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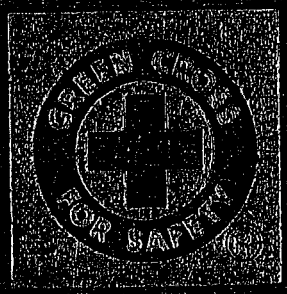
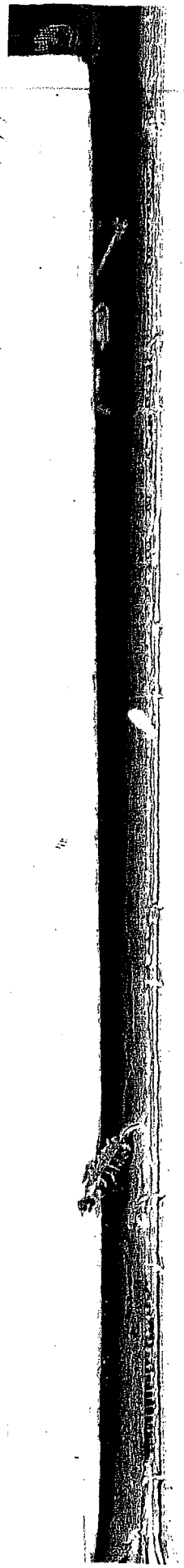


ACCIDENT PREVENTION MANUAL

FOR INDUSTRIAL OPERATIONS

NATIONAL SAFETY COUNCIL



4th Edition

ACCIDENT PREVENTION MANUAL

FOR INDUSTRIAL OPERATIONS

Two years before completion of this FOURTH EDITION of the *Accident Prevention Manual,* an unprecedented review of the previous edition's content was undertaken to update, refine, and augment text and illustrations.

The "pilot review" operation was conducted by members of the National Safety Council's Industrial Conference under the direction of its Publication Committee Chairmen W. O. Wilson and E. Clark Woodward.

Roy Benson, Secretary of the Conference and Manager of NSC's Industrial Department, coordinated the project in liaison with the Committee.

In all, close to four hundred reviewers—individuals experienced in the field of industrial safety—screened assigned sections of the Third Edition and provided a firm basis for thoroughgoing revision of that volume's forty-three chapters.

Revision manuscripts and copy for two and one-half entirely new chapters then were prepared by Industrial Department engineers and other NSC staff specialists, collaborating with a group of outstanding authorities drawn from the professions and industry of the nation.

A host of consultants checked final drafts and proofs and contributed commentaries that further improved the new edition's material.

The following credits name original authors of indicated chapters (in roman typeface) and FOURTH EDITION revision authors (in *italic* typeface).

cells, which appear as a dark or bloody urine. The kidneys may then become too clogged to operate at all.

The possibility of arsine formation should always be considered when there is hydrogen formation around the active metals or around ores of the heavy metals, since arsenic is widely distributed in small amounts and only a trace of it is required to produce enough arsine to be troublesome.

One of the more common sources of arsine incidents in recent years has been the handling of dross from the aluminum refining of metals.* Probably the most significant observation about these cases, aside from the fact that the moisture in the atmosphere is enough to form arsine, is the fact that the people involved in them have not been aware of the garlic-like odor which is supposed to be a warning of the presence of arsine.

The extremely high acute toxicity is reflected in the maximum acceptable concentration of 0.05 ppm. Arsine, in very small amounts, is also capable of producing a chronic type of poisoning, but it is more typically a source of acute episodes.

Asbestos is a hydrated magnesium silicate found in the minerals chrysotile, amianthus, actinolite, and tremolite. Practically all the commercial asbestos is either chrysotile or amianthus, and about 90 per cent of that used in this country is chrysotile. It is used almost exclusively for heat insulation or for textiles which must resist high temperature, such as heat-resistant clothing and brake linings.

Inhalation of excessive quantities of asbestos fiber can produce a fibrosis in the lungs similar to that found in silicosis but somewhat milder and usually not so rapidly progressive. Like silicosis, the condition develops slowly and advances slowly and is equally resistant to treatment.

Prevention is essentially dust control. A maximum acceptable dust concentration of 5 million particles per cubic foot has been suggested, precisely as for pure free silica.

Barium, in the form of its soluble salts, is toxic on both ingestion and inhalation and highly caustic when applied to the skin. The carbonate and sulfide are sufficiently soluble to be toxic, although not very caustic. The sulfate, which is used as a contrast medium in X-ray work, is too insoluble to show any toxicity, and soluble sulfates are specific antidotes for ingested barium salts.

Since these salts produce violent stimulation of all muscle, upon ingestion they produce severe disturbances of the digestive system. After absorption, the barium salts produce an increase of blood pressure by constriction of the arterial muscle, a slow heart beat by an action similar to that of digitalis on the heart, and first excitation and then paralysis of the central nervous system. In spite of the high inherent toxicity, there are few cases of industrial poisoning with barium. The maximum acceptable concentration for soluble barium compounds is 0.5 mg/m.[3]

Barium is a heavy metal, and the dust of the insoluble salts will collect in the lungs and give rise to the condition known as baritosis. Its nodular appearance on X-ray film may be mistaken for that of silicosis. Men showing the sign of baritosis are apparently not disabled or inconvenienced in any way.

Benzene is a colorless, flammable, volatile liquid with a rather pleasant aromatic odor. Its fire hazard is between that of ethyl alcohol and that of ether. *The greatest hazard is that of chronic poisoning by inhalation of comparatively small amounts over a long period of time. It is one of the two or three most dangerous organic solvents in commercial use.*

The action is primarily on the blood-forming organs, producing severe anemia, bleeding under the skin, and great reduction in the ability of the blood to clot.

The extent of chronic exposure to benzene may be determined qualitatively by measurement of the ratio of organic to inorganic sulfates in the urine. The most convenient measurement of damage is given by a blood count.

People who may be exposed to benzene vapor should have blood counts at regular intervals. Consistent change in the blood count should be closely investigated. Par-

*"Arsine Poisoning, Epidemiologic Studies of an Outbreak Following Exposure to Gases from Metallic Dross," Louis W. Spolyar, R. N. Harger, *AMA Archives of Industrial Hygiene and Occupational Medicine,* 8:419–436 (1950).

"Arsine Poisoning in the Smelting and Refining Industry," K. M. Morse and A. N. Setterlind, *AMA Archives of Industrial Hygiene and Occupational Medicine,* 2:148 (August, 1950).

TABLE OF CHEMICAL HAZARDS—*Continued*

Substance†	Flash point ° F.	Explosive limits % by volume Lower	Explosive limits % by volume Upper	Auto-ignition temperature ° F.	Maximum acceptable concentration for 8-hr. exposure	Usual mode of entrance to body	Signs and symptoms of poisoning	Evaporation rate Ether=1**
asbestos[7]		nonflammable			5 mppcf[36]	inhalation	*Chronic:* shortness of breath.	...
barium (soluble compounds)		peroxide, chlorate, and nitrate produce violent combustion in flammable materials			0.5 mg/cu m[36]	inhalation or ingestion of soluble salts, direct action on skin	Severe dermatitis from the caustic salts, vomiting, dyspnea, abdominal pain, cyanosis, paralysis.	...
benzene (benzol)[6, 48]	12	1.4	7.1	1000	25 ppm[36]	inhalation	*Chronic:* weakness, fatigue, bleeding from the gums and nose, headache, dizziness. *Acute:* inebriation, convulsions, and loss of consciousness.	2.8
benzene hexachloride	...	...	...	...	.....	.....	See lindane.	...
benzyl chloride[48]	153	1.1	...	...	1 ppm[36]	inhalation, skin contact	*Acute:* irritation of skin, eyes, nose, throat, and lungs.	47.8
beryllium[37, 52, 53]	...	...	...	...	2 μg/cu m[38]	inhalation	.....	...
bromine[9]	...	...	...	...	0.1 ppm[36]	inhalation, direct attack on skin and mucous membranes	Irritation of eyes and respiratory tract, irritation and corrosion of skin, probable lung irritation in acute cases.	...
butadiene—1, 3	gas	2.0	11.5	842	1000 ppm[36]	inhalation	Narcotic, irritation of eyes and throat, nausea.	...
butane—n	—76	1.9	8.5	806	none adopted (see gasoline)	inhalation	Mildly anaesthetic.	...
butanol (butyl alcohol—n)[10, 48]	84	1.4	11.2	650	100 ppm[36]	inhalation	No known industrial poisonings, local anaesthetic, narcotic, produces dermatitis.	19.6

*Open cup flash point.
**The higher the number, the slower the evaporation rate.
†Superior numbers in this column indicate collateral references.

TABLE OF CHEMICAL HAZARDS—*Continued*

Auto- Maxim Evapor

TABLE 45-O. A GUIDE TO VENTILATION RATES FOR TYPICAL INDUSTRIAL EQUIPMENT

State or Local Regulations Should Be Consulted and Followed Where Higher Ventilation Rates Are Specified

Operation	Ventilation		Usual Transport Velocity (FPM)	Remarks and References
	Type of Hood	Air Flow		
Abrasive blast rooms (sand, grit, or shot)	Tight enclosure with air inlets (usually in roof)	60-100 fpm downdraft (long rooms of tunnel proportions 100 fpm crossdraft)	3500	Ref. 8. Many codes specify minimum downdraft of 80 fpm
Abrasive blast cabinets	Tight enclosure with access openings	20 air changes per minute but not less than 500 fpm through all openings	3500	Ref. 14
Asbestos Carding Spool winding	 Enclosure Local hoods	 800 cfm per machine 50 cfm per spool	 3000 3000	Ref. 2, 16, 17. See references for details and other operations
Bagging Open bag top	Booth or enclosure (provide spillage hopper)	Paper bags—100 cfm per sq. ft. open area Cloth bags—200 cfm per sq. ft. open area	3500 3500	Ref. 18
Barrels — Drums (filling or removing material by scoop)	Local hood Booth	100 cfm/sq. ft. of container cross section 100 fpm at face	3500 3500	Ref. 15, 19. Hood with 1-in. slot extending 120 to 180 deg container. Does not confine spillage. Confine spillage—also recommended for container upsetting.
Belt conveyors	Hood at transfer point	Belt speeds less than 200 fpm-350 cfm per foot of belt width, but not less than 150 fpm through open area. Belt speeds over 200 fpm—500 cfm per foot of belt width but not less than 200 fpm through open area	3500	Ref. 18, 20.
Bins (closed top)	Connect to bin top away from feed point	150-200 fpm through open area at feed points	3500	Ref. 19, 20
Bucket elevators	Tight casing required	10 cfm per sq. ft. of elevator casing cross-section	3500	Ref. 19