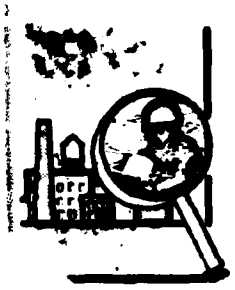
NIOSH

Current Intelligence Bulletins:

Summaries

September 1987



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

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INTRODUCTION

Current Intelligence Bulletins (CIB's) are reports produced by the National Institute for Occupational Safety and Health (NIOSH), CDC, Atlanta, Georgia, to disseminate new scientific information about occupational hazards. A CIB may focus attention on a hazard previously unrecognized or may report new data indicating that a known hazard is either more or less dangerous than was previously thought.

To date, NIOSH has issued 49 CIB's. The summaries provided here reflect the state of knowledge at the time the bulletin was prepared. Estimates of the number of workers potentially exposed to a given substance or agent were derived from projections based on the National Occupational Hazard Survey conducted by NIOSH between 1972 and 1974, which encompassed potential exposures of approximately 900,000 workers at nearly 5,000 facilities. An italicized statement immediately following a summary indicates any revisions in NIOSH policy made subsequent to the issuance of the particular CIB. This compendium of summaries does not include any new NIOSH policy; it is rather a compilation of summaries of the 49 CIB's along with any subsequent policy statements related to the same topics.

Note to Readers:

Those who want the full text of Current Intelligence Bulletins should note that Nos. 1-18 (NIOSH publication #78-127), Nos. 19-30 (#79-146), and Nos. 31-47 (#86-122) have been reprinted. These collections, single copies of CIB's #19 and higher, and other NIOSH documents referred to are available from:

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CUMULATIVE LIST OF NIOSH CURRENT INTELLIGENCE BULLETINS

CUMULATIVE LIST OF NIOSH CURRENT INTELLIGENCE BULLETINS--CONTINUED

DEFINITIONS OF ABBREVIATIONS AND TERMS USED IN THIS PUBLICATION

ACGIH	American Conference of Governmental Industrial Hygienists
CIB's	Current Intelligence Bulletins
CNS	central nervous system
DCMA	Dry Color Manufacturer's Association
DDM	4,4'-diaminodiphenylmethane
DECC	diethylcarbamoyl chloride
DMCC	dimethylcarbamoyl chloride
DNT	dinitrotoluenes
EDB	ethylene dibromide
2EE	2-ethoxyethanol
EtO	ethylene oxide
ETU	ethylene thiourea
HMPA	hexamethylphosphoric triamide
MDA	p,p'-methylenedianiline; 4,4'-methylenedianiline
2ME	2-methoxyethanol
NCI	National Cancer Institute
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PBNA	N-phenyl-beta-naphthylamine
PCB's	polychlorinated biphenyls
PCDD	polychlorinated dibenzo-p-dioxin
PCDF	polychlorinated dibenzofuran
PEL	Permissible Exposure Limit (OSHA)
REL	Recommended Exposure Limit (NIOSH)
RF	radiofrequency
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TCE	trichloroethylene
TLV®	Threshold Limit Value (ACGIH)
TMA	trimellitic anhydride
TWA	time-weighted average
WL	working levels

CIB #1--Chloroprene

Issued: January 20, 1975 (#78-127)

Because of its resistance to abrasion, heat, flame, oxygen, ozone, and solvents, chloroprene is used in the manufacture of a variety of neoprene elastomers including cable sheaths, hoses, fabrics, adhesives, and a large number of technical rubber articles. The automotive industry is the largest user of this chemical. An estimated 2,500 U.S. workers are potentially exposed to chloroprene. Based on human and animal studies, NIOSH warns of carcinogenic, reproductive, and central nervous system (CNS) effects.

The current Permissible Exposure Limit (PEL) of the Occupational Safety and Health Administration (OSHA) is 25 parts per million (8-hour time-weighted average [TWA]). In 1977, NIOSH published a criteria document (#77-210) on chloroprene with a Recommended Exposure Limit (REL) of 1 ppm as a ceiling (15 minutes).

CIB #2--Trichloroethylene (TCE)

Issued: June 6, 1975 (#78-127)

Prelimirary evaluation by the National Cancer Institute (NCI) of the carcinogenic activity of TCE in laboratory rodents indicates that this material is a potent liver carcinogen. TCE is one of the most important chlorinated solvents used as a metal degreaser and a dry cleaning agent. A pharmaceutical grade of this chemical is used as a general anesthetic and analgesic. TCE is also used to extract caffeine in the production of decaffeinated coffee. Approximately 290,000 U.S. workers are potentially exposed to the chemical. The OSHA PEL of 100 ppm (8-hour TWA) was based on the Threshold Limit Value (TLV®) of the American Conference of Governmental Industrial Hygienists (ACGIH). In 1973, NIOSH recommended an exposure limit of 100 ppm (8-hour TWA). It should be noted that the NCI study is the first to associate TCE with cancer in animals. No published reports have indicated any association between TCE and cancer in humans. However, because of potential risks of human exposure in the work environment, NIOSH is alerting the occupational health community to the NCI findings. Additional animal studies, as well as detailed epidemiological investigations, are anticipated.

In 1978, NIOSH published a special Occupational Hazard Review of TCE (#78-130), which indicated that occupational exposure can be easily limited to 25 ppm by current engineering control methods. NIOSH recommended that exposure be controlled to the fullest extent possible

CIB #3--Ethylene Dibromide (EDB)

Issued: July 7, 1975 (#78-127)

A preliminary report from NCI indicates that EDB is carcinogenic in laboratory rodents. EDB is used primarily as an antiknock agent in gasoline and as a fumigant for grains, fruits, and vegetables. Approximately 108,000 U.S. workers are potentially exposed to EDB during its production and use. In addition, an estimated 875,000 workers are potentially exposed to very low concentrations of EDB while working with leaded gasoline. Based on the NCI study, NIOSH warns of a potential carcinogenic risk to workers.

Exposure to EDB may also produce renal, liver, pulmonary, and CNS effects. In view of the NCI findings, NIOSH recommends that employers make every effort to maintain the exposure as low as is technically feasible.

In 1977, NIOSH published a criteria document (#77-221) on ethylene dibromide, with an REL ceiling of 0.13 ppm (1 mg/m^3) in any 15 minute period. In 1981, in a revised CIB (#82-105), NIOSH reaffirmed its REL on the basis of inhalation studies on rats and mice, which indicated that EDB is carcinogenic at exposure concentrations below the OSHA PEL of 20 ppm. In 1984 testimony to OSHA, NIOSH recommended that the PEL be reduced to an 8-hour TWA of 0.045 ppm with a 15-minute ceiling of 0.13 ppm.

CIB #4--Chrome Pigment

Issued: June 24, 1975, October 7, 1975 and October 8, 1976 (#78-127)

A series of three letters was distributed on behalf of the Lead Chromate Task Force of the Dry Color Manufacturer's Association (DCMA) to alert producers and users to the carcinogenic potential of chrome pigments. The OSHA PEL's at the time of a DCMA-sponsored study follow: 0.2 mg/m^3 for lead; 0.5 mg/m^3 as Cr for chromium, soluble chromic, or chromic salts; and 0.1 mg/m^3 as CrO_3 for chromic acid or chromates. However, results of an epidemiologic study also sponsored by the DCMA showed an excess of respiratory cancer in lead chromate workers. These findings are consistent with the NIOSH criteria document on hexavalent chromium (#76-129) published in December 1975, which states that lead chromate should be regarded as a human carcinogen.

CIB #5--Asbestos: Asbestos Exposure During Servicing of Motor Vehicle Brake and Clutch Assemblies

Issued: August 8, 1975 (#78-127)

Based on data presented by investigators from the Mount Sinai School of Medicine, NIOSH alerts brake repair and servicing personnel to the potential for exposure to high concentrations of asbestos during the servicing of motor vehicle brake and clutch assemblies. Approximately 908,000 U.S. workers are potentially exposed to asbestos in the manufacture and servicing of brake linings and clutches. Control procedures in this industry are recommended to minimize dust exposures.

In 1976, NIOSH published a revised criteria document (#77-169) on asbestos, with an REL of 100,000 fibers/m^3 of air (fibers >5 m long) as an 8-hour TWA and peak concentrations not exceeding 500,000 fibers/m^3 of air (fibers >5 m long) for a 15-minute sample period. In 1980, a joint NIOSH/OSHA work group issued a report that reaffirms the REL of 100,000 fibers/m^3. In 1984, in testimony to OSHA, NIOSH once again stated the need for 100,000 fiber/m^3 of air as an 8-hour TWA exposure limit.

CIB #6--Hexamethylphosphoric Triamide (HMPA)

Issued: October 24, 1975 (#78-127)

NIOSH received a report from E.I. du Pont de Nemours and Company, an American producer of HMPA, which indicated that malignant tumors were produced in laboratory animals exposed to the chemical. HMPA possesses

unique solvent properties and is widely used as a solvent, in small quantities, in organic and organo-metallic reactions in laboratories. Of the approximately 5,000 U.S. workers who are occupationally exposed to the chemical, more than 90% work in research laboratories. Based on the du Pont studies, NIOSH recommends that HMPA be treated as a potential occupational carcinogen.

CIB #7--Polychlorinated Biphenyls (PCB's)

Issued: November 3, 1975 and August 20, 1976 (#78-127)

Reports on PCB's indicate a possible association between occupational exposure to PCB's and cancer in humans. Known toxic effects of PCB's on humans include chloracne, pigmentation of skin and nails, excessive eye discharge, swelling of eyelids, and distinctive hair follicles. PCB's are widely used in industry in the manufacture of capacitors and transformers. Other applications include use in investment casting processes, as heat-exchange fluids, and as hydraulic fluids. Approximately 12,000 U.S. workers are potentially exposed to PCB's.

NIOSH published a criteria document (#77-225) in 1977 with an REL of 1.0 g/m^3 (TWA for up to a 10-hour workday, 40-hour workweek).

CIB #8--4,4'-Diaminodiphenylmethane (DDM)

Issued: January 30, 1976 (#78-127)

DDM, also known as p,p'-methylenedianiline or 4,4'-methylenedianiline (MDA), is an important chemical intermediate. Of the over 200 million pounds manufactured in the United States each year, 99% is used in the production of isocyanates and polyisocyanates. Approximately 2,500 U.S. workers are potentially exposed to the chemical. Based on the results of several studies, NIOSH warns of liver disease in exposed workers and the carcinogenic effects of DDM in animals.

See entry for CIB #47--4,4'-Methylenedianiline (MDA).

CIB #9--Chloroform

Issued: March 15, 1976 (#78-127)

An NCI study demonstrated the carcinogenicity of chloroform in laboratory mice and rats. Chloroform is used as a raw material in the preparation of fluorocarbons. Additional applications include use in extraction and purification of penicillin and other antibiotics; purification of alkaloids; solvent extraction of vitamins and flavors; as a general solvent and intermediate in the preparation of dyes, drugs, and pesticides; and as an anesthetic. Approximately 40,000 U.S. workers are potentially exposed to the chemical. In 1974, NIOSH recommended that no worker be exposed to chloroform in excess of 10 ppm (10-hour TWA) or 50 ppm ceiling (10 minutes). No studies have shown an association between chloroform and cancer in humans. However, because of the results of the NCI study, NIOSH alerts the occupational health community to the chemical's potential for cancer induction in humans.

NIOSH published a revised recommended standard (Chloroform revised 1976) with an REL of 2 ppm as a 60-minute ceiling.

CIB #10--Radon Daughters

Issued: May 11, 1976 (#78-127)

NIOSH has found that in a number of National Park Service caves, concentrations of the radioactive decay products, "daughters," of radon gas are near the occupational limits set forth in the OSHA standards for uranium miners. NIOSH warns of the potential hazards associated with the presence of radon gas in privately owned caves and "cave air"-conditioned buildings. Studies of uranium miners have shown that alpha radiation emitted by the radon daughters caused an increase in lung cancer that became evident 10 years or more after individuals first started mining. The OSHA requirements for uranium mines, deemed by the Environmental Protection Agency to be applicable to natural caves, are as follows: above 0.1 working levels (WL) alpha radiation - all underground smoking stops; 0.1-0.2 WL - monitor workspace at least once yearly; 0.2-0.3 WL - monitor workspace quarterly; above 0.3 WL - monitor workspace weekly and maintain exposure records on all exposed workers; 1.0-2.0 WL - take immediate corrective action to lower the concentration below 1.0 WL; above 2.0 WL - withdraw all workers who are not involved in implementing the corrective actions necessary to lower the concentrations below 1.0 WL; and cumulative individual exposure shall not exceed four WL months in any calendar year. NIOSH supports these recommendations and also recommends that radiation levels be assessed in state and privately owned caves throughout the United States.

CIB #11--Dimethylcarbamoyl Chloride (DMCC), Revised

Issued: July 7, 1976 (#78-127)

Inhalation studies conducted at the Institute of Environmental Medicine, New York University, indicate that DMCC causes cancer in laboratory rats. DMCC is used in synthesizing pharmaceuticals for the treatment of myasthenia gravis and as a reagent for the synthesis of carbamates in chemical research laboratories. Fewer than 200 persons are estimated to be potentially exposed to DMCC. Based on studies at New York University with rats in which DMCC at a concentration of 1 ppm produced squamous cell carcinomas of the nose within 200 days, NIOSH warns of the carcinogenic potential of DMCC.

CIB #12--Diethylcarbamoyl Chloride (DECC)

Issued: July 7, 1976 (#78-127)

Based on studies by the Institute of Environmental Medicine, New York University, NIOSH warns of the mutagenic potential of DECC in two Escherichia coli strains (WP2 and WP2S from Witkin). The only known commercial domestic use for DECC is in the synthesis of the pharmaceutical diethylcarbamazine citrate, an anthelmintic (worming agent). Annual production of DECC has been under 15,000 pounds.

CIB #13--Explosive Azide Hazard

Issued: August 16, 1976 (#78-127)

NIOSH warns of the explosive hazards that may exist in hospital and clinical laboratory plumbing systems caused by the formulation of sodium azide into effluents used with automatic blood cell counters. These counters are found

in over 15,000 hospitals and laboratories in the United States. Lead azide is a more sensitive primary explosive than nitroglycerin and a more effective detonating agent than mercury fulminate. In comparison with lead azide, copper azide is even more explosive and too sensitive to be used commercially. Laboratory maintenance workers, especially plumbers, should be alerted to the azide hazard so that proper precautions can be taken. Decontamination procedures for plumbing systems containing copper and/or lead azide are recommended.

CIB #14--Inorganic Arsenic: Respiratory Protection

Issued: September 27, 1976 (#78-127)

To meet the NIOSH REL for arsenic of 2 g As/m^3, particular attention should be given to using appropriate protective equipment for exposed workers. NIOSH recommends particular types of personal respiratory protective devices that are suitable for worker protection under defined conditions; these include full-face respirators, high-efficiency particulate filters for inorganic arsenic compounds that have no significant vapor pressure, and air-purifying respiratory protection with an acid gas canister, as a minimum, for inorganic arsenic compounds with significant vapor pressure. Engineering controls are recommended to keep arsenic concentrations below the occupational exposure limit.

In 1982, in testimony at an OSHA hearing on arsenic, NIOSH reaffirmed the previous NIOSH REL that occupational exposure to inorganic arsenic not exceed 2 g As/m^3 as determined by a 15-minute sampling period.

CIB #15--Nitrosamines in Cutting Fluids

Issued: October 6, 1976 (#78-127)

NIOSH has been informed that diethanolnitrosamine is present in commercial cutting fluids produced by four randomly selected companies. It was formed in a grinding fluid containing nitrite and triethanolamine. This substantiates a recent finding that nitrosamines may be formed in air and other nonacidic media by the reaction of secondary and tertiary amines with nitrites or other oxides of nitrogen. Historically, nitrosamines have been regarded as potent animal carcinogens, although their carcinogenic potential in humans has not been proven. An estimated 780,000 U.S. workers are potentially exposed during the manufacture and use of cutting oils. NIOSH recommends implementing a program of good work practices, engineering controls, and personal protective equipment, where necessary, to minimize dermal and respiratory exposure to cutting fluids.

CIB #16--Metabolic Precursors of a Known Human Carcinogen, beta-Naphthylamine

Issued: December 17, 1976 (#78-127)

Based on human and animal studies conducted by several chemical manufacturers, NIOSH warns that N-phenyl-beta-naphthylamine (PBNA), a widely used rubber antioxidant, and 2-nitronaphthalene, a by-product of alpha-naphthylamine production, are metabolized to the known human carcinogen, beta-naphthylamine. NIOSH estimates that about 15,000 U.S. workers are potentially exposed to PBNA during its manufacture and use.

NIOSH recommends the use of industrial hygiene practices to minimize exposure in the workplace, the evaluation of PBNA substitutes for possible human effects, and the additional assessment of metabolic pathways of chemical agents in the workplace. NIOSH also recommends that materials metabolized by the human body to known carcinogens be handled in the same manner as carcinogens.

CIB #17--2-Nitropropane

Issued: April 25, 1977 (#78-127)

An inhalation study indicates that 2-nitropropane, a solvent used widely in industrial coatings and printing inks, causes liver cancer in rats exposed to 207 ppm over a 6-month period. Thirty million pounds of 2-nitropropane are produced and 12 million pounds are sold per year in the United States. The unsold portion is either exported or used by the International Minerals and Chemical Corporation. An estimated 100,000 U.S. workers are potentially exposed to 2-nitropropane. NIOSH recommends that 2-nitropropane be treated as a human carcinogen. As interim measures to reduce employee exposure to 2-nitropropane, NIOSH recommends establishing regulated areas, engineering controls, personal protective equipment, and medical monitoring. NIOSH further recommends that a solvent not containing 2-nitropropane be substituted whenever possible.

In 1980, a joint OSHA/NIOSH health hazard alert (#80-142) was issued reaffirming that 2-nitropropane has the potential to cause cancer in humans and that worker exposure should be reduced to the lowest feasible level.

CIB #18--Acrylonitrile

Issued: July 1, 1977 (#78-127)

Studies by E.I. du Pont de Nemours and the Manufacturing Chemists Association indicate that occupational exposure to acrylonitrile may be associated with an excess of lung and colon cancer. The du Pont study demonstrated an excess of cancer among workers exposed to acrylonitrile at a textile plant. In a 1-year interim report of an ongoing study by the Manufacturing Chemists Association involving ingestion and inhalation of acrylonitrile by laboratory rats, the rats developed a variety of tumors including carcinomas. Acrylonitrile is used mainly in the production of acrylic and modacrylic fibers. The acrylic fibers are used to manufacture apparel, carpeting, blankets, draperies, and upholstery, while modacrylic fibers are used for synthetic furs and wigs. Other major uses of acrylonitrile include the manufacture of acrylonitrile-butadiene-styrene and styrene-acrylonitrile resins (used in a variety of plastic products), nitrile elastomers and latexes, and other chemicals (e.g., adiponitrile, acrylamide). Acrylonitrile is also used as a fumigant. Approximately 125,000 U.S. workers are potentially exposed to acrylonitrile in the workplace. NIOSH recommends handling acrylonitrile in the workplace as a human carcinogen and also recommends interim industrial hygiene practices to reduce occupational exposure to acrylonitrile.

In 1978, NIOSH published a criteria document (#78-116) on acrylonitrile, which recommends that no worker be exposed to more than 1 ppm (8.7 mg/m^3) in air as determined by a 4-hour sample collected at 0.2 L/minute. Later

that year in testimony to OSHA, NIOSH reaffirmed its position that acrylonitrile be considered an occupational carcinogen and supported the proposed OSHA PEL of 2 ppm (8-hour TWA).

CIB #19--2,4-Diaminoanisole in Hair and Fur Dyes

Issued: January 13, 1978 (#78-111 or #79-146)

Studies by NIOSH and NCI indicate that 2,4-diaminoanisole may be carcinogenic. The chemical is used principally as a component of oxidation ("permanent") hair and fur dye formulations. Hairdressers and cosmetologists comprise the largest portion of the estimated 400,000 workers with potential exposure to 2,4-diaminoanisole. Two NIOSH epidemiologic studies suggest excess cancer among cosmetologists, although they do not clearly demonstrate an association between hair dyes and cancer. In addition, laboratory studies by NCI showed an excess of site-specific malignant tumors in rats and mice given oral doses of 2,4-diaminoanisole. Based on the results of these studies, NIOSH recommends that 2,4-diaminoanisole and its salts be treated as potential human carcinogens and that occupational exposure be minimized.

CIB #20--Tetrachloroethylene (Perchloroethylene)

Issued: January 20, 1978 (#78-112 or #79-146)

Tetrachloroethylene (perchloroethylene) is a solvent used widely in dry cleaning, fabric finishing, metal degreasing, and other applications. Approximately 500,000 U.S. workers are potentially exposed to tetrachloroethylene in dry cleaning establishments and a large number of other industries that manufacture or use the chemical. In 1976, NIOSH published a criteria document (#76-185) with an REL of 50 ppm (TWA for a 10-hour workday, 40-hour workweek). However, a study by NCI indicates that tetrachloroethylene causes liver cancer in mice. As a result of these findings and other pertinent data, NIOSH recommends that this substance be handled in the workplace as a potential human carcinogen.

CIB #21--Trimellitic Anhydride (TMA)

Issued: February 3, 1978 (#78-121 or #79-146)

NIOSH has identified TMA as an extremely toxic substance that can cause noncardiac pulmonary edema, immunologic sensitization, and irritation of the pulmonary tract, eyes, nose, and skin. This substance is used as a curing agent for epoxy and other resins, in vinyl plasticizers, paints and coatings, polymers, polyesters, agricultural chemicals, dyes and pigments, pharmaceuticals, surface active agents, modifiers, intermediates, and specialty chemicals. Approximately 20,000 U.S. workers are potentially exposed to TMA. NIOSH recommends that TMA be handled in the workplace as an extremely toxic agent and that engineering and work practice controls be used to minimize exposure of workers.

CIB #22--Ethylene Thiourea (ETU)

Issued: April 11, 1978 (#78-144 or #79-146)

ETU is a white crystalline solid used extensively as an accelerator for curing polychloroprene (Neoprene®) and other elastomers. Approximately

3,500 U.S. workers in the rubber industry are potentially exposed to ETU. Exposure also results from the widely used ethylene bis-dithiocarbamate fungicides in which ETU may be present as a contaminant. A NIOSH literature evaluation shows ETU to be a teratogen and a carcinogen in laboratory rats; studies in other species support these findings.

NIOSH, in 1978, published a Special Occupational Hazard Review (#79-109), recommending that workers be informed of the potential hazards of ETU and emphasizing the need for good work practices and sanitation.

CIB #23--Ethylene Dibromide (EDB) and Disulfiram, Toxic Interaction

Issued: April 11, 1978 (#78-145 or #79-146)

Results of a NIOSH study on laboratory rats suggest a serious toxic interaction between inhaled EDB and ingested disulfiram. As a result, NIOSH recommends that no worker be simultaneously exposed to EDB and disulfiram. EDB is used primarily as a lead scavenger in leaded fuels, a fumigant, an intermediate in the synthesis of dyes and pharmaceuticals, and a solvent for resins, gums, and waxes. Disulfiram is a prescription drug used under the trade names Antabuse® and Ro-Sulfiram® as an alcohol deterrent in programs for the control of alcoholism. It is also used as an accelerator in the manufacture of rubber and as a fungicide and insecticide. Approximately 9,000 U.S. workers are potentially exposed to EDB; in addition, 650,000 gas station attendants are potentially exposed to very low concentrations. Approximately 70,000 workers are potentially exposed to disulfiram in addition to an estimated 100,000 people who use it therapeutically for alcoholism. Toxic interactions with other chemicals were not considered in the NIOSH REL of 0.13 ppm (1.0 mg/m^3) EDB as a 15-minute ceiling (#77-221). The current NIOSH study shows a high rate of mortality for rats exposed by inhalation to 20 ppm EDB for 6 hours a day, 5 days a week, and fed a diet containing 0.05% disulfiram by weight. Therefore, NIOSH concludes that no worker should be exposed to EDB when disulfiram is used in the workplace. In addition, workers potentially exposed to EDB should not be administered disulfiram unless the physician responsible believes the benefit of disulfiram therapy strongly outweighs the risk for that particular patient.

CIB #24--Direct Blue 6, Direct Black 38, Direct Brown 95: Benzidine-Derived Dyes

Issued: April 17, 1978 (#78-148 or #79-146)

NIOSH recommends that three widely used benzidine-derived dyes--Direct Blue 6, Direct Black 38, and Direct Brown 95--be handled in the workplace as human carcinogens. These dyes are used in a variety of industries, including paper and allied products, petroleum, rubber and plastics, leather products, instrumentation and measuring devices, banking, and the textile industry. In short-term feeding studies of these dyes by NCI, cancerous and precancerous liver conditions were found in rats, and degeneration of liver cells was found in mice. Although the dyes tested by NCI contained less than 4 ppm residual benzidine when fed to the test animals, greater quantities of benzidine were found in the urine of the dosed rats and mice. NIOSH field studies reported that humans working with these dyes also excrete higher than expected levels of benzidine in their urine. Both

laboratory and field studies indicate that these benzidine derived dyes can be metabolized to benzidine, a known carcinogen. NIOSH recommends that exposure to Direct Blue 6, Direct Black 38, and Direct Brown 95 be limited to as few workers as possible, while minimizing workplace exposure levels. The area in which they are used should be restricted to only those workers essential to the process or operation.

CIB #25--Ethylene Dichloride (1,2-Dichloroethane)

Issued: April 19, 1978 (#78-149 or #79-146)

NIOSH recommends that ethylene dichloride (1,2-dichloroethane) be handled in the workplace as a human carcinogen. This chemical is one of the highest volume chemicals in the United States. It is used in the production of vinyl chloride, 1,1,1-trichloroethane, trichloroethylene, perchloroethylene, vinylidene chloride, and ethyleneamines. It is also a lead scavenger and appears as a component of most leaded fuels. In addition, it is used as an extraction solvent, as a solvent for textile cleaning and metal degreasing, in certain adhesives, and as a component in fumigants for upholstery, carpets, and grain. An estimated two million U.S. workers are potentially exposed to ethylene dichloride. In a 1976 criteria document (#76-139), NIOSH proposed an REL of 5 ppm (TWA 10-hour workday; 40-hour workweek). However, this recommended limit was selected to prevent toxic effects other than cancer and may not provide adequate protection from potential carcinogenic effects. Subsequently, results of an NCI study indicated that laboratory rats and mice fed ethylene dichloride experienced a significant excess of malignant and benign tumors. Other toxic effects of ethylene dichloride include cardiovascular system disorders (extreme lowering of blood pressure and cardiac impairment), pulmonary edema, fatty degeneration of the liver and kidney, and degeneration of the adrenal cortex. It has also been found to be mutagenic to bacteria and fruit flies and to cause abnormal development of the rat fetus. NIOSH recommends that occupational exposures be limited to as few workers as possible and that workplace exposure concentrations be minimized through engineering and work practice controls.

In September 1978, NIOSH published a revised criteria document (#78-211) on ethylene dichloride (1,2-dichloroethane) that reaffirms its recommendations that ethylene dichloride be controlled as an occupational carcinogen and that the previous REL be revised downward from 5 ppm (20 mg/m^3) to 1 ppm (4 mg/m^3) determined as a TWA exposure for up to a 10-hour workshift. Also, a ceiling concentration is recommended of 2 ppm (8 mg/m^3) as determined over a 15-minute sampling period.

CIB #26--NIAX® Catalyst ESN: A Mixture of Dimethylaminopropionitrile and bis[2-(dimethylamino)ethyl]ether

Issued: May 22, 1978 (#78-157 or #79-146)

NIOSH and OSHA jointly recommend that NIAX® Catalyst ESN and its components, dimethylaminopropionitrile and bis[2-(dimethylamino)ethyl]ether, as well as formulations containing either component, be handled in the workplace as exceedingly hazardous materials. NIAX® Catalyst ESN, which is used in the manufacture of flexible polyurethane foam, has been linked to urinary dysfunction and neurologic manifestations in exposed workers. No current

Federal standard exists for occupational exposure to the catalyst or either of its components. However, on April 7, 1978, OSHA issued a Health Hazard Alert stating, "It is imperative that worker exposure to ESN and its components be completely avoided." NIOSH recommends limiting exposure to as few workers as possible, while minimizing workplace exposure with engineering and work practice controls. NIOSH further recommends that exposed workers be carefully monitored for potential disorders of the genitourinary and nervous systems.

CIB #27--Chloroethanes: Review of Toxicity

Issued: August 21, 1978 (#78-181 or #79-146)

NIOSH recommends that four chloroethanes--1,2-dichloroethane (ethylene dichloride); 1,1,2-trichloroethane; 1,1,2,2-tetrachloroethane; and hexachloroethane--be handled in the workplace as human carcinogens. This recommendation is based primarily on the results of NCI studies that showed an excess of cancer in animals exposed to chloroethane. Chloroethanes are used extensively as solvents and in degreasing agents, cutting fluids, and fumigants as well as in the manufacture of plastics, textiles, and other chemicals. Over 3 million U.S. workers are potentially exposed to one or more chloroethanes. NIOSH recommends that occupational exposure to these four chloroethanes be minimized. Exposures should be limited to as few workers as possible, while minimizing exposure concentrations through engineering and work practice controls. In addition, five other chloroethane compounds--chloroethane (ethyl chloride); 1,1-dichloroethane; 1,1,1-trichloroethane (methyl chloroform); 1,1,1,2-tetrachloroethane; and pentachloroethane--should be treated with caution in the workplace because of their relationship to the four chloroethanes shown to be carcinogenic.

CIB #28--Vinyl Halides: Carcinogenicity
Joint NIOSH/OSHA Statement

Issued: September 21, 1978 (#79-102 or #79-146)

Approximately 2.5 million U.S. workers are potentially exposed to the vinyl halides, which include vinyl chloride, vinyl bromide, vinylidene chloride, vinylidene fluoride, and vinyl fluoride. The vinyl halides have widespread industrial use, especially in the plastics industry. Vinyl chloride is currently regulated by OSHA as a carcinogen. However, all vinyl halides should be considered potential human carcinogens. Studies have demonstrated that exposure by inhalation to vinyl chloride, vinyl bromide, or vinylidene chloride caused angiosarcoma of the liver and other cancers in laboratory animals. Other adverse health effects attributed to vinyl halides in animals include CNS, cardiovascular, respiratory, skin, and skeletal effects and liver or spleen abnormalities. NIOSH and OSHA recommend that occupational exposure to vinyl bromide and vinylidene chloride be reduced to the lowest possible levels. Exposures should be limited to as few workers as possible, and workplace exposure concentrations should be reduced through engineering and work practice controls. These recommendations reaffirm those previously made by NIOSH and transmitted to OSHA in 1978 in the form of a criteria document.

CIB #29--Glycidyl Ethers

Issued: October 12, 1978 (#79-104 or #79-146)

Glycidyl ethers are used primarily as components of epoxy resin systems. Epoxy resins containing glycidyl ethers are used in a variety of applications, including protective coatings and reinforced plastics, as well as bonding materials and adhesives. An estimated 1 million U.S. workers are potentially exposed to epoxy resins. Studies in several different research laboratories indicate that some of the glycidyl ethers are capable of producing adverse effects on the testes and hemopoietic system in laboratory animals. Other reported adverse effects in laboratory animals exposed to glycidyl ethers include sensitization and skin and eye irritation, as well as mutagenic and tumorigenic activity. In a 1978 criteria document (#78-166), NIOSH advised strict adherence to the REL's (Table 1.) for glycidyl ethers. In addition, particular attention should be given to appropriate medical surveillance to detect testicular atrophy or hemopoietic abnormalities in exposed workers.

TABLE 1. National Institute for Occupational Safety and Health (NIOSH)--Recommended Exposure Limits (REL's) for Glycidyl Ethers

Glycidyl Ethers	NIOSH REL's (15-minute ceiling)
Allyl Glycidyl Ether	45 mg/m^3
n-Butyl Glycidyl Ether	30 mg/m^3
Diglycidyl Ether	1 mg/m^3
Isopropyl Glycidyl Ether	240 mg/m^3
Phenyl Glycidyl Ether	5 mg/m^3

CIB #30--Epichlorohydrin

Issued: October 12, 1978 (#79-105 or #79-146)

NIOSH recommends that epichlorohydrin be handled in the workplace as a human carcinogen. This recommendation is based on two studies--a long-term epidemiologic study showing respiratory-tract cancer deaths of workers exposed to epichlorohydrin and an inhalation study showing an increase in nasal carcinomas in rats. In addition, other studies have shown a significant increase in chromosome abnormalities in exposed workers. Other toxic effects include burning of the skin, eyes, and nasal passages; pulmonary edema; and kidney problems. Epichlorohydrin is used in the manufacture of epoxy resins, surface-active agents, pharmaceuticals, insecticides, agricultural chemicals, textile chemicals, coatings, adhesives, ion-exchange resins, solvents, plasticizers, glycidyl esters, ethynylethylenic alcohol, and fatty acid derivatives. An estimated 85,000 U.S. workers are potentially exposed. In a 1976 criteria document (#76-206), NIOSH recommended an occupational exposure limit of 2 mg/m^3

(10-hour TWA) and a ceiling limit of 19 mg/m^3. As a result of the epidemiologic study and the inhalation study cited in this CIB, NIOSH now recommends limiting exposure to as few workers as possible and minimizing workplace exposure through engineering and work practice controls. In particular, skin exposure should be avoided.

CIB #31--Adverse Health Effects of Smoking and the Occupational Environment

Issued: February 5, 1979 (#79-122 or #79-146)

Smoking by workers in various occupations provides an opportunity for interaction between smoking and workplace exposure to physical and chemical agents. NIOSH warns of the combined effects of tobacco use and exposure to chemical and physical agents in the workplace. Six modes of action through which smoking may cause adverse health effects in the workplace include: (1) increased exposure to toxic agents found in both the tobacco products and the workplace; (2) the transformation of workplace chemicals into more harmful agents by the heat generated in smoking; (3) the contamination of tobacco products by workplace chemicals, which can then be ingested, inhaled, or absorbed through the skin; (4) the additive biologic effects of simultaneous exposure to agents that produce effects similar to those caused by smoking; (5) synergistic effects of smoking and exposure to toxic agents; and (6) increased incidence of accidents among smokers in the workplace. NIOSH recommends that the use of and/or carrying of tobacco products into the workplace be curtailed in situations where workers may be exposed to physical or chemical agents that may interact with tobacco products.

CIB #32--Arsine (Arsenic Hydride) Poisoning in the Workplace

Issued: August 3, 1979 (#79-142)

Arsine and stibine are toxic gases formed, often accidentally, through chemical reactions involving arsenic and antimony, respectively. Arsine is a highly poisonous, colorless, nonirritating gas with a mild garlic odor. Generation of this gas is likely when inorganic arsenic is exposed to nascent (freshly-formed) hydrogen or when water reacts with a metallic arsenide. Arsine is commercially produced for use in organic synthesis and for processing solid-state electronic components. Approximately 900,000 U.S. workers are potentially exposed to identified sources of arsenic. However, arsenic is a widespread element and unidentified exposures can occur in unsuspected work situations. Several cases were reported of worker exposure to arsine, which resulted in severe toxic effects or death; most of these exposures occurred when arsine was accidentally generated during an industrial process. Stibine, another toxic gas, is formed when antimony is exposed to nascent hydrogen. In most situations where arsine can be formed, stibine can also be formed if antimony is present. Approximately 1.7 million U.S. workers are potentially exposed to antimony. The NIOSH REL for arsine is a ceiling value of 2 g As/m^3 of air as determined by a 15-minute sampling period. NIOSH recommends that steps be taken to prevent exposure to arsine and/or stibine. Whenever either gas could be generated, such as when working with metals (crude, drosses, or implements made of metal), care should be taken to assure that arsenic and antimony do not react with any sources of fresh hydrogen. If arsine and/or stibine are generated, workers should be removed immediately from the contaminated area and given prompt medical attention. In all occupational settings where

arsenic is present, workers should be informed of the possibility of arsine formation when nascent hydrogen is also present. Likewise, workers exposed to antimony compounds should be informed of possible exposure to stibine when freshly formed hydrogen is present.

CIB #33--Radiofrequency (RF) Sealers and Heaters: Potential Health Hazards and Prevention
Joint NIOSH/OSHA Statement
Issued: December 4, 1979 (#80-107)

Based primarily on the results of studies with laboratory animals, NIOSH and OSHA warn of potential health hazards to workers exposed to RF energy emitted by RF dielectric heaters (more widely known as RF sealers and heaters). When RF energy is absorbed in sufficient amounts by workers, it may produce adverse thermal effects resulting from heating deep-body tissue, such as potentially damaging alterations in cells. NIOSH and OSHA also warn of "nonthermal" effects, reported to occur at exposure levels lower than those causing thermal effects. Exposure of workers should be minimized through shielding and other engineering controls. The OSHA PEL applies to frequencies of 10-100,000 MHz and limits occupational exposures to a maximum power density of 10 mW/cm^2 as averaged over any possible 6-minute period. NIOSH and OSHA recommend that precautionary measures be instituted to minimize the risk to workers from unwarranted exposure to RF energy.

CIB #34--Formaldehyde: Evidence of Carcinogenicity
Issued: April 15, 1981 (#81-111)

NIOSH recommends that formaldehyde be handled as a potential occupational carcinogen and that appropriate controls be used to reduce worker exposure. These recommendations are based on the results of several studies. The first was a study by the Chemical Industry Institute of Toxicology, which showed that rats and mice exposed to formaldehyde vapors developed nasal cancer. This report was supported by a New York University study indicating that rats exposed to a mixture of formaldehyde and hydrochloric acid vapors developed nasal cancer. In several short-term laboratory studies, formaldehyde was also shown to be a mutagen. Formaldehyde is widely used in a variety of products and industrial processes. However, its principal use is in the production of synthetic resins, such as urea-formaldehyde and phenol-formaldehyde resins. Approximately 1.6 million U.S. workers in 60 different industrial categories are potentially exposed, with 57,000 workers potentially exposed for more than four hours per day. The OSHA PEL for formaldehyde is 3 ppm (8-hour TWA), with a ceiling concentration of 5 ppm and an acceptable maximum peak above the ceiling of 10 ppm for no more than 30 minutes in any 8-hour shift. In 1976, before the studies on formaldehyde's carcinogenic potential, NIOSH recommended that exposure be no more than 1.2 mg/m^3 of air (1 ppm) for any 30-minute sampling period. This REL was based on the chemical's irritant effects. However, in light of the carcinogenicity studies, NIOSH recommends that engineering controls and stringent work practices be employed to reduce occupational exposure to the lowest feasible limit.

In 1986, NIOSH presented testimony at an OHSA hearing reaffirming its recommendation that formaldehyde be regarded as an occupational carcinogen

and that no worker be exposed to a concentration of formaldehyde greater that 0.1 ppm in any 15-minute period. This represents the lowest reliably quantifiable concentration at the present time. In 1987, NIOSH, in a letter to OSHA, clarified its REL by stating that exposure to formaldehyde not exceed 0.1 ppm for any 15-minute sampling period and 0.016 ppm as an 8-hour TWA. These recommended exposure limits are intended to protect against carcinogenic and other health effects of peak and chronic exposure.

CIB #35--Ethylene Oxide (EtO): Evidence of Carcinogenicity

Issued: May 22, 1981 (#81-130)

NIOSH recommends that EtO be regarded in the workplace as a potential occupational carcinogen and that appropriate controls be used to reduce worker exposure. This recommendation is based primarily on an animal study sponsored by Union Carbide Corporation, which showed an association between EtO and leukemia in female rats and peritoneal mesotheliomas in male rats. It is also supported by epidemiologic studies that show an excess risk of cancer mortality among EtO workers. Other studies have demonstrated the chemical's mutagenic and reproductive hazard potential. EtO is primarily used as an intermediate in the production of several industrial products, such as ethylene glycol for automobile antifreeze, and as an intermediate for polyester fibers, films, and bottles. It is also used in the production of nonionic surface-active agents for industrial applications, heavy-duty laundry detergents, dishwashing formulations, and glycol ethers and ethanolamines. In addition, it is used as a fumigant and sterilant. The OSHA PEL for EtO is 50 ppm (90 mg/m^3)(8-hour TWA). NIOSH supported that PEL in 1977 and also recommended a ceiling limit of 75 ppm (135 mg/m^3) as determined in any 15-minute sampling period. NIOSH now recommends that the present OSHA PEL be reexamined in light of the discovery of EtO's carcinogenic potential. Meanwhile, NIOSH urges employers to voluntarily assess the conditions under which their workers may be exposed to EtO and to take all reasonable steps to reduce exposure. In addition, the NIOSH "Guidelines for Minimizing Worker Exposure to Ethylene Oxide" in Appendix I of this CIB should be applied to specific work situations.

In a 1982 memorandum to OSHA, NIOSH reiterated its previous conclusions on EtO and recommended that OSHA reexamine its PEL. In 1983 testimony at the OSHA rulemaking hearing for ethylene oxide, NIOSH concluded that ethylene oxide is mutagenic and carcinogenic and capable of causing adverse reproductive effects in animals and humans. NIOSH recommended that exposure be reduced through engineering controls to the lowest feasible concentration. NIOSH also recommended that exposure be controlled so that no worker is exposed to EtO at more than 5 ppm for more than 10 minutes in any working day and that an 8-hour TWA be set at less than 0.1 ppm.

CIB #36--Silica Flour: Silicosis

Issued: June 30, 1981 (#81-137)

Based on NIOSH studies at two silica flour mills, NIOSH warns that producers and users of silica flour may be at great risk of developing silicosis, a debilitating respiratory disease caused by inhalation of fine crystalline silica dust that is retained in the lungs. Silica flour is used industrially as an abrasive cleaner and as an inert filler. It is found in

toothpastes, scouring powders, metal polishes, paint, wood fillers, and road-surfacing mixtures and is used in some foundry processes. The actual number of workers exposed to silica flour in the United States is unknown. In 1974, NIOSH published a criteria document (#75-120) with an REL of 50 g/m^3 (TWA 10-hours/day, 40-hours/week) for silica dust. In addition, NIOSH recommended that silica sand or other materials containing more than 1% free silica be prohibited as abrasive substances in abrasive blasting or cleaning operations. NIOSH recommends that employers and workers take appropriate actions to reduce exposure to this limit by labeling silica flour containers and using exposure monitoring, engineering controls, medical surveillance, work practices, personal protective equipment, and worker education.

CIB #37--Ethylene Dibromide (EDB), Revised

Issued: October 26, 1981 (#82-105)

Because of anticipated increased exposure in the use of EDB as a fruit fumigant, NIOSH reaffirms its 1977 recommendation that EDB be treated as a potential occupational carcinogen. Animal studies have confirmed that EDB is carcinogenic and that chronic exposure may increase the risk of mutagenic, teratogenic, and other adverse reproductive effects as well as adverse effects on the liver, kidneys, heart, and other internal organs. The studies also indicated that skin contact with EDB produced chemical burns and systemic effects from percutaneous absorption. Additionally, the studies confirmed the 1978 reports of increased toxic effects related to the interactions of EDB and disulfiram. EDB is used primarily as a scavenger in leaded fuels. It is also used as a soil, grain, and fruit fumigant; as an intermediate in the synthesis of dyes and pharmaceuticals; and as a solvent for resins, gums, and waxes. Approximately 108,000 U.S. workers are potentially exposed to the chemical during its production and use, in addition to an estimated 875,000 workers who are potentially exposed to very low concentrations while working with leaded gasoline. OSHA's current PEL is 20 ppm (8-hour TWA) with an acceptable ceiling concentration of 30 ppm. The maximum peak permitted above the acceptable ceiling concentration is 50 ppm for not more than 5 minutes in an 8-hour work shift. In 1977, NIOSH issued a criteria document (#77-221) recommending that exposure be limited to a ceiling concentration of 0.13 ppm (1.0 mg/m^3) for any 15-minute sampling period. NIOSH urges employers to voluntarily assess the conditions under which their workers may be exposed to EDB, especially with concurrent exposures to disulfiram or other similarly structured chemicals, such as Thiram®. NIOSH also reaffirms its 1977 REL of 0.13 ppm for EDB. Employers should regard this level as the upper boundary of exposure and make every effort to maintain the exposure as low as is technically feasible.

In 1984, NIOSH recommended in testimony to OSHA that the PEL be reduced to an 8-hour TWA of 0.045 ppm, with a 15-minute ceiling of 0.13 ppm.

CIB #38--Vibration Syndrome

Issued: March 29, 1983 (#82-110)

NIOSH concludes that vibrating handtools can cause vibration syndrome, a condition also known as vibration white finger and Raynaud's phenomenon of occupational origin. Vibration syndrome has adverse circulatory and neural

effects in the fingers. The signs and symptoms of vibration syndrome include numbness, pain, and blanching (turning pale or ashen) of the fingers. Of particular concern is evidence of advanced stages of vibration syndrome after exposures as short as 1 year. NIOSH recommends that jobs be redesigned to minimize the use of vibrating handtools and that power handtools be redesigned to minimize vibration. Approximately 1.2 million U.S. workers are exposed to hand-arm vibration and are potentially at risk of developing vibration syndrome.

CIB #39--Glycol Ethers, with Particular Reference to 2-Methoxyethanol and 2-Ethoxyethanol: Evidence of Adverse Reproductive Effects

Issued: May 2, 1983 (#83-112)

Based on the results of several recent studies, NIOSH warns that 2-methoxyethanol (2ME) and 2-ethoxyethanol (2EE) have the potential to cause adverse reproductive effects in both male and female workers. Both 2ME and 2EE can penetrate the skin. They are used as solvents in the manufacture of a variety of protective coatings as well as for nitrocellulose, printing inks, textile dyes and pigments, and leather finishes. They are also used as antiicing additives in brake fluids and aviation fuels, as antistall agents in gasoline, and in organic synthesis. Additionally, 2EE is used in varnish removers, thinners, cleaning products, soaps, detergents, cosmetics, pesticides, pharmaceuticals, and adhesives. An estimated 100,000 U.S. workers are potentially exposed to 2ME and 400,000 to 2EE. OSHA's PEL for 2ME is 25 ppm (80 mg/m^3)(8-hour TWA), and for 2EE it is 200 ppm (740 mg/m^3)(8-hour TWA). However, no studies on reproductive effects of the two chemicals were available when these PEL's were adopted. NIOSH believes that the OSHA PEL's for 2ME and 2EE should be reexamined in view of studies that demonstrated the adverse reproductive and embryotoxic potential of the chemicals. NIOSH also recommends that employers voluntarily assess their workers' exposure to 2ME and 2EE and reduce exposure to the lowest extent possible. Exposure to structurally related glycol ethers should also be reduced until adequate testing demonstrates their safety.

CIB #40--2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD, "dioxin")

Issued: January 23, 1984 (#84-104)

NIOSH recommends that TCDD be regarded as a potential occupational carcinogen and that occupational exposure be controlled to the fullest extent feasible. TCDD has demonstrated various systemic effects in animals at a wide range of exposure concentrations. These effects include tumorigenesis, immunologic dysfunction, and teratogenesis. Studies of humans exposed to TCDD-contaminated materials suggest that TCDD is the cause of observed chloracne, metabolic disorders, and other systemic problems. The studies are also suggestive of TCDD's ability to cause cancer. TCDD occurs as a contaminant of materials such as 2,4,5-trichlorophenol (TCP), 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), and 2-(2,4,5-trichlorophenoxy) propionic acid (silvex). Occupational exposure may occur through contact with these materials during use or from the past contamination of worksites; thus it is not possible to estimate accurately the current number of U.S. workers potentially exposed to TCDD. NIOSH also recommends that decontamination measures be used for TCDD-contaminated work environments.

CIB #41--1,3-Butadiene

Issued: February 9, 1984 (#84-105)

NIOSH recommends that 1,3-butadiene be regarded as a potential occupational carcinogen and teratogen and as a possible reproductive hazard. Inhalation exposure of rats and mice to 1,3-butadiene induced malignant tumors at multiple sites. The offspring of pregnant rats exposed to 1,3-butadiene had major skeletal defects. Epidemiologic studies of workers employed in facilities producing styrene-butadiene rubber showed an increased but not statistically significant risk of mortality from leukemia and from neoplasms of the lymphatic and hematopoietic tissues. Employers should take all reasonable precautions to reduce worker exposure to 1,3-butadiene. Styrene-butadiene rubber and polybutadiene rubber account for the two largest uses of 1,3-butadiene in the United States. Approximately 65,000 U.S. workers are potentially exposed to 1,3-butadiene.

CIB #42--Cadmium (Cd)

Issued: September 27, 1984 (#84-116)

NIOSH recommends that cadmium and its compounds be regarded as potential occupational carcinogens and that appropriate controls be implemented to reduce worker exposure. This recommendation is based primarily on two studies. An epidemiologic study has demonstrated an excess of lung cancer mortality among workers exposed to cadmium oxide, and a chronic inhalation-exposure study has shown a dose-dependent incidence of malignant lung tumors in rats exposed to cadmium chloride aerosol. In a 1976 criteria document (#76-192), NIOSH recommended an REL of 40 g/m^3 (10-hour TWA) and 200 g/m^3 of air as a 15-minute ceiling limit. This REL was intended to protect against the effects of cadmium on the respiratory system and the kidneys but not against the development of cancer. Cadmium is found primarily as cadmium sulfide in ores containing zinc, lead, and copper. Because of its low boiling point and its high vapor pressure relative to the metals with which it is found, cadmium volatilizes readily during smelting and then condenses to form fine airborne particles that react with oxygen to form respirable cadmium oxide fume. An estimated 1.5 million U.S. workers may be potentially exposed to cadmium.

CIB #43--Monohalomethanes: Methyl Chloride, Methyl Bromide, Methyl Iodide

Issued: September 27, 1984 (#84-117)

NIOSH recommends that methyl chloride, methyl bromide, and methyl iodide be considered as potential occupational carcinogens and that methyl chloride be considered a potential occupational teratogen. All three compounds were found to be direct-acting mutagens in the Ames assay. In experimental studies in either rats or mice using various routes of administration, these three compounds have demonstrated their ability to produce cancer. Methyl chloride produced heart defects in the offspring of pregnant mice exposed by inhalation. Employers should reduce exposure to these monohalomethanes to the fullest extent feasible. Commercially, the monohalomethanes are used as methylating agents, laboratory reagents, refrigerants, aerosol propellants, pesticides, fumigants, fire-extinguishing agents, anesthetics, degreasers, blowing agents for plastic foams, and chemical intermediates. Approximately 146,000 U.S. workers are potentially exposed to these monohalomethanes.

CIB #44--Dinitrotoluenes (DNT)
Issued: July 5, 1985 (#85-109)

NIOSH recommends that technical grade DNT (TDNT) and the 2,6-isomer of DNT (2,6-DNT) be considered potential human carcinogens in the workplace. Exposure to TDNT or 2,6-DNT has been shown to produce malignant tumors in rats or mice. In addition, a reproductive hazard may exist for workers exposed to TDNT or 2,6-DNT. Testicular atrophy, decreased spermatogenesis, or aspermatogenesis seen in three species of experimental animals exposed to TDNT form the basis for this concern. Additionally, limited evidence indicates that the 2,4-isomer of DNT (2,4-DNT) may pose a risk to human health. Therefore, NIOSH recommends that occupational exposures to TDNT and the isomers of DNT be controlled to the fullest feasible extent. DNT is used in the manufacture of dyes, munitions, and explosives, but its major use is in the production of toluenediamine, an intermediate in the production of polyurethane. Approximately 1,300 U.S. workers are exposed to the various forms of DNT.

CIB #45--Polychlorinated Biphenyls (PCB's): Potential Health Hazards from Electrical Equipment Fires or Failures
Issued: February 24, 1986 (#86-111)

Fire-related incidents involving electrical equipment containing PCB's have resulted in widespread contamination of buildings with PCB's and, in some cases, with polychlorinated dibenzofurans (PCDF's) and polychlorinated dibenzo-p-dioxins (PCDD's), including 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Emergency response personnel, maintenance or cleanup workers, or building occupants may be exposed to the compounds by inhalation, ingestion, or skin contact. In experimental animal studies, exposure to PCB's, PCDF's, or PCDD's has resulted in various effects, including decreased body weights, hepatic lesions, thymic atrophy, and adverse reproductive effects at a wide range of exposure concentrations. In addition, PCB's and TCDD have been shown to be carcinogenic in rats and mice. Humans exposed to PCB's, PCDF's, or PCDD's have developed chloracne, gastrointestinal disturbances, elevated serum enzyme and triglyceride levels, and numbness of the extremities. Epidemiologic studies of humans exposed to PCB's or PCDD's including TCDD are suggestive of an association between exposure to these compounds and increased incidences of cancer. NIOSH continues to recommend that PCB's and TCDD be regarded as potential human carcinogens in the workplace. Existing evidence also suggests that PCDF's may pose a risk to human health. Therefore, NIOSH recommends that occupational exposure to PCB's, PCDF's, and PCDD's resulting from electrical equipment fires or failures be controlled to the lowest feasible limit and that workers involved in decontamination activities use all necessary protective measures to prevent exposure.

CIB #46--Methylene Chloride
Issued: April 18, 1986 (#86-114)

B6C3F$_1$ mice exposed to methylene chloride in air developed cancers (alveolar/bronchiolar carcinomas) and tumors (alveolar/bronchiolar adenomas) of the lung, and cancers (hepatocellular carcinomas) of the liver. Fischer 344/N rats exposed to methylene chloride in air developed tumors (fibromas and fibroadenomas) of the mammary gland. Sprague-Dawley rats exposed to

methylene chloride in air developed cancers (sarcomas) of the salivary glands and tumors (fibromas and fibroadenomas) of the mammary glands. Though existing epidemiologic data derived from workers exposed to methylene chloride are inconclusive, the observation of cancers and tumors in both rats and mice treated with methylene chloride meets the criteria established in the Occupational Safety and Health Administration (OSHA) Cancer Policy for considering methylene chloride a "potential occupational carcinogen." Therefore, the National Institute for Occupational Safety and Health (NIOSH) recommends that worker exposure to methylene chloride be controlled to the lowest feasible limit. Methylene chloride is widely used in paint removers, degreasing agents, and aerosol propellants; as a blowing agent in flexible urethane foams; or a process solvent in the manufacture of pharmaceutical and food products, including the decaffeination of coffee; and as a fumigant for grains and fruits. Approximately 1 million U.S. workers are potentially exposed to methylene chloride or to products containing methylene chloride.

CIB #47--4,4'-Methylenedianiline (MDA)

Issued: July 25, 1986 (#86-115)

Wistar rats receiving a single injection of 2,2'-dihydroxy-N-nitrosodipropylamine (a tumor initiator) followed by 4,4'-methylenedianiline (MDA) in the diet for 19 weeks, developed thyroid follicular cell carcinomas and follicular cell and papillary adenomas. Fischer 344/N rats and B6C3F$_1$ mice receiving MDA as a 4,4'-methylenedianiline dihydrochloride ad libitum in drinking water for 2 years developed thyroid follicular cell carcinomas and adenomas, C-cell adenomas of the thyroid, hepatocellular carcinomas and adenomas, alveolar bronchiolar adenomas, malignant lymphomas, and benign tumors of the adrenal gland. Workers with airborne and dermal exposure to powdered MDA have developed toxic hepatitis. In addition, increased incidences of cancers of the bladder and large intestine and of lymphosarcoma and reticulosarcoma have been reported in workers with potential exposure to MDA.

The observation of cancers and tumors in both rats and mice treated with MDA meets the criteria established in the Cancer Policy of the Occupational Safety and Health Administration (OSHA) for considering MDA a potential human carcinogen in the workplace. Although there is limited evidence indicating that MDA presents a carcinogenic risk to humans, the probability of developing such effects would be decreased by reducing exposure to the compound in the workplace. Therefore, the National Institute for Occupational Safety and Health (NIOSH) recommends that occupational exposures to MDA be controlled to the lowest feasible limit. MDA is primarily used in the production of methylene diphenyl diisocyanate, which is used to produce polyurethanes. MDA is also used to make protective coatings, a hardening agent for epoxy resins, anti-corrosive materials, printed circuit parts, dyestuff intermediates, filament-wound pipe, and wire coatings. Approximately 9,000 U.S. workers may be exposed to MDA.

CIB #48--Organic Solvent Neurotoxicity

Issued: March 31, 1987 (#87-104)

Acute exposure to organic solvents can impair manual dexterity, response speed, coordination, or body balance. Epidemiologic studies of workers

chronically exposed to organic solvents have demonstrated reduced function of peripheral nerves and increases in the rates of neurobehavioral effects. Such effects include reversible, subjective symptoms (e.g., fatigability, irritability, and memory complaints), sustained changes in personality or mood, and impaired intellectual function (e.g., decreased learning ability, memory, and ability to concentrate). Results of studies involving the chronic exposure of animals to a limited number of organic solvents support the observations of peripheral nervous system dysfunction and neurobehavioral effects in humans. On the basis of the identified adverse health effects of solvent exposure, NIOSH recommends that employers use engineering controls, personal protective equipment and clothing, and worker education programs to reduce exposure to organic solvents--at least to the concentrations specified in existing OSHA PEL's or to NIOSH REL's or the ACGIH TLV's® if they provide a greater degree of protection. Approximately 49 million tons of industrial solvents were produced in the U.S. in 1984. They are used in paints, adhesives, glues, coatings, degreasing/cleaning agents, dyes, polymers plastics, textiles, printing inks, agricultural products, and pharmaceuticals. An estimated 9.8 million workers in these industries are potentially exposed to organic solvents by either skin contact or inhalation.

CIB #49--Injuries and Amputations Resulting From Work With Mechanical Power Presses

Issued: May 22, 1987 (#87-107)

The existing standard promulgated by OSHA for mechanical power presses (29 CFR 1910.217) provides requirements for press construction and operation. Power press operators, however, continue to be at risk of injury. Data from the Bureau of Labor Statistics indicate that about 20,000 amputations occur each year. Between 1,600 and 2,000 (approximately 10%) of these amputations have occurred among power press operators. Additionally, recent statistics compiled by OSHA indicate that approximately 49% of the injuries on mechanical power presses result in an amputation. Furthermore, NIOSH research indicated that young male operators appear to be at greater risk than other operators and mechanical power presses are the metal working machines most in need of research to improve safety. In 1980, there were an estimated 151,000 operators of mechanical power presses in the U.S. Adherence to the recommendations contained in this bulletin should reduce the risk of injury among mechanical power press operators.

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