

# MMWR

*Supplement*

MORBIDITY AND MORTALITY WEEKLY REPORT

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NIOSH  
Recommendations  
for  
Occupational Safety  
and  
Health Standards

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U.S. Department of Health and Human Services  
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## INTRODUCTION

Acting under the authority of the Occupational Safety and Health Act of 1970 (Public Law 91-596), the National Institute for Occupational Safety and Health (NIOSH) develops, and periodically revises, recommendations for limits of exposure to potentially hazardous substances or conditions in the workplace. It also recommends preventive measures designed to reduce or eliminate adverse health effects of these hazards. In formulating these recommendations, NIOSH evaluates all known and available scientific information relevant to the potential hazard. These recommendations are then published and transmitted to the Department of Labor, Occupational Safety and Health Administration (OSHA) for use in promulgating legal standards.

NIOSH recommendations are published in a variety of documents. Criteria Documents specify a NIOSH recommended exposure limit (REL) and appropriate preventive measures designed to reduce or eliminate adverse health effects. Special Hazard Reviews, Occupational Hazard Assessments, and Technical Guidelines are other types of documents published by NIOSH which complement the Institute's recommendations for standards. These documents provide assessments, from a safety and health standpoint, of specific problems associated with a given agent or hazard, and recommend control and surveillance methods.

Although these documents do not supplant the more comprehensive Criteria Document, they are prepared in such a way as to assist OSHA in the formulation of regulations. NIOSH also periodically presents testimony before various Congressional committees and at regulatory hearings convened by OSHA. The testimony presented always includes the current NIOSH policy concerning the particular hazard in question.

NIOSH also publishes documents known as Current Intelligence Bulletins (CIB) which review and evaluate emerging information on occupational hazards. Each CIB is based on rapid evaluation of new and changing information on a particular hazard in light of existing knowledge.

The *NIOSH Recommendations for Occupational Safety and Health Standards* is based on existing NIOSH policy as previously published in any of the forms listed above. The intent of this table is to provide, in rapid-reference form, the most recent NIOSH REL for each potential hazard. The current OSHA permissible exposure limit (PEL) is also presented. Unless otherwise noted in the table, the NIOSH recommendations were originally published in Criteria Documents.

**Note to Readers:**

Copies of NIOSH publications are generally available from the U.S. Government Printing Office and the National Technical Information Service. Single copies of these publications may be obtained (while the supply lasts) from:

Publications Dissemination  
 Division of Standards Development  
 and Technology Transfer  
 National Institute for Occupational Safety and Health  
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 Cincinnati, Ohio 45226  
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Please enclose a self-addressed mailing label with your request.

## Definitions of abbreviations and terms used in this publication:

Action level	the level of exposure at which certain provisions of the proposed standards must be initiated, such as periodic measurements of worker exposure, training of workers, and medical surveillance (if appropriate for the particular substance)
CFR	Code of Federal Regulations
CIB	Current Intelligence Bulletin
dBA	decibel, weighted according to the A scale, which approximates the response of the human ear
ECG	electrocardiogram
J/cm <sup>2</sup>	joules per square centimeter
μg/m <sup>3</sup>	micrograms per cubic meter
mg/m <sup>3</sup>	milligrams per cubic meter
mppcf	millions of particles per cubic foot
mW/cm <sup>2</sup>	milliwatts per square centimeter
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PEL	permissible exposure limit (OSHA)
ppb	parts per billion
ppm	parts per million
REL	recommended exposure limit (NIOSH)
(Skin)	potential contribution to overall exposure by the cutaneous route including mucous membranes and eyes
TWA	time-weighted average
WBGT	wet bulb globe temperature

**SUMMARY OF OSHA REGULATIONS AND NIOSH RECOMMENDATIONS  
FOR OCCUPATIONAL SAFETY AND HEALTH STANDARDS, 1985**

**NIOSH Recommendations**

<b>Potential Hazard*</b>	<b>OSHA Standard</b>	<b>NIOSH Recommended Exposure Limit (s)<sup>†</sup></b>	<b>Health Effect (s) Considered</b>	<b>Comments</b>
Acetylene (July 1976)	2,500 ppm (10% of lower explosive limit)	No exposure > 2,500 ppm (2,662 mg/m <sup>3</sup> )	Asphyxia	Employers to check for and inform workers of contaminants such as arsine and phosphine
Acrylamide (October 1976)	0.3 mg/m <sup>3</sup> , 8-hr TWA (Skin)	0.3 mg/m <sup>3</sup> TWA	Skin, eye, and nervous system effects	Skin and eye contact to be prevented
Acrylonitrile (September 1977; revised March 1978 as part of NIOSH testimony at OSHA hearing)	2 ppm, 8-hr TWA; 10 ppm ceiling (15 min) (Skin)	1 ppm 8-hr TWA; 10 ppm ceiling (15 min) (Skin)	Brain tumors; lung and bowel cancer	Chest X-ray required; first-aid and medical kits to be available during use; skin contact should be prevented
Aldrin/dieldrin (Special Hazard Review September 1978)	0.25 mg/m <sup>3</sup> , 8-hr TWA (Skin)	Lowest reliably detectable level; 0.15 mg/m <sup>3</sup> TWA by NIOSH-validated method	Cancer	Aldrin/dieldrin no longer produced in U.S.; skin contact to be prevented
Alkanes (C5-C8) (March 1977)	Pentane: 1,000 ppm (2,950 mg/m <sup>3</sup> ); n-hexane: 500 ppm (1,800 mg/m <sup>3</sup> ); n-heptane: 500 ppm (2,000 mg/m <sup>3</sup> ); octane: 500 ppm (2,350 mg/m <sup>3</sup> ), 8-hr TWA	All are TWA values: Pentane: 120 ppm (350 mg/m <sup>3</sup> ); hexane: 100 ppm (350 mg/m <sup>3</sup> ); heptane: 85 ppm (350 mg/m <sup>3</sup> ); octane: 75 ppm (350 mg/m <sup>3</sup> ) mixtures not to exceed 350 mg/m <sup>3</sup> TWA;	Skin and nervous system effects	Action level defined as 200 mg/m <sup>3</sup> for these substances

		All are ceiling values (15 min) singly or mixtures: pentane: 610 ppm (1,800 mg/m <sup>3</sup> ); hexane: 510 ppm (1,800 mg/m <sup>3</sup> ); heptane: 440 ppm (1,800 mg/m <sup>3</sup> ); octane: 385 ppm (1,800 mg/m <sup>3</sup> )		
Allyl chloride (September 1976)	1 ppm (3 mg/m <sup>3</sup> ), 8-hr TWA	1 ppm (3.1 mg/m <sup>3</sup> ) TWA; 3 ppm (9.3 mg/m <sup>3</sup> ) ceiling (15 min)	Liver, kidney, and lung effects	Urine, blood, and pulmonary function testing required
Ammonia (July 1974)	50 ppm (35 mg/m <sup>3</sup> ), 8-hr TWA	50 ppm (34.8 mg/m <sup>3</sup> ) ceiling (5 min)	Respiratory irritation	Eye contact should be prevented
Animal rendering processes (Occupational Hazard Assessment March 1981)	Existing OSHA PEL's or NIOSH REL's for specific hazards are applicable		Mechanical injury; burns; heat stress; infections from biologic agents; chemical hazards	Guidelines for engineering controls and work practices to reduce injury and illness presented
Antimony (September 1978)	0.5 mg/m <sup>3</sup> , 8-hr TWA	0.5 mg/m <sup>3</sup> TWA	Irritation; heart and lung effects	Chest X-ray, pulmonary function testing, and electrocardiogram required
Arsenic, inorganic (September 1974; revised June 1975; reaffirmed July 1982 as part of NIOSH testimony at OSHA hearing)	10 µg/m <sup>3</sup> , 8-hr TWA	2 µg As/m <sup>3</sup> ceiling (15 min)	Lung and lymphatic cancer; dermatitis	Chest X-ray required

\*Date recommendation was transmitted to OSHA is in parentheses.

†NIOSH TWA recommendations are based on exposures up to 10 hours unless otherwise noted.

NIOSH Recommendations

Potential Hazard*	OSHA Standard	NIOSH Recommended Exposure Limit(s) <sup>†</sup>	Health Effect(s) Considered	Comments
Arsine (CIB August 1979)	0.2 mg/m <sup>3</sup> (0.05 ppm), 8-hr TWA	2 µg As/m <sup>3</sup> ceiling (15 min)	Sudden extensive hemolysis	Workers to be warned of working with arsenic compounds in presence of freshly formed hydrogen
Asbestos (January 1972; revised September 1976; revised March 1984 as part of NIOSH testimony at Congressional hearing; reaffirmed June 1984 as NIOSH testimony at OSHA hearing)	2 million fibers/m <sup>3</sup> , over 5 µm in length, 8-hr TWA; 10 million fibers/m <sup>3</sup> ceiling	100,000 fibers/m <sup>3</sup> over 5 µm in length, 8-hr TWA in a 400 liter air sample	Asbestosis; lung cancer; mesothelioma	None
Asphalt fumes (September 1977)	See Coal-tar products	5 mg/m <sup>3</sup> ceiling measured as total particulate (15 min)	Eye and respiratory irritation	Medical surveillance required; skin contact to be prevented
Benzene (July 1974; revised August 1976; revised July 1977 as part of NIOSH testimony at OSHA hearing)	10 ppm, 8-hr TWA; 25 ppm acceptable ceiling; 50 ppm maximum ceiling (10 min)	1 ppm (3.2 mg/m <sup>3</sup> ) ceiling (60 min)	Blood changes including leukemia	Blood testing required

Benzidine-based dyes (Special Hazard Review November 1979; reaffirmed January 1983)	Not controlled as such	Reduce exposure to lowest feasible level; replace with less toxic materials	Cancer	Urine monitoring suggested
Benzoyl peroxide (June 1977)	5 mg/m <sup>3</sup> , 8-hr TWA	5 mg/m <sup>3</sup> TWA	Respiratory and eye irritation; skin effects	None
Benzyl chloride (August 1978)	5 mg/m <sup>3</sup> (1 ppm), 8-hr TWA	5 mg/m <sup>3</sup> ceiling (15 min)	Irritation; skin and eye effects	Chest X-ray and pulmonary function testing required
Beryllium (June 1972; revised August 1977 as part of NIOSH testimony at OSHA hearing)	2 µg/m <sup>3</sup> , 8-hr TWA; 5 µg/m <sup>3</sup> acceptable ceiling; 25 µg/m <sup>3</sup> maximum ceiling (30 min)	Not to exceed 0.5 µg/m <sup>3</sup>	Lung cancer	Pulmonary function testing, chest X-ray, and sputum cytology required
Boron trifluoride (December 1976)	1 ppm (3 mg/m <sup>3</sup> ) ceiling	No exposure limit recommended due to the absence of a reliable monitoring method	Respiratory effects	Appropriate engineering and work-practice controls to reduce exposure to lowest feasible level; pulmonary function testing required
1,3-Butadiene (CIB February 1984)	1,000 ppm (2,200 mg/m <sup>3</sup> ), 8-hr TWA	Reduce exposure to lowest feasible level	Cancer; teratogenicity; reproductive effects	Appropriate engineering and work-practice controls; restrict access to areas where 1,3-butadiene is used

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Potential Hazard*	OSHA Standard	NIOSH Recommendations		
		NIOSH Recommended Exposure Limit(s) <sup>†</sup>	Health Effect(s) Considered	Comments
Cadmium (August 1976; revised in CIB September 1984)	Fume: 0.1 mg/m <sup>3</sup> , 8-hr TWA; 0.3 mg/m <sup>3</sup> ceiling; dust: 0.2 mg/m <sup>3</sup> , 8-hr TWA; 0.6 mg/m <sup>3</sup> ceiling	Reduce exposure to lowest feasible level	Lung cancer	None
Carbaryl (September 1976)	5 mg/m <sup>3</sup> , 8-hr TWA	5 mg/m <sup>3</sup> TWA	Central nervous system and reproductive system effects	Workers to be warned of possible effects on reproductive system and to have only minimum exposure during pregnancy; skin and eye contact to be prevented
Carbon black (September 1978)	3.5 mg/m <sup>3</sup> , 8-hr TWA	3.5 mg/m <sup>3</sup> TWA; 0.1 mg/m <sup>3</sup> TWA in presence of polycyclic aromatic hydrocarbons	Lung, heart, and skin effects; cancer	Chest X-rays, pulmonary function testing, ECG, and sputum cytology required
Carbon dioxide (August 1976)	5,000 ppm (9,000 mg/m <sup>3</sup> ), 8-hr TWA	10,000 ppm (18,000 mg/m <sup>3</sup> ) TWA; 30,000 ppm (54,000 mg/m <sup>3</sup> ) ceiling (10 min)	Respiratory effects	None
Carbon disulfide (May 1977)	20 ppm, 8-hr TWA; 30 ppm acceptable ceiling; 100 ppm maximum ceiling (30 min)	1 ppm (3 mg/m <sup>3</sup> ) TWA; 10 ppm (30 mg/m <sup>3</sup> ) ceiling (15 min)	Heart, central nervous system, and reproductive system effects	Workers to be advised of potential effects on reproductive system
Carbon monoxide (August 1972)	50 ppm (55 mg/m <sup>3</sup> ), 8-hr TWA	35 ppm (40 mg/m <sup>3</sup> ), 8-hr TWA; 200 ppm (229 mg/m <sup>3</sup> ) ceiling (No minimum time)	Heart effects	None
Carbon tetrachloride (December 1975; revised June 1976)	10 ppm, 8-hr TWA; 25 ppm acceptable ceiling; 200 ppm maximum ceiling (5 min in 4 hr)	2 ppm (12.6 mg/m <sup>3</sup> ) ceiling 45 liter sample (60 min)	Liver cancer	Recommended standard based on lower limit of detection

Chlorine (May 1976)	1 ppm (3 mg/m <sup>3</sup> ) ceiling	0.5 ppm (1.45 mg/m <sup>3</sup> ) ceiling (15 min)	Eye and respiratory irritation	Chest X-rays required
Chloroform (September 1974; revised June 1976)	50 ppm (240 mg/m <sup>3</sup> ) ceiling	2 ppm (9.78 mg/m <sup>3</sup> ) ceiling 45 liter sample (60 min)	Liver or kidney tumors and central nervous system effects	None
Chloroprene (August 1977)	25 ppm (90 mg/m <sup>3</sup> ), 8-hr TWA	1 ppm (3.6 mg/m <sup>3</sup> ) ceiling (15 min)	Reproductive effects; potential for cancer	Chest X-ray and pulmonary function testing required; pregnant workers to be counseled about continuing work with chloroprene
Chromic acid (July 1973; revised—see Chromium (VI), December 1975)	1 mg/10 m <sup>3</sup> ceiling	25 µg/m <sup>3</sup> TWA; 50 µg/m <sup>3</sup> ceiling (15 min) as noncarcinogenic Cr (VI)	Nasal ulceration	None
Chromium (VI) (December 1975)	100 µg chromates/m <sup>3</sup> ceiling	Carcinogenic Cr (VI): 1 µg/m <sup>3</sup> TWA; other Cr (VI): 25 µg/m <sup>3</sup> TWA; 50 µg/m <sup>3</sup> ceiling (15 min)	Lung cancer; skin ulcers; and lung irritation	Employer must demonstrate absence of carcinogenic Cr (VI); X-ray required
Chrysene (Special Hazard Review June 1978)	None	To be controlled as an occupational carcinogen	Cancer	Document also contains control recommendations for polycyclic aromatic hydrocarbons
Coal gasification plants (September 1978)	OSHA PEL's or NIOSH REL's for specific hazards are applicable		Various effects depending on substances present; carcinogenic potential	Extensive work-practice and control procedures recommended

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Potential Hazard*	OSHA Standard	NIOSH Recommendations		
		NIOSH Recommended Exposure Limit(s) <sup>†</sup>	Health Effect(s) Considered	Comments
Coal liquefaction, volumes I and II (Occupational Hazard Assessment June 1981)	OSHA PEL's or NIOSH REL's for specific hazards are applicable		Various effects depending on substances present; carcinogenic potential	Extensive work-practice and control procedures recommended
Coal-tar products (September 1977)	0.2 mg/m <sup>3</sup> , 8-hr TWA (benzene-soluble fraction)	0.1 mg/m <sup>3</sup> TWA (cyclohexane-extractable fraction)	Lung and skin cancer	Includes coal tar, creosote, and coal-tar pitch; pulmonary function testing and chest X-rays required
Cobalt (Occupational Hazard Assessment November 1981)	0.1 mg/m <sup>3</sup> , 8-hr TWA	NIOSH has concluded that there is insufficient evidence to warrant recommending a new exposure limit	Dermatitis; potential for pulmonary fibrosis	Includes recommendations for engineering controls, work practices, protective equipment, worker education, monitoring, and medical surveillance
Coke oven emissions (February 1973; revised November 1975 as part of NIOSH testimony at OSHA hearing)	150 µg/m <sup>3</sup> , 8-hr TWA	0.5-0.7 mg/m <sup>3</sup> (total particulates) as screening level	Lung cancer	Sputum cytology and chest X-ray required; work practices to minimize exposure to emissions

Confined spaces, working in (December 1979)	Covered under numerous OSHA regulations for General Industry (29 CFR 1910)	Various recommendations including a permit system to prevent worker injury and death	Injury and death	None
Cotton dust (September 1974; reaffirmed September 1983 as part of NIOSH testimony at OSHA hearing)	Yarn manufacturing: 200 $\mu\text{g}/\text{m}^3$ , 8-hr TWA; slashing and weaving operations: 750 $\mu\text{g}/\text{m}^3$ , 8-hr TWA; all other operations: 500 $\mu\text{g}/\text{m}^3$ , 8-hr TWA	200 $\mu\text{g}/\text{m}^3$ lint-free cotton dust	Pulmonary disease (byssinosis)	Pulmonary function testing required
Cresol (February 1978)	5 ppm (22 $\text{mg}/\text{m}^3$ ), 8-hr TWA (Skin)	2.3 ppm (10 $\text{mg}/\text{m}^3$ ) TWA	Skin, liver, kidney, and pancreas effects	Applies to mixtures of cresols and cresylic acid; skin and eye contact to be prevented; possible delayed effects
Cyanide, hydrogen and cyanide salts (March 1977)	Hydrogen cyanide: 10 ppm (11 $\text{mg}/\text{m}^3$ ), 8-hr TWA (Skin); cyanide: 5 $\text{mg}/\text{m}^3$ , 8-hr TWA (Skin)	4.7 ppm (5 $\text{mg}/\text{m}^3$ ) ceiling (10 min)	Thyroid; blood; respiratory system effects	Concurrent measurement required for HCN when measuring for cyanide salt; trained first-aid personnel and first-aid kits to be available during use; skin and eye contact to be prevented
DDT (Special Hazard Review September 1978)	1 $\text{mg}/\text{m}^3$ , 8-hr TWA (Skin)	Lowest reliably detectable level; 0.5 $\text{mg}/\text{m}^3$ TWA by NIOSH-validated method	Cancer	Skin contact to be prevented

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## NIOSH Recommendations

Potential Hazard*	OSHA Standard	NIOSH Recommended Exposure Limit (s) <sup>†</sup>	Health Effect(s) Considered	Comments
2,4-Diaminoanisole and its salts (CIB January 1978)	None	Reduce exposure to lowest feasible level	Cancer	Skin contact to be prevented; engineering and work-practice controls are recommended
Dibromochloropropane (September 1977)	1 ppb, 8-hr TWA; eye and skin contact to be avoided	10 ppb (0.1 mg/m <sup>3</sup> ) TWA	Sterility; renal and liver effects	Workers to be warned of reproductive system abnormalities, including sterility
Di-2-Ethylhexyl phthalate (DEHP) (Special Hazard Review March 1983)	5 mg/m <sup>3</sup> , 8-hr TWA	Reduce exposure to lowest feasible level	Cancer	DEHP, widely used in the quantitative fit testing of respirators, should be replaced with less toxic material such as refined corn oil
Diisocyanates (September 1978)	Toluene diisocyanate (TDI): 0.02 ppm (0.14 mg/m <sup>3</sup> ) ceiling; diphenylmethane diisocyanate (MDI): 0.02 ppm (0.2 mg/m <sup>3</sup> ) ceiling	Each equivalent to 5 ppb TWA and 20 ppb ceiling. All values given in µg/m <sup>3</sup> and all ceiling values for 10 min: TDI: 35 TWA, 140 ceiling; MDI: 50 TWA, 200 ceiling; hexamethylene diisocyanate (HDI): 35 TWA, 140 ceiling; naphthalene diisocyanate (NDI): 40 TWA, 170 ceiling; isophorone diisocyanate (IPDI): 45 TWA, 180 ceiling; dicyclohexylmethane 4,4'-diisocyanate (hydrogenated MDI): 55 TWA, 210 ceiling; other diisocyanates also to be controlled to 20 ppb ceiling and 5 ppb TWA	Respiratory effects and sensitization; irritation	Chest X-ray and pulmonary function testing required

Dinitro-ortho-cresol (February 1978)	0.2 mg/m <sup>3</sup> , 8-hr TWA (Skin)	0.2 mg/m <sup>3</sup> TWA	central nervous system and metabolic effects	Blood and urine monitoring required; skin and eye contact should be prevented; possible delayed effects
Dinitro-toluene (CIB July 1985)	1.5 mg/m <sup>3</sup> 8-hr TWA (Skin)	Reduce exposure to lowest feasible level	Cancer; potential for reproductive effects	Skin contact to be prevented
Dioxane (September 1977)	100 ppm (360 mg/m <sup>3</sup> ), 8-hr TWA (Skin)	1 ppm (3.6 mg/m <sup>3</sup> ) ceiling (30 min)	Cancer; liver and kidney effects	Blood and urine testing required; skin contact should be prevented
Dioxin (CIB January 1984)	None	Reduce exposure to lowest feasible level	Cancer; chloracne	None
Elevated workstations, emergency egress from (December 1975)	Sections under Subpart E, Means of Egress, General Industry Standards, and Subpart R, Special Industries (29 CFR 1910.261)	Various recommendations concerning means and availability of egress	Trauma and injury	None
Epichlorohydrin (September 1976; revised in CIB October 1978)	5 ppm (19 mg/m <sup>3</sup> ), 8-hr TWA	Minimize occupational exposure	Cancer; mutagenesis; reproductive effects; skin, kidney, liver, and respiratory effects	Skin contact should be prevented

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**NIOSH Recommendations**


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Potential Hazard*	OSHA Standard	NIOSH Recommended Exposure Limit (s) <sup>†</sup>	Health Effect(s) Considered	Comments
Ethylene dibromide (August 1977; revised November 1983; reaffirmed February 1984 as part of NIOSH testimony at OSHA hearing)	20 ppm, 8-hr TWA; 30 ppm acceptable ceiling; 50 ppm maximum peak (5 min)	0.045 ppm (0.38 mg/m <sup>3</sup> ), 8-hr TWA; 0.13 ppm (1 mg/m <sup>3</sup> ) ceiling (15 min)	Cancer; mutagenesis; damage to skin, eyes, heart, liver, spleen, and respiratory and central nervous systems	Workers to be warned of potential reproductive abnormalities and cancer; hazardous liquid; contact to be prevented
Ethylene dichloride (March 1976; revised in CIB April 1978; revised September 1978)	50 ppm, 8-hr TWA; 100 ppm acceptable ceiling; 200 ppm maximum ceiling (5 min in 3 hr)	1 ppm (4 mg/m <sup>3</sup> ) TWA; 2 ppm (8 mg/m <sup>3</sup> ) ceiling (15 min)	Cancer; nervous system, respiratory, heart, and liver effects	Nursing infants of exposed mothers at risk
Ethylene oxide (Special Hazard Review September 1977; revised July 1983 as part of NIOSH testimony at OSHA hearing)	1 ppm (1.8 mg/m <sup>3</sup> ), 8-hr TWA	< 0.1 ppm (0.18 mg/m <sup>3</sup> ), 8-hr TWA; 5 ppm (9 mg/m <sup>3</sup> ) ceiling (10 min/day)	Cancer; mutagenesis; reproductive effects	Blood monitoring and medical counseling recommended
Ethylene thiourea (Special Hazard Review October 1978)	None	Should be used in encapsulated form in industry; worker exposure to be minimized	Carcinogenesis and teratogenesis	Workers to be informed of carcinogenic and teratogenic hazards; special attention to be given to thyroid function tests

Excavations, development of draft construction safety standards for (Technical Guideline May 1983)	Many aspects covered under OSHA regulations governing excavations, trenching, and shoring practices in the construction industry (29 CFR 1926, Subpart P)	Many work-practice recommendations concerning safety standards for excavations	Injury and death	None
Fibrous glass (April 1977)	15 mg/m <sup>3</sup> total dust; 5 mg/m <sup>3</sup> respirable fraction (nuisance dust)	3 million fibers/m <sup>3</sup> TWA (fibers $\leq$ 3.5 $\mu$ m diameter and $\geq$ 10 $\mu$ m length); 5 mg/m <sup>3</sup> TWA (total fibrous glass)	Eye, skin, and respiratory effects	NIOSH recommends that this limit also apply to other manmade fibers
Fluorides, inorganic (June 1975)	2.5 mg/m <sup>3</sup> , 8-hr TWA	2.5 mg F/m <sup>3</sup> TWA	Kidney and bone effects	Urine monitoring required
Fluorocarbon polymers, decomposition products (September 1977)	None	Various recommendations emphasizing good work practices, engineering controls, and medical management	Lung effects; polymer fume fever	Workroom air to be monitored for inorganic fluorides and hydrogen fluoride
Formaldehyde (December 1976; revised in CIB April 1981)	3 ppm, 8-hr TWA; 5 ppm acceptable ceiling; 10 ppm maximum ceiling (30 min)	Minimize workplace exposure levels; limit exposure to lowest feasible level	Cancer	Medical surveillance; skin protection
Furfuryl alcohol (March 1979)	50 ppm (200 mg/m <sup>3</sup> ), 8-hr TWA	50 ppm (200 mg/m <sup>3</sup> ) TWA	Respiratory effects	None

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**NIOSH Recommendations**


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Potential Hazard*	OSHA Standard	NIOSH Recommended Exposure Limit (s) <sup>†</sup>	Health Effect(s) Considered	Comments
Glycidyl ethers (June 1978; revised in CIB October 1978)	All values in ppm (mg/m <sup>3</sup> ): allyl glycidyl ether (AGE): 10 (45) ceiling; n-butyl glycidyl ether (BGE): 50 (270), 8-hr TWA; di-2,3-epoxypropyl ether (DGE): 0.5 (2.8), 8-hr TWA; isopropyl glycidyl ether (IGE): 50 (240), 8-hr TWA; phenyl glycidyl ether (PGE): 10 (60), 8-hr TWA	All are ceiling values (15 min) in ppm (mg/m <sup>3</sup> ): AGE: 9.6 (45) BGE: 4.4 (30) DGE: 0.2 (1) IGE: 50 (240) PGE: 1 (5)	Cancer for DGE; skin and mucous membrane effects; sensitization potential; tumorigenesis and mutagenesis; possible hemopoietic and reproductive effects	Possible additive effects with mixtures; medical surveillance
Glycol ethers (CIB May 1983)	2-Methoxyethanol: 25 ppm (80 mg/m <sup>3</sup> ), 8-hr TWA (Skin); 2-Ethoxyethanol: 200 ppm (740 mg/m <sup>3</sup> ), 8-hr TWA (Skin)	Reduce exposure to lowest feasible level	Reproductive effects; teratogenicity	Skin contact to be prevented
Grain elevators and feed mills, occupational safety in (Technical Guideline September 1983; reaffirmed June 1984 as part of NIOSH testimony at OSHA hearing)	Many general aspects (e.g., protective equipment, dust control, etc.) covered under the numerous OSHA regulations for General Industry (29 CFR 1910)	Various recommendations for control of combustible dusts and ignition sources, machine guarding, isolation and lockouts, bin entry, training, and personal protective equipment	Injury and death	Health hazards from exposure to fumigants, pesticides, and grain dust
Hexachloroethane (CIB August 1978)	1 ppm (10 mg/m <sup>3</sup> ), 8-hr TWA (Skin)	Reduce exposure to lowest feasible level	Cancer	None

Hot environments (June 1972)	None	Action levels: 79°F WBGT (men) 76°F WBGT (women); sliding-scale limits for unimpaired mental function	Heat-induced illnesses	Recommendations include acclimatization, strict work practices, and protective equipment
Hydrazines (June 1978)	All values in ppm (mg/m <sup>3</sup> ): hydrazine: 1 (1.3), 8-hr TWA; 1,1-dimethylhydrazine: 0.5 (1.0), 8-hr TWA; phenyl hydrazine: 5 (22), 8-hr TWA; methyl hydrazine: 0.2 (0.35) ceiling	All are ceiling values (120 min) in ppm (mg/m <sup>3</sup> ): hydrazine: 0.03 (0.04); 1,1-dimethylhydrazine: 0.06 (0.15); phenyl hydrazine: 0.14 (0.6); methyl hydrazine: 0.04 (0.08)	Liver, blood, eye, and skin effects; cancer	Blood and urine monitoring and chest X-ray required; bowel examination for some workers
Hydrogen fluoride (March 1976)	3 ppm, 8-hr TWA	3 ppm (2.5 mg F/m <sup>3</sup> ) TWA; 6 ppm (5.0 mg F/m <sup>3</sup> ) ceiling (15 min)	Skin, eye, and airway irritation; bone effects	Pelvic X-ray (male workers only) and urine testing required
Hydrogen sulfide (May 1977)	20 ppm acceptable ceiling; 50 ppm maximum ceiling (10 min)	10 ppm (15 mg/m <sup>3</sup> ) ceiling (10 min)	Irritation; severe acute effects involving nervous and respiratory systems	Continuous monitoring required if potential exists for exposure to $\geq 70$ mg/m <sup>3</sup> ; evacuation required at this level
Hydroquinone (April 1978)	2 mg/m <sup>3</sup> , 8-hr TWA	0.44 ppm (2 mg/m <sup>3</sup> ) ceiling (15 min)	Eye and skin effects	Special provisions for darkroom use
Identification system for occupationally hazardous materials (December 1974)	Sections of Hazard Communication and Carcinogen Standards may be applicable	Complete designation system for occupationally hazardous materials	None	Includes definition, safety data sheets, alert symbols, and label statements
Isopropyl alcohol (March 1976)	400 ppm (980 mg/m <sup>3</sup> ), 8-hr TWA	400 ppm (984 mg/m <sup>3</sup> ) TWA; 800 ppm (1,968 mg/m <sup>3</sup> ) ceiling (15 min)	Mucous membrane irritation; possible cancer threat in manufacturing process	More stringent work practices and medical surveillance required for manufacturing workers

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## NIOSH Recommendations

Potential Hazard*	OSHA Standard	NIOSH Recommended Exposure Limit (s) <sup>†</sup>	Health Effect(s) Considered	Comments
Kepone (January 1976)	None	1 $\mu\text{g}/\text{m}^3$ TWA	Nervous system effects; liver cancer	Liver function testing required
Ketones (June 1978)	All are 8-hr TWA values in ppm ( $\text{mg}/\text{m}^3$ ): acetone: 1,000 (2,400); methyl ethyl ketone: 200 (590); methyl n-propyl ketone: 200 (700); methyl n-butyl ketone: 100 (410); methyl n-amyl ketone: 100 (465); methyl isobutyl ketone: 100 (410); methyl isoamyl ketone: none; diisobutyl ketone: 50 (290); cyclohexanone: 50 (200); mesityl oxide: 25 (100); diacetone alcohol: 50 (240); isophorone: 25 (140)	All are TWA values in ppm ( $\text{mg}/\text{m}^3$ ): acetone: 250 (590); methyl ethyl ketone: 200 (590); methyl n-propyl ketone: 150 (530); methyl n-butyl ketone: 1 (4); methyl n-amyl ketone: 100 (465); methyl isobutyl ketone: 50 (200); methyl isoamyl ketone: 50 (230); diisobutyl ketone: 25 (140); cyclohexanone: 25 (100); mesityl oxide: 10 (40); diacetone alcohol: 50 (240); isophorone: 4 (23)	Irritation; liver, kidney, and nervous system effects	Urinalysis required; workers exposed to methyl n-butyl ketone to be warned of nervous system effects
Land-based oil and gas well drilling, comprehensive safety recommendations for (Technical Guideline September 1983; reaffirmed March 1984 as part of NIOSH testimony at OSHA hearing)	Many aspects covered under the numerous OSHA regulations for General Industry (29 CFR 1910)	Various recommendations for safe work practices and technologic improvements	Injury and death	Many tasks, types of equipment, and conditions are not covered by existing regulations

Lead, inorganic (January 1973; revised May 1978)	50 $\mu\text{g}/\text{m}^3$ , 8-hr TWA; over 8-hr exposure to be determined by formula	< 100 $\mu\text{g}/\text{m}^3$ TWA; air level to be maintained so that worker blood lead remains $\leq 60 \mu\text{g}/100\text{g}$	Kidney, blood, and nervous system effects	Blood monitoring required
Lockout/tagout, guidelines for controlling hazardous energy during maintenance and servicing (Technical Guideline September 1983)	Many aspects covered under OSHA regulations for General Industry (29 CFR 1910) and construction standards (29 CFR 1926)	Work-practice recommendations for controlling hazardous energy during maintenance and servicing activities	Injury and death	"Energy" defined in this document as kinetic energy, potential energy, electrical energy, and thermal energy
Logging from felling to first haul (July 1976)	None	Extensive work-practice and personal protection recommendations	Primarily trauma and falls	Immunization and first-aid programs to be instituted
Malathion (June 1976)	15 $\text{mg}/\text{m}^3$ , 8-hr TWA	15 $\text{mg}/\text{m}^3$ TWA	Nervous system effects	Skin contact to be prevented; blood monitoring required
Mercury, inorganic (August 1973)	0.1 $\text{mg}/\text{m}^3$ acceptable ceiling	0.05 $\text{mg}/\text{m}^3$ , 8-hr TWA	Central nervous system and mental effects	Work practices, sanitation, monitoring, and medical surveillance emphasized
Methyl alcohol (March 1976)	200 ppm (260 $\text{mg}/\text{m}^3$ ), 8-hr TWA	200 ppm (262 $\text{mg}/\text{m}^3$ ), TWA; 800 ppm (1,048 $\text{mg}/\text{m}^3$ ) ceiling (15 min)	Blindness; metabolic acidosis	None
Methyl parathion (September 1976)	None	0.2 $\text{mg}/\text{m}^3$ TWA	Nervous system effects	Skin contact to be prevented; blood monitoring required

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## NIOSH Recommendations

Potential Hazard*	OSHA Standard	NIOSH Recommended Exposure Limit(s) <sup>†</sup>	Health Effect(s) Considered	Comments
4,4'-Methylenebis (2-chloroaniline) (Special Hazard Review September 1978)	Standard formally revoked by OSHA, August 1975	3 $\mu\text{g}/\text{m}^3$ TWA (lowest detectable level)	Cancer	Chest X-ray; blood and urine testing required
Methylene chloride (March 1976)	500 ppm, 8-hr TWA; 1,000 ppm acceptable ceiling; 2,000 ppm acceptable maximum peak for 5 minutes in any 2-hr period above the acceptable ceiling for an 8-hr shift	75 ppm (261 $\text{mg}/\text{m}^3$ ) TWA; 500 ppm (1,740 $\text{mg}/\text{m}^3$ ) ceiling (15 min) to be lowered in presence of carbon monoxide	Central nervous system effects; carbon monoxide toxicity	Blood monitoring required
Monohalo-methanes (CIB September 1984)	Methyl chloride: 100 ppm, 8-hr TWA; 200 ppm ceiling; 300 ppm acceptable maximum peak for 5 minutes in any 3-hr period above the acceptable ceiling for an 8-hr shift; methyl bromide: 20 ppm (80 $\text{mg}/\text{m}^3$ ) ceiling (Skin); methyl iodide: 5 ppm (28 $\text{mg}/\text{m}^3$ ), 8-hr TWA (Skin)	Exposure to methyl chloride, methyl bromide, and methyl iodide should be reduced to the lowest feasible level	Cancer; for methyl chloride: cancer and teratogenicity	None
Niax® Catalyst ESN (Joint NIOSH/ OSHA CIB May 1978)	OSHA and NIOSH recommend that exposure to Niax® Catalyst ESN and its components, dimethylaminopropionitrile and bis [2-(demethylamino)ethyl] ether, be minimized		Urological disorders; nervous system effects	Work-practice and engineering controls to reduce exposure

Nickel carbonyl (Special Hazard Review May 1977)	1 ppb ( $7 \mu\text{g}/\text{m}^3$ ), 8-hr TWA	1 ppb ( $7 \mu\text{g}/\text{m}^3$ ) TWA (least detectable level)	Cancer	Chest X-ray, pulmonary function testing, and urine monitoring required
Nickel, inorganic compounds (May 1977)	1 $\text{mg}/\text{m}^3$ , 8-hr TWA	15 $\mu\text{g Ni}/\text{m}^3$ TWA	Skin effects; lung and nasal cancer	Chest X-ray and pulmonary function testing required
Nitric acid (March 1976)	2 ppm ( $5 \text{ mg}/\text{m}^3$ ), 8-hr TWA	2 ppm ( $5 \text{ mg}/\text{m}^3$ ) TWA	Dental erosion; nasal/lung irritation	Skin and eye contact to be prevented; chest X-ray required
Nitriles (September 1978)	Acetonitrile: 40 ppm ( $70 \text{ mg}/\text{m}^3$ ), 8-hr TWA; tetramethyl succinonitrile: 0.5 ppm ( $3 \text{ mg}/\text{m}^3$ ), 8-hr TWA (Skin)	All are TWA values in ppm ( $\text{mg}/\text{m}^3$ ): acetonitrile: 20 (34); n-butyronitrile: 8 (22); isobutyronitrile: 8 (22); propionitrile: 6 (14); malononitrile: 3 (8); adiponitrile: 4 (18); succinonitrile: 6 (20). All ceiling values (15 min) in ppm ( $\text{mg}/\text{m}^3$ ): acetone cyanohydrin: 1 (4); glycolonitrile: 2 (5); tetramethyl succinonitrile: 1 (6). When present as mixtures or with other sources of cyanide, exposure to be considered additive and environmental limit to be calculated	Hepatic, renal, respiratory, cardiovascular, gastrointestinal, and nervous system effects	Chest X-ray and pulmonary function testing required; trained personnel and first-aid kits to be available during use; skin and eye contact to be prevented

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## NIOSH Recommendations

Potential Hazard*	OSHA Standard	NIOSH Recommended Exposure Limit (s) <sup>†</sup>	Health Effect(s) Considered	Comments
Nitrogen oxides (March 1976)	NO <sub>2</sub> : 5 ppm (9 mg/m <sup>3</sup> ) ceiling; NO: 25 ppm (30 mg/m <sup>3</sup> ), 8-hr TWA	NO <sub>2</sub> : 1 ppm (1.8 mg/m <sup>3</sup> ) ceiling (15 min); NO: 25 ppm (30 mg/m <sup>3</sup> ) TWA	Respiratory effects; blood effects	Pulmonary function testing required
Nitroglycerin and ethylene glycol dinitrate (EGDN) (June 1978)	Nitroglycerin: 2 mg/m <sup>3</sup> , (0.2 ppm) ceiling (Skin); EGDN: 1 mg/m <sup>3</sup> (0.2 ppm) ceiling (Skin)	0.1 mg/m <sup>3</sup> ceiling (20 min) recommended limit for either substance alone or mixtures	Circulatory system effects	Skin contact to be prevented
2-Nitronaphthalene (CIB December 1976)	None	Reduce exposure to lowest feasible level	Cancer	Compound metabolizes to beta-naphthylamine, a known carcinogen
2-Nitropropane (CIB April 1977; revised October 1980 in Joint OSHA/NIOSH Health Hazard Alert)	25 ppm (90 mg/m <sup>3</sup> ), 8-hr TWA	Reduce exposure to lowest feasible level	Cancer	Medical monitoring with specific emphasis on liver function tests
Noise (August 1972)	90 dBA, 8-hr TWA	85 dBA TWA; 115 dBA ceiling	Hearing damage	None
Organotin compounds (November 1976)	0.1 mg tin/m <sup>3</sup> , 8-hr TWA	0.1 mg tin/m <sup>3</sup> TWA	Eye, skin, liver, nervous system, and heart effects	Chest X-ray, blood and urine monitoring, eye tests, heart examination, and nervous system testing required; skin and eye contact to be prevented

Paint and allied coating products, manufacture of (September 1984)	Many aspects covered under the numerous OSHA regulations for General Industry (29 CFR 1910)	Various recommendations for the handling of raw materials and finished products; dispersion of pigment or resin particles; thinning, tinting, and shading; filling; and laboratory functions	Injury and a wide range of toxicities considered	Paint and allied coating products include paints, varnishes, lacquers, stains, putties, and paint and varnish removers
Parathion (June 1976)	0.1 mg/m <sup>3</sup> , 8-hr TWA (Skin)	0.05 mg/m <sup>3</sup> TWA	Nervous system effects	Skin contact to be prevented; blood monitoring required
Pesticide manufacturing and formulation (July 1978)	Current OSHA PEL's or previous NIOSH REL's to be followed; stringent work-practice and medical surveillance requirements to be instituted. Pesticides considered in groups based on toxicity		Wide range of toxicities considered; nervous and reproductive system effects; cancer	Blood monitoring required for some groups; workers to be warned of reproductive effects for some compounds; skin contact to be prevented
Phenol (July 1976)	5 ppm (19 mg/m <sup>3</sup> ), 8-hr TWA (Skin)	5.2 ppm (20 mg/m <sup>3</sup> ) TWA; 15.6 ppm (60 mg/m <sup>3</sup> ) ceiling (15 min)	Skin, eye, central nervous system, liver, and kidney effects	Skin and eye contact to be prevented
Phenyl-beta-naphthylamine (CIB December 1976)	None	Reduce exposure to lowest feasible level	Cancer	Compound metabolizes to beta-naphthylamine, a known carcinogen
Phosgene (February 1976)	0.1 ppm (0.4 mg/m <sup>3</sup> ), 8-hr TWA	0.1 ppm (0.4 mg/m <sup>3</sup> ) TWA; 0.2 ppm (0.8 mg/m <sup>3</sup> ) ceiling (15 min)	Respiratory effects	Pulmonary function testing and X-ray required
Polychlorinated biphenyls (September 1977)	42% chlorine: 1 mg/m <sup>3</sup> , 8-hr TWA; 54% chlorine: 0.5 mg/m <sup>3</sup> , 8-hr TWA	1 µg/m <sup>3</sup> TWA	Cancer; skin, liver, and reproductive effects	Blood testing required; women workers of child-bearing age and nursing mothers to be warned of potential adverse effects

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## NIOSH Recommendations

Potential Hazard*	OSHA Standard	NIOSH Recommended Exposure Limit (s)†	Health Effect(s) Considered	Comments
Precast concrete products industry, comprehensive safety recommendations for (Technical Guideline June 1984)	Many aspects covered under the numerous OSHA regulations for General Industry (29 CFR 1910)	Various recommendations for safe work practices and worker training	Injury and death	Equipment, conditions, and many of the tasks specific to the industry are not covered under the existing regulations
Refined petroleum solvent (July 1977)	2,900 mg/m <sup>3</sup> (500 ppm), 8-hr TWA (Stoddard solvent)	Kerosene 100 mg/m <sup>3</sup> TWA; all other solvents: 350 mg/m <sup>3</sup> TWA; 1,800 mg/m <sup>3</sup> ceiling (15 min)	Skin, lung, and nerve irritation	Blood and urine monitoring required; action level for petroleum ether, rubber solvent, naphtha: 200 mg/m <sup>3</sup> TWA; action level for mineral spirits and Stoddard solvent: 350 mg/m <sup>3</sup> TWA; action level for kerosene: 100 mg/m <sup>3</sup> TWA; skin contact to be prevented
Silica, crystalline (November 1974)	250/%SiO <sub>2</sub> +5 in mppcf, or 10 mg/m <sup>3</sup> /%SiO <sub>2</sub> +2 (respirable quartz)	50 μg/m <sup>3</sup> TWA, respirable free silica	Chronic lung disease (silicosis)	X-ray, pulmonary function testing required
Sodium hydroxide (September 1975)	2 mg/m <sup>3</sup> , 8-hr TWA	2 mg/m <sup>3</sup> ceiling (15 min)	Respiratory irritation	Skin and eye contact to be prevented
Styrene (September 1983)	100 ppm, 8-hr TWA; 200 ppm acceptable ceiling; 600 ppm maximum ceiling (5 min in 3 hr)	50 ppm (213 mg/m <sup>3</sup> ) TWA; 100 ppm (426 mg/m <sup>3</sup> ) ceiling	Nervous system effects; eye and respiratory system irritation	Action level set at 25 ppm; skin contact to be prevented; workers to be warned of possible adverse reproductive effects

Sulfur dioxide (February 1974; revised May 1977 as part of NIOSH testimony at OSHA hearing)	5 ppm (13 mg/m <sup>3</sup> ), 8-hr TWA	0.5 ppm (1.3 mg/m <sup>3</sup> ) TWA	Respiratory effects	Pulmonary function testing required
Sulfuric acid (June 1974)	1 mg/m <sup>3</sup> , 8-hr TWA	1 mg/m <sup>3</sup> TWA	Pulmonary irritation	Skin and eye contact to be prevented
1,1,2,2-Tetra- chloroethane (December 1976; revised in CIB August 1978)	5 ppm (35 mg/m <sup>3</sup> ), 8-hr TWA (Skin)	Reduce exposure to lowest feasible level	Cancer; liver, gastro- intestinal, and nervous system effects	Skin contact to be prevented; blood monitoring required
Tetrachloro- ethylene (July 1976; revised January 1978 in CIB)	100 ppm, 8-hr TWA; 200 ppm acceptable maximum ceiling; 300 ppm maximum ceiling (5 min in 3 hr)	Minimize workplace exposure levels; limit number of workers exposed	Cancer	None

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Potential Hazard*	OSHA Standard	NIOSH Recommendations		
		NIOSH Recommended Exposure Limit(s) <sup>†</sup>	Health Effect(s) Considered	Comments
Thiols: n-alkane mono, cyclohexane, and benzene (September 1978)	Butylmercaptan: 10 ppm (35 mg/m <sup>3</sup> ), 8-hr TWA; ethylmercaptan: 10 ppm (25 mg/m <sup>3</sup> ) ceiling; methylmercaptan: 10 ppm (20 mg/m <sup>3</sup> ) ceiling	All values in ppm (mg/m <sup>3</sup> ), ceilings 15 min: 1-methanethiol: 0.5 (1.0); 1-ethanethiol: 0.5 (1.3); 1-propanethiol: 0.5 (1.6); 1-butanethiol: 0.5 (1.8); 1-pentanethiol: 0.5 (2.1); 1-hexanethiol: 0.5 (2.4); 1-heptanethiol: 0.5 (2.7); 1-octanethiol: 0.5 (3.0); 1-nonanethiol: 0.5 (3.3); 1-decanethiol: 0.5 (3.6); 1-undecanethiol: 0.5 (3.9); 1-dodecanethiol: 0.5 (4.1); 1-hexadecanethiol: 0.5 (5.3); 1-octadecanethiol: 0.5 (5.9); cyclohexanethiol: 0.5 (2.4); benzenethiol: 0.1 (0.5); mixtures of thiols to be controlled by calculation of equivalent concentrations	Irritation; eye, skin, blood, and nervous system effects	Blood and urine monitoring required; skin contact to be prevented
o-Tolidine (August 1978)	None	20 µg/m <sup>3</sup> ceiling (60 min)	Nasal irritation; cancer	Urine testing required; quarterly urine monitoring recommended; skin contact to be prevented
Toluene (January 1974)	200 ppm, 8-hr TWA; 300 ppm acceptable ceiling; 500 ppm maximum ceiling (10 min)	100 ppm (375 mg/m <sup>3</sup> ), 8-hr TWA; 200 ppm (750 mg/m <sup>3</sup> ) ceiling (10 min)	Central nervous system depressant	None

Toluene diisocyanate (July 1973; revised—See Diisocyanates, September 1978)	0.02 ppm (0.14 mg/m <sup>3</sup> ) ceiling	0.005 ppm (0.036 mg/m <sup>3</sup> ) TWA; 0.02 ppm (0.14 mg/m <sup>3</sup> ) ceiling (20 min)	Respiratory effects	Chest X-rays, blood tests, pulmonary function testing required
1,1,1-Trichloroethane (July 1976)	350 ppm (1,900 mg/m <sup>3</sup> ), 8-hr TWA	350 ppm (1,910 mg/m <sup>3</sup> ) ceiling (15 min)	Nervous system, liver, and heart effects	Action level set at 200 ppm TWA; medical warning of possible congenital abnormalities required
1,1,2-Trichloroethane (CIB August 1978)	10 ppm (45 mg/m <sup>3</sup> ), 8-hr TWA (Skin)	Reduce exposure to lowest feasible level	Cancer	None
Trichloroethylene (July 1973; revised in Special Hazard Review, February 1978)	100 ppm, 8-hr TWA; 200 ppm acceptable ceiling; 300 ppm maximum ceiling (5 min in 2 hr)	25 ppm TWA	Cancer; central nervous system depressant	Workers to be warned of hazards; 25 ppm level can be achieved by use of existing engineering control technology
Trimellitic anhydride (CIB February 1978)	None	Should be handled in the workplace as an extremely toxic substance	Pulmonary edema; immunological sensitization; irritation of pulmonary tract, eyes, nose, and skin	Limit exposure to as few workers as possible while minimizing workplace levels
Tungsten and cemented tungsten carbide (September 1977)	None	Insoluble tungsten: 5 mg/m <sup>3</sup> TWA; soluble tungsten: 1 mg/m <sup>3</sup> TWA; dust of cemented tungsten carbide (containing > 2% cobalt): 0.1 mg cobalt/m <sup>3</sup> TWA; dust of cemented tungsten carbide (containing > 0.3% nickel): 15 µg nickel/m <sup>3</sup> TWA	Lung and skin effects	Pulmonary function testing and chest X-ray required

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**NIOSH Recommendations**


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Potential Hazard*	OSHA Standard	NIOSH Recommended Exposure Limit(s) <sup>†</sup>	Health Effect(s) Considered	Comments
Ultraviolet radiation (December 1972)	10 mW/cm <sup>2</sup> averaged over any 0.1-hr period	1.0 mW/cm <sup>2</sup> for periods > 1,000 sec; 1,000 mW (1.0 J/cm <sup>2</sup> ) sec/cm <sup>2</sup> for periods ≤ 1,000 sec	Skin and eye effects	None
Vanadium (August 1977)	Vanadium pentoxide (dust): 0.5 mg/m <sup>3</sup> ceiling; (fume): 0.1 mg/m <sup>3</sup> ceiling; ferrovanadium: 1 mg/m <sup>3</sup> , 8-hr TWA	Vanadium compounds: 0.05 mg/m <sup>3</sup> ceiling (15 min); metallic vanadium and vanadium carbide: 1 mg/m <sup>3</sup> TWA	Eye, skin, and lung effects	Pulmonary function testing and chest X-ray required
Vibration syndrome (CIB March 1983)	None	Jobs should be redesigned to minimize the use of vibrating handtools; powered handtools should be redesigned to minimize vibration	Vibration syndrome; adverse circulatory and neural effects in the fingers	None
Vinyl acetate (September 1978)	None	4 ppm (15 mg/m <sup>3</sup> ) ceiling (15 min)	Irritation	None
Vinyl chloride (March 1974; reaffirmed June 1974 as part of NIOSH testimony at OSHA hearing)	1 ppm, 8-hr TWA; 5 ppm ceiling (15 min)	Lowest reliably detectable level; air-supplied respirator with auxiliary self-contained air supply to be worn	Liver cancer	Liver function testing required

Vinyl halides (September 1978)	None except for vinyl chloride	Vinyl halides to be controlled as specified for vinyl chloride in 29 CFR 1910.1017 with eventual goal of zero exposure	Cancer	Vinyl halides include vinyl chloride, vinylidene chloride, vinyl bromide, vinyl fluoride, and vinylidene fluoride monomers
Waste anesthetic gases and vapors (May 1977)	None for substances when used as anesthetic agents	Halogenated anesthetic agents: 2 ppm ceiling (1 hr); nitrous oxide: 25 ppm TWA during periods of use	Reproductive effects and audiovisual performance decrements	Workers to be advised of potential effects; abnormal outcome of pregnancies of workers and spouses to be documented
Xylene (May 1975)	100 ppm (435 mg/m <sup>3</sup> ), 8-hr TWA	100 ppm (434 mg/m <sup>3</sup> ) TWA; 200 ppm (868 mg/m <sup>3</sup> ) ceiling (10 min)	Central nervous system depressant; respiratory irritation	None
Zinc oxide (October 1975)	5 mg/m <sup>3</sup> , 8-hr TWA	5 mg/m <sup>3</sup> TWA; 15 mg/m <sup>3</sup> ceiling (15 min)	Metal fume fever	None

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