Protection Agency, 1981.
- First Long-Term Study of World Trade Center Rescue and Recovery Workers Shows Widespread Health Problems Ten Years After 9-11*, Icahn School of Medicine at Mount Sinai, 2011
- "Five companies face OSHA violations, \$115K in fines after federal inspectors observe multiple safety hazards at Lincoln construction site." OSHA Trade News Release—Region 5: Washington, DC: U.S. Department of Labor, June 14, 2016.
- Flammable and Combustible Liquids Fact Sheet, Oregon OSHA, Salem, OR, 08/19/2005.
- Flashpoint Index of Trade Name Liquids* (9th ed.). Boston: National Fire Protection Association, 1978.
- Fleming, Susan Hall, "Secretary of Labor Reich Announces Violence Prevention Guidelines for Health Care and Social Service Workers," Release USDL: 96-99, Washington, DC: U.S. Department of Labor News, March 14, 1996.
- Fleming, Susan Hall, "Florida Excavation Firm Involved in Fatal Trench Collapse Faces \$448,000 OSHA Penalty, Third Highest for Trenching," Release USDL: 97-147. Washington, DC: U.S. Department of Labor News, April 30, 1997.
- Foremanship and Accident Prevention in Industry*. Boston, MA: American Mutual Liability Insurance Company, 1943.
- Forms for Recording Work-Related Injuries and Illnesses, U.S. Department of Labor, Washington, DC, 1971
- Foulke, Edwin G., Jr., "Contested Cases Get a Fair Shake," *Safety and Health*, September 1992, Vol. 148, No. 3, p. 68.
- Foundries: Health and Safety Guide* (NIOSH 76-124). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1976.
- Fox, Stephen, "Manhole Cover Industry Hurt by Industry Imports," (an Associated Press interview with Jim Pinkerton, Pinkerton Foundry, Lodi, CA), *Northwest Arkansas Times*, 1981.
- "Fraud: It doesn't pay to cheat," *BWC Focus Magazine*, Autumn, 1997, Vol. 1 No. 1.
- Friend, Mark A., "What Can Responders Learn from Sept. 11?" *Responder Safety*, a quarterly supplement to *Occupational Hazards*, 2002, Vol. 1, No. 1.
- Fumes and Gases in the Welding Environment*. Miami, FL: American Welding Society, 1979.
- Garg, A., D. B. Chaffin, and G. D. Herrin, "Prediction of Metabolic Rates for Manual Materials Handling Jobs," *American Industrial Hygiene Association Journal*, 1978, Vol. 39, pp. 661-674.
- "Gartner Says 8.4 Billion Connected 'Things' Will Be in Use in 2017, Up 31 Percent From 2016," Gartner, February 7, 2017.

- Geller, Elizabeth, Mg. Ed. *Dictionary of Scientific and Technical Terms* (6th ed.). New York: McGraw-Hill Companies, Inc., 2003.
- General Industry OSHA Safety and Health Standards* (29 CFR 1910, OSHA 2206) (rev.). Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration, 1989.
- GHS Guide—A Guide to the Globally Harmonized System of Classification and Labeling of Chemicals (GHS), Occupational Safety and Health Administration, October, 2005
- GHS-OSHA HCS, Comparison of Hazard Communication Requirements, www.osha.gov/dsg/hazcom/GHSOSHAComparison.html, July, 2008.
- Glantz, Stanton A., "Health Hazards of Secondhand Smoke," *Trial*, June 1, 1991, Vol. 29, No. 6, p. 36.
- Gonzales, Claire, "EEOC Sues Exxon for Disability Act Violation," U.S. Equal Employment Opportunity Commission News Release, June 28, 1995.
- Grain Mills: Health and Safety Guide* (NIOSH 75-144). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1975.
- Greene, Warner C., "AIDS and the Immune Systems," *Scientific American*, September 1, 1993, Vol. 269, No. 3, p. 98.
- Griffin, Mark F., "A Review of the Effectiveness of OSHA's Safety Enforcement Policy," Master's thesis, University of Arkansas, Fayetteville, AR, 1993.
- Grimaldi, John V., and Rollin H. Simonds, *Safety Management* (3rd ed.). Homewood, IL: Richard D. Irwin, 1975.
- Grover, Nancy, "The 'On-Demand' Economy: A Major Disruption for the Worker's Compensation System," Workers Compensation 2016 Issues Report, Boca Raton, FL, May, 2016.
- Hamilton, Robert W., "The Role of Nongovernmental Standards in the Development of Mandatory Federal Standards Affecting Safety or Health," *Texas Law Review*, November 1977, Vol. 56, No. 8.
- Hammer, Willie, *Occupational Safety Management and Engineering* (2nd ed.). Englewood Cliffs, NJ: Prentice Hall, 1981.
- Handbook of Organic Industrial Solvents*, Technical Guide 6 (5th ed.). Chicago: Alliance of American Insurers, 1980.
- Hawley, Gessner G. (revision author), *The Condensed Chemical Dictionary* (9th ed.). New York: Van Nostrand Reinhold, 1975.
- Hazard Communication 2012—The Revised Standard and What Changes You Can Expect in the Workplace*, SCHC and U.S. Department of Labor (OSHA), August, 2012
- Hazard Communication Guidelines for Compliance (1910.1200 Appendix E), U.S. Department of Labor, Washington, D.C., November 25, 1983.
- Hazard Communication Guidelines for Compliance (1910.1200 Appendix E), U.S. Department of Labor, Washington, D.C., August 24, 1987.
- "Hazardous Employer Program" (Amended Rule 2) Little Rock, AR: Arkansas Workers' Compensation Commission, 1997.
- Health and Safety Guide for Public Warehousing*. Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1978.
- Heinrich, H. W., *Industrial Accident Prevention* (4th ed.). New York: McGraw-Hill, 1959.
- Hotels and Motels: Health and Safety Guide* (NIOSH 76-112). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1975.

- Houston Chronicle*, January 10, 1984.
- "How to Lift and Carry Safely," Fact Sheet, National Safety Council, Itasca, IL, 2005.
- Hyatt, E. C., et al., "Effect of Facial Hair on Worker Performance," *American Industrial Hygiene Association Journal*, April 1973.
- Imre, John, unpublished doctoral dissertation, Michigan State University, East Lansing, MI, 1974.
- The Industrial Environment: It's Evaluation and Control*. Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1973.
- Industrial Noise Control Manual* (NIOSH 79-117) (rev. ed.). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1978.
- Industrial Ventilation* (15th ed.). Lansing, MI: Committee on Industrial Ventilation, American Conference of Governmental Industrial Hygienists, 1978.
- Injury Facts*, 2002 Edition. Itasca, IL: National Safety Council, 2002.
- Injury Facts*, 2009 Edition. Itasca, IL: National Safety Council, 2009.
- Injury Facts*, 2016 Edition. Itasca, IL: National Safety Council, 2016.
- Inspection Report. OSHA Inspection 1123855.015 opened on February 9, 2016.
- "Issues Update: Legalization of Marijuana," Workers' Compensation 2016 Issues Report, Boca Raton, FL, May, 2016.
- "Issues Update: Opt-Out," Workers' Compensation 2016 Issues Report, Boca Raton, FL, May, 2016.
- Kamp, John, *Job Candidate Profile Technical Manual* (2nd ed.). St. Paul, MN: St. Paul Fire and Marine Insurance Company, 1991.
- Konz, Stephan, and Steven Johnson, *Work Design Industrial Ergonomics* (6th ed.). Scottsdale, AZ: Holcomb Hathaway Publishers, June 2003.
- Kroemer, Karl, Henrike Kroemer, and Katrin Kroemer-Elbert, *Ergonomics* (2nd ed.). Upper Saddle River, NJ: Prentice Hall, 2001.
- LaBar, Gregg, "Hamlet, NC: Home to a National Tragedy," *Occupational Hazards*, September 1992, Vol. 54, No. 9, p. 29.
- LaBar, Gregg, "Substituting Safer Materials," *Occupational Hazards*, November 1997, Vol. 59, No. 11, pp. 49-51.
- LaBar, Gregg, "Testing the Limits of Industrial Hygiene," *Occupational Hazards*, May 1993, Vol. 55, No. 5, p. 56.
- Lapedes, Daniel N., ed. *Dictionary of Scientific and Technical Terms* (2nd ed.). New York: McGraw-Hill, 1978.
- Lastowka, James A., "OSHA's Process Safety Standard: Key Lessons from the First Five Years," *Occupational Hazards*, July 1997, Vol. 59, No. 7, p.45.
- Leading 20-minute Meetings that Matter (video)*. Richmond, Virginia: Briefings Publishing Group, 2008.
- Lee, Cynthia, and Sheila Hall, "Region V: Partnership and Teamwork for Success," *Job Safety and Health Quarterly*, Winter 1995, Vol. 6, No. 2, p. 10.
- "Les Posen's Fear of Flying Weblog," posted by Les Posen, May 19, 2004. <http://homepage.mac.com/lesposen/iblog/B80495344/C840540124/E1966059962/index.html>.
- Lithographic Printing Industry: Employee Health and Safety* (NIOSH 77-223). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1977.
- Loewer, Otto J., Thomas C. Bridges, and Ray A. Bucklin, *On-farm Drying and Storage*. St. Joseph, MI: American Society of Agricultural Engineers, 1994.

- Lombardi, David, *Report to the National Safety Council Fatigue Blue Ribbon Panel*, Chicago, Illinois, December 13, 2016.
- Lorenzi, Neal, "From Research to Reality," *Professional Safety*, August 1995, Vol. 40, No. 8, p. 16.
- Lovett, John N., *Industrial Noise Control Manual*, Little Rock, AR: Arkansas Department of Labor, 1976.
- Luttman, Alwin, Matthias Jäger, and Barbara Griefahn, "Preventing Musculoskeletal Disorders in the Workplace," *Protecting Worker's Health Series No. 5*, World Health Organization, 2003.
- Machine Guarding: Assessment of Need* (NIOSH 75-173). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1975.
- Main, Jeremy, "The Big Cleanup Gets It Wrong," *Fortune*, May 20, 1991, Vol. 123, No. 10, p. 95.
- Management of Work-Related Musculoskeletal Disorders*, ANSI Accredited Standards Committee Z365 working draft. Itasca, IL: National Safety Council, August 6, 2002.
- Manual of Respiratory Protection against Radioactive Materials* (NUREG-0041). Washington, DC: U.S. Atomic Energy Commission, Directorate of Regulatory Standards, 1974.
- Manufacturers of Paints and Allied Products: Health and Safety Guide* (NIOSH 75-179). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1975.
- Martimo et al., "Effect of training and lift equipment for preventing back pain in lifting and handling: systematic review," *British Medical Journal*, January 2008.
- McClay, Robert E., "Toward a More Universal Model of Loss Incident Causation," *Professional Safety*, January 1989, Vol. 34, No. 1.
- McElroy, Frank E., ed., "Administration and Programs," *Accident Prevention Manual for Industrial Operations* (10th ed.). Chicago: National Safety Council, 1992.
- McElroy, Frank E., ed., "Engineering and Technology" *Accident Prevention Manual for Industrial Operations* (10th ed.). Chicago: National Safety Council, 1992.
- Metal Stamping Operations, Health and Safety Guide* (NIOSH 75-174). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1975.
- Metalworking Fluids: Safety and Health Best Practices Manual*, U.S. Department of Labor, November, 2001.
- Method of Recording and Measuring Work Injury Experience* (ANSI Z16.1-1967). New York: American National Standards Institute, 1967.
- Moore, Larry R., "Preventing Homicide and Acts of Violence in the Workplace," *Professional Safety*, July 1997, Vol. 42, No. 7, p. 20.
- Most Frequently Asked Questions Concerning the Bloodborne Pathogens Standard*, OSHA Administrative Memo Information Booklet, Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration, February 1, 1993.
- Mukherjee, Sougata, "OSHA's Cost to Business Tops \$33 Billion," *Baltimore Business Journal*, November 1, 1996, Vol. 14, No. 24, p. 27.
- National Electrical Code*[®] (NEC). Boston: National Fire Protection Association, 1971 and 1981.
- National Safety Council, Safety Training Institute program announcement, Itasca, IL: National Safety Council, October, 1995.
- Nemeth, John C., "Risk: Dollars and Trust," *Environmental Spectrum*, 1991, Vol. 8, No. 1.
- NFPA Inspection Manual* (3rd ed.). Boston: National Fire Protection Association, 1970.
- NIOSH Certified Equipment: Cumulative Supplement* (NIOSH 77-195). Morgantown, WV: U.S. Department of Health, Education, and Welfare (NIOSH), 1977.
- Nolibos, Alejandra and Boles, Tapio, "The Life Cycle of a State Workers' Compensation Fund Change, Challenge and a Review of Mission," *Emphasis*, December 2013.

- Nonfatal Occupational Injuries and Illnesses Requiring Days Away from Work 2007*, Bureau of Labor Statistics, Washington, DC, November, 2008.
- Nonmandatory Compliance Guidelines for Hazard Assessment and Personal Protective Equipment Selection*, OSHA standard 29 CFR-1910, Subpart I, App. B.
- "NRT Quick Reference Guide: Ebola and Marburg Hemorrhagic Fevers," U.S. National Response Team. <https://www.osha.gov/SLTC/ebola/index.html>. Accessed June, 2017
- Occupational Diseases: A Guide to Their Recognition*. Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1951.
- Occupational Exposure Sampling Manual (NIOSH 77-173)*. Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1977.
- Occupational Injuries and Illnesses in the United States by Industry*. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, 1985.
- Occupational Safety and Health Cases*, Vols. 1-9. Washington, DC: Bureau of National Affairs, 1974-1982.
- Occupational Safety and Health Directory (NIOSH 80-124)*. Cincinnati, OH: U.S. Department of Health and Human Services (NIOSH), 1980.
- Occupational Safety and Health Reporter* (weekly periodical), Vols. 1-11. Washington, DC: Bureau of National Affairs, Inc., 1971-1982.
- Occupational Safety and Health in Vocational Education (NIOSH 79-125)*. Cincinnati, OH: U.S. Department of Health and Human Services (NIOSH), 1979.
- "Ohio worker's death highlights grim 2016 national stat: trench collapse fatalities have more than doubled," OSHA Trade News Release—Region 5: Washington, DC: U.S. Department of Labor, November 17, 2016.
- Olishifski, Julian B., and Frank E. McElroy, eds. *Fundamentals of Industrial Hygiene*, Chicago: National Safety Council, 1971.
- "OSHA cites South Florida tree trimming service in worker's fatal electrocution," OSHA Trade News Release—Region 4: Washington, DC: U.S. Department of Labor, October 18, 2016.
- "OSHA cites Wisconsin metal fabrication company for safety failures after investigation of teenaged worker's fatal injuries, two weeks after starting job," OSHA Trade News Release—Region 5: Washington, DC: U.S. Department of Labor, December 27, 2016.
- "OSHA," column, *Occupational Hazards*, December 1992, Vol. 54, No. 12, p. 11.
- "OSHA," column, *Occupational Hazards*, September 1993, Vol. 55, No. 9, p. 26.
- "OSHA Commits to Reducing Forklift Accidents in the Southeast," Region 4 News Release, USDOL: 02-180, Sept. 10, 2002.
- OSHA Consultation Service*, Fact Sheet No. OSHA 97-04, Washington, DC: U.S. Department of Labor, January 1, 1997.
- "OSHA Proposes Fines for Ergonomics-Related Injuries," *Material Handling Engineering*, February 1989, Vol. 44, No. 2, p. 42.
- "OSHA Requests Comments On Proposed Improvements to Twenty-three Health Standards," *OSHA Trade News Release*, Washington, DC: U.S. Department of Labor, October 30, 2002.
- "OSHA's Role at the World Trade Center Emergency Project," *OSHA News Release*, Washington, DC: U.S. Department of Labor, September 21, 2002.
- Ott, Wayne R., and John W. Roberts, "Everyday Exposure to Toxic Pollutants," *Scientific American*, February 1998, Vol. 278, No. 2, p. 86.
- Overhead and Gantry Cranes (ANSI B.30.2.0-1976)*. New York: American National Standards Institute, 1976.

- Perl, Raphael, "The Department of Homeland Security: Background and Challenges." Washington DC: The National Academies Press, 2004.
- Peterson, Donald R., and David B. Thomas, *Fundamentals of Epidemiology*. Lexington, MA: Lexington Books, 1978.
- Plumbing, Heating and Air Conditioning Contractors: Health and Safety Guide* (NIOSH 76-127). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1975.
- Powder Actuated Fastening Tools* (NIOSH 78-178A). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1978.
- "Preamble to the OSHA Lockout/Tagout Standard," *Federal Register*, September 1, 1989, Vol. 54, No. 169.
- Pregnancy and Substance Abuse, National Women's Health Information Center, Department of Health and Human Services, Fairfax, Virginia www.nlm.nih.gov/medlineplus/pregnancyand-substanceabuse.html accessed January 13, 2009.
- A Prescription for Battery Workers* (NIOSH 76-153). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1976.
- "Privatized Workers' Comp Succeeding in West Virginia," *Occupational Health & Safety*, April 10, 2008.
- "Psychological Tests & Workplace Violence," *The Florida Bar Journal*, March 1994.
- Public Law 91-596* (Williams-Steiger Occupational Safety and Health Act of 1970), U.S. Congress, December 19, 1970.
- Public Law 101-336* (Americans with Disabilities Act of 1990), U.S. Congress, July 26, 1990.
- Ramachandran, Kumar, "An Analysis Tool for Building Design Based on the Simulation Modeling of Human Behavior in Buildings During Emergencies/Fires," proposal for a doctoral dissertation, Department of Industrial Engineering, University of Arkansas, Fayetteville, AR, August 1997.
- "Rapid Rater," Independent Insurance Agents of Arkansas, May 1, 1991.
- Recordkeeping OSHA Fact Sheet*, Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration, 2001.
- Recordkeeping OSHA Fact Sheet*, Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration, 2014.
- Recordkeeping Requirements under the Occupational Safety and Health Act of 1970*. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration, 1978.
- Registry of Toxic Effects of Chemical Substances*. Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1976.
- Rekus, John F., "OSHA's Lockout Tagout Standard Mandates Control of Energy Sources," *Occupational Health and Safety*, November 1990, Vol. 59, No. 11, p. 108.
- Respiratory Protection: An Employer's Manual* (NIOSH 78-193A). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1978.
- Respiratory Protection: A Guide for the Employee* (NIOSH 78-193B). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1978.
- Rigging Manual*. Toronto: Construction Safety Association of Ontario, 1975.
- Ritzel, Dale O. and Rodney G. Allen, "Validity of the Basic Principle of Safety Management or Loss Control," *Professional Safety*, February 1996, Vol. 41, No. 2, p. 24.
- Roberts, Stacey, "Tyson: Guilty of Fatal Violation," *Arkansas Democrat-Gazette*, January 7, 2009.

- Ryan, Joseph P., "Power Press Safeguarding: A Human Factors Perspective," *Professional Safety*, August 1987, Vol. 32, No. 8, pp. 23–26.
- Safety Requirements for Woodworking Machinery* (ANSI 01.1–1975). New York: American National Standards Institute, 1975.
- Safety Standard for Monorail Systems and Underhung Cranes* (ANSI B30.11–1973). New York: American National Standards Institute, 1973.
- Sample Bloodborne Pathogens Exposure Control Plan*. Philadelphia: OSHA Philadelphia Regional Office of Technical Support, March 25, 1992.
- Saulter, Gilbert J., Regional Administrator, OSHA Region VI, in a speech entitled "OSHA Update," Little Rock, AR, July 27, 1988.
- Sax, N. Irving, *Dangerous Properties of Industrial Materials* (5th ed.). New York: Van Nostrand Reinhold, 1975.
- Scannell, Gerard F., "OSHA's Efforts to Protect Workers from Indoor Air Pollution," Congressional Testimony. Washington, DC: Committee on Energy and Commerce, Subcommittee on Environment, April 10, 1991.
- Schmidt, S. "One by one, 3 utility workers descended into a manhole. One by one, they died." *Washington Post*, January, 2017.
- Schuster, Eric S., "Understanding the ADA," *Association Management*, April 1, 1991, Vol. 43, No. 4, p. 51.
- Sensidyne Product Literature, *The First Truly Simple Precision Gas Detector System*. Largo, FL: Sensidyne, 1984.
- Sign and Advertising Display Manufacturers: Health and Safety Guide* (NIOSH 76–126). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1976.
- Smith, Harry C., "BLEVE Can Blow You to Oblivion," *Ohio Monitor*, October 1979, Vol. 52, No. 10, p. 16.
- "Standard Code of Practice for Safety of Machinery," British Standard BS5304:1988.
- "Tesla driver dies in first fatal crash while using autopilot mode," *The Guardian*, June 30, 2016.
- Threshold Limit Values* (TLV booklet). Cincinnati, OH: American Conference of Governmental Industrial Hygienists. September 1993–1994.
- Title III Fact Sheet*. Washington, DC: U.S. Environmental Protection Agency, 1987. U.S. Government Printing Office Document 1987–718–872–1302/1280.
- The Tobacco Settlement, Statements and Information*. Washington, DC: The American Cancer Society, June 20, 1997, Internet address: www.cancer.org/tobacco/tralertl.html.
- Trotto, Sarah, "Fatigue and Worker Safety," *Safety + Health Magazine*, February 26, 2017.
- Tyson, Pat, speech at the 18th Annual Employment Law & Legislative Conference, sponsored by the Society for Human Resource Management, Washington, DC, 2001.
- United Nations—United Nations Historical Background of GHS as of August, 2016
- "Use of Respiratory Protection Among Responders at the World Trade Center Site—New York City, September 2001," *Morbidity and Mortality Weekly Report*, Center for Disease Control, September 11, 2002.
- Wallace, L.A., "Human Exposure to Environmental Pollutants: A Decade of Experience," *Clinical and Experimental Allergy*, 1995, Vol. 25, No. 1, pp. 4–9.
- The Welding Environment*. Miami, FL: American Welding Society, 1973.
- Wells, A. Judson, "Deadly Smoke," *Occupational Health and Safety*, September 1989.

- Wilkinson, Bruce S., "Substance Abuse Programs," Proceedings of the American Society of Safety Engineers Annual Professional Development Conference and Exposition, Baltimore, MD, June 14-17, 1987.
- Work-Related Musculoskeletal Disorders (WMSDs), draft ANSI standard Z365, August 6, 2002.
- Wooden Furniture Manufacturing: Health and Safety Guide* (NIOSH 75-167). Cincinnati, OH: U.S. Department of Health, Education, and Welfare (NIOSH), 1975.
- Worker Exposure to AIDS and Hepatitis B*. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration, 1987.
- Work Injury and Illness Rates*. Chicago: National Safety Council, 1981.
- Work Practices Guide for Manual Lifting* (NIOSH 81-122). Cincinnati, OH: U.S. Department of Health and Human Services (NIOSH), 1981.
- "Workplace Smoking Rule Moves Too Slowly for ASH," *Keller's Industrial Safety Report*, May 1997, Vol. 7, No. 5.
- Zumar, Tony, "Workers' Comp Safety Division Update," presentation in Little Rock, AR, September 16, 1993.

Glossary

ACGIH American Conference of Governmental Industrial Hygienists.

ADA Americans with Disabilities Act (of 1990).

Aggravating factor In the study of loss incident causation, a circumstance that makes the outcome of a loss incident more severe.

AIDS Acquired immunodeficiency syndrome. A terminal illness or condition resulting from exposure to the HIV virus. (*See also* HIV.)

AIHA American Industrial Hygiene Association.

AL Action level.

amp Ampere.

ANSI American National Standards Institute.

Anti tie-down Means of preventing a control panel from being tied down and thus rendering the machine unsafe.

Anti two-block device Mechanism for preventing a crane hook block from being drawn up to the point at which it contacts the boom point.

API American Petroleum Institute.

ASH Action on Smoking and Health.

ASME American Society of Mechanical Engineers.

Asphyxiants Substances that prevent oxygen from reaching the body cells.

ASSE American Society of Safety Engineers.

ASTM American Society for Testing and Materials.

AWS American Welding Society.

Barrier guard In machine guarding terminology, a rigid partition on a machine to prevent any part of the operator's or any other's body from entering the danger zone. (Compare with Shield guard.)

BCSP Board of Certified Safety Professionals

BLEVE Boiling liquid expanding vapor explosion.

Block Mechanical assembly containing one or more freely rotating pulleys.

Block and Bleed *See* Double block and bleed.

Block and tackle Assembly consisting of (usually two) blocks reeved together to achieve mechanical advantage.

Bloodborne pathogens Term used in the OSHA standards to refer principally to the HIV and HBV viruses.

Boom Long pivoting structure or arm on a crane.

Brake monitor Device that monitors stopping time or ram overtravel every time the clutch disengages on a part-revolution mechanical press.

Bridge crane Industrial crane that accesses loads by means of a bridge that travels on parallel overhead rails and by means of a trolley that travels back and forth on the bridge.

Bridgeplate Support surface for the transition between dock and a vehicle being loaded; dockboard.

C Ceiling value; maximum acceptable exposure concentration.

Carcinogen A substance that causes or is suspected of causing cancer.

CAS Chemical Abstracts Service number, a reference list for chemical substances.

CDZ Controlled Decking Zone. In steel erection, an area of a new floor having exposed edges and subject to prescribed precautions for workers who must work in these defined areas.

CERCLA Comprehensive Environmental Response, Compensation, and Liability Act.

CIH Certified Industrial Hygienist.

Combustible Having a flashpoint higher than 100°F.

Combustible Dust Any combustible material in a finely divided form.

CPSC Consumer Product Safety Commission.

CSP Certified Safety Professional.

DAFWII Days Away From Work Injury and Illness Case Rate; a standard occupational safety and health index for comparing industry safety records. The DAFWII is comparable to the DART, except that the DAFWII counts only cases involving *days away* from work.

DART Days Away, Restricted, or Transferred Rate; a standard occupational safety and health index for comparing industry safety records. The DART rate counts both injuries and illnesses and does not include fatalities. The DART rate has largely replaced the LWDI as a measure of a firm's safety record.

dB Decibel(s).

dBA Decibel, by the A-weighted scale.

DEHP di-2-ethylhexyl phthalate.

Detector tube Small (usually glass) tube installed in-line in a flexible tube connected to an air-sampling pump. The tube contains a material that changes color in quantifiable layers to provide a measure of the concentration of the particular air contaminant being tested.

Distal cause Secondary or indirect cause of a loss incident, such as a deficient management policy. Distal causes create and shape proximal causes.

Dockboard Support surface for the transition between a dock and a vehicle being loaded; a bridgeplate.

Dosimeter Instrument worn on the person to collect a cumulative measure of exposure over a specified time period; used especially for TWAs. (*See also* TWA.)

Double block and bleed Method of positive isolation of fluids in which two successive valves are closed and between the two closed valves a small "bleeder" valve is opened to relieve pressure that might build up if one of the closed valves were to leak.

EEOC Equal Employment Opportunity Commission.

Egregious violation Glaring or flagrant safety violation that invokes high penalties from OSHA.

Energy isolation device Device for positively locking off a source of energy to a machine or other equipment.

Engulfment Capture and sinking of a person in a dry granular solid material that has fluidlike qualities.

EPA Environmental Protection Agency.

Epidemiology Statistical study of populations of victims of various diseases or disorders.

EPOs Emergency power-offs.

Ergonomics Study of human capability in relation to the work environment.

Experience rating Insurance rating based on a company's claim history.

Extra-hazardous employer In some states, a Workers' Compensation Commission designation given to certain establishments in which the rate of lost workday injuries and illnesses exceed certain defined averages for the industry. The designation results in extra duties for the employer and follow-up consultation to determine whether the firm has complied with the extra duties.

Fail-safe principles Principles of engineering design that consider the consequences of component failure within the system.

Fault-tree analysis Logic diagram used to analyze probabilities associated with various causes and their adverse effects.

FCAW Flux core arc welding.

Fibrillation Rapid, irregular convulsions of the heart; the condition is induced by electric shock, especially when the shock is from alternating current.

Flammable Having a flashpoint lower than 100°F.

Flashback In welding terminology, the phenomenon that occurs when an oxygen/fuel gas flame begins to propagate back into the mixing chamber of the welding torch or welding gas manifold.

Flux In soldering and welding, a material that melts along with the metal and is used to facilitate the process by combining with impurities and preventing oxidation.

FMEA Failure modes and effects analysis.

Full revolution In presswork terminology, a type of mechanical press drive in which the ram is tripped by a positive engagement of the flywheel and cannot be disengaged midstroke.

Fume Tiny particles of resolidified vapors of substances that are normally solids. Metal fumes are often encountered in welding operations.

Gate In presswork terminology, a temporary barrier that closes to protect the operator during the dangerous part of the machine cycle. Type A closes at the beginning of the cycle and stays closed for the entire cycle. Type B closes at the beginning of the cycle, then reopens during the less dangerous portion of the stroke (e.g., when the ram starts back up and the dies begin to reopen).

GFCI Ground-fault circuit interrupter.

GHS Globally Harmonized System.

GMAW Gas metal arc welding (also known as *MIG*).

Gross load Total load being supported by the system, including both the payload and the equipment being used to move it. In the case of a hoist mechanism, gross load equals the weight of the payload plus the weight of the load block.

Ground Object or conductor that has zero voltage potential from ground potential; in electrical wiring terminology, "ground" usually refers to the noncurrent-carrying conductor that is intended to ground unwanted voltage, sometimes called the *grounding* conductor. Sometimes "ground" is used to refer to the current-carrying neutral conductor; sometimes called the *grounded* conductor.

GTAW Gas tungsten arc welding (also known as *TIG*).

HAZMAT Hazardous material.

HBV Hepatitis B virus.

HIV Human immunodeficiency virus.

Hot In electrical wiring terminology, the current-carrying conductor that has a significant voltage potential from ground potential.

Hydrostatic test Periodic test performed on fire extinguishers to verify the integrity of the shell to contain adequate pressures.

Hz Hertz (cycles per second).

IBP Initial boiling point.

ICHD Industrial chemical hazards database.

IDL Immediately dangerous to life.

IDLH Immediately dangerous to life or health.

Impairment A physical or mental handicap that qualifies under the Americans with Disabilities Act (ADA) for protecting the worker from discrimination in employment.

Incidence rate Rate of job-related injuries and illnesses, including total-recordable-cases, fatalities, lost-workday-cases, number-of-lost-workdays, specific-hazards, lost-workday-injuries, days-away-restricted-or-transferred, and days-away-from-work-injury-and-illness-case rates.

Interlock Switch, usually electrical, that turns off power to a machine whenever a guard is removed or a gate opened or some other safety device is disabled.

Irreversibility *See* Point of irreversibility.

Irritants Substances that inflame surfaces of parts of the body by their corrosive action.

JCP Job candidate profile; a screening test used in job placement testing.

Kickback Accidental engagement between the material and a rotating tool that causes the material to be thrown back at the operator, or alternatively, if the material is fixed, causes the tool, such as a hand-held circular saw, to be jerked out of control.

Lay In wire rope terminology, the length, measured along the core of a wire rope, required for one strand to make one complete revolution (twist) about the core.

LBW Laser beam welding.

LEL Lower explosive limit (for flammable vapors); the percent concentration in air below which the mixture is too lean to ignite.

LFL Lower flammable limit (for flammable vapors); the lowest concentration of a material that will propagate a flame. The LFL is usually expressed as a percent by volume of the material in air. The term is used somewhat interchangeably with LEL and is applied to the control of fires around dip tanks.

Load block Pulley assembly to which the load is attached.

Lockout Method of assuring that machines being serviced are not turned back on prematurely. The power switch or control box is locked out by the maintenance person performing the service. Only the maintenance person performing the service has the key to the lock. Multiple maintenance personnel each have their own locks so that all locks must be removed before the machine can be returned to service. Lockout is considered more reliable than "tagout."

Lost workday According to OSHA definition and current terminology, a "lost" workday includes both days away from work and days in which the worker is temporarily transferred to another job within the firm because of a workplace injury or illness.

LPG Liquefied petroleum gas.

LWDI Lost-workday incidence rate (for injuries only, not illnesses); a standard occupational safety and health index for comparing industry safety records. The LWDI was formerly used by OSHA Compliance Officers to determine whether a particular firm should receive a full

inspection. Later the LWDI became an index for nationwide decision making in determining industry (SIC) priorities for inspection. (*See also* DART.)

ma Milliampere.

MAC Maximum acceptable ceiling concentration.

MAPP gas Commercially available welding fuel gas used as a somewhat safer substitute for acetylene when lower welding temperatures are acceptable for the process.

Mechanical advantage Favorable ratio of output force to the required input force for a mechanism.

MIG Metal inert gas (welding); also known as GMAW.

Mitigating factor In the study of loss-incident causation, a circumstance that makes the outcome of a loss incident less severe.

MSD Musculoskeletal disorder.

MSHA Mine Safety and Health Administration.

Mutagens Substances that affect chromosomes and are thus a hazard to the species.

NAICS North American Industry Classification System; a system of codes for classifying industries. (*See also* SIC.)

NEC *National Electrical Code*®.

NEP National Emphasis Program.

Neutral In electrical wiring terminology, the current-carrying conductor that is at ground or near-ground potential; sometimes called the grounded conductor.

NFPA National Fire Protection Association.

NIOSH National Institute for Occupational Safety and Health.

Nip point Position at which moving parts meet and can draw clothing or body parts into the machine. Examples are points at which gears mesh, chains engage sprockets, or belts engage pulleys.

Nomex Commercially available material used in clothing and personal protective equipment for welders.

Nominal Generally, a specification or dimension before safety factor has been applied. (*See also* Rated.)

NOx Oxides of nitrogen (e.g., NO, NO₂, N₂O).

NRR Noise Reduction Rating.

NSC National Safety Council.

OBI Open-back inclinable, a type of mechanical power press used in high-speed blanking operations.

OSHA Occupational Safety and Health Administration.

PAH Polycyclic aromatic hydrocarbon. Some PAHs may be carcinogenic, teratogenic, or mutagenic. PAHs may be found in metalworking fluids.

Part revolution In presswork terminology, a type of mechanical press drive in which the flywheel is equipped with a friction clutch and can be disengaged midstroke and a brake applied to stop the ram.

Parts of rope Mechanical advantage provided by block and tackle; number of lines supporting the load block.

Payload Weight of the load exclusive of the vehicle, material-handling device, or other equipment being used to move the load.

PE Registered professional engineer.

PEL Permissible exposure limit.

Pharmacokinetics Study of the absorption, disposition, metabolism, and elimination of chemicals in the body.

Plugging Using reverse torque as a brake to stop the travel of a crane hoist.

Point of irreversibility In the study of loss-incident causation, the point in the causal diagram that, if reached, will definitely result in a loss incident.

Power rail Fixed electrical conductor for delivering continuous power to a moving device.

PPE Personal protective equipment.

Proximal cause Direct hazard; a primary, immediate cause of a loss incident.

Pullback Method of safeguarding the point of operation of a press by a mechanical linkage between the action of the press ram and a set of wristlets worn by the operator. As the ram descends, the linkage pulls the operator's hands away from the danger zone. Pullbacks are sometimes called "pull-outs."

Rail clamp In industrial crane terminology, a device for clamping a crane bridge to the rail on which it is traveling; the clamp is used to prevent drifting of the bridge under wind loading.

Rated Describes a specification or dimension for which a safety factor has already been applied. (*See also* Nominal.)

RCRA Resource Conservation and Recovery Act.

Reeving Threading of ropes through pulleys.

RELS Recommended Exposure Levels; levels recommended by NIOSH.

Risk assessment code (RAC) A U.S. Air Force classification system for accidents that is based on both mishap severity and mishap probability of occurrence.

Roadmap approach A method of filing documents in which a central file tells where within the plant to find various other required documents.

ROPS Rollover protective structures.

RSEW Resistance seam welding.

RSW Resistance spot welding.

SARA Superfund Amendments and Reauthorization Act.

SAW Submerged arc welding.

SCBA Self-contained breathing apparatus.

SDS Safety data sheet.

SHARP Safety and Health Achievement Recognition Program.

Sheave Pulley used in a hoisting arrangement, especially when several pulleys are used together to achieve mechanical advantage.

Shield guard In machine guarding terminology, a barrier to protect against flying chips or sparks flying out of a machine. (*Compare with* Barrier guard.)

SIC Standard industrial classification. (*See also* NAICS, which is superseding the SIC system of classification.)

Slag In welding, the nonmetallic molten, then solid, residue that consists of solidified flux combined with impurities.

Sling In material-handling terminology, the wire rope, chain, or other connector (not to be confused with the hoist rope itself) used to attach a load to the crane, hoist, helicopter, or other lifting device.

SLM Sound-level meter.

SMAW Shielded metal arc welding (also known as stick electrode welding).

Sphere of control In a loss-incident causation diagram, the region prior to the point of irreversibility.

Spreader In power saw terminology, a device to maintain separation between the two walls of a cut to assure that the saw blade will not accidentally reengage the material that has already been cut and thus result in a kickback.

STEL Short-term exposure limit.

Strand In wire rope terminology, any of several bundles of wires that are twisted about the core of the wire rope.

Sweep Obsolete (no longer legally recognized) method of safeguarding a press. Sweeps are mechanically linked to the press ram mechanism and strike and brush away the operator's arms or other objects in the area of the entrance to the danger zone.

Switch loading Filling a tank with a material different from that which it contained previously. Switch loading usually refers to the switching of flammable/combustible fuels to be transported in a tank truck.

TAG Popular test method for determining flashpoint.

Tagout Method of assuring that machines being serviced are not turned back on prematurely. A tag placed on the power switch warns operators and others not to turn on the machine until the tag is removed by the person performing the service. (*See also* Lockout.)

Teratogens Substances that have harmful effects on fetuses.

TIG Tungsten inert gas (welding); also known as GTAW.

TLV Threshold limit value.

Tongue gap On a wheel-type grinding machine, the clearance between the upper opening (tongue) guard and the grinding wheel. The maximum legal clearance is $\frac{1}{4}$ inch.

Tongue guard Adjustable plate attached to the upper edge of the opening that exposes the wheel on a grinding machine. The purpose is to contain flying fragments in the event of wheel failure.

TOSCA Toxic Substances Control Act.

Toxicology Study of the nature and effects of poisons.

TRC Total-Recordable-Cases; a standard occupational safety and health index for comparing industry safety records; the TRC counts all OSHA-recordable cases whether or not the cases involve lost workdays.

Tribology The study of the mechanisms and phenomena of friction; in safety, especially applies to the study of trips and falls.

Trip bar Bar that can be quickly and conveniently accessed by the operator or others nearby to deactivate or disengage a machine in an emergency. Also called a triprod.

Trip wire Flexible cable that can be pulled or otherwise quickly and conveniently accessed by the operator or others nearby to deactivate or disengage a machine in an emergency.

Trolley In industrial crane terminology, the assembly that travels back and forth on top of the bridge on an overhead bridge crane. The trolley carries the hoist mechanism.

TW Thermit welding.

TWA Time-weighted average.

Two-blocking Hazardous, accidental contact between blocks of sheaves that occurs when the hoist rope is drawn too far. The condition will quickly break the hoist rope, causing the load block and the load (if any) to fall.

UEL Upper explosive limit (for flammable vapors); percent concentration in air above which the mixture is too rich to ignite.

Vapors Gases of substances that are normally liquid or solid, usually liquid.

VPP Voluntary Protection Program.

WMSDs Workplace musculoskeletal disorders.

Workers' compensation Statutory compensation levels to be paid by the employer for various injuries that may be incurred by the worker.

Zero mechanical state State of a machine after any residual sources of energy have been relieved or restrained to render them harmless, after the machine has been turned off.

Index

Abatement, 97, 99

Aboveground tanks, 271
Abrasive
 blasting, 308
 wheel, 92, 196, 407, 422
Accident
 accidental motion, 370
 analyses, 59, 67
 cause analysis, 35–36
 costs (hidden), 40
 records, 16
 reports, 21, 40, 58
Acetone, 270, 430, 431, 516
Acetylene, 209, 430–432, 434, 469
ACGIH. *See* American Conference of Governmental Industrial Hygienists (ACGIH)
Acid mists, 208, 314
Acoustics, 19, 256
Action levels (ALs), 77, 220, 229
ADA. *See* Americans with Disabilities Act (ADA)
Adjustable barriers, 379, 384, 391
Administrative controls, 184, 202, 259
Aerial baskets, 166, 167
Aerial lifts, 498
Aggravating factors, 73
Ainlay, John A., 271, 271n2
Air
 compressors, 209, 308, 415
 conditioners, 473
 contaminants, 213–214
 dosimeters, 226
 dusts, 216–214
 exposures, approaches to, 225
 fumes, 213–214
 gases, 216
 Indoor Air Quality, Proposed Rule, 44
 mists, 213
 particulates, 214
 permissible exposure limits for, 516–532
 sizes of, 214
 vapors, 213
Air line respirator, 301–302
 continuous flow mode, 301
 demand-flow mode, 302
 pressure-demand mode, 302
Air purifying devices, 242, 298–299

Aisles, 154–159
 blockage, 337
 marking, 157
 standards for, 157
 trip hazards, 157
 water on the floor, 157
 widths, 151
Alarms
 audible, 63, 240, 347
 backup, 500
 filter, 240
 smoke, 93, 325
 systems, 325
 visible, 63
Alcohol, 42–43, 270–271
 abuse, 43
Aluminum
 aluminosis, 207
 Company of America (ALCOA), 42
 extrusions, 412
American Board of Industrial Hygiene, 7
American Conference of Governmental Industrial Hygienists (ACGIH), 214
American Foundrymen's Society (AFS), 10
American Industrial Hygiene Association (AIHA), 7
American Iron and Steel Institute (AISI), 10
American Metal Stamping Association (AMSA), 10
American National Standards Institute (ANSI), 9, 21, 90, 181
American Petroleum Institute (API), 10, 271
American Society for Testing and Materials (ASTM), 9, 268
American Society of Heating, Refrigerating, Air-conditioning Engineers (ASHRAE), 242
American Society of Mechanical Engineers (ASME), 9
American Society of Safety Engineers (ASSE), 7
Americans with Disabilities Act (ADA), 44, 49, 109–111, 164, 169, 199, 306, 307

American Welding Society (AWS), 10
Ammonia, 126, 207, 284
 anhydrous, 284–285
Amputations, 23, 26, 78, 174, 387
Analysis (of hazards), 2, 8, 109, 137, 140
Analytical approach, 67–76
 accident analysis, 67
 epidemiological studies, 74–75
 fault-tree analysis, 68–71
 fishbone diagrams, 72
 FMEA, 67–68
 loss incident causation models, 73
 Swiss cheese theory, 72–73
 toxicology, 73–74
Anchoring machines, 378
Angiosarcoma, 74, 211
Angle of repose, 501
ANSI. *See* American National Standards Institute (ANSI)
Anthrax, 539
Antikickback device, 409
Antikickback fingers, 410
Antirepeat mechanism, 391
Anti-tie-down controls, 174
Anti two-block devices, 348
Appeals of citations, 99
Arc flash, 469–470
Arcs, 339, 440, 464–465, 469
Arc welding, 427, 428, 437–438
Argon, 209–210, 428, 444, 445
Arsenic, 44, 169, 444
Artificial intelligence, 129
Asbestosis, 74, 538
"ASH" (Action on Smoking and Health), 45
ASHRAE. *See* American Society of Heating, Refrigerating, Air-conditioning Engineers (ASHRAE)
Asphalt, 439
Asphyxiants, 209–212
 carbon dioxide, 210
 chemical, 210
 hydrogen cyanide, 211
 simple, 210
Associated General Contractors of America (AGCA), 10
Asthma, 307
Atmosphere-supplying devices, 298, 299
Audible alarms, 63, 240, 347

Audiometric testing, 259
Automated welding process, 197
Automatic
 automated welding process, 197
 fire detection systems, 325
 machine control sequence (case study), 174
 shutdowns, 308
 shutoffs, 276
 sprinkler systems, 330
Awareness barriers, 385, 386, 410, 419
A-weighted scale, 249
Back belts, 194–195
Back injury, 307, 363
Back pain, 19, 178, 194–195
Backup
 alarms, 325, 500
 power (case study), 61
Baghouses, 242
Bag-type filters, 242
Balconies, 151
Band saws, 412
Barlow decision, U.S. Supreme Court, 94
Barriers, 383–385
 awareness barriers, 385, 386
 creams, 315
 guards, 405
 installing, 63
 sound, 293
Baseline examinations, 206–207
Behavioral Science Technology, Inc., 43
Belt conveyors, 362
Belts and pulleys, 370, 413–415
Benzene, 209, 211, 228
Beryllium, and welding, 446
Beverly Enterprises (Arkansas), 179
Bhopal, India, disaster, 6, 134
Black lung, 74
Blanking, 311
Blasting, 509–510
Bleeding, 311
BLEVE. *See* Boiling Liquid Expanding Vapor Explosion
Blinding, 311
Block-and-tackle safety factor (case study), 352–353
Block flow diagram, 137, 147
Bloodborne pathogens, 45–47, 220

- BLS. *See* Bureau of Labor Statistics (BLS)
- Board of Certified Safety Professionals of America, 7
- Boilers, 168-169
- Boiling Liquid Expanding Vapor Explosion (BLEVE), 283
- Boiling point, flammable liquids, 268
- Bonding, 272-273, 464
- Boom, 166, 167, 336, 347, 348
- Boom platforms, 166
- Brace, 176
- Brake monitoring, 403-405
- Brakes, 349-350
- Brake stop-time measurement device, 401
- Branch circuits, 474
- Brazing, 426, 432, 442
- Breathing-air type compressor, 308
- Bridge cranes, 344, 347
- Bridge plates, 162
- British standard hazard classification, 82
- Brown lung, 74
- Brucellosis, 539
- Bubonic plague, 74
- Building codes, 147, 150, 159, 460
- Building official, 158
- Buildings/facilities, 150-169 codes, 150 exits, 162-163 illumination, 164-165 miscellaneous facilities, 165-169 boilers, 168-169 elevators, 167-168 maintenance platforms, 165-167 sanitation, 169 walking/working surfaces, 151-164 dockboards, 162 fixed ladders, 160-162 floors and aisles, 154-159 guarding open floors and platforms, 151 ladders, 159-160 stairways, 159
- Bulk plant, 275
- Bumpers, 348
- Bureau of Labor Statistics (BLS), 23, 26, 35, 96, 181, 194
- Burn, 268, 270-272, 283-284, 314, 330, 406, 427, 435, 440-442, 464
- Burnability range, 270-271
- Burnability range, gasoline, 270-271
- Bursitis, 178, 539
- Butane, 268, 283
- Byssinosis, 207, 538
- Cadmium, 44, 208, 221, 296, 444, 445**
vapor, 296
- Calcium carbide, 431
- Calibration, 201, 253, 259
- Cancer, 82, 123, 211, 225
- Cantilever gantry cranes, 345
- Cap (valve protection), 433, 434
- Capacitor, 438-439
- Capacitors, 375
- Capital investment, 2, 36, 54, 79
- Carbon fuels, 6. *See also* Global warming; Green engineering
carbon dioxide, 210, 213, 222, 243, 274, 277, 280, 303, 327, 331, 437, 444, 445
carbon disulfide, 209, 234, 271
carbon monoxide, 210, 211, 213, 215, 222, 240, 303, 306, 308, 340
carbon tetrachloride, 223, 237, 328, 330
- Carcinogen, 45, 120, 211, 221, 229, 308
- Cargo hooks, 497
- Carpal tunnel syndrome, 32, 176-179
- Carpet pole rider, 343
- Cartridges, 300
gas, 328
respirator, 306
- CAS number, 129
- Catastrophic accident, 348
- Catch platforms, 153
- Catwalks, 151
- Causal relationships, 69, 72
- Caustics, 137, 218, 316, 360, 437
- Cave-in, 22, 55, 56, 95, 101
- CDZs. *See* Controlled decking zones (CDZs)
- Ceiling, 219, 221, 229, 253, 330, 347, 441, 474
levels, 219
- Centrifugal, 140, 242
- Centrifugal devices, 242
- Centrifugal forces, 407, 410
- Ceramics, 242
- CERCLA, 124, 127. *See also* Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- Certified Industrial Hygienist (CIH), 7
- Certified Safety Professional (CSP), 7, 233
- Chaffin and Park, 364
- Chain, 68, 98, 316, 350, 355, 359, 361-363, 385, 416, 421, 446
saws, 247, 413
- Chemical asphyxiants, 209-211, 444, 445
Chemical Abstracts Service (CAS) Number, 216
engineering, 147, 224
highly hazardous, 540-543
reaction, 213, 222, 223, 300, 303, 328, 430, 431, 443
Chemical Abstracts Service (CAS) number, 129
- Chip removal and disposal, 417
- Chlorine, 135, 163, 208, 213
- Chloroethane, 437
- Chrome holes, 314, 445
- Chromium trioxide, 445
- Chute, 377
- Cigarette, 44, 269-270, 436
- Circuit(s)
breaker, 375, 453, 456, 460
breakers, 464
open/closed circuit, 303-304
tester, 471
- Citations, 96-99
appeals of, 99
- Civil Rights Act (1964), 44, 199
- Classes, 281
- Classes of explosives, 281
- Classification of hazards, 79
- Class I liquid, 268, 273
storage tanks, inventory records for, 276
- Class I magazines, 281
- Class II magazines, 281
- Claustrophobia, 307
- Cleaning, 40, 45, 124, 157, 165, 223, 279, 309, 373, 374, 415, 416, 446
- Clearance, 98, 150, 151, 157, 161, 330, 348
- Cleats, 491
- Cleveland open-cup test, 268
- Closed-circuit, 303-304
- Clothing, 130, 201-202, 226, 313-315, 326, 362, 370, 407, 442-443
- Coal dust, 208, 469
- Coccidioidomycosis, 539
- Cold, 5, 37, 183, 185, 201-202, 283, 434
- Combustible, 92, 207, 268-269, 273, 276-279, 323, 324
- Combustible liquids, 268
dip tanks, 281
vs. flammable (case study), 277-278
spray finishing, 278-280
- Committee on Industrial Ventilation, 8
- Committees, 10, 36-37, 59, 108, 135
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 124
- Compressed air for cleaning, 415, 416
gases, 285
- Compressor, 5, 137, 209, 308, 415, 416
- Compressors, 301
- Computer information systems, 35, 129-131
artificial intelligence, 129
expert systems, 129
Industrial Chemical Hazards Database (ICHD), 129-131
- Computer terminal operators, 179
- Concrete, 505-507
- Concrete shoring failure shoring failure (case study), 507
Willow Island nuclear tower collapse (case study), 505
- Confined space entry, 302-303, 309-312
- Congress, 35, 44, 88-90, 104-105, 176-177, 180-181
- Construction, 479-512
aerial lifts, 498
concrete work, 505-507
Willow Island nuclear tower collapse (case study), 505
cranes, 493-498
demolition, 508-509
electrical, 488-489
electric utilities, 510-511
explosive blasting, 509-510
fire protection, 486
floors and stairways, 493
general facilities, 480-481
controlled decking zones, 480-481
guardrails, 480-481
lighting, 481
materials handling and storage, 481

- Construction (*Continued*)
 heavy vehicles and equipment, 498–501
 dump trucks, 501
 rollover protective structures (ROPS), 498–500
 runover protection, 500–501
 hoists, 493–498
 ladders and scaffolds, 490–493
 material hoists, 498
 personal protective equipment, 482–485
 eye protection, 482
 face protection, 482
 fall protection, 482–485
 hard hats, 482
 hearing protection, 482
 personnel hoists, 498
 standards, 90
 steel erection, 507–508
 tools, 486–488
 hydraulic tools, 486–487
 pneumatic tools, 486, 487
 powder-actuated tools, 487–488
 trenching and excavations, 501–505
- Consultation, 103
- Consumer Product Safety Commission (CPSC), 6, 11, 88, 121, 211, 413
- Contact dermatitis, 538
- Contact lens, 46, 294–296
- Container
 labeling, 116
 limits, 275
- Contaminant detection, 222–224
 exposure comparisons, 228
 measurement instruments, 224–226
 measurement strategy, 224
- Continuity tester, 472–473
- Continuous flow mode, air line respirator, 301
- Continuous processes, 237
- Contractor personnel, 142
- Control circuitry, 399
- Controlled decking zones (CDZs), 480–481
- Conventional glasses, 296
- Conveyors, 362–363
 accidents, 336
 belt conveyor, 362
 orientations, 363
 overhead conveyor, 362–363
 screw conveyor, 363
- Cornice hooks, 492
- Corrosive liquids, 294
- Cost(s)
 of compliance, 78, 102
 of correcting a health hazard, 78
 of correcting violations, 99
 of damage to material or equipment, 38
 direct, 38
 electrical equipment installations, 277
 explosion-proof electrical equipment, 277, 466
 hidden, 38–40
 intangible, 38, 76, 84
 of learning period of new worker, 40
 of overtime work, 40
 spray painting area, 278
 uninsured medical, 40
 of wages paid, 38
 workers' compensation, 16–21
- Cotton
 balls, 292
 byssinosis, 207
 dust, 207, 221
 fabric, 442
- Court, 45, 77, 79, 90, 94, 99, 216, 220
- CPSC. *See* Consumer Product Safety Commission (CPSC)
- Cranes, 344–358, 493–498
 anti two-block devices, 348
 brakes, 349
 bridge cranes, 344, 347
 cantilever gantry cranes, 345
 gantry cranes, 345
 hammerhead tower, 496–497
 inspections, 354–356
 lockout/tagout requirement, 351
 monorails, 345
 moving parts, 350
 operating outdoors, 346
 operations, 358
 overhead bridge cranes, 344
 overhead traveling crane, 344, 345
 pendant, 345
 pulpit, 345
 ropes/sheaves, 351–354
 slings, 355, 358–361
 two-blocking, 347–348
 underhung cranes, 345
 wire rope components, 357
 wear, 356–358
- Cribbing, 491
- Criminal violations, 98
- Crisis management, national, 106
- Crystalline silica, 533
- Cumulative trauma disorders (CTDs), 177–178
- Cutoff valves, 64
- Cutting oils, 213, 215, 314, 315
- Cyanide, 211
- Cyclones, 242
- Cylinders, 284
 LPG cylinders, 284
 oxygen, 433–434
 welding cylinders, 430
- DAFWII. *See* Days away from work injury and illness case rate (DAFWII)**
- DART. *See* Days-away-restricted-or-transferred (DART)
- Days away from work injury and illness case rate (DAFWII), 24, 33, 95
- Days-away-restricted-or-transferred (DART), 25
- Dead-man controls, 173
- Death rate, 22, 101. *See also* Statistics
- Decapitate, 374, 436
- Decibels, 4, 26, 246–249, 253, 256, 261
 noise levels of familiar sounds, 247
 scale for combining, 247
- Defective, 69, 81, 159–160, 283
- Defective crane hooks, 356
- Defective cylinder, 431
- Defective wheel, 408
- Defensive driving, 62
- Defrosting, 500
- Degreasing, 215, 223, 295
- Demand-flow mode, 326
- Demand-flow mode, air line respirator, 302
- De minimis violations, 77
- Demolition, 508–509
- Demonstration, 107
- Department of Homeland Security (DHS), 128
- Depressants, 208–209
- DeQuervain's disease, 178
- Dermatitis, 313
- Derrick trucks, 487
- Design principles, 63–64, 161, 173, 238–239
 ventilation, 64, 236–242
- Detector tube test (case study), 226
- Deterioration, 4, 125, 207, 229, 308, 330, 357, 378, 435, 436
 equipment, 435
 health, 207
- DHS. *See* Department of Homeland Security (DHS)
- Diabetics, 307
- Die
 enclosure guard, 382–383
 mechanical power presses, 387
- Diesel, 337, 338, 340
- Di-2-ethylhexyl phthalate (DEHP), 308
- Dikes, 275, 284
- Dilution ventilation, 238
- Dip tanks, 281
 automatic extinguishing facilities, 281–282
 covers, lack of, 281
 principal problems, 281
- Direct
 costs, 38, 41, 99
 current (electrical), 454
- Disabilities, 25, 44
- Disaster preparedness, 134–147
- Disconnects, marking of, 474
- Discrimination, 43, 49, 95, 100, 110–111, 212, 261, 306–307
- Distal causes, 73
- Ditches, 154
- Dockboards, 162
- Docks, 151–152, 313
- Doses, 214
- Dosimeters, 225, 226, 254
- DOT. *See* Transportation, Department of
- Double
 block and bleed, 311
 cleat ladder, 490
 cup lifter, with release button, 380
 insulation, 456, 461
- Drowning, 270, 452
- Drug and alcohol abuse, 42–43, 49
- Dry chemical systems, 280, 331
- Ductwork, 153
- Dump trucks, 501
- Dust
 explosion, 323–324
 vs. fume particle, 213
 mask, 298, 299
- Dye marking underground utilities, 504, 505
- Ear**
 anatomy, 245
 protection, 58, 289, 292
 sensitivity, 245
- Earmuffs, 293
- Earplugs, 292
- Earthmoving equipment, 498, 500
- Earthquakes, 140
- Economics, 37–41, 283, 292
- Eczema/rash, 538

- Education, 5, 7, 47, 93, 105, 109, 314, 328-329
- Effluents, 64
- Egregious violations, 98, 105
- Egress, 162. *See also* Exits
- Electric
 shock, 348, 452
 utilities, 510-511
- Electrical hazards, 451-478.
See also Electrocutation hazards
- arc flash, 469-470
- electrocution hazards, 451-464
- double insulation, 461
- grounding, 457-459
- miswiring dangers, 461-464
- Ohm's law, 453-457
- physiological effects, 452-453
- wiring, 459-461
- fire hazards
 arcs and sparks, 464-465
 hazardous locations, 465-469
 wire fires, 464
- frequent violations, 473-474
 connection of plugs to cords, 474
 exposed live parts, 474
 flexible cords, improper use of, 474
 marking of disconnects, 474
 portable tools and appliances, grounding of, 473
- test equipment, 471-473
 circuit tester, 471
 continuity tester, 472-473
 receptacle wiring tester, 471-472
- Electric arc welding, 427
- Electrocution hazards, 451-464
- Electrode, 242, 427-429, 438
- Electromagnetic, 260
- Electromagnetic field type, of presence-sensing device, 394
- Electromechanical, 348
- Electromechanical devices, 392, 421
- Electromechanical style, 404
- Electrostatic precipitators, 242, 280
- Elevated load, 344
- Elevators, 167-168, 242, 323, 324, 469
- Emergency
 action plan, 142, 330
 action plans, 321, 324, 325
- alarm systems, 325
- evacuation, 324-326
- showers, 316
- shutdown, 140
- temporary standards (ETS), 90
- Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA), 124
- Emergency power-offs (EPOs), 418
- Emphysema, 207, 307, 326, 445
- Employee
 assistance programs, 43
 discrimination, 100
 hazard communication program, 116
 owned equipment, 290
 representative, 135, 139
- End-of-service-life indicator, 306
- Energy isolation devices, 374
- Enforcement, 94-100
 approach, 55-57
 citations, 94-95
 employee discrimination, 99-100
 of federal regulation, 88-112
 inspections, 94-96, 104
- Engagement point, 402
- Engineering approach, 59-67
 barriers, installing, 63
 controls, 59-60, 254-258
 design principles, 63-64
 engineering pitfalls, 64-67
 fail-safe principles, 60-62
 filters, 64
 human interface, 64
 redundancy, 61, 62
 substitution, 63
 three lines of defense, 59-60
 ventilation, 62, 64
 warning labels, 64
 worker removal/defeat of, 65
- Engineering design principles, 63-64
 alternate process substitution, 63
 barriers installation, 63
 exhaust ventilation systems, design of, 64
 exposure slow down, 63
 filters usage, 64
 hazards cause, elimination of, 63
 human interface, 64
 personnel, guard, 63
 pitfalls, 64-67
 visible or audible alarms, warn with, 63-64
 warning labels usage, 64
- Engulfment, sand, 310
- Entrapment, 310
- Environmental control, 236-261
 indoor air quality, ASHRAE standards and, 242-243
- Industrial Noise, 243-260
 administrative controls, 259
 characteristics of sound waves, 244-246
 decibels, 246-249
 engineering controls, 254-258
 hearing protection and conservation, 259-260
 noise measurement, 253-254
 OSHA noise standards, 250-253
 noise, 236-261 (*See also* *Industrial noise*)
 radiation, 260
 ventilation, 236-242
 design principles, 238-239
 makeup air, 239-241
 purification devices, 242
- Environmental Protection Agency (EPA), 6, 123-128, 239
 medical surveillance, 124-126
 reporting, 126-128
- EPA. *See* Environmental Protection Agency (EPA)
- EPCRA. *See* Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA)
- Epicondylitis, 178
- Epidemiological studies, 74-75, 443
- Epidemiology, 74-75
- Epilepsy, 307, 326
- Equal Employment Opportunity Commission (EEOC) (case study), 44, 110
- Ergonomics, 90, 108, 172-202, 260, 347
 affected industries, 179
 automatic machine control sequence (case study), 174-175
 facets of, 172-176
 designing safety features into workplace machines, 173
 vehicle design for human performance, 173
 hazards sources, 193
- back belts, 194
 manual lifting, 194
 work environment, 201-202
 work itself, 193
 workpiece, 201
 workstation, 195-201
- NIOSH lifting equation, 185-193
- risk analysis, 184-185
 job analysis, 185
 risk factors, 184
 standards, 179-182
 ANSI, 181
 OSHA, 179
 OSHA Guidelines, 181
 workplace musculoskeletal disorders, 176-178
 management programs, 182-184
- Escape, 93, 142, 151, 162-163, 240, 301, 310, 311, 322, 331
 as a strategy for fire protection, 322
- Escape strategy, 324
- Ethanol (ethyl alcohol), 209
- Evacuation, 324-326
- Examination(s), 2, 7, 101, 110, 125, 206-207, 229, 314, 315, 458
- Excavation, 22, 55, 95, 101, 165, 276, 501-505
- Exhaust, 64, 211, 238-242, 278, 338, 446
 air, 240-242
 ventilation systems, 64, 239
- Exits, 162-163
- Expandable foam, 306
- Experience rating, 17
- Expert systems, 129
- Explosion (ive), 281-282, 323-324, 439-441
 blasting, 509-510
 demolition, 508-509
 fire extinguisher, 510
 materials, 267-285 (*See also* *Flammable*)
 proof equipment, 278, 466, 468
 proof motors, 62
 storage magazines, 281
 vehicles for, 510
 welding, 439-441
- Exposed
 live parts, 348, 474
 rebars, 505, 506
 shaft couplings, 413, 415
- Exposure
 comparisons, 228
 measures of, 216-220
 ceiling levels, 219

- Exposure (*continued*)
 STELs (short-term exposure limits), 219
 time-weighted averages (TWAs), 217-218
 units, 219-220
- Extension cords, 460
- Extinguisher. *See* Fire extinguishers
- Extinguishing systems, fixed, 330-331
- Extra-hazardous employer, 108-109
- Eye
 protection, 441-442
 route of entry (toxic substances), 213
 strain, 179
 wash stations, 316
- Fabric filter, 242**
- Face protection, 294-296, 326, 482
- Facilities. *See* Buildings/facilities
- Fail-safe principles, 60-62
 fail-safe principle of redundancy, 62
 general fail-safe principle, 61-62
 of redundancy, 62
 of worst case, 62
- Failure Modes and Effects Analysis (FMEA), 67-68, 139
- Failure-to-abate violations, 97
- Fall protection, 54, 152, 482-485
- False
 floor, 157
 sense of security, 65, 277, 290, 291, 298
- Fan blade guards, 377-378
- Fault-tree analysis, 68-71, 139, 436
 difficulties, 70
 electrocution of workers, 69
 logic codes, 69
- Federal Register*, 21, 45, 89, 98, 180, 309
- Federal regulation, 43, 88-112
 enforcement, 94-100
 citations, 96-99
 employee discrimination, 99-100
 inspections, 94-96
 immigrant workers, 111
 NIOSH, 93-94
 political trends, 104-111
 Americans with Disabilities Act, 109-111
 ergonomics, 108
- "Extra-Hazardous Employer" status, 108-109
 national crisis management, 106
 positive developments, 106
 SHARP program, 106-107
 VPP program, 107-108
- public uproar, 100-102
- role of the states, 102-104
 consultation, 103
 employer reluctance, 103
 enforcement, 102-103
 inspection immunity, 104
- standards, 88-93
 General Duty Clause, 89, 91-92
 national consensus, 90
 standards development, 89-90
 structure, 91-93
- Fermentation, 209, 311
- Fetus, 211, 212
- Fibers, 337, 467, 474
- Fibers (fibrosis), 207-208, 227
- Fibrillation, 452, 453, 456, 457
- Fibrosis, 443
- Filters, 64, 242, 274, 300, 323
- Fines. *See* Penalties
- Fire
 brigades, 326
 classes of, 327-328
 detection systems, 325-326
 employee fitness, 326
 extinguishers, 327-329
 firefighter training, 326
 firepoint, 265, 268
 forbidden, 327, 328
 industrial, 322-323
 inspection/testing/
 mounting, 328
 mechanics of, 322
 prevention, 323
 protective clothing and apparatus, 326
 training and education, 328-329
 welding, 439-441
 Fire classes, 327-328
 Fire detection systems, 325-326
 Fire extinguishers, 327-329
 forbidden, 327, 328
 Firefighter training, 326
 Fire hazards, 464-469
 Firepoint, 268
 Fire protection
 automatic sprinkler systems, 330
 construction, 486
 dust explosions, 323-324
 emergency evacuation, 324-326
 alarm systems, 325
 fire detection systems, 325-326
 fire brigades
 employee fitness, 326
 firefighter training, 326
 protective clothing and apparatus, 326
 fire extinguishers, 327-329
 fire classes, 327, 328
 inspection, testing, and mounting, 328
 training and education, 328-329
 fire prevention, 323
 fixed extinguishing systems, 330-331
 dry chemical systems, 331
 other fixed systems agents, 331
 industrial fires, 322-323
 standpipe and hose systems, 329
 equipment, 329
 maintenance, 329
 Fires/explosions, 439-441
 Fire triangle, 322
 Fire watch, 441
 First aid, 23, 289-317
 treatment, 536-537
 Fishbone diagrams, 72
 Fit testing (for respiratory protection), 143, 298, 304, 307-308, 326
 Fixed
 barrier guards, 383, 405
 extinguishing systems, 330-331
 ladders, 160-162
 Fixed-barrier guards, 419
 Flammable and explosive materials, 267-285
 Flammable liquids, 267-272
 vs. combustible (case study), 277-278
 definition, 268
 dip tanks, 281
 myths, 269-272
 sources of ignition, 272-274
 spray finishing, 278-280
 standards compliance, 274-276
 Flashback, 435, 437
 Flashpoint, 265, 268-269, 272, 276-278
 Flexible cords, improper use of, 474
 Floating-roof storage tank, 275
 Floors, 150-151, 154-159
 and aisles, 154-159
 in construction, 480, 493
 floor-load marking plates, 158
 openings, 151, 158
 scaffolds, 151, 160, 166
 standards, 150-161, 164-167, 169
 water on, 157
 Flour batch mixer (case study), 373
 Flow process diagram, 137-138
 Fluorides, 222, 444, 446
 Fluorine, 208, 446
 Flux, 427-429, 435, 446
 Flux-cored arc welding (FCAW), 427
 Flywheel accident (case study), 375
 Flywheels, 375, 376, 387, 400
 FMEA. *See* Failure Modes and Effects Analysis (FMEA)
 Foam agents, 331
 Food and Drug Administration (FDA), 45
 Food poisoning, 539
 Footcandles, minimum illumination intensities in, 164-165
 Foot controls, 66
 Footings, 160
 Footswitches, 173
 Footwalks, 347
 Footwear, 313
 Forklift rider, 343
 Forklifts/forklift trucks
 center of gravity, 341-342, 358, 364
 charging in nondesignated areas, 339
 driver training, 340-342
 forklift rider, 343
 in-plant refueling of, 284
 overhead guard, 344
 stability of, 341
 visibility, 342
 Forklift truck
 accidents reduction, 341
 center of gravity location, 341, 342
 driver training, 340-342
 hazard prevention, 343
 Formaldehyde, 44, 221, 233, 417
 Forms. *See* Recordkeeping
 Foundry, 10, 155, 310
 Freeze, 283, 437, 452
 Freezers, 473
 Freon, 238
 Frequency, 23, 244, 396
 Frequency rate, 23. *See also* Statistics
 Friction, 157, 353, 356, 375, 389, 390
 Friend, Mark A., 144
 Frozen, 434

- Full-face masks, 300
 Fumes, 213, 239, 306, 443-446
 vs. dust particle, 213
- Galvanized, 445**
 Galvanized screen, 381
 Gamma rays, 260
 Gantry cranes, 345
 Gas(es)
 compressed gases, 285
 masks, 301, 305
 welding, 430-437
 acetylene hazards, 430-432
 oxygen cylinders, 433-434
 service piping, 436-437
 torches and apparatus, 434-436
 Gases, 213, 443-446
 Gas mask, 301, 305
 Gas metal arc welding (GMAW), 427
 Gasoline, 269-272, 338
 burnability range, 270-271
 myths about, 269-270
 octane rating, 271-272
 vapors, 270-272, 276
 Gas tungsten arc welding (GTAW), 427, 428
 Gas welding, 427, 428
 Gates, 392-393
 type A gate, 392
 type B gate, 392, 393
 Gears, 256, 350, 370, 421
 General
 Duty Clause, 89, 91-92, 96, 115, 140, 172, 176-177, 179, 181-182, 309
 fail-safe principles, 60-62
 General Duty Clause, 89, 91-92, 416, 421, 496
 General industry, 91
General Industry, Part 1910, 91
 machine mechanical hazards, 370
 Generator, 274, 278, 431, 459
 Geologic fault, 140
 German measles, 74
 Girder, steel, 428
 Global AIDS Policy Coalition, 46
 Globally Harmonized System (GHS), 116, 122
 Global warming, 6, 106, 243
 Gloves, 56, 143, 314, 315, 326
 Goggles, 294, 295, 442
 Golden Gate Bridge (safety nets on), 507
 Good faith, 96, 97, 140, 158
 Grain
 dust, 155, 242, 469
 elevator, 155, 242, 323, 324
 mills, 467, 469
- Grease, 315, 434, 435, 437
 Green engineering, 6, 243
 and global warming, 6, 106, 243
 Green, Warner, 45
 Gregg, N. McAlister, 74
 Grinding machines, 294, 406-408
 Grocery retail restocking, 191
 Ground (ing)
 conductors, 456, 458, 459
 faults (GFCI)
 working of, 460
 jumping to neutral, 462, 472, 474
 open/not continuous, 463
 portable tools and appliances, 473
 Ground-fault circuit-interrupter (GFCI), 460
 drawbacks, 489
 Grounding, 438, 457-459
 Guarding, 439
 Guardrails, 67, 151, 152, 154, 166, 169, 413, 480-481
 counter-moment force analysis, 483
 Guards (ing), 379-382. *See also* Machine guarding
 die enclosure, 382-383
 by distance, 372-373, 421
 fixed-barrier, 383
 jig guards, 385-386
 by location, 348, 372-373
 nylon mesh, 378
 opening size gauge, 381
 press, 391-392
 transparent machine, 382
- Habits, 41, 57, 58, 194, 199, 298, 315**
 Hacksaws, 413
 Half mask, 299, 300
 Halogen, 208
 Halon extinguishing systems, 331
 Hammer, 193, 247, 435
 Hammerhead tower cranes, 496-497
 Hammers, 431
 Hand
 feeding, 379, 380, 386, 388, 391, 392, 394, 395, 398, 403
 held pendant control, 348, 349
 held power tools, 422
 held saws, 412
 rails *versus* railings, 159
 speed constant, 401, 403
 trucks, 430
 Handicapped, 110, 164, 306
 Hand trucks, 337
- Harassment, 100
 Hard hats, 143, 308, 312, 482
 Hardship, 111, 296, 307, 308
 Hazard avoidance concepts
 analytical approach, 67-76
 accident analysis, 67
 epidemiological studies, 74-75
 fault-tree analysis, 68-71
 fishbone diagrams, 72
 FMEA, 67-68
 loss incident causation models, 73
 Swiss cheese theory, 72-73
 toxicology, 73-74
 enforcement approach, 55-57
 engineering approach, 59-67
 defense, three lines of, 59-60
 design principles, 63-64
 fail-safe principles, 60-62
 pitfalls, 64-67
 redundancy, 61, 62
 safety factors, 60
 worker removal/defeat of, 65
 hazard-classification scale, 76-82
 psychological approach, 57-59
 ground up safety, 58-59
 religion vs. science, 57
 top management support, 57-58
 worker age, 58
 Hazard-classification scale, 76-82
 risk-assessment code (RAC), 80-81, 83
 Hazardous chemicals
 information for process safety analysis, 135-136
 standard references, 135
 Hazards
 acetylene, 430-432
 arc welding, 437-438
 communication, 116-123
 employee hazard communication program, 116
 construction cranes, 494
 drowning, 485
 electrical fires, 464-469
 electrocution, 451-464
 forklift truck, 337
 gas welding, 430-437
 health vs. safety, 4-5
 industrial chemical hazards database, 129-131
 material handling, 336
 mechanical, 370-372
 oxygen cylinders, 433-434
- press, 387-389
 resistance welding, 438-439
 severity, 23
 shock, 438-439
 sources of ergonomic, 193-201
 back belts, 194-195
 work environment, 201-202
 work itself, 193
 workpiece, 201
 workstation, 195-201
 two-blocking, 493
 HAZWOPER, 124, 164
 Headache ball, 496
 Head protection, 312-313
 Health and Human Services (HHS), 89
 Health-care providers (HCPs), 179-180, 183
 Health economics, 37
 Health, education, and welfare (HEW), 93-94
 Health hazards
 baseline examinations, 206-207
 contaminants, detecting, 222-224
 detector tube test (case study), 226
 exposure comparisons, 228
 measurement instruments, 224-226
 measurement strategy, 224
 nanotechnology, 226-227
 measures of exposure, 216-220
 standards completion project, 220-222
 toxic substances, 207
 Hearing
 conservation, 259-260
 loss, 26
 protection, 292-293, 482
 cotton balls, 292
 earmuffs, 293
 earplugs, 292
 helmets, 293
 molded ear caps, 292-293
 Swedish wool, 292
 Heart, 125, 307, 326, 452, 453, 455-457
 Heat exchanger, 240
 Heat exhaustion, 539
 Heating, ventilating, air-conditioning (HVAC), 243
 Heat processes, 406, 421
 Heatstroke, 539
 Heavy vehicles and equipment, 498-501
 Heinrich, H.W., 59
 Helicopter, 358

- Helium, 208, 428, 444, 445
Helmets, 56–57, 293
Hemoglobin, 210
Hepatitis B virus (HBV), 46
Herniated spinal disc, 178
Hertz (Hz), (measure of frequency), 245, 452
HEW. *See* Health, education, and welfare (HEW)
Hidden costs, 38–40
High-rise office fire evacuation (case study), 325
Histoplasmosis, 539
Hitchhikers, 343
HIV virus, 46, 213
Hoist chains, 355
Hoist drum, 353
Hoisting mechanism, 345
Hoists, 493–498
Hold-outs (restraints), 379, 397–399
Homeland Security, Department of, 128, 143
Homicide (in the workplace), 48
Hood, 209, 301, 306, 410, 412, 457
Hook(s), 347, 355–356, 360, 362, 363, 408
Horizontal standard, 91
Horn, 344
Horsepower, 60
Hose mask, 299, 302
Hotel, 60, 158, 326
Hot wire, 69, 456, 457, 459, 460, 471
Hot work permits, 440–441
Housekeeping, 46, 154–156, 169, 323, 324, 336
Human anatomy, 381
interface, 64, 173
Hydraulic failure, 370
Hydraulic-powered models, 387
Hydraulic power presses, 389
Hydraulic presses, 402
Hydraulic pressure, 375
Hydraulic tools, 163, 193, 200–201, 258
Hydrogen cyanide, 211, 223
Hydrogen fluoride gas, 296
Hydrogen sulfide, 141, 213, 222, 223, 283, 309, 469
IAQ. *See* Indoor air quality (IAQ)
Ice, 161, 163
Idaho trench, 56
IDLH. *See* Immediately Dangerous to Life or Health
IDL/IDLH, 296
Ignitable dusts, 465–467
Ignitable fibers, 466
Ignition sources, 439, 465
Illumination, 164–165. *See also* Lighting
Illuminating Engineering Society (IES), 165
Immediately Dangerous to Life or Health (IDLH), 296
Immigrant workers, 111
Imminent danger, 5, 76, 77, 79, 94–95, 324
Impact load, 499, 508
noise, 4, 253
Impalement hazards, 505, 506
Imperial Foods, 323
Importer, 116, 122
Incidence Rates, 23–26, 30, 33, 95, 195. *See also* Statistics
Index, traditional, 22–23
Indoor air quality (IAQ), 45, 243
Industrial administrative controls, 184, 256, 259, 279, 290, 442
decibels, 4, 26, 246–249
engineering controls, 65, 66, 183–184, 254–258
fires, 322–323
hearing protection and conservation, 259–260
hygienists, 4–5, 8, 206, 214, 446
Industrial Chemical Hazards Database (ICHD), 129–131
measuring, 253–254
noise, 243–260
OSHA noise standards, 250–253
robots, 417–420
safety glasses, 294–296
sound wave characteristics, 244–246
trucks, 342, 344 (*See also* Forklift truck)
Industrial robot, 66
Industrial Safety Equipment Association (ISEA), 10
Inert gas, 209, 311, 428, 439
inerting (strategy), 210, 311
mode, 61
Inerting agents, 445
Infectious hepatitis, 539
Infirmary, 315
Information systems, 115–131
computer information systems, 129–131
expert systems, artificial intelligence and, 129
Department of Homeland Security, 128
Environmental Protection Agency (EPA), 123–128
medical surveillance, 124–126
reporting, 126–128
hazard communication, 116–123
container labeling, 116
employee hazard communication program, 116
Material Safety Data Sheets, 116
international standards, 123
record retention, 123
Infrared, 401
Infrared frequencies, 393
Ingoing nip point, 370
Inhalation, 136, 211–212, 302, 303
Injunction, 77, 94
Injury and Illness Report (OSHA Form 301), 30–31
Injury facts, 22
In-running nip point, 65, 362, 370, 371, 439
Insecticides, 208, 211
Inspections immunity, 104
industrial trucks, 337–342
Institute of Makers of Explosives (IME), 10
Insurance, 17–18, 38, 335
insurance fraud, 19
Intangible costs, 38, 76
Intelligent front ends, 129
Intelligent machines, evolution in, 420–421
Interlock, 138, 336, 438
Interlocked-barrier guards, 379, 384, 391, 392, 405, 406, 419
Interlocks, 376, 418
International standards, 123
Internet, 2, 131
Inventory records, 276
Ionizing radiation, 260, 261, 539
Irritant(s), 136, 207–208, 299
air contaminants, 213–214
asphyxiants, 209–211
carcinogens, 211
depressants, 208–209
routes of entry, 212–213
systemic poisons, 208
teratogens, 212
Jackhammer, 482, 486
Jacks, 416
Jig guards, 385–386
Job analysis, 181–183, 185
Job Candidate Profile (JCP), 43–44
Job-made ladders, 490
placement testing, 44
Kansas City hotel disaster (1981), 60
Kerosene, 277
Kickback, saws, 411–412
Kickout forms, 506
Kidneys, 208
Label, 64, 116, 123, 141, 305, 346, 466, 469
Ladders, 159–160, 490–493
common error in the use of, 160
construction, 482, 490
fixed, 160–162
job-made, 490
portable, 160, 347
safety devices, 161
Landings, stairways, 159
Lanyard, 484
difficulties with, 485
length, 484
Laser beam welding (LBW), 430
Lasers, 430
Lathes, 294
Lead-based paints, 238
Leak testing, 307
Leather, 27, 290, 314, 442
Legislation, 6, 17, 37, 45, 88, 90, 110
LEL. *See* Lower explosive limit (LEL)
Leukemia, 63, 209, 228
Liberty Mutual Insurance Company, 335
Life jackets, 485
lifelines, 166
Life Safety Code, 157, 332
Lifesaving skiff, 485
Lifting, 364–365
angular measure, 187
horizontal axis, 187
manual, 194
NIOSH lifting equation, 185–193
platform, 343
vertical axis, 187
Lifts, aerial, 498
Lift tables, 198
Lighting, 164–165, 340, 481
Lightning, 274
Line personnel, 15

- Liquefied petroleum gas (LPG), 168, 282–284, 327
- Liquids
 combustible, 276–278
 flammable, 267–272
 flammable vs. combustible liquids (case study), 277–278
 use of term, 268
- Litigation, 43, 116, 316
- Loading docks, 152
- Load rating, 166, 346, 355
- Location, guarding by, 372–373
- Locked exits, 163, 323
- Lockouts/tagouts, 310, 351, 373–375
- Logarithmic decibel scale, 246, 256
- Logic diagram, 68
- Log of Work-related Injuries and Illnesses, 26, 28
- Loss-control representative, 19
- Loss incident causation models, 73
- Lost-workday-cases incidence rate (LWDI), 24–25
- Lost workdays, 23, 25, 32, 33
- Lower explosive limit (LEL), 271
- Lubricating, 314, 390
- Lumber, 121, 174
- Lunchroom sanitation, 169
- LWDI. *See* Lost-workday-cases incidence rate (LWDI)
- Machine guarding, 369–422, 426**
 belts and pulleys, 413–415
 chip removal and disposal, 417
 compressed air, 415–416
 general, 369–378
 anchoring machines, 378
 fan blade guards, 377–378
 interlocks, 376
 location/distance, guarding by, 372–373
 mechanical hazards, 370–372
 tagouts and lockouts, 373–375
 trip bars, 376, 377
 zero mechanical state, 375–376
 grinding machines, 406–408
 heat processes, 406
 industrial robots, 417–420
 jacks, 416
 metalworking fluids, 416–417
 point of operation, safe-guarding methods, 379–386
 adjustable barriers, 384
 awareness barriers, 385, 386
 die enclosures, 382–383
 fixed barriers, 383
 guards, 379–382
 interlocked barriers, 384
 jig guards, 385–386
 power presses, 386–405
 saws, 408–413
- Machine mechanical hazards, 370
- Machining operations, 294
- Magazines (explosive), 281
- Magnesium, 208, 327, 444, 469
- Main, Jeremy, 82
- Maintenance
 department, 3, 15
 platforms, 165–167
 worker, 30, 165, 166, 290, 309, 347, 350, 373–375, 419, 470
- Makeup air, 239–241
- Managed care, 19
- Manager, use of term, 2
- Manganese, 208, 222, 231, 444
- Manhole, 302, 309
- Manifold, 92, 430, 432, 434, 436
- Manlifts, 151, 167, 168
- Manual
 feeding, 392
 lifting, 179, 185, 193–194
 Manufacture materials, 126
- MAPP gas, 427, 432
- Marijuana, 43
- Masks, 298–301, 305
 dust, 299
 full-face, 300
 gas, 301
 half, 299, 300
 hose, 302
 quarter, 298–300
- Masonry, 295
- Mass/motion hazards, 336
- Material handling, 193–194, 196, 335–337, 344, 350, 353, 358
- Material hoists, 498
- Material Safety Data Sheets (MSDSs), 116
- Materials handling
 block-and-tackle safety factor (case study), 352–353
 conveyors, 362–363
 belt conveyor, 362
 overhead conveyor, 362–363
 screw conveyor, 363
 cranes, 344–358
 ropes/sheaves, 351–354
 industrial trucks, 337–342
 forklift driver training, 340–342
 industrial truck design, 338
 operations, 339–340
 truck selection, 337–339
 lifting, 364–365
 materials storage, 336–337
 passengers, 343–344
 parking/maintenance, 344
 slings, 358–361
- Materials storage, 336–337
- Maximum acceptable ceiling (MAC), 219
- McClay, Robert, E., 73
- Means of egress. *See* Exits
- Measles, 74
- Measurement instruments, 224–226
- Measurement strategy, 224
- Measures of exposure, 216–220
 action levels, 220
 ceiling levels, 219
 time-weighted averages, 217–219
 units, 219–220
- Meatpacking, 108, 179
- Mechanical
 advantage, 351, 352
 power presses (*See* Power presses)
- Mechanics of fire, 322
- Medical EPA, 124–126
- Medical examinations, 125–126
 monitoring the adverse effects of exposure, 125
 records, 125
 surveillance, 124–126
- Medical surveillance, 124–126
- Medical treatment, 535. *See also* First aid
 classification of, 538–539
 disorders associated with repeated trauma, 539
 disorders due to physical agents (other than toxic materials), 539
 occupational skin diseases/disorders, 538
 other occupational illnesses, 539
 poisoning (systemic effect of toxic materials), 538
 respiratory conditions due to toxic agents, 538
- Mercury, 136, 208, 305, 446
- Merit (VPP Program), 107
- Metal
 cutting, 242
 dusts, 469
 fumes, 213–214, 443
 ladders, 160
 safety cans, 275
 stamping, 10
- Metal-stamping industry, 389
- Metal working fluid (MWF), 215, 314, 416–417
 natural fluids, 314
 semisynthetic fluid, 314
 soluble oil, 314
 synthetic fluid, 314
- Methane, 209, 222, 225, 282–283
- Methanol, 305
- Methanol (methyl alcohol), 208, 209
- Mineral dusts, 216, 533–534
- Mineral fiber, 292
- Mine Safety and Health Administration (MSHA), 88, 165
- Mining, 27, 169, 242
- Missile silo, 439
- Mists, 208, 213–214, 216, 222, 223, 295, 314
- Miswiring dangers, 461–464
- Mitigating factors, 73
- Mobile
 cranes, 166, 348
 scaffolds, 490–493
- Molded ear caps, 292–293
- Monday morning sickness, 445
- Monomer, 211
- Monorails, 345
- Motorcycle, 56
- Mounting, 45, 174, 328, 353, 378
- Mouthpiece respirator, 299, 301
- MSD. *See* Musculoskeletal disorders (MSDs)
- MSDSs. *See* Material Safety Data Sheets (MSDSs)
- Murphy's law, 62, 73
- Musculoskeletal disorders (MSDs). *See* Workplace musculoskeletal disorders (WMSDs)
- Mushroomed heads (on chisels), 486
- Mutagens, 212, 229
- Muting, 395
- MWF. *See* Metal working fluid (MWF)
- NAICS. *See* North American Industry Classification System (NAICS)**
- Nails, nailers, 157
- Nanomanufacturing. *See* Nanotechnology
- Nanotechnology, 226–227
- Nanotubes, 227
- Narcotics, 208
- National consensus, 10, 90, 164, 172, 215–216

- National Consensus Standard, 340, 375
- National Electrical Code, 458, 459
- National Electrical Code® frequent violations, 473–474
connection of plugs to cords, 474
exposed live parts, 474
flexible cords, improper use of, 474
marking of disconnects, 474
portable tools and appliances, grounding of, 473
ground-fault circuit-interruptor (construction), 489
hazardous locations classification, 465
- National Electrical Manufacturers Association (NEMA), 10
- National Emphasis Program (NEP), 95
- National Fire Protection Association (NFPA), 9, 90, 157, 268, 271–272
- National Institute for Occupational Safety and Health (NIOSH), 10, 93–94
lifting equation, 185–193
multipliers for, 189
recommended exposure levels, 215
- National LP-Gas Association (NLPGA), 10
- National Machine Tool Builders Association (NMTBA), 10
- National Safety Council (NSC), 8–9, 21–22, 26, 37, 41, 152, 296, 335
- National Trade Associations, 10
- Natural
cutting oils, 213, 215, 314, 315
gas, 168, 209, 222, 225, 271, 282–283
illumination, 164
language interfaces, 129
- Nemeth, John, C., 82
- NFPA. *See* National Fire Protection Association (NFPA)
- NIOSH. *See* National Institute for Occupational Safety and Health (NIOSH)
- NIOSH Registry of Toxic Effects of Chemical Substances*, 135
- Nip point (in-running), 65, 362, 370, 371, 439
- Nitric acid, 136, 218
- Nitrogen, 208–209, 445–446
as a hazard (case study), 210
- Noise exposure, 243, 245, 293.
See also Industrial noise
- Noise-induced hearing loss, 539
- Noise measurement, 253–254
- Noise Reduction Rating (NRR), 293
- Nomex™, 314, 442
- Nominal breaking strength, 351–353
- Nonionizing radiation, 260, 261, 539
- Nonsmokers, 44
- North American Industry Classification System (NAICS), 26, 27
- NSC. *See* National Safety Council (NSC)
- Nuclear Regulatory Commission, 307
- Nuisance dusts, 534
- Nuisance tripping, 460, 489
- Nylon mesh guards, 378
- Obama, 106**
- Occupational Safety and Health Act (1970), 1, 88
- Occupational Safety and Health Administration (OSHA), 1, 88, 220
citations, 154, 279, 375, 475
ergonomics, 179–180
federally approved state plans for, 548
forms (*See* Recordkeeping)
inspections, 26, 91, 94, 103
penalties, 96, 375
public criticism of, 100
Red Tape Award received by, 56, 284
repeal, 104
Voluntary Protection Program (VPP), 107
website, 2, 11, 201
and workplace violence, 47
- Octane rating (gasoline), 271–272
- Octave-band analysis, 254–255
- Ohm's law, 453–457, 460, 462, 469
- Oil folliculitis, 314
- Oil production, 168
- Olfactory, 222, 283
- Open
circuit, 303
cup (testing method), 268
floors and platforms, 151–154
ground, 463, 472
- Open-back inclinable (OBI) power press model, 387
- Opiates, 42
- Organic vapor respirator, 305
- Organization of committees, 36–37
- OSHA. *See* Occupational Safety and Health Administration (OSHA)
- OSHA citations, 328
- OSHA forms. *See* Record-keeping
- Outlets (electrical), 467, 468
- Outside contractor, 142
- Overhead
bridge cranes, 344
conveyors (*See* Conveyors, overhead)
cranes (*See* Cranes, overhead)
guards (*See* Forklift truck) traveling crane, 344, 345
- Overrun switch, 404
- Oxidation, 428, 445
- Oxyacetylene, 427, 435, 442
- Oxygen
confined space entry, 311
cylinders, 284, 433–434
deficiency, 209, 225, 229, 296, 298, 311, 439
enrichment, 311
piping systems, 437
- Paint, 306**
spray areas (booths), 4, 279–280, 465, 467, 469
- Palletized loads, 344
- Pallet loads, 336
- Palm button, 66, 174, 399–402
- Pan-type treads, 493
- Paper plan, 109, 141
- Parking/maintenance, 344
- Particulates, 214, 222
- Particulates not otherwise regulated (PNOR), 532
- Parts of rope, 351, 353
- Passengers, 343–344
- Passive smoking, 44
- Pedal, 66, 173, 388
- Pedestal, 403
- Pedestrian, 341, 342
- PELs. *See* Permissible exposure limits (PELs)
- Penalties (fines), 96–98
- Pendant control, 348
hand-held, 348, 349
hoist mechanism, 349
lockout/tagout requirement, 351
plugging, 350
runway conductor, 350
spring-return controllers, 349
- toggle switches, 349
- Pensky–Martens closed tester method, 268
- Pepperidge Farm (Pennsylvania), 179
- Pep talks, 57
- Performance standards, 92, 93, 157, 199, 294
- Period, 245
- Permanent
partial disability, 23, 25, 80
threshold shift (hearing), 259
total disability, 23, 80
- Permissible exposure limits (PELs), 124, 136, 215–216
for air contaminants, 516–532
for specialized materials, 532–533
table of, 216, 250–251
- Personal protection, 289–317
confined space entry, 309–312
hazard identification, 310–311
isolation of space, 311, 312
eye and face protection, 294–296
first aid, 315–316
head protection, 312–313
hearing protection, 292–293
cotton balls, 292
earmuffs, 293
earplugs, 292
helmets, 293
molded ear caps, 292–293
Swedish wool, 292
- PPE training, 291
- protection need assessment, 290–291
- respiratory protection, 296–313
air line respirator, 301–302
dust masks, 299
fit testing, 308
full-face masks, 300
gas masks, 301
half masks, 299, 300
hose masks, 302
mouthpiece respirator, 299, 301
personnel screening, 306–307
quarter masks, 299, 300
respirator plan, 304
respirator selection, 304–306
self-contained breathing apparatus, 302–304
systems and maintenance, 308
- Personal protective equipment (PPE), 316

- clothing and skin hazards, 313-315
 construction, 482-485
 safety shoes, 313
 training, 291
- Personnel hoists, 498
 Personnel screening, 306-307
 Pesticide, 121, 213, 223
 Petrochemical, 134, 142, 209
 Petroleum conservation, 6. *See* also Global warming; Green engineering
- Pharmacokinetics, 73
 Pharyngitis, 538
 Phenolic vapors, 360
 Phillips Petrochemical Plant explosion, 134
 Phosgene, 208, 211, 443-445
 Photoelectric presence-sensing screen, 65, 393, 395
 Physical examinations. *See* Examination(s)
 Physician, 23, 125-126, 306, 307, 316, 326, 440
 Pipe(s), piping, 140, 276, 284, 311, 436-437
 Pitch, 243, 245, 249, 261
 Pits, 154, 271, 353
 Plate girders, 428
 Platforms, 151
 boom, 166
 catch, 153
 lift trucks, 337
 maintenance, 165-167
 open, 151
 vehicle-mounted, 166
 Plating, 135, 208, 213, 223, 281, 314, 445
 Plug, 69
 Plugging (crane controls), 350
 Pneumatic
 hose, 486
 press, 66
 tools, 486, 487
 Pneumoconiosis, 207, 443, 538
 Pneumonitis, 538
 Point
 of irreversibility, 73
 of operation guards, 379-382, 386
 Poison, 33, 136, 208
 Poisson processes, 62
 Political, 104-111
 Polyester, 360, 361
 Polypropylene, 360, 361
 Polyvinyl chloride (PVC), 211
 Portable electronic drills, 69
 Portable, ladders, 160
 Positioners, 370
 Positive pressure differential, 301, 302
 Positive-pressure mode,
 firefighting, 326
 Poultry processing, 135,
 163, 172, 179, 201,
 323, 332
 Powder-actuated tools, 482,
 487-488
 color identification for cased
 power loads for, 488
 Powdered metal, 237
 Power hacksaws, 413
 Power presses, 386-405
 brake monitoring,
 403-405
 controls vs. trips, 400
 designs, 389-390
 full-revolution, 389-391
 gates, 392-393
 guards, 391-392
 hazards, 387-389
 hold-outs, 397-399
 misaligned workpiece in
 die, 388
 part-revolution, 389-391
 point-of-operation safe-
 guarding, 390-391
 presence-sensing devices,
 393-396
 pullbacks, 396-397
 safeguarding summary, 405
 safety distances, 400-403
 sweeps, 397, 398
 two-hand controls, 399
 PPE. *See* Personal protective
 equipment (PPE)
 Pregnancy, 74, 212
 Presence-sensing devices, 379,
 393-396
 Press brake (type of machine),
 372-373, 375, 389
 Presses. *See* Power presses
 Pressure
 air line respirator, 301, 302
 firefighting, 326
 reducer, 416
 wave, 244
 Pressure-demand mode, air
 line respirator, 302
 Prime *versus* subcontract, 142
 Printing press, 65
 Prison, 97-98, 211, 322
 Privacy, 30, 126
 Probability, 70, 80-81
 Process
 analysis, 139-140
 contractor personnel, 142
 disaster preparedness,
 134-147
 equipment, 138-139
 information, 135-139
 materials, 126
 operating procedures,
 140-141
 safety, 134-147
 terrorism, acts of, 142-145
 training, 141
 Professional certification/
 societies, 7-8
 Programming, 418, 419
 Promulgation, 89
 Propane, 238, 268, 283, 432
 fire control, 284
 safety hazards, 283
 Propellants, 238
 Protective clothing. *See* also
 Personal Protective
 Equipment
 flameproof gauntlet
 gloves, 314
 gloves, 314
 heavy-duty protective
 aprons, 314
 welding, 442-443
 Proximal causes, 73
 Proximity, 315
 Proximity warning devices, 166
 Psychological approach, 57-59
 ground up safety, 58-59
 religion vs. science, 57
 top management support,
 57-58
 worker age, 58
 Public law 89, 109, 306, 479, 541
 Pullbacks, 396-397
 Pulley, 30, 328
 Pulleys, 362, 413-415
 Pulmonary irritants, 444
 Pulpit, cranes, 210, 345
 Punch presses, 174, 382, 386.
See also Power presses
 Purchasing, 5, 369, 390
 Purification devices, 242
Qualitative, 224, 225
 Quality control, 16
 Quantitative, 70, 83, 224, 465
 Quantitative fit testing, 326
 Quarter mask, 298-300
**RAC. *See* Risk-assessment
 code (RAC)**
 Radar, 510
 Radial saws, 408-410
 Radiation, 260
 Radio-frequency sensors, 394
 Radon, 82
 Rail
 clamps, 346
 sweeps, 348
 Railings, 152-154, 159
 Rainstorms, as cave-in
 hazard, 502
 Ramp-in procedure, 184
 Random events, 62
 Rapid Entire Body Assessment
 (REBA), 185
 Rapid Upper Limb Assess-
 ment (RULA), 185
 Rated capacities, 346, 359
 Rated load marking, 346
 Raynaud's phenomena, 539
 Raynaud's phenomenon, 178
 RCRA. *See* Resource Conser-
 vation and Recovery
 Act (RCRA) (1976)
 Reasonable
 accommodation (ADA), 110,
 164, 194
 objectives, 2-4
 REBA. *See* Rapid Entire Body
 Assessment (REBA)
 Rebars, 505, 506
 concrete caps, 506
 Receptacle wiring tester,
 471-472
 Recessed head fasteners, 379
 Reciprocating moving
 parts, 370
 Recognition pins/certificates/
 prizes, 57
 Recommended exposure level
 (RELs), 215
 Recommended weight limits
 (RWLs), 186
 Recordkeeping, 21-35
 calculation of, 33-35
 Form R (EPA), 126
 forms, 26-33
 incidence rates, 23-26
 Log of Work-related Injuries
 and Illnesses, 26, 28
 retention, 35, 123
 Summary of Work-related
 Injuries and Illnesses
 (OSHA Form 300A), 29
 traditional indexes, 22-23
 Record retention, 123
 Red Tape Award, 56
 Redundancy, 62
 Reeving, 347, 351-353
 Refinery, 209, 268, 283, 285,
 302, 324. *See* also
 Petrochemical
 Reflective face shields, 295
 Reform, 17, 37, 109
 Refrigerators, 467, 473
 Refueling, 165, 284, 339
 Regulators, 434
 Reinforcing steel rebars, 505
 Reinstatement with back
 pay, 100
 REL. *See* Recommended
 exposure level

- Reliability, 8, 44, 67–68, 272, 325, 389, 403, 404
- Religion, 57, 110, 307
- Remodeling, 30, 111, 341
- Repeat
strokes, 391
violations, 96–97
- Repetitive
hand motion, 176
strain injuries (RSIs), 177
- Reporting, 126–128
- Repose (angle of), 501
- Reproductive system, 208
- Rescue, 56, 78, 143–144, 302, 303, 307, 309, 310
- Residue accumulation, 279
- Resistance spot welding (RSW), 430
- Resistance welding, 426, 428–429, 438–439
- Resource Conservation and Recovery Act (RCRA) (1976), 124
- Respirator
plan, 304
selection, 304–306
- Respiratory protection, 296–313
- Restrictions, 397–399
- Restricted work activity, 24, 32, 35
- Restrooms, 315
- Resuscitation, 55, 69, 457
- Retrofit, 150, 377
- Reversed polarity, 463, 472
- Rewards, from top management, 57
- Rhinitis, 538
- Rigging equipment, 481
- Right-to-know movement, 35, 116, 131
- Ring buoys, 485
- Ring test (for grinding wheels), 408
- Risk analysis, 184–185
- Risk-assessment code (RAC), 80–81, 83
- Riveters, 482
- Rivets, 485, 508
- Road-map approach, 139
- Robotics, evolution in, 420–421
- Robots, industrial, 417–420. *See also* Industrial robot
- Rocks, 502
- Rollover protective structures (ROPS), 498–500
- Roofing, 152, 306
- Ropes and Sheaves, 351–354
- ROPS. *See* Rollover protective structures (ROPS)
- Rotator cuff syndrome, 178
- Routes of entry, toxic substances, 212–213
- Rubber, 27, 160, 193, 242, 257, 284–285, 292, 300, 376
- Rubella, 74
- RULA. *See* Rapid Upper Limb Assessment (RULA)
- Runovers, 498
protection, 500–501
- Runway, 151, 153, 344, 350
- Ruptured eardrums, 307, 326
- Safeguarding, 379–386**
- Safety
belts, 153, 166, 290
committees, organization of, 36–37
distances, machine guarding, 369–422
factors, 60, 346, 351, 352
glasses, 57, 294–296
versus health, 4–5
and health economics, 37–41
meetings, 57
National Safety Council (NSC), 8–9, 21–22, 26, 37
nets, 507
shoes, 32, 160, 291, 313
training, 41–42, 433, 441
workplace violence, 47–48
- Safety and Health
Achievement Recognition Program (SHARP), 106–107
- Safety Data Sheets (SDSs), 116, 117, 122, 135
- Safety distances, 400–403
- Safety factor
overhead crane hoists, 60
scaffold ropes, 60
- Safety function
accident cause analysis, 35–36
bloodborne pathogens, 45–47
job placement testing, 43–44
recordkeeping, 21–35
training, 41–42
drug and alcohol abuse, 42–43
violence, 47–48
workers' compensation, 16–21
workplace smoke-free, 44–45
- Safety glasses, 294
- Safety shoes, 313
- Sand
blasting, 238
engulfment, 310
- Sand engulfment (case study), 310
- Sanitation, 169
- Saulter, Gilbert, L., 106
- Sawdust, 155, 242, 410
- Saws, 408–413
band, 412
chain, 413
hand-held, 412
kickback, 411–412
power hacksaws, 413
radial, 408–410
table, 410–411
- Scaffolding, Shoring, and Forming Institute (SSFI), 10
- Scaffolds, 490–493
disassembly accident (case study), 492
floor of, 492
plank overlap specifications, 493
safety factor, 490
suspended swinging, 492
tube and coupler, 491
- SCBA. *See* Self-contained breathing apparatus (SCBA)
- Sciatica, 178
- Scrap material, 155
- Screen (ing)
face shields, 295
tests, 42, 110
- Screw conveyors, 363
- Seam welding, 430, 439
- Search warrant, 94
- Seat belts, 499
- Security. *See* Homeland Security, Department of
- Self-contained breathing apparatus (SCBA), 302–304, 326
closed-circuit, 303–304
open circuit, 303
- Sense of smell, 222
- Sensing device, 65, 393–396
- Sensors, 67, 166, 175, 393, 394, 400
- September 11 terrorist attack, 128, 142–145
- Service piping, 436–437
- Service stations
aboveground, 271
tanks, 271
underground, 271, 276
leaks (case study), 276
- Setscrews, 350, 413, 415
- Sewers, 309, 311
- Shaft couplings, 413, 415
- Shale, 502, 503
- SHARP. *See* Safety and Health Achievement Recognition Program (SHARP)
- Sharps, 46
- Shear, 374, 385, 386, 389
- Shear hazard (case study), 374
- Sheaves, 351–354
- Sheet metal, 256–257, 372, 379, 389, 413, 430, 466
- Shield, 66, 292, 372, 428
- Shielded metal arc welding (SMAW), 427
- Shield guard, 372
- Shock
electric, 348, 452
hazards, 438–439
loads, 346, 348
- Shoes (safety), 160, 291, 313
- Shoring, 10, 506
- Short-circuiting, 439
- Shorts, 460
- Short-term exposure limits (STELs), 217
for specialized materials, 532–533
- Showers, 316
- Shutdown, 77, 79, 94, 140, 308
- Shutoff, 209, 276
- Shutoff-type nozzles, 329
- SIC. *See* Standard Industrial Classification
- Siderosis, 207, 445, 538
- Signs, 1, 5, 57, 125, 182, 259, 279, 281, 315, 355, 416
- Silica, 238
- Silica dust, 213
- Silicosis, 207, 238, 538
- Silos, 310
- Simple asphyxiants, 209, 210
- Skin, 33, 212
- Skin hazards, 313–315
- Slag, 428, 429, 435
- Slings, 358–361
requirements for, 360, 361
selection, 360
- SLM. *See* Sound-level meter (SLM)
- Smoke
alarms, 93, 325
free workplace, 44–45
Smoke-free workplace, 44–45
- Soldering, 222, 237, 426, 427, 432, 442, 446
- Solvent, 138, 315
- Sound
intensity, 249, 252, 253, 255, 256, 261
level meters, 249, 253–254
pressure, 245–246, 261
wave, 244–246
- Sound-level meter (SLM), 253
- Sound waves, 244–246
- Sparks, 272, 294, 339, 370–372, 421, 440, 442, 464–465

- Specification standards, 92, 93, 158
- Sphere of control, 566**
- Spill, 62
- Spindle speed, 407
- Splash loading, 274
- Splice, 160
- Spot welding, 430, 439
- Spray finishing, 278–280
- Spraying, 223, 278–280
- Spreader, 410, 412
- Sprinkler, 279–280, 330
- Sprinkler systems, automatic, 330
- Sprockets, 350, 355
- Stack material, 330
- Stacks, 336, 337, 343
- Stainless steel, welding, 445
- Stairways, 151, 159, 163, 493
- Standard Industrial Classification (SIC) Code, 26, 545–547
- partially exempt industries, 446–447
- principal manufacturing categories, 545
- Standard railings, 152
- Standards
- for buildings/facilities, 150
 - completion project, 220–222
 - ergonomics, 179–182
 - institutes, 9–10
 - railings, 152
- Standpipe and hose systems, 329
- Static electricity, 274, 277, 438
- Statistics. *See* Incidence rates; recordkeeping
- Steam boilers, 168
- Steel erection, 507–508
- Steeple, 497
- STELs. *See* Short-term exposure limits (STELs)
- Stem fires, 431
- Stenching agent, 222, 283
- Stick electrode, 427
- Stops, 161, 348, 389, 400, 458
- Stop-time measurement device, 401
- Storage tanks, 275–276
- Street safety glasses, 294
- Strippers, 277
- Strip stock, 30, 391
- Structural
- collapse, 158
 - steel erection sites, 508
 - tests, 481, 499
- Submerged arc welding (SAW), 428
- Substitution, 63, 238, 256, 432, 446, 464, 474
- Suffocation, 501
- Sugar refinery, 324
- Sulfur dioxide, 223
- Sulfuric acid, 218, 223
- Summary of Work-related Injuries and Illnesses (OSHA Form 300A), 29
- Sunstroke, 539
- Superfund Amendments and Reauthorization Act (SARA), 124
- Suppression, 138, 322, 330, 331, 417
- Supreme Court (U.S.), 94, 99, 216
- Surveillance, 124–126, 157, 181–183
- Suspended swinging scaffolds, 492
- Swedish wool, 292
- Sweeps, rail, 348
- Swiss cheese theory, 72–73, 436
- Switch loading, 277
- problem remedies, 277
- Synergistic effect, 218
- Synovitis, 539
- Synthetic oils, 314
- Systemic poisons, 208
- System(s) safety, 138
- Table saws, 410–411**
- Tag closed-tester method, 268
- Tagouts. *See* Lockouts/tagouts
- Tank(s). *See also* Service stations
- aboveground, 271
 - federal codes for, 275
 - relief valves, 283–284, 303
 - trucks, 274, 277
 - underground, 271, 276
- Target Industries Program (TIP), 95
- Target organs, 130
- Teach pendant, 419
- Temperatures, 138, 185, 201, 277, 283, 361, 427, 432, 445, 446
- Temporary
- disabilities, 23
 - floors, 507
 - lighting, 489
 - operations, 140
- Tendonitis, 179
- Tenosynovitis, 179, 539
- Tension neck syndrome, 178
- Teratogens, 212
- Termination, 48, 100, 125
- Terrorism, 142
- Terrorism, acts of, 142–145
- Terrorist (terrorism), 106, 128, 142–145, 323
- Test equipment, 471–473
- Tetraethyl lead, 208
- Textile, 27, 74
- Thermit method of welding (TW), 430
- Three lines of defense, 59–60, 183, 236
- Threshold limit values (TLVs), 214–215
- Threshold shift, 26, 259
- Tie-down, 174
- Timbers, 502
- Time-weighted averages (TWAs), 217–218, 244, 261
- Tires, 87
- Tobacco, 44–45, 121
- Toeboard, 151, 154, 166
- Toluene, 219
- Tongs, 379, 380, 389, 398
- Tongue guard, 406, 407
- Tool balancer, 193
- Tools
- hand-feeding, 379, 380
 - for hand-feeding, 379, 380, 398
 - portable electric, 473
- Top management, 15–16
- Top-stop brake monitor, 404
- Torches, 434–436
- Total Recordable Cases (TRC), 24
- Toxic metals
- cadmium, 208
 - magnesium, 208
 - manganese, 208
 - mercury, 208
- Toxicology, 73–74
- Toxic substances, 207–216
- chemicals, 126–127
 - irritants, 207–208
 - permissible exposure limits, 215–216
 - recommended exposure levels, 215
 - threshold limit values, 214–215
- Toxic Substances Control Act (TOSCA), 88
- Tractors, 5, 336, 337
- Trade
- associations, 10
 - secret, 94
 - trade-off, 442
- Traditional indexes, 22–23
- Training, 41–42, 141, 291
- firefighting, 326, 328–329
 - forklift driver, 340–342
 - process, 141
 - safety, 41–42
- Transit, 27, 341
- Transitional limits (PELs), 216
- Transmission lines, 348
- Transportation, Department of, 136, 168, 282
- TRC. *See also* Total Recordable Cases
- Treads, 493
- Trenching and excavations, 501–505
- Trench jacks, 502
- Trench shoring, 502
- Triangle Shirtwaist Company fire (NYC), 323
- Tribology, 157
- Trichloroethylene, 223, 237, 315, 445
- 1,1,1-trichloroethylene, 437
- Trigger finger, 178
- Triodyne, Inc., 66
- Trip
- bars, 376, 377
 - hazards, 157, 336
 - wires, 376, 377
- Triple rolling hitch, 485
- Tripping mechanism, 362
- Trouble light, 396, 457
- Trucks. *See* Forklift truck
- Truck selection, 337–339
- Tumbling machine, 376
- Tumors, malignant and benign, 539
- Tunnel(s), 165, 437
- Two-blocking hazards, 493
- Two-hand controls, 174, 379, 399
- Two-hand trips, 379, 400–403, 405
- Type A gate, 392, 395, 405
- Type B gate, 392, 393, 395, 405
- Type N canisters, 306
- UEL. *See* Upper explosive limit (UEL)**
- UL. *See* Underwriters' Laboratories (UL)
- Underhung cranes, 345
- Underwriters' Laboratories (UL), 321, 339
- Upper explosive limit (UEL), 271
- U.S.
- Air Force estimates of accident cost categories, 41
 - Bureau of Labor Statistics, 23
 - Constitution, 94
 - Court of Appeals, 216
 - Nuclear Regulatory Commission, 307
 - Senators, 56
 - Solicitor General, 216
 - Supreme Court, 94, 216
 - Transportation, Department of, 42, 282

- Valves, 56, 173, 284, 430, 431, 435-436**
 protection caps, 434
- Vapors, 213
 explosive, 280, 464, 467
- Variable air volume systems (VAV), 243
- Variances, 99
- Vats, 154, 268, 467
- VAV. *See* Variable air volume systems (VAV)
- Vehicle
 design for human performance, 173
 mounted platforms, 166
 rollovers, 498
 runovers, 498
- Ventilation, 236-242
- Vertical standard, 91-92
- Vibrations, as cave-in hazard, 502
- Vinyl chloride, 44, 74, 169, 211, 221, 222
- Violence. *See* Workplace violence
- Violence, workplace, 47-48
- Volatile, 228, 237, 268
- Volatile flammable solvents, 467
- Voluntary compliance, 11, 181, 203
- Voluntary Protection Program (VPP), 107
- VPP. *See* Voluntary Protection Program (VPP)
- Vulcanized, 489
- Walking and working surfaces, 151-162**
- Walking/working surface, 151-162
 dockboards, 162
 fixed ladders, 160-162
 floors and aisles, 154-159
 guarding open floors and platforms, 151
 ladders, 159-160
 stairways, 159
- Warehouse fires, 336
- Warning
 labels, 64
 properties, 306
 systems, 331
- Washing, 46, 130, 213, 315, 378
- Waste
 hazardous, 121, 124, 164
 receptacles, 169
 treatment, 127
- Water on the floor, 157
- Water spray, 331
- Weather, 62, 240, 325, 336, 434, 468
- Welding, 426-446. *See also* Arc welding
 welding: Gas welding
 arc welding hazards
 equipment design, 437
 grounding, 438
 operation, 438
 in a confined space (case study), 440
 eye protection, 441-442
 fires and explosions, 439-441
 hot work permits, 440-441
 gases and fumes, 443-446
 contaminant categories, 443-444
 hazard potentials, 445-446
 gas welding hazards, 430-437
 acetylene hazards, 430-432
 oxygen cylinders, 433-434
 service piping, 436-437
 torches and apparatus, 434-436
 process terminology, 426-430
 protective clothing, 442-443
 resistance welding hazards, 438-439
 guarding, 439
 shock hazards, 438-439
- sparks, 272
 substitution, reducing a hazard by (case study), 432
 welding torch safety (case study), 436
- Wet scrubbers, 242
- Williams-Steiger Occupational Safety and Health Act (1970), 88
- Willow Island nuclear tower collapse, 505
- Wire diameters, 464
- Wire fires, 464
- Wire rope
 components, 357
 gauging, 358
 lay, 357
 strands, 357
 wear, 356-358
- Wiring, 279-280, 459-461
- WMSD. *See* Workplace musculoskeletal disorders (WMSD)
- Wood, 121, 411
- Woodworking, 155, 242, 295
- Woollen clothing, 314
- Work envelope, 418-420
- Worker carelessness, 59
- Workers' compensation, 16-21
 cost of, 19
 fraud, 19
 prevention, 19
 state reforms for, categories of, 19
- Workmen's compensation laws, 17
- Workplace
 machines safety, 173
 musculoskeletal disorders, 176
 security, 145-146
 smoke-free, 44-45
 violence, 47-48
- Workplace musculoskeletal disorders (WMSDs), 176-179
 carpal tunnel syndrome, 176-177
 cumulative trauma disorders (CTDs), 177-178
 defined, 179
 historical progression of the recognition of, 179
 management programs, 182-184
 administration and support, 182
 case management, 183
 job analysis, 183
 job design and intervention, 183-184
 surveillance, 182-183
 musculoskeletal disorders, 178
 repetitive strain injuries (RSIs), 177
- Workplace violence, 47-48
- Work-practice controls, 46, 59, 236, 259
- Workrest, 406-408, 422
- Workstation, 195-201
- World Health Organization, 185
- World Trade Center attack, 143, 158
- Worst-case number, of flywheel rotations, 403
- Wrecking balls, 496, 508
- Wrench, 36, 431
- Wristlet assembly, 396, 397
- X rays, 260**
- Zero mechanical state, 375-376**
- Zinc, welding, 444, 445
- Z16.1 system, 21-22