

GENERAL SESSIONS

NSC OFFICERS MEMBERS p. 4-10

SAFETY EXPO EXHIBITORS p. 35-51

CEMENT, QUARRY, MINERAL OFFICERS p. 13, 14

CHEMICAL SECTION

RESPIRATORY PROTECTION p. 6-12
Is new respirator designed for protection against asbestos fibers a success? p. 12

CHEMICAL RESEARCH AND DEVELOPMENT OFFICERS p. 50, 51, 54-55

CONSTRUCTION, PUBLIC EMPLOYEE SECTION
use of respirators p. 71-86
respirator testing etc approval p. 87-89

CONSTRUCTION, PUBLIC EMPLOYEE OFFICERS p. 136-141

ELECTRICAL OFFICERS p. 24, 25

GLASS, CERAMICS, RUBBER, PLASTICS OFFICERS p. 33-35

INDUSTRIAL OFFICERS p. 102-120

LABOR OFFICERS p. 3

MARINE OFFICERS p. 43-46

METALS SECTION - DUST, MIST, FUME, RESPIRATORS p. 5-10
silica type dusts p. [illegible]

METALS OFFICERS p. 18-20

MINING OFFICERS p. 56, 57

PETROLEUM OFFICERS p. 36, 37

PUBLIC UTILITIES [illegible] p. 22-28

RAILROAD OFFICERS p. 12, 23

WOOD, TEXTILE OFFICERS p. 28-29

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57th NATIONAL SAFETY CONGRESS

Papers Delivered in the

GENERAL SESSIONS

CONTENTS

Officers of the National Safety Council, 1969-70 4

Trustees of the National Safety Council, 1969-70 6

Board of Directors of the National Safety Council, 1969-70 9

ANNUAL COUNCIL MEETING

Invocation ..... *Bishop William E. McManus* 20

Minutes of the Annual Council Meeting 21

Involvement of Youth in Safety ..... *Perry Joseph Ludy* 23

President's Report ..... *Howard Pyle* 25

Acceptance ..... *J. H. Tyler McConnell* 28

Remarks ..... *A. S. Alston* 29

NATIONAL SAFETY CONGRESS BANQUET 30

Address ..... *The Hon. John A. Volpe* 31

Exhibitors—57th National Safety Congress & Exhibition 35

Index to All (28) Volumes of 1969 National Safety Congress 53

Five Years of Future Dates for the National Safety Congress ..... Inside Back Cover

Other Volumes in 1969 National Safety Congress Transactions ..... Back Cover

000710

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GORDON H. SHEEHE, Director, Highway Traffic Safety Center, Michigan State University, East Lansing, Mich.

DR. W. HENRY SHILLINGTON, Field Secretary, General Board of Pensions of the Methodist Church, Evanston, Ill.

PERCY H. SHUE, Assistant Secretary, Program Development, Kiwanis International, Chicago, Ill.

MATTHEW C. SIELSKI, Vice President for Safety and Traffic Engineering, Chicago Motor Club, Chicago, Ill.

P. L. SIEMILLER, Washington, D. C.

JAMES M. SLAVIN, Director, Traffic Institute, Northwestern University, Evanston, Ill.

LOUIS J. SLAVIN, President, Hawthorne Paper Company, Kalamazoo, Mich.

JUSTIN B. SNYDER, Manager, Activities Department, Lions International, Chicago, Ill.

S. F. SPENCE, Director, Safety and Loss-Prevention, American Cyanamid Company, Wayne, N. J.

PETER R. SPILLER, United Auto Workers Local 588, South Holland, Illinois

LOUIS P. SPITZ, Executive Director, American Association of Motor Vehicle Administrators, Washington, D. C.

HERMAN J. SPOERER, Canfield, Ohio

WINSLOW A. STAHLE, Resident Manager, Liberty Mutual Insurance Company, Springfield, Massachusetts

STANFORD C. STODDARD, President, Michigan Bank, National Association, Detroit, Michigan

W. E. STUCKEY, Leader, Safety & Emergency Preparedness, Cooperative Extension Service, The Ohio State University, Columbus, Ohio

W. E. STUFANG, Director of Safety, Carrier Corporation, Syracuse, New York

EDWIN W. TANQUARY, Elmhurst, Illinois

VINCENT L. TOFANY, Commissioner, Department of Motor Vehicles, State of New York, Albany, New York

C. A. TOLIN, Vice President, Ralston Purina Company, St. Louis, Mo.

N. A. TROMBLEY, Manager, Industrial Health Services, Chrysler Corporation, Detroit, Mich.

J. W. TYSSE, Manager of Safety, Republic Steel Corporation, Cleveland, Ohio

JAMES F. VAN NAMEE, Administrator Accident Prevention, Westinghouse Electric Corporation, Pittsburgh, Pennsylvania

MRS. J. S. VAN WERT, Hampton, Iowa

DR. PRESTON A. WADE, Professor of Clinical Surgery, Cornell University Medical School, New York, New York

MRS. JOANNE J. WARREN, Bangor, Maine

CHARLES A. WEBB, President, National Association of Motor Bus Owners, Washington, D. C.

T. K. WEBB, Regional Vice President, Union Carbide Corporation, Charleston, West Virginia

MISS MARY M. WEEKS, Program Specialist, Health and Safety Education, Girl Scouts of the United States of America, New York, New York

BEN WEST, Attorney, Nashville, Tennessee

MISS JANICE R. WESTARY, M.P.H., Associate Professor, School of Public Health, The University of North Carolina, Chapel Hill, North Carolina

HUNTER P. WILKTON, General President, International Union of Operating Engineers, Washington, D. C.

GEORGE M. WHEATLEY, M.D., Senior Medical Director, Metropolitan Life Insurance Company, New York, New York

WILLIAM V. WHITE, Executive Director, National Commission on Product Safety, Washington, D. C.

VICTOR E. WHITEHOUSE, Director of Safety, International Brotherhood of Electrical Workers, Washington, D. C.

T. H. WILKENSON, Director of Safety, Department of the Army, Washington, D. C.

HOWARD L. WILLETT, Chairman, The Willett Company, Chicago, Illinois

S. L. WILLIAMS, Supervising Fire Protection Engineer, E. I. du Pont de Nemours & Company, Inc., Wilmington, Delaware

DORWIN L. WILLIAMS, Vice President, Training and Safety, Cleveland Transit System, Cleveland, Ohio

LOWELL F. WINGER, Vice President, Mountain States Telephone and Telegraph Company, Denver, Colorado

PAUL S. WISE, President, American Mutual Insurance Alliance, Chicago, Illinois

MACK W. WORDEN, Vice President, General Motors Corporation, Detroit, Michigan

REV. DAVID A. WORKS, Executive Vice President, North Conway Institute, Boston, Massachusetts

JOHN ZICH, Manager, Technical Data & Standards Department, Ford Motor Company, Tractor & Implement Division, Bloomfield Hills, Michigan

000719

George Washington Carver, or a Michelangelo.

I want to add that we are greatly concerned with the school bus problem overall. The typical school bus hasn't changed very much in design or safety performance since the thirties. Our current research is being stepped up to ensure the maximum feasible protection for the 17 million innocent youngsters who are being transported in these vehicles every day. We are studying problems of crash survivability, flammability of interior materials, roof crush strength, and escape and rescue procedures.

Let me also point out, however, that perfecting the vehicle will never solve the problem by itself. We must continue and intensify our broadbased efforts under the Highway Safety Act of 1966 to help the States tighten up motor vehicle inspection, driver education and licensing, to upgrade emergency medical services, to improve traffic enforcement and investigation, and to get some kind of effective control over lethal [illegible]

[illegible] fatalities and 5,000 injuries per year. An astonishing 44 per cent of drivers killed in accidents lost their lives because the other guy was drunk. Why should a drunk get a license in the first place? Why should he keep it, when it's so easy to prove his guilt?

It's as illogical — and inhumane — to give a driving permit to a known alcoholic with repeated convictions for drunk driving as it is to furnish knives to homicidal maniacs.

Let me emphasize that our major immediate focus will be on the chronic alcoholic; not the social drinker. The Report on Alcohol and Highway Safety which we submitted to the Congress in 1968 clearly pinpoints the alcoholic as the principal offender.

This is a problem we must face foursquare. We must move rapidly with a program to identify the alcoholic and control his access to a car. We must clear inebriated menaces off the road.

But we must also recognize that the social drinker who takes one too many poses a serious driving threat on the highway. We need related programs to help social drinkers, and especially young people, recognize that even limited amounts of alcohol can impair their driving skills and judgment.

Even a brief review shows that automotive safety is a complex, many-sided problem that is as much social as it is technical. We do not as yet have the problem under control. But I see hopeful signs that we are on the move — in the private sector, in State and local government, in the research community, and in the Federal Government itself, acting as a catalyst. It is self-evident that safety is a national problem requiring national solutions — not just a Federal program with [illegible]

The safer vehicles of tomorrow will be designed, built and marketed by Detroit. The safer drivers will be produced in local communities that take their young people's lives seriously. The better licensing and anti-alcohol procedures will emanate from the progressive State capitals. The more sophisticated public attitudes will be generated by councils such as this one — whose help is vital. And from the universities, foundations and research labs will come the new knowledge we need to build better [illegible]

Above all, we must find ways of mobilizing the full energies of the voluntary safety movement. The National Safety Council and its local chapters throughout the country exemplify the "grass roots" support and participation that is essential for success. We must find ways of helping these organizations to move ahead vigorously on this national problem.

If at first we can't prevent all accidents, we can at least make them the kind you walk away from. This is realistic; it's well within the reach of America's engineering brains and financial power.

Ultimately, however, safety can carry a price tag because human lives are at stake — it's an investment in the future of this country. We have made a start during the last two years. This Administration intends to push on toward the safer world of tomorrow with all the resources at our command.

Transportation safety undoubtedly must be, and will be, the challenge of the seventies.

With industry, the voluntary movement and government at all levels working together, the challenge can be met.

SAFETY EXPOSITION EXHIBITORS–1969

Aden Supply Co., 5706 W. River Dr., N. E., Belmont, Mich. 49306
Safety glasses.

Adolph and Company, 3453 W. Foster Ave., Chicago, Ill. 60625
Industrial clothing.

Advance Glove Mfg. Co., 901 W. Lafayette Ave., Detroit, Mich. 48226
Industrial work gloves and clothing.

Advanced Learning Systems, Inc., 25 E. Salem St., Hackensack, N. J. 07601
Instruction in safe lifting practices.

Ag-Tronic, Inc., 1801 W. "B" St., Hastings, Nebr. 68901
Slow moving vehicle emblems.

Akron Brass Mfg. Co., P. O. Box 86, Wooster, Ohio 44691
Fire fighting equipment.

Alan Wood Steel Co., Conshohocken Road, Conshohocken, Pa. 19428
Abrasive rolled steel floor plate.

Alderson Research Laboratories, 390 Ludlow St., Stamford, Conn. 06904
Teaching and training mannikin.

Allied Glove Corp., 4308 W. Armitage Ave., Chicago, Ill. 60639
Gloves and clothing.

American Allsafe Co., Inc., 1245 Niagara St., Buffalo, N. Y. 14213
Drybrow sweatbands, nylon fan guards and related products.

American Chain and Cable Co., Inc., 929 Connecticut Ave., Bridgeport, Conn. 06602
Sling chains and sling chain assemblies, wire rope slings and assemble-your-own wire rope slings.

American Footwear Corp., 1 Oak Hill Rd., Fitchburg, Mass. 01420
Safety shoes and boots.

American Industrial Safety Equipment Co., 3500 Lakeside Ave., Cleveland, Ohio 44114
Welding and cutting goggles, spectacles, welders' lenses, hard hats, visitors' spectacles, and goggle clips.

000720

American Optical Corp., 14 Mech[illegible] St., Southbridge, Mass. 01550
Head, eye, respiratory, protective devices; safety clothing; safety specialty products.

American Society of Safety Engineers, 850 Busse Hgwy., Park Ridge, Ill. 60068
Professional society.

Ames Publishing Co., One W. Olney Ave., Philadelphia, Pa. 19120
Industrial trade magazine publishers.

Ampco Metal, Inc., 1745 S. 38th St., Milwaukee, Wis. 53201
Hand tools of spark-resistant alloys for use in explosive or flammable conditions.

Ansul Co., One Stanton St., Marinette, Wis. 54143
Fire protection products.

Antrex Corp., 4355 N. Avers, Chicago, Ill. 60618
Safety Talker Message Repeater, portable public address systems.

Apex Safety Products, Washington and Elm Sts., Cleveland, Ohio 44113
Safety hats and caps.

Arnar-Stone Laboratories, Inc., 601 E. Kensington Rd., Mt. Prospect, Ill. 60056
Americaine Topical Anesthetic.

Atlas Safety Equipment Co., Inc., 175-179 N. 10th St., Brooklyn, N. Y. 11211
Industrial safety belts, harnesses, and straps. Ladder climber's safety device. St
Genie descent control.

Babbitt Industries, Inc., 340 Roebling Rd., S. San Francisco, Cal. 49080
Eye and head protection.

Bacharach Ind. Inst. Co., 625 Alpha Dr., Pittsburgh, Pa. 15238
Gas analyses instruments. Humidity and temperature indicators and recorde
Multi-gas leak detectors. Air flow velocity indicators.

Badger-Powhatan, Rt. #9, Ranson, W. Va. 25438
Fire protection equipment.

B & K Instruments, Inc., 5111 W. 164th St., Cleveland, Ohio 44142
Hearing protection equipment.

W. M. Bashlin Co., 119 W. Pine St., Grove City, Penn. 16127
Linemen's and industrial safety belts, slings, high voltage rubber gloves, sleeves.

Bauer Mfg. Co., 1505 E. Bowman St., Wooster, Ohio 44691
Ladders.

Bausch & Lomb Inc., 635 St. Paul St., Rochester, N. Y. 14602
Vision and audio testing equipment.

Bell Glass & Mirror Co., 1328 Flatbush Ave., Brooklyn, N. Y. 11210
Traffic safety mirrors.

Bell & Howell Co., 7100 McCormick Rd., Chicago, Ill. 60645
Motion picture cameras, projectors, and filmstrip projectors.

Beltone Electronics Corp., 4201 W. Victoria, Chicago, Ill. 60646
Hearing protection equipment.

Best's Safety Publications, A. M. Best Co., Inc., Park Ave., Morristown, N. J. 07960
Safety publications.

Best Mfg. Corp., Menlo, Ga. 30731
Work Gloves.

Channing L. Bete Co., 45 Federal St., Greenfield, Mass. 01301
Scriptographic Booklets.

Big Beam, 290 E. Prairie St., Crystal Lake, Ill. 60050
Battery operated hand lamps, flashers, emergency lights.

E. W. Bliss Co., 80 Second St., S. Portland, Maine 04106
Fire fighting equipment.

H. L. Bouton Co., Inc., 320 Main St., St. Buzzards Bay, Mass. 02532
Industrial eye protection, goggles, and spectacles.

W. H. Brady Co., 727 W. Glendale Ave., Milwaukee, Wis. 53209
Self-sticking markers and accident prevention signs.

Lester L Brossard Co., 540 N. Michigan Ave., Chicago, Ill. 60611
Safety mirrors for industrial use. Liquid hand cleaner.

Stewart R. Browne Mfg. Co., 839 Stewart Ave., Garden City, N. Y. 11530
Portable explosionproof inspection lights.

Brunswick Corp., 69 W. Washington St., Chicago, Ill. 60602
Anti-static clothing.

Buckeye Fire Equipment Co., 4103 Detroit Ave., Cleveland, Ohio 44113
Fire fighting equipment.

R. H. Buhrke Div., Mathias Klein & Sons, Inc., 7200 McCormick Rd., Chicago, Ill. 60645
Hand tools, safety belts, linemen's equipment.

E D. Bullard Co., 2680 Bridgeway, Sausalito, Calif. 94965
Safety hats, caps, and accessories, industrial first aid kits, safety hoist hooks, ve-
hicle alarms, air purifiers, and ear plugs.

CAH Industries, 10245 Pacific Av[illegible]nklin Park, Ill. 60131
Self-extinguishing waste recep[illegible]

Calgon Commercial Div., Calgon C[illegible] 7501 Page Ave., St. Louis, Mo. 63166
Hand cleaning products.

Canrad Precision Industries, Inc., [illegible]fth Ave., New York, N. Y. [illegible]
Safety signs.

Cardox Div., Chemetron Corp., 84[illegible] Michigan Ave., Chicago, Ill. 60611
Fire fighting equipment and supplies.

000721

Carhoff Co., 13440 Cedar Rd., Cleveland, Ohio 44118
Lens cleaning items.

Casco Products Corp., 512 Hancock Ave., Bridgeport, Conn. 06602
Hand-portable pressurized dry chemical fire extinguishers.

Casell Co., Inc., 1785 Tanen St., Napa, Calif. 94558
Emergency lights and barricades.

Cesco Safety Products, 2727 W. Roscoe St., Chicago, Ill. 60618
Safety glasses and lenses, cup goggles, special purpose goggles, welding helmets, face shields, respirators, plastic aprons, and hoods.

A. B. Chance Co., 210 N. Allen St., Centralia, Mo. 65240
Hot line maintenance and line construction tools. Hot line tools.

Charleston Rubber Co., 16 Stark Industrial Park, Charleston, S. C. 29405
Rubber, plastics, and rubber coated gloves, aprons and sleeves.

Chrysler Corp., 341 Massachusetts Ave., Detroit, Mich. 48231
Safety features in 1967 line of automobiles and trucks.

David Clark Co., Inc., 360 Franklin St., Worcester, Mass. 01604
Muff-type ear protection.

Clear View, 5701 W. 60th Ave., Arvada, Colo. 80002
Lens cleaning items.

The Coca-Cola Co., P. O. Drawer 1734, Atlanta 30301
Coca-Cola served through the courtesy and cooperation of the Coca-Cola Bottling Company of Chicago

Columbus McKinnon Chain Div., 160 Fremont St., Tonawanda, N. Y. 14152
Sling chains, hooks, and coupling links.

Converse Rubber Co., 392 Pearl St., Malden, Mass. 02148
Safety toe rubber footwear, industrial rubber footwear, protective clothing of rubber and neoprene.

Custom Materials Inc., Alpha Industrial Park, Chelmsford, Mass. 01824
Static-free permanently conductive polyolefin.

Den-Va Company, 62 Stanhope St., Brooklyn, N. Y. 11221
Nylon safety spectacles.

Detex Corp., 53 Park Place, New York, N. Y. 10007
Watchmen's clocks.

R. E. Dietz Co., 225 Wilkinson St., Syracuse, N. Y. 13201
Lanterns, torches, flashers, barricades, and safety equipment.

Dockson Corp., 3839 Wabash Ave., Detroit, Mich. 48208
Spectacles, goggles, face shields, helmets, hats, and respirators.

Dow Corning Corp., Midland, Mich. 48640
Sight Savers, lens cleaning stations.

Duff-Norton Co., 100 Pioneer Rd., Box 1719, Charlotte, N. C. 28201
Hand chain hoists.

E. I. du Pont de Nemours & Co., Inc., Centre Rd. Bldg., Wilmington, Del. 19898
"Nomex" fabric.

Duracraft Corp., 2630 S. 2nd W., Salt Lake City, Utah 84110
Gloves.

Durable Textile Products Co., 809 N. 19th St., Philadelphia, Pa. 19130
Dust masks.

Eagle Mfg. Co., 24th & Charles Sts., Wellsburg, W. Va. 26070
Safety cans, cigarette-cigar butt cans, drain cans, drip cans, brass oilers.

Eastern Metal of Elmira, Inc., 1430 Sullivan St., Elmira, N. Y. 14901
Safety signs.

Eastern Safety Equipment Co., Inc., 36-12 Astoria Blvd., Long Island City, N. Y. 11103
Safety goggles and spectacles.

Economy Engineering Co., 484 Thomas Dr., Bensenville, Ill. 60106
Telescoping work platform.

Edmont-Wilson, 1205 Walnut St., Coshocton, Ohio 43812
Coated and impregnated work gloves.

Electronic Specialties Co., 525 River St., Batavia, Ill. 60510
Warning lights, barricades, and accessories.

Elkhart Brass Mfg. Co., Inc., 1302 E. Beardsley Ave., Elkhart, Ind. 46514
Nozzles and other fire department supplies and fire fighting equipment.

Emed Co., Inc., 1573 South Park Ave., Buffalo, N. Y. 14220
Safety signs.

E M F Corp., 4239 24th Ave., W., Seattle, Wash. 98199
Brakes for electric motors.

Encon Mfg. Co., 4914 Dickson St., Houston, Tex. 77007
Eye wash fountains, emergency showers, personal air conditioning equipment.

Erdco Engineering Corp., 136 [illegible] Road, Addison, Ill. 60101
Gas vapor alarm systems.

Falcon Safety Products, Inc., [illegible] Route 22, Mountainside, N. J. 07092
Fire alarms, sirens, horns, [illegible] and other signaling devices.

000722

Faultless Rubber Co., 268 E. Fourth St., Ashland, Ohio 44805
Industrial gloves.

Federal Sign and Signal Corp., 13625 S. Western Ave., Blue Island, Ill. 60406
Sirens, horns, bells, and warning lights for visual and audible signaling.

Fendall Co., 2222 Diversey Pkwy., Chicago, Ill. 60647
Spectacles, face shields, and cup-type and cover goggles.

Ferno-Washington, Inc., 6th and Pine Sts., Greenfield, Ohio 45123
Emergency patient handling equipment and accessories for the first aid room.

Fibre-Metal Products Co., 5th and Tilghman Sts., Chester, Pa. 19016
Safety hats and caps, face shields, safety masks, welding helmets, headrest and combination goggles.

Fine Organics, Inc., 205 Main St., Lodi, N. J. 07644
Solvents, carbon removers, emulsion cleaners, polishers, and disinfectants.

Fire-Atak, Ltd., 777 Dundas St., E., Toronto, Canada
Fire extinguishers.

Ford Division—Ford Motor Co., Box 658, Dearborn, Mich. 48121
Ford passenger car with safety features.

Franklin Metal Products, 217 N. Jefferson St., Chicago, Ill. 60606
Safety cans, containers, smoking receptacles.

Frommelt Industries, Inc., 465 Huff St., Dubuque, Iowa 52001
Wrap-around portable safety welding shield; portable welding screen.

Fyre-Blok, First National Bank Arcade, Huntington, W. Va. 25715
Vehicle safety device.

Fyrepel Products, Inc., 951 Buckeye, Newark, Ohio 43055
High heat protective clothing and equipment for industry, space-military, and fire fighting agencies.

General Fire Extinguisher Corp., 1685 Shermer Road, Northbrook, Ill.
Fire Extinguishers.

General Motors Corp., 3044 W. Grand Blvd., Detroit, Mich. 48202
Automotive safety.

General Radio Co., 300 Baker Ave., W. Concord, Mass. 01781
Hearing protection equipment and testing.

Gen Tex Corp., Box 315, Carbondale, Pa. 18407
Head protection equipment.

Glas-Tex, 14832 Arrow Highway, Baldwin Park, Calif. 91706
Fiberglass safety signs

Glendale Optical Co., Inc., 130 Crossways Park Drive, Woodbury, N. Y. 11797
Eye and face protective equipment.

Globe Div. U. S. Gypsum, 101 S. Wacker Drive, Chicago, Ill. 60606
Safety grating, cable tray, channel and fittings, slotted angles.

Globe Safety Products, 125 Sunrise Place, Dayton, Ohio 45407
Resuscitators.

Goodall Rubber Co., Whitehead Rd., Trenton, N. J. 08638
Fire hose, hose couplings, nozzles, and adapters.

B. F. Goodrich, Industrial Products Co., 500 S. Main St., Akron, Ohio 44313
Industrial rubber safety footwear, and protective clothing.

The Granet Corp., 25 Loring Drive, Framingham, Mass. 01701
Coated fabric work glove.

Graphic Caution Systems Div., Diversa Mfg. Co., 4518 Lakeside Ave., Cleveland, Ohio 44114
Changeable letter safety sign panels.

Grem, Inc., 23958 Clawiter Rd., Hayward, Calif. 94545
Ladders.

A. E. Halperin Co., Inc., 716 Columbus Ave., Boston, Mass. 02118
Stretchers, first aid kits, and accessories.

Haws Drinking Faucet Co., 4th and Page Sts., Berkeley, Calif., 94710
Emergency eyewash and showers.

Hazard Controls, Inc., Woodland & Yale Aves., Cherry Hill, N. J. 08034
Warning lights, barricades, signs, reflectors, cylinder clamps, lockouts, ladder shoes, can carriers, flags, and barrier rope.

Warren Heim Corp., 222 N. 5th Ave., Mt. Vernon, N. Y. 10553
Canvas buckets, bags, and protective covers.

Hild Floor Machine Co., Inc., 5339 W. Lake St., Chicago, Ill. 60644
Explosionproof vacuum cleaners and floor scrubbing and polishing machines.

Hilti Fastening Systems, 360 Fairfield Ave., Stamford, Conn. 06904
Power-assisted drive tools that fasten [illegible] and threaded studs into concrete, masonry and steel.

Himco, Inc., Valley Head, Ala. 35989
Ladders.

Hydra-Lok, Inc., 4600 Beechnut, Houston, Tex. 77003
Fire safety device.

000723

Hy-Test Safety Shoes, Div., of International Shoe Co., 1509 Washington Ave., St. Louis, Mo. 63166
Safety Shoes and conductive and nonconductive footwear.

Hytronic, Inc., 420 1st Ave., W., Seattle, Wash. 98119
Face shield and helmet with self-containing air ventilation blower.

Illinois Glove Co., 7301 N. Lawndale Ave., Skokie, Ill. 60078
Industrial work gloves and lineman's gloves.

Industrial Products Co., 2820 N. 4th St., Philadelphia, Pa. 19133
Industrial clothing.

International Film Bureau, Inc., 332 S. Michigan Ave., Chicago, Ill. 60604
Safety films available on a sales and rental basis.

Intext Driver Testing Equipment, 530 Electric St., Scranton, Pa. 18509
Driver testing equipment.

Interstate Rubber Products Corp., 908 Avilla St., Los Angeles, Calif. 90012
Traffic cone system for traffic control.

Iron Age Safety Shoe Co., 1205 Madison Ave., Pittsburgh, Pa. 15212
Work and dress-style safety shoes and safety rubber footwear.

Jackson Products, 5523 E. Nine Mile Rd., Warren, Mich. 48091
Goggles, welding helmets, face shields, safety hats and caps.

Jomac-Products, Inc., 863 Easton Rd., Warrington, Pa. 18976
Chemical and protective vinyl clothing and gloves, and terry cloth gloves and products.

Jones and Co., 861 Broad St., Providence, R. I. 02907
Full-vision visor goggles and replaceable lenses.

Junkin Safety Appliance Co., Inc., 3121 Millers Lane, Louisville, Ky. 40216
Interlocking barrier gate guard for power presses; safety shields for grinders; stretcher cases and stretchers.

Justrite Mfg. Co., 2061 N. Southport Ave., Chicago, Ill. 60614
Safety cans, bench cans, plunger cans, Oily waste cans. Electric lanterns and flashlights for use in hazardous areas.

Karel First Aid Supply Co., 4342 Ogden Ave., Chicago, Ill. 60623
Medical equipment for industrial hospitals and first aid rooms.

K-D Lamp Co., 1910 Elm St., Cincinnati, Ohio 45210
Emergency lighting.

Walter Kidde and Co., Inc., 675 Main St., Belleville, N. Y. 07109
Portable fire extinguishers, and accessories. Automatic carbon dioxide fire extinguishing system.

Kimberly-Clark Corp., N. Lake St., Neenah, Wisc. 54956
Industrial wipers, disposable industrial clothing.

Kimsafe, Inc., 4900 Campbell Road, Willoughby, Ohio 44094
Personal protection devices for industry.
Personal protection devices for employees in industrial plants.

Knapp Brothers Shoe Mfg. Corp., 173 Spark St., Brockton, Mass. 02401
Safety shoes.

J. Kunz Glove Co., 2141 W. North Ave., Chicago, Ill. 60647
Leather and rubber work gloves.

Laerdal Medical Corp., 136 Marbledale Rd., Tuckahoe, N. Y. 10707
Training aids and equipment for resuscitation and first aid.

Lectric Lites Co., 2504 W. Vickery St., Ft. Worth, Tex.
Barricade flasher lights and traffic signs.

Walter G. Legge Co., Inc., 101 Park Ave., New York, N. Y. 10017
Safety floor maintenance materials, Personnel and equipment grounding devices.

Lehigh Safety Shoe Co., First and Minor Sts., Emmaus, Pa. 18049
Leather and rubber safety footwear including conductive and electrical hazard shoes.

Lensclean, Inc., 151 W. 25th St., New York, N. Y. 10001
Lens cleaning products.

Liberty Protective Leathers, Box 211, Clark Mills, N. Y. 13321
Leather gloves and mittens.

Link Division-Singer, Colesville Rd., Binghamton, N. Y. 13902
Driver trainer.

Louisville Ladder Co., 1163 Algonquin Pkwy., Louisville, Ky. 40208
Fiberglass and aluminum steps, platforms, extension trestles, aluminum planks and stages, steel warehouse ladders.

Thom McAn Shoe Co., 67 Millbrook St., Worcester, Mass. 01606
Safety shoes.

Julian A. McDermott Corp., 1639 St[illegible], Ridgewood, Brooklyn, [illegible]227
Warning and safety lighting for [illegible] industrial and utility use.

Machinery Center, Inc., 1201 S. 6th W[illegible] Box 964, Salt Lake City, Utah 84110
Sala Safety Block.

000724

Magid Glove Mfg. Co., Inc., 2201 W. [illegible]ansia Ave., Chicago, Ill. 60647
Industrial gloves.

Maico Hearing Instruments, 7375 Bus[illegible] Lake Rd., Minneapolis, Minn. 5543[illegible]
Hearing protection equipment.

Marathon Rubber Products Co., Box 448, Wausau, Wis. 54401
Industrial first aid kits and supplies.

Mark Indicator Co., Box 70, Easton, Pa. 18042
Crane warning device.

Marketing Frontiers, 235 Bear Hill Rd., Waltham, Mass. 02154
Traffic safety products.

Mars Disposables, 350 Fifth Ave., New York, N. Y. 10001
Disposable wearing apparel.

Martindale Electric Co., 1375 Hird Ave., Cleveland, Ohio 44107
Protective masks and refills, protective eyeshields, and electrical testing instruments.

Martin-Decker Corp., 1928 S. Grand Ave., Santa Ana, Calif. 92705
Safety tools.

A. J. Masuen Co., Le Mars, Iowa 51031
Industrial first aid kits and supplies.

Medical Supply Co., 1027 W. State St., Rockford, Ill. 61101
First aid kits and accessories, Resuscitation training aids, stretchers.

Meyer Mfg. Inc., Box 114, Red Wing, Minn. 44066
Safety products for the protection of person while climbing.

Milburn Co., 3246 E. Woodbridge, Detroit, Mich. 48207
Protective hand creams and related products.

Miller Allied Corp., 1418 Park Ave., Alameda, Calif. 94501
Material handling slings and adjustable lifting safety beams.

Miller Equipment Co., Inc., 13th and New Sts., Franklin, Pa. 16323
Linemen's safety equipment and accessories.

Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh, Pa. 15208
Complete line of safety equipment for industry and mining.

Miracle Instrument Co., Inc., 1569 Third Ave., New York, N. Y. 10028
Safety self-ejecting lathe and drill press chuck keys.

Mopeco Div., General Cable Corp., 2001 S. Bannock St., Denver, Colo. 80223
Portable ventilating and heating equipment.

Morton Mfg. Co., 5th & Church Sts., Libertyville, Ill. 60048
Safety grating.

Mott Corp., 500 Shawmut Ave., LaGrange, Ill. 60526
Safety mowers.

M-P Corp., 6466 Chene St., Detroit, Mich. 48211
Safety blade for rotary lawn mowers.

National Assn. of Fire Equipment Distributors, Inc., 604 Davis St., Evanston, Ill. 60204
Technical association.

National Capital Building Supply Co., Inc., 640 T St., N. E., Washington, D. C. 20018
Ladder extension device.

National Display Specialties, Ltd., 15 Broad St., Brockville, Canada
Sign painting equipment.

National Fire Hose Corp., 516 E. Oaks St., Compton, Calif. 90024
Fire hose specialties for the industrial fire departments.

National Foam System, Inc., Union & Adams Sts., W. Chester, Pa. 19380
Fire fighting equipment.

National Marker Corp., 496 Waterman Ave., E. Providence, R. I. 02914
Sign markers.

Newco Mfg. Co., Inc., 3636 Main St., Kansas City, Mo. 64111
Wire rope fittings, miniature slings, and a miniature crane demonstrating various lifts.

Newton Glove, Inc., P. O. Drawer 271, Newton, N. C. 28658
Safety and work gloves.

Norris Industries, U. S. Highway #1, South, Newark, N. J. 07114
Fire extinguishers and fire fighting systems.

North American Signal Co., 2700 N. Pulaski Rd., Chicago, Ill. 60639
Emergency warning lights.

Northern Signal Co., 350 Tower Rd., Saukville, Wis. 53080
Flashers and barricades.

Occupational Hazards, 614 Superior Ave., W., Cleveland, O. 44113
Occupational Hazards Magazine.

On Gard Industrial Footwear, Inc., 5516 W. Cermak Rd., Chicago, Ill. 60650
Safety shoes.

Osborn Mfg. Co., 960 N. Lake [illegible] Kenosha, Wis. 53140
Safety pliers, lockout devices, [illegible]s and storage cases.

Pacific Plantronics, Inc., 111 Jo[illegible]e St., Santa Cruz, Calif. 95060
Communication headsets.

Pac-Kit Safety Equipment Co., [illegible]eca Place, Greenwich, Conn. 06831
First aid kits and supplies.

Paralta Equipment Co., 2036—[illegible] Pl., Hammond, Ind. 46325
Flashing lights, barricades, traffic cones, vests, flags, trouble lights, signs.

000725

Pass & Seymour, Inc., 50 Boyd Ave., Syracuse, N. Y. 13209
Electrical wiring devices.

Patent Scaffolding Co., 3100 S. Kilbourn, Chicago, Ill. 60623
Aluminum scaffolding, rolling, and wood and aluminum ladders.

Pedley-Knowles & Co., 533 Second St., San Francisco, Calif. 94107
Safety and work nets of manila rope and plastic.

Pem-All Mfg. Co., 39A Myrtle St., Cranford, N. J. 07016
Fire extinguishers.

The Pioneer Rubber Co., 1939 Tiffin Road, Willard, Ohio 44890
Industrial gloves.

Pitman Mfg. Co., P. O. Box 605, Grandview, Mo. 64030
Hydraulic digger, derrick, and aerial devices.

The Positive Safety Mfg. Co., 1052 E. 134th St., Cleveland, Ohio 44110
Power press safety devices.

Power-Pak Products, 83 Clyde Ave., Buffalo, N. Y. 14215
Fire Fighting Equipment.

Prairie State Products Co., 3822 W. Lawrence Ave., Chicago, Ill. 60625
Industrial safety signs.

Pressure Products, 320 W. Washington St., Charleston, W. Va. 25302
Safety sight glass.

Protectoseal Co., 1920 S. Western Ave., Chicago, Ill. 60608
Safety containers for the handling, storing and dispensing of flammable liquids.

Protexall Co., P. O. Box 307, Green Lake, Wis. 54941
Clothing.

Pulmosan Safety Equipment Corp., 30-48 Linden Pl., Flushing, N. Y. 11354
Respirators, eye protection, helmets, protective clothing, asbestos and leather gloves, safety glasses, first aid kits, and face shields.

Pyrotronics, Div. Baker Industries, 8 Ridgedale Ave., Cedar Knolls, N. J. 07927
Fire and smoke detection and alarm systems.

Racine Glove Co., Inc., Box 368, Rio, Wis. 53960
Safety gloves and apparel for industry and fire protection, safety specialty products.

Radiator Specialty Co., 1400 W. Independence Blvd., Charlotte, N. C. 28201
Traffic guides; cones, light, flags.

Rainfair, Inc., 1501 Albert St., Racine, Wis. 53401
Wet weather and safety clothing.

Ramset Fastening System, 289 Winchester Ave., New Haven, Conn. 06504
Low-velocity piston tool.

R. C. Industries, 320 Cantor Ave., Linden, N. J. 07036
Fire extinguishers.

Record Industrial Co., 3301 Arch St., Philadelphia, Pa. 19104
Industrial safety shoes, work clothing and work gloves.

Red Wing Shoe Co., 119 Main St., Red Wing, Minn. 55066
Safety workshoes, oxfords, and boots.

J. C. Renfroe Sons, Inc., 1926 Spearing St., Jacksonville, Fla. 32206
Safety clamps for lifting steel.

Reviv-A-Life Resuscitators, 8335 S. Halsted St., Chicago, Ill. 60620
Resuscitation equipment.

Reynolds Televator Corp., 1104 Sixth St., Muskegon, Mich. 49440
Telescopic work platform.

Rite Hardware Mfg. Co., 4530 San Fernando Rd., Glendale, Calif. 91204
Air-conditioned helmet systems.

Rockford I. C. Webb, Inc., 301 N. Madison St., Rockford, Ill. 61110
Noise resistant ear protectors.

Rose Mfg. Co., 2700 W. Barberry Pl., Denver, Colo. 80204
Automotive seat belts. Industrial safety belts, lanyards, net, and ladder safety devices.

The Rucker Co., 2366 Stanwell Ct., Concord, Calif. 94520
Electrical shock safety device.

Safeline Products, Putnam, Conn. 06260
Safety Clothing.

Safety & Industrial Net Co., 23 Edgerton St., East Hampton, Conn. 06424
Safety Nets.

Safety Clothing and Equipmen[illegible]0 E. 69[illegible] Cleveland [illegible]4103
Safety clothing and equipm[illegible]dustr[illegible]kers.

Safety First Products Corp., 17[illegible] Mill Road, Elmsford, N. Y. 10523
Portable stored pressure dry[illegible]l fire extinguishers.

000726

Safety First Shoes, Inc., 8th and [illegible]enleaf Sts., Allentown, Pa. 18105
Safety shoes for industry, ra[illegible] and military use.

Safety Guide Products, Borg-Warner Corp., 345 N. Third, Scottsburg, Ind. 47170
Highway warning devices.

The Safety Journal, Anderson, S. C. 29621
Safety publication.

Safeway Safety Products Corp., 918 Blackhawk Blvd., Rockton, Ill. 61072
Safety cans.

Salescaster Displays Corp., 1010 E. Elizabeth Ave., Linden, N. J. 07036
Illuminated moving message signs.

W. H. Salisbury and Co., 401 N. Morgan St., Chicago, Ill. 60622
Linemen's rubber protective devices.

Sawyer-Tower Products, Inc., 76 Stanley Ave., Watertown, Mass. 02172
Industrial protective, and safety clothing.

Schuberth Corp., 1205 Champlain St., Toledo, Ohio 43604
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Helmets, safety hats and caps, safety goggles, and wrap-around protective goggles

Scott Aviation, 225 Erie St., Lancaster, N. Y. 14086
Respirators, inhalators, and environmental protection equipment.

Searjeant Safety Products, 3111 Winton Rd., S., Rochester, N. Y. 14623
Press guards.

Seco Mfg. Inc., 4461 W. Jefferson, Detroit, Mich. 48209
Fire fighting equipment.

Seiberling Latex Products, 4500 S. E. 59th St., Oklahoma City, Okla. 73135
Industrial rubber gloves.

Sellstrom Mfg. Co., Highway 53 at U. S. 14, Palatine, Ill. 60067
Eye and face protective equipment.

The Servus Rubber Co., 1136 Second St., Rock Island, Ill. 61201
Rubber footwear of all types.

Sigma Engineering Co., 11320 Burbank Blvd., N. Hollywood, Calif. 91601
Hearing protection equipment.

Fred Silver & Co., 145 Sussex Ave., Newark, N. J. 07103
Traffic Safety Mirrors.

Singer Safety Products, 450 N. Lake Shore Dr., Chicago, Ill. 60611
Gloves, portable welding screens.

Speakman Co., 301 E. 30th St., Wilmington, Del. 19899
Emergency eyewash and showers.

Standard Industrial Products Co. of Ill., 3527 Farmington Rd., Peoria, Ill. 61601
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Standard Safety Equipment Co., 431 N. Quentin Rd., Palatine, Ill. 60067
Acid and chemically resistant clothing.

Standard Signs Inc., 3190 E. 65th St., Cleveland, Ohio 44127
Industrial accident prevention signs and road work area protection equipment.

Steel Grip Safety Apparel Co., Inc., 700 Garfield St., Danville, Ill. 60832
Hand and body protection.

Stephenson, Div. of Bangor Punta, Box 1000, Red Bank, N. J. 07701
Resuscitation equipment, Speedalyzer, Breathalyzer.

Stonehouse Signs, Inc., 5550 W. 60th St., Arvada, Colo. 80002
Accident prevention signs and tags.

Stop-Fire, Inc., U. S. 1 at Black Horse Lane, New Brunswick, N. J. 08902
Fire extinguishers.

Surety Rubber Co., North High St., Box 97, Carrollton, Ohio 44615
Safety apparel, gloves, sleeves, aprons, and specialized protective equipment.

Surty Mfg. Co., 4139 W. Kinzie St., Chicago, Ill. 60624
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Survivair, Division of U. S. Divers Co., 3323 W. Warner Ave., Santa Ana, Calif. 92702
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3M Co., Retail Tape & Wrap Div., 2501 Hudson St., St. Paul, Minn. 55119
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Titmus Optical Co., Inc., 1015 Commerce St., Petersburg, Va. 23804
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Toledo Pressed Steel Co., 397 Phillips Ave., Toledo, Ohio 43612
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Trans Continental Electronics Corp., 865 Roosevelt Ave., Secaucus, N. J.
Safety shower—eyebath combination.

Trippe Mfg. Co., 133 N. Jefferson, [illegible] Ill. 60606
Warning lights.

Tri-Tix, Inc., 6411 N. Mequon Rd., Mequon, Wis. 53092
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000727

Underwriters' Laboratories, Inc., 207 E. Ohio St., Chicago, Ill. 60611
An independent testing organization for public safety.

Unico Environmental Instruments, 150 Cove St., Fall River, Mass. 02720
Environmental health services.

Uniroyal, Inc., 1230 Sixth Ave., New York, N. Y. 10020
Safety footwear.

U. S. Forgecraft Corp., Box 387, Fort Smith, Ark. 72901
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United States Safety Service Co., 1535 Walnut St., Kansas City, Mo. 64108
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U. S. Safety Trolley Corp., 1070 Banksville Ave., Pittsburgh, Pa. 15216
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Velcro Corp., 681 Fifth Ave., New York, N. Y. 10022
The Velcro fastener.

Wagner Sign Service, Inc., 3100 Hirsch St., Melrose Park, Ill. 60160
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Welsh Mfg. Co., 9 Magnolia St., Providence, R. I. 02909
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Western Drinking Fountains, Inc., 45563 Industrial Pl., Fremont, Calif. 95438
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Western Optical Supply, 1200 Mercer St., Seattle, Wash. 98109
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Wheeler Protective Apparel, Inc., 224 W. Huron St., Chicago, Ill. 60610
Industrial safety apparel.

Whelen Engineering Co., Inc., 3 Winter St., Deep River, Conn. 06417
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Whitehall Laboratories, 685 Third Ave., New York, N. Y. 10017
Industrial first-aid.

Williams Jewelry and Mfg. Co., 4544 N. Western Ave., Chicago, Ill. 60625
Safety plaques, trophies, awards, emblems, badges, and incentives.

Willson Products Div., Electric Storage Battery Co., 2nd and Washington Sts., Reading, Pa. 19603
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Wolverine World Wide, 9341 Courtland Dr., Rockford, Mich. 49341
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Worklon, Inc., 64 New York Ave., Huntington, N. Y. 11744
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Worksafe, Inc., 12 W. 31st St., New York, N. Y. 10001
Protective clothing.

Wyandotte Chemicals Corp., Wyandotte, Mich. 48192
All-purpose absorbant for grease, oil.

Young Fire Equipment Corp., Cemetery Rd., Lancaster, N. Y. 14086
In-plant fire truck and utility carts.

American Assn. of Industrial Nurses, 101 W. Jersey Ave., Pitman, N. J. 08071
The industrial nurse's role in safety.

American Industrial Hygiene Association, 25711 Southfield Rd., Southfield, Mich. 48075
Information about associations activities.

American Medical Association, Council on Occupational Health, 535 N. Dearborn St., Chicago, Ill. 60610
Occupational Health literature.

American National Red Cross, 17th & D Sts., N.W., Washington, D. C. 20006
Water safety.

Chicago Fire Department
Information on the work of the Fire Prevention Bureau.

Chicago Police Dept., Traffic Div.
Traffic safety.

Inter-American Safety Council, 140 Cedar St., New York, N. Y. 10006
Safety publications, visual aids, and films, in Spanish for industrial, highway, and home.

Prevention of Blindness Inc., National Society for the, 16 E. 40th St., New York, N. Y. 10016
Literature and information in industrial and vocational school eye health and safety programs.

President's Committee on Employment of the Handicapped, 14th & Constitution Ave., N. W., Washington, D. C. 20210
Information on employing the handicapped.

U. S. Air Force Academy, Colorado 8[illegible]
USAFA Cadet Wing safety progra[illegible]

000728

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000729

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000730

ication to the operators of the unit and
r personnel working in the unit, who
not otherwise be aware of the type of
k being performed in their area of op-
ion. This can prevent them from possibly
ng a sample or draining a line, which
ld affect the area where the work is
g performed.

fter the repair work has been com-
ed, the maintenance supervisor checks the
rk site and determines to his satisfaction
t all work is completed. He then desig-
es on the permit that the job is completed
l returns the permit to the operations
ervisor.

The operating supervisor checks the work
a and determines to his satisfaction that the conditions are such that the equipment can be returned to normal service. This would include determining that the connecting lines have had their blanks removed, all lines are connected, all lockouts have been removed and the vessel closed up and ready for service. This should complete the permit.

In summary, a work permit is nothing but a check-list that formalizes a communication between people requiring a job to be done and people performing the job in order to obtain the desired result. This is effective communication. It is of no more value than the effort expended in completing it. It provides a means for the elimination of assumption. When we assume, we have made our first step towards trouble.

RESPIRATORY PROTECTION

By HOWARD H. FAWCETT
Technical Secretary, National Academy of Sciences, Washington, D. C.

Assisted By: W. Burgess, School of Public Health, Harvard University, R. J. Fireng Naval Ordnance Systems Command, E. Hyatt, Los Alamos Scientific Laboratory, G. S. MacLeod, Rite Hardware Manufacturing Co., W. H. Revoir, Chairman, Respirato Committee, Joint A.I.H.A., A.C.G.I.H., R. H. Schultz, U. S. Dept. of the Interio Bureau of Mines, Mary E. Seaver, R. N., Mobil Oil Co., and J. T. Siedlecki, Americ Medical Assn.

This presentation on respiratory protection is a report on a few of many impressions gleaned from representing the National Safety Council since 1963 on the A.S.A. (then U.S.A.S.I., now American National Standards Institute) Z88 Code on Respiratory Protection.

There are two views of standards. Some maintain that standards are the answer to the world's problems. Others dispute this, arguing that standards are only legal outs, which operate only to encourage compromise and easily-achieved performance, and that they serve no useful purpose to the common man who is not a fool. The answer as to the real value of standards is probably somewhere between these two extreme viewpoints. Standards are certainly not a panacea; they are no better than the paper on which they are printed if people do not understand their background and intelligently and honestly apply them.

The hazards of chemicals are best understood when chemicals are seen as part of a system. The system in this case consists of three parts: (1) a human being; (2) an environment; and (3) control by appropriate means such as ventilation, engineering changes, or protective devices (respirators, masks, hoods, or breathing apparatus.)

Some chemicals will fume when mixed (a mixture of glycerine with HTH); some will ignite or erupt (model fuel = 25 per cent nitromethane in methanol with HTH and other chemicals will explode when mixed with air and ignited by a spark (as the two drops of carbon disulfide with in an explosion gallery with a spark pump).

A philosopher once observed it is better to light a candle than to curse the darkness. Darkness is so widespread on this subject I am lighting three candles, using as my ignition source chromium trioxide with a drop of acetone. One candle is dedicated to the user of respiratory protective equipment. The second candle is dedicated to the regulatory authorities, especially to the U.S. Department of the Interior, Bureau of Mines. The third candle is respectfully dedicated to the manufacturers, in the hope they will communicate a little more effectively, and inform us more adequately, as to the limitations, as well as advantages, of their products.

As a result of all this light — three candle power — perhaps we will begin to understand more completely the complex problem of respiratory protection.

The American Chemical Society estimates 1½ million chemicals are known today, a million of which are referenced in chemical abstracts. In 1965, 3.28 billion people inhabited planet Earth, at least a third of whom were classified as illiterate (according to one United Nations study). Hence, even the best standards in the world on any subject will not be read by a third of the people. There are real barriers to knowledge, but we must find ways to use it more effectively if we and our descendants are to survive.

All is not hopeless, however. We do have at least some information on the potential hazards of several hundred, or at most a thousand or so chemicals. The National Safety Council currently has 60 or 70 chemical data sheets (and active work is underway by the Chemical Section on dozens more); the Manufacturing Chemists' Association has developed approximately a hundred chemical data sheets; the American Industrial Hygiene Association has prepared 150 hygienic guides. The National Fire Protection Association lists some data on perhaps 2,000 substances or combinations at most in 491M and 704M. Many substances — in fact, most — are still inadequately known insofar as safety aspects are concerned. Misleading references and incompleteness confuse even the knowledge which is available.

Several thousand chemicals are in everyday use or commerce. The system I mentioned previously deserves repeating for emphasis: man; environment; control. Man (or woman) alone contains thousands of variables about which we really know little. For example, a recently published paper shows that a group of several hundred per-

000731

[illegible] vary a thousand-fold in their ability to detect a typical gas odorant. Yet odor [illegible] criteria with respect to fitting face pieces for tightness against leakage, and odor is still the criteria used to determine when an industrial-type canister or chemical respirator has been expended in ability to absorb.

The environment is complex too, and full of unknowns. We really know little about the effects of environments on man. Even the A.C.G.I.H. tabulation of threshold limit values, which in the 1969 edition gives criteria for about 250 substances, admits in the preamble it should not be considered foolproof for prevention of injury to all workers, and must be used with intelligence by competent personnel. For short term exposure to higher concentrations, the Commonwealth of Pennsylvania and the National Academy of Sciences-National Research Council Committee on Toxicology have each attempted to establish short term exposure limits for several substances.

Beyond that, little real data or judgment is available. For example, no public limits have been established useful to someone who must evacuate an area in case of an accidental release, an emergency condition which is occurring with increasing frequency. The National Air Pollution Control Administration is understood to be considering the issuance of air quality criteria for short term exposures of the public to atmospheric contaminants under the authority of the Clean Air Act.

Changes in processes, materials, or other measures should be considered first when one begins to study environments. No standard is any better than the understanding and application of how it fits into the system, for it is intended to be a part of a whole, not an isolated piece of literature.

We next consider respiratory protection. We must know what is involved and in what concentration. We must select the correct device, we must train wearers in its use and carefully explain why. We must continually insure it is being properly maintained and cleaned and defective parts replaced. Finally, we must medically monitor the wearer to insure the device is, in fact, preventing the injurious substance from contact with the body — the real test of the success or failure of the system.

000732

All this costs money, real money, and unless we are willing to make this investment completely and properly, we should not attempt to protect at all, for only futility will result. You buy protection and human health — not a respiratory device.

Respiratory protection was not just invented. Some devices on display in the Dresden, Germany, Fire Museum are dated from 1875 to 1887. Even then, carbon adsorbents were used. For ammonia, a sponge soaked with vinegar was incorporated in a face piece, the ancestor of the chemical respirator. Ask about various devices — there is more background information than you might expect, and it is available if you insist on completeness.

In June 1969, students at a major university appeared in an academic procession wearing World War II surplus gas masks. This is a very serious matter; such masks are being sold in surplus stores all over the country, and they are essentially worthless. The same mistake occurred after World War I — thousands were sold or given away, and loss of life resulted from their misuse. If you come across such old equipment, destroy it at once before it kills.

Not all mask face pieces fit everyone properly. This is poorly appreciated, since we have a tendency to accept something offered without question. About 95 per cent of the adult population can be accommodated by the average full face piece if properly worn and adjusted. The various sizes and shapes of faces are well known; the Army and the Bureau of Mines are well aware of the problem of human variations, but most people who buy and wear masks are not.

Another confusing situation develops when the medical and nursing professions use the word "respirator" to indicate a device for inducing or modifying breathing. Two of these were recently condemned as unsafe by the Food and Drug Administration and ordered removed or recalled from the market. (Devices were manual bellows or bag-type blowers for introducing air into patients through a half-mask piece.)

Respirators are of many types, and the face pieces may not fit properly unless carefully adjusted. It should be noted that the recent revival of beards, sideburns, and other surplus hair on the face is definitely contra-indicated, since all Bureau of Mines tests show that a clean-shaven face is essential for a proper respiratory face piece fit, and this is mentioned in the Z88.2 Code.

There are also specialized respirators, such as the ones for radioactive materials and unusually toxic substances such as beryllium. Even more care than usual is required if they are to perform their intended purpose.

Several chemicals are now definitely known as carcinogenic. A list of a few noted by the A.C.G.I.H. in the 1969 revision include: 2-acetylaminofluorene; 4-aminodiphenyl; benzidine and its salts; dichlorobenzidine; 4-dimethylaminoazobenzene; beta-naphthylamine; 4-nitrodiphenyl; n-nitrosomethylamine; beta-propiolactone; and p-tolidine. These chemicals must be placed in a super-hazard classification, and leave no margin for error.

Another unresolved and very practical problem is the mechanism for wearing corrective lenses inside full face pieces by persons who are virtually helpless without the lenses. All internally-mounted lenses are subject to improper optical alignment when a mask is donned in haste; all external-mounted glasses, even with flat temples, permit or encourage leakage. Only an air-supplied hood accommodates glasses without sacrifice of safety due to leakage.

There appears to have been a serious lack of imagination and initiative over the years in the development and research into respiratory protection in this country. As noted previously, gas masks, respirators, and even self-contained breathing apparatus (including the oxygen self-generating devices) were in a considerably advanced state of development in Germany and England prior to the beginning of World War II when the United States first began to look at the problem. In some ways, the tremendous potential for application of technology and engineering know-how seems to have largely escaped the respiratory protection field. Very few significant advances in respiratory devices during the last fifty years have originated in the United States. (If calcite, the mixture of metal oxides which under favorably dry conditions, converts carbon monoxide to carbon dioxide, could appear as one outstanding American contribution, along with potassium superoxide and refinements in chemical oxygen sources). A number of impregnated activated carbons have been developed for certain vapors and gases.

A recent advance of the British seems very significant. "Schliere" is the German word for "streak" or "shadow". When one has the proper light source, lenses, and mirrors, it is possible to see as well as photograph shadows representing different densities of air or vapors. In one case, a man was introduced into the Schlieren system and very clear pictures were made of the air movements during inhalation and exhalation, as well as the normal upward air flow of the air closest to the body. This technique could be useful in studying respiration and respiratory devices. Already, it has suggested why we can expect dust and bacteria from clothing, such as coveralls or nurse's uniforms, to be transferred to the breathing zone due to the upward movement of air close to the body. There is much need for more creative initiative in the field of respiratory protection.

If we want a supply of oxygen in a self-contained device of some type, an interesting question arises as to the most effective and light-weight source. Here is an interesting comparison between the three possible oxygen sources — gaseous, liquid or solid:

Oxygen Sources

	Volume of Free Stored O_2	Weight Unit + Cont.	Space cu. in.
Gas	126	44.5	2,160
Solid	630	28	460
Liquid	860	19	1,355

Ref: Miller

All three have application; it should be obvious which offers the greatest potential for the future development of light-weight, long-life, self-contained breathing apparatus or hoods of some type if certain technical problems can be resolved.

As one practical illustration, a photo taken in Toronto a few years ago shows 72 forty-cubic-feet air or oxygen cylinders, part of the supply emptied by firemen in their attempts to control a fire. Large numbers of cylinders are needed, and few fire departments or plants have instant refill capability. This is certainly a serious limitation of the cylinder-supplied air or oxygen mask; chemical-oxygen self-generating masks have a similar limitation which is all too often overlooked. There are many instances of fires where many dozens of cylinders or canisters were expended. To illustrate the importance of this problem of masks as it affects the real world, here are some figures recently received from a state fire coordinator relating to the volunteer firemen in that state.

Active Firefighters 2,966

	No. of Devices	Mask/ Man	Time Mask	Man Hrs.	Add. Hrs.	Tot. Hrs.
Type N Masks	233	1-15	1 hr?	233	50?	283
Self-Gen. O_2 B. A.	123	1-30	1 hr?	123	246?	369
Demand-Air-O_2	351	1-12	½ hr	175	241	416
Spares	483					1068

20 men — 20 hrs. — alarm

Two-thirds time at actual exposure = 14 hrs. real "working time", for 2,966 men.

From this, the very real limits of operations of the firemen imposed by breathing apparatus and spare cylinders and canisters, become apparent.

There are certain fundamental limitations of any breathing equipment. These have not been widely appreciated.

1. Some substances highly toxic by skin absorption require skin, as well as breathing protection. Examples are: liquid HCN, aniline, other nitro and amino aromatic compounds, phenol, ethylenimine, and certain organo-phosphates. There are others.

2. Maintenance. There is no excuse for poor or inadequate maintenance of breathing apparatus, masks, or respirators, but in fact,

unless they are properly cleaned, adjusted, expendable parts replaced, canisters discarded after shelf-time is up, and all other recommendations (usually in small print in the instruction manual) taken, protection is an illusion, not a reality.

3. Training. The more complex the mask, starting with the self-rescuer and the dust mask to the self-contained breathing apparatus, the more the need for training. Unfortunately, the U. S. Bureau of Mines does not specify a real training course for wearers of self contained breathing apparatus other than mine-rescue devices. But train you must, in dark, smoke, wetness, cold, and heat, if you are to really acquire the degree of familiarity which will give you assurance about a mask or breathing apparatus when the chips are down and the emergency is real. The extreme importance of this statement is emphasized by numerous fatal cases, which, while beyond the scope of this presentation, are sobering and should some day be published by an impartial scientific organization.

To emphasize again, we must consider respiratory protection as part of the system—man, environment, control. Each part of the system, with all variations, must be carefully evaluated, weighed, and understood before any successful protection either by control measures or by protective devices can be effective. It is far more complicated than buying devices from a salesman who himself may not have all the necessary information or whose zeal for essential details may be less than enthusiastic.

If one wishes to succeed in using respiratory protective devices, we would recommend he look at it as part of a system—man, environment, and control. To ignore an in-depth analysis of any one of the three is essentially to negate any value from a device, no matter how high its rating or how costly its price.

Human life demands our best, and nothing is more vital or urgent to life than our next breath. As our three candles die out, so will life, but hopefully we have encouraged you to look deeply at breathing systems.

To emphasize that my concern for the inadequate state of respiratory protection is not unique, but is shared by others, I have invited a panel to sit with me, to attempt to answer questions.

MacLeod: We are advocates of the positive-pressure approach, with an air-supplied hood. This overcomes many objections of the usual devices or masks. We feel the positive-pressure approach is the device of the future, and it is gradually being recognized as such.

Siedlecki: Representing the medical end of the problem, I would emphasize the necessity for team work by the industrial physician, the nurse, the industrial hygienist, and the safety engineer in a complete evaluation and monitoring of the system. Employees with certain functional impairments or mental or emotional problems should not work in areas where there is potentially hazardous exposure to toxic substances requiring the use of respiratory protective equipment. Employees protected by respirators should have the same medical supervision as those protected by ventilation or other control measures.

Mrs. Seaver: The industrial nurse has a very real part in the education of workers in the need for and proper use of protective equipment, including respiratory. There is a great need in the nursing profession for more information about the system you mentioned. While we concentrate on the man, the environment and control components must be of concern to us as part of the health and safety team. We are anxious to help in this activity.

Hyatt: Even though respirators are the oldest known control measure for protection of the respiratory passages, health and safety men know less about selection and use of respirators than any other aspect of health and safety. I would stress one phase—in working with radioactive materials we knew we had to have a very high degree of protection. Looking at all the respirators made in the United States and other countries to see if they would fit, the one thing that we have learned that many health and safety men do not realize is that the half-mask face piece fits well only three out of four men, and not nearly that high a percentage of women.

Revoir: The use of respirators requires a complete program: knowing the hazard, selecting the proper device, training the user, supervising the use, maintenance, and medical surveillance. I feel that the greatest problem involving the use of respirators is poor maintenance. Even the best respirators, if poorly maintained, offer little protection. While in Florida to visit pesticide respirators in the field and in pesticide formulating plants, we found in most cases they were very poorly maintained. They did not give any protection.

Schutz: About ten years ago I heard you say that the respirator business was going to pot, and the Bureau of Mines was leading the way. In view of the new meaning of the word "pot," the old statement has a most interesting new twist, and we categorically deny the accusation is true.

Firenze: Our concern is for those people working in contaminated atmospheres where the nature and extent of the hazard are unknown or are difficult to determine. Firefighters cannot take the time nor do they have the facility to sample the environment to which they are subjected; consequently they often expose themselves to concentrations of contaminants outside the protective limits of their respiratory equipment. For this reason, equipment of this type should be carefully chosen to assure protection against high concentrations of gas, particulate matter, or a lack of oxygen in the atmosphere. Having the right man to select breathing equipment for the organization is crucial. In many instances, such people are lacking sufficient technical ability and information required for the task, thus making faulty decisions. Some of these faulty decisions have caused deaths. In one case, where 14,000 firemen were involved, the officer responsible for the purchase of respiratory equipment selected canister-type apparatus. After an unfortunate fatality occurred, his decision was reversed and self-contained equipment was purchased.

At this time there is a need for better self-contained breathing equipment. Innovations combining lightness and durability with greater capacity would make this type of apparatus more efficient. There is a major short-coming in today's self-contained equipment. In the event the wearer becomes pinned or unconscious there is no provision designed into his breathing equipment to automatically vent to the atmosphere when the air supply is exhausted. Some type of an emergency venting system is needed. Respiratory equipment manufacturers should consider this problem in the design of newer devices.

000737

Burgess: When I first entered the field of environmental health about twenty years ago, engineering control methods would improve and the usefulness of respirators would be limited by 1970. Quite the opposite has occurred. We seem to be faced with more and more cases which respirators are necessary. As the need for respirators increases, design and innovation must keep pace.

Question: With all your comments about air pollution compounds damaging respiratory systems, I am surprised you did not condemn the tobacco industry.

Answer: As Manager of Health and Safety and not far from the Roswell Park Cancer Research Center, we have read much scientific information that our number one killer is cigarette smoking. Probably five to six times as many people are killed by cigarettes as by automobiles, yet you know the slaughter on the roads. I will admit I am at a loss to know why we do so little about this source of deliberate air pollution. Perhaps it ties in with something I read about six years ago: the author said the strongest force in the world is not the nuclear bomb but human inertia; meaning it is difficult to change any of us from what we are doing at a particular moment.

Question: Does the National Academy of Sciences sponsor research on respiratory protection devices?

Answer: No, the NAS does not. The National Academy of Engineering recently completed a study for the U. S. Bureau of Mines involving both rescue and survival equipment and techniques.

Question: What is the best satisfactory method of combining prescription safety glasses with a full face mask, or full chin respiratory protection?

Answer: With a hood covering the whole area, any glasses can be worn. If needed in a full face piece, we suggest they be mounted completely inside the face piece.

Question: What is the status of the approval of agricultural respirators?"

Answer: For the past two years (since the Department of Agriculture discontinued the testing of respirators), there has been none. The Bureau of Mines in Washington has the problem under study, and should render

a decision shortly on whether the Bureau will undertake this additional responsibility. For the past two years, including today, there has been no monitoring of agricultural respirators in the United States.

Question: Are panel members advocates of (1) strong government laws and rules for industrial uses of respiratory protection, or (2) of voluntary use of respirators in industry?

Answer: The panel was polled, and five of the nine voted for option (1) four for option (2).

Question: Is the new respirator designed for protection against asbestos fibers a success?

Answer: The respirator developed by Johns-Manville is presently under field evaluation. One cannot answer your question at this time. However, the unit is light-weight and expendable. I understand that the present evaluation study will consider acceptance and level of protection afforded under field conditions.

Question: What will be the actual effect of the new Z88.2 code on the use of respirators?

Answer: It will be mandatory for users of respiratory protective devices to carry out a comprehensive program, including determination of the hazard, selection of the proper device, training the wearer, maintaining the device, and carrying out medical surveillance, since standard becomes, in fact, part of Federal health and safety regulations. Voluntary consensus standards such as this are considered to be part of new industrial health and safety regulations being issued by Federal agencies such as the U. S. Department of Labor.

SAFETY ASPECTS OF NUCLEAR GAUGES

By J. R. COLEMAN
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Nuclear gauges using radioactive isotopes were introduced in the early 1950's. These instruments are designed to provide continuous on-line information regarding process material thickness, composition, level, or density.

Prior to 1962, the industrial usage of such gauges was controlled by the United States Atomic Energy Commission. During 1962, a program was initiated to transfer this control to the individual states. At the present time 19 states have assumed this responsibility and are known as Agreement States. Licensing by one of these agencies is a prerequisite to the possession of a nuclear gauge.

In 1964, the Titanium Pigment Division of National Lead Company instituted a study to evaluate the process control capabilities of nuclear level and density gauges. This study has resulted in the installation of numerous nuclear measurement and control systems. Further, this study has established that the radioactive materials associated with these systems represent no health hazard when they are used in conjunction with appropriate safety procedures.

The Atomic Energy Commission and the Agreement State Boards of Health place the responsibility for the formulation and implementation of such procedures in the hands of the user and evaluate the results of safety programs via periodic inspection.

The radiation safety program developed by the Titanium Pigment Division of National Lead Company is the subject of this report. This program has been favorably received by the United States Atomic Energy Commission, the Canadian Atomic Energy Control Board, the Atomic Energy Technical Committee of the AFL-CIO and has been cited by the Prentice-Hall Publishing Company in their monthly *Personnel Management Report*.

As is the case with any potentially hazardous material, the characteristics of the material must be understood before effective safety measures can be formulated. The first portion of this report will deal with the characteristics of nuclear radiation and the basic principles of nuclear gauges.

000734

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000735

endeavor. Another problem often to be encountered when any new system is introduced into an organization is one arising from political controversies. These controversies may result from jealousies, rivalries, etc., between the safety system and other organizational subsystems. This problem is not uncommon and results primarily because of fears that this new system will detract from the effectiveness of existing systems. The safety administrator must allay this fear by clearly indicating how the safety system will enable other subsystems to maximize their effectiveness and contribute more to the overall organizational goal. After solving these initial problems, the safety administrator must work out a transitional plan for moving the new system into operation. He must consider when the system will be placed into operation and should determine if it is practical to place the entire system into existence at once, or if segments of the system should be phased into the picture at predetermined intervals. Another consideration concerns developing a plan for patterning the activity of the safety system's smaller subsystems. The administrator must be certain that the system's goals, objectives, strategies, rules for operation, work flow procedures, etc., are understood by each member of his system.

Once the system is implemented, it must be managed. The administrator must rely on basic management practices (e.g., planning, executing, and control) to be effective. He must be able to survive the demands of the future as well as the present. He will do well to consider alternative ways to accomplish his long range goals and objectives and weigh these against available resources. Projections of this kind will foster operational efficiency and effectiveness.

Ultimate Responsibilities of Safety System

Once designed and made operational, the safety system will make efforts to:

(a) gain and maintain management support;
(b) motivate, educate and train organizational personnel;
(c) develop and maintain an accurate record system;
(d) establish the duties and responsibilities of supervisory and employee personnel
(e) institute a system of accident investigation and reporting;
(f) establish safe work practices;
(g) provide controls over purchase, use, and maintenance of personal protective equipment;
(h) develop and maintain an accurate record system;
(i) provide a program of inspection for equipment, vehicles and buildings;
(j) provide a system of preventive maintenance for vehicles;
(k) maintain close liaison with medical units, legal units, and communication units;
(l) provide an employee suggestion program. A system must be promulgated by which to draw opinions and suggestions regarding safety from the rank and file.

In Conclusion

Only fundamental concepts of safety system design have been discussed here. Deeper consideration is required before these ideas can be made to satisfy individual organizational requirements. However, if the administrator treats the suggestions as a frame of reference from which he can further develop his system and add his own pertinent inputs, these ideas could lead to effective safety system development.

As a final note, we must be convinced that, for a safety program to be effective, it must permeate all operations within an organization. Operational effectiveness and safe work practices should be made synonymous.

We must also consider that the people in the organization can make or break the safety effort. It is therefore the responsibility of the safety administrator to sell the organization on the purpose and benefits of the program, and solicit its support.

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000738

RESPIRATORS—SELECTION AND TRAINING

By E. C. HYATT
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Although respiratory protective devices are probably the oldest method of controlling occupational diseases, health and safety men are generally less informed about the selection, applications, and limitations of these devices than about any other particular field in health and safety. It is emphasized that in the control of occupational diseases caused by airborne contaminants, primary consideration should always be given to preventing the air from becoming contaminated.

There are many situations in which respiratory protective devices are a must either for emergencies or routine use. Personal respiratory protective devices are intended to serve as adjuncts to other control measures, not as substitutes for them. However, because a large variety of these devices are available commercially and may be had on short notice and at relatively low cost, such equipment is frequently improperly selected, misused, and abused. All too many select and use respiratory protective devices on faith, without knowing where and when not, when and when not, to use these devices or how to select and use them properly.

To know this, it is necessary to understand the nature and extent of the exposure and the degree of protection needed, as well as to be acquainted with the various types of respirators and their uses and limitations. The many new and unusual occupational diseases resulting from industrial processes in the atomic and space age have created a demand for many types of respiratory protective devices with a very high degree of protection; however, the state of development of respiratory protective devices exceeds the state of their selection and use by health and safety personnel. In fact, the state of knowledge of the performance of respiratory devices in relation to the situation of use is better than the use that is made of them.

The essentials for training in the use of any respirator are (1) discussion of airborne contaminants; (2) reasons for using respirator; (3) description of its construction, operating principles and limitations; (4) instructions in procedures for assuring that it is in proper working condition; (5) instruction in fitting and checking proper fit; (6) instruction in proper use and maintenance; and (7) discussion of importance of careful reading of labels on respirator and manufacturer's instruction.

USE OF RESPIRATORS

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Although the best procedures to prevent inhalation of harmful air contaminants are the elimination of the contaminants at their source of generation or the reduction of the contaminant concentration to levels sufficiently low not to cause bodily harm, there are situations where, for one reason or another, these procedures are inapplicable, impractical, impossible, or not adequately effective. In such situations, respirators are utilized to protect personnel.

Prior to using respirators, a study must be made of the contaminated atmosphere to determine the nature of the hazard. The effective use of respirators requires the establishment and operation of a planned respiratory protection program. The program should include the following essential

000739

parts: selection; training; use; supervision; maintenance; storage and issue; medical surveillance; and evaluation. This paper will cover the use of respirators only.

After the proper respirator has been selected and the wearer has been trained to use it properly, it is essential that the wearer be given an explanation of the character and magnitude of the hazard, the principles of operation of the respirator, the probable time that the respirator will offer protection, how to recognize faulty functioning of the respirator, and instructions of what to do under emergency conditions resulting from his work or by accidental injury to his respirator.

It should be remembered that the normal oxygen content of atmospheric air at sea level pressure is 20.9 per cent by volume. The symptoms of anoxia begin to appear in humans in atmospheric air at sea level pressure when the oxygen content drops to 16 per cent by volume. Thus, an oxygen deficiency for humans in atmospheric air at sea level pressure exists when the oxygen content is less than 16 per cent by volume. The adverse effects of an oxygen deficiency increase with decreasing atmospheric pressure or increasing altitude.

Whenever possible, respirators tested and approved by the U.S. Bureau of Mines or respirators tested and listed as acceptable by the U.S. Department of Agriculture should be used. Sometimes, a respirator user must employ a respirator that has not been approved or listed as acceptable because either the type of respirator he must use is not covered by a test schedule or the hazard for which the respirator is to provide protection against is not covered by a test schedule. When this occurs, the respirator user must assure himself that the respirator manufacturer or another reliable organization has tested the respirator for the intended application and that the respirator manufacturer maintains a high standard of quality control during production.

Fitting of Respirator Facepiece

Fitting of a respirator facepiece is essential. Often, little attention is given to this matter. Difficulty may be experienced in fitting a full facepiece if the wearer has hollow temples or facial irregularities. A satisfactory seal cannot be obtained if spectacle temple bars extend under the sealing edge of the full facepiece. Systems for mounting corrective lenses inside full facepieces are available and should be used. The corrective lenses should be mounted in the facepiece by a qualified person to insure good vision. Wearing of contact lenses with a full facepiece should not be allowed. The contact lens prevents air from contacting the cornea of the eye and this hampers cooling of the cornea which can lead to corneal damage.

Fitting difficulties with a half-mask facepiece may be encountered if the wearer has a small, heavily jowelled, or irregular face. Missing rear teeth or the absence of upper or lower dentures can cause problems in fitting a half-mask facepiece. It may be necessary to try two or more styles or sizes of half-mask facepieces in order to obtain a good fit.

Headbands employed with half-mask facepieces may consist of a single loop of elastic strapping which passes around the head either below the ears or above the ears or may consist of two loops of elastic strapping, one loop passing around the head below the ears and the other passing around the head above the ears. The double loop headband will give a facepiece fit superior to that obtained with a single loop headband. The best fit of a half-mask facepiece can be obtained with a double loop headband which is attached to the facepiece at four separate points, two points on each side of the facepiece. Adjustment of the tension of the upper loop will insure a good facepiece fit around the nose, while adjustment of the tension of the lower loop will result in a good facepiece fit around the mouth and chin. The elastic strapping may be either rubber or woven elastic braid. The rubber strap material will last longer than the woven elastic braid. However, a strap of woven elastic braid will not slip on the head as easily as a strap of rubber, and thus a headband using woven elastic braid may result in a more secure facepiece fit than that provided by a headband using rubber.

Such conditions as excessive growth of hair on the face — sideburns, moustache, or beard — will prevent a good facial seal of both a full facepiece or a half-mask facepiece.

Each time a respirator is w[illegible] facepiece must be carefully fitted t[illegible] ing and yet be comfortable. [illegible] proper location of the facepiece on the face and satisfactory adjustment of the tension of headband or head harness straps. Instructions given by the manufacturer should be followed to improve fit and comfort.

A recent publication by Burgess and Held gives comprehensive details for four facepiece fitting tests that may be carried out in the field.[1] Respirator users are urged to refer to this article for detailed instructions. A simple positive pressure test may be used if the respirator contains an inhalation valve system. The wearer merely blocks off the exhalation valve and gently exhales into the facepiece to create a slight positive pressure. The facepiece fit is considered to be satisfactory if the positive pressure remains within the facepiece without observable leakage at the facial sealing area.

Another simple facepiece fitting test involves a negative pressure within the facepiece. In this test, the inlet part of a filter, cartridge, or canister is closed off by covering with the hand or a breathing tube may be squeezed. The wearer then inhales gently and holds his breath for five to ten seconds. If the facepiece fit is satisfactory, the facepiece will collapse against the face and no inward leakage of air between the facepiece and the face will be detected.

Another facepiece fitting test involves wearing the respirator in an odorous atmosphere. This test can be used for self-contained breathing apparatus, hose masks, airline respirators, and with air-purifying respirators that can be equipped with an organic vapor canister or cartridge. Isoamyl acetate, commonly called banana oil, is used to provide the odor, since its odor can easily be detected in a concentration as low as one part vapor per million parts of air. A small quantity of isoamyl acetate is poured on a cloth and the cloth is moved slowly around the periphery of the facepiece. If the wearer cannot detect the odor of isoamyl acetate, he has a satisfactory facepiece fit.

A highly irritant smoke can be employed to check the facepiece fit of self-contained breathing apparatus, hose masks, airline respirators, and air-purifying respirators that are equipped with ultra-high efficiency particulate filters. In this test, a highly irritant smoke is generated by a commercially available smoke tube commonly used in testing ventilation systems.[2] Air is forced through the tube with a rubber squeeze bulb, and the moisture in the air reacts with the material in the tube, creating a dense white smoke with a particle size range of 0.1 to 3 microns. Smoke from the tube is directed at the sealing edge of the facepiece. Leakage between the facepiece and face is easily detected by noticing irritation of the nose and throat. When the fit of a half-mask facepiece is being checked, the wearer must be cautioned to close his eyes.

Use of Particulate-Removing Respirators

Particulate-removing respirators, commonly called mechanical filter respirators, protect personnel against inhalation of nonvolatile airborne particles in the form of dust, fume, spray, and mist. They do not provide protection against vapors, gases, or an oxygen deficiency. They should not be used against volatile particulates or particulates that hydrolyze or decompose to release a noxious vapor or gas. These respirators should never be used for protection during shot or sand blasting operations which involve exposure to very high concentrations of abrasive and rapidly moving airborne particulates. For such operations, a special form of an airline respirator called an abrasive blasting airline respirator should be utilized. The U.S. Bureau of Mines tests and approves particulate = removing respirators against various dust, fumes, sprays, and mists.[3]

A knitted fabric covering for the periphery of the facepiece that contacts the face sometimes is employed to absorb perspiration and to prevent irritation of the skin when the respirator is worn in hot atmospheres or in atmospheres containing corrosive particulate. This covering should be used only when the respirator is employed against coarse dusts and sprays. Usually, the covering cannot be used in atmospheres containing very small size particles such as fume or mist because these particles may be able to penetrate the knitted fabric and enter the interior of the respirator.

The respirator filter may be designed for protection against one or more than one specific type of airborne particulate — dust, fume, spray, or mist. The filter may employ one or more than one fibrous media for

000740

removal of particles from the inspired air, and the fibrous material may be in the form of a circular disc, a folded pad, a corrugated cylinder, etc. The fibrous filter sometimes is housed in a rigid container to protect material from damage and facilitates attachment of the filter to the respirator. The size, shape, and the fibrous media employed in the filter generally depend upon the type or types of airborne particulate which the filter must protect against. Usually, the filters are replaceable, but in some cases are a permanent part of the respirator. Most filters are designed to be used once and then discarded, while a few filters are designed so that they can be cleansed and reused. Reuseable filters may be cleaned by brushing or blasting with a jet of compressed air, but never by washing in an aqueous solution or organic solvent. Extreme care must be taken in selecting the proper type of filter for the intended operation.

The respirator filter has a useful service life that depends upon its shape, size, fibrous material, type of airborne particle, particle size, particle concentration, and the activity of the respirator user. The breathing resistance offered by the filter will increase progressively during use as its fibrous material becomes plugged with retained particulate, and eventually breathing becomes difficult. When this occurs, the respirator wearer should leave the contaminated area and replace the plugged filter with a new filter or clean a reuseable filter. Small size particles plug a filter to a greater degree than large size particles. The resistance to breathing offered by a filter generally will increase at a rapid rate if used in a moist atmosphere. The lack of an inhalation valve system in a respirator or damage of a respirator's inhalation valve system may cause condensation of moisture present in the exhaled air on the respirator filter and thereby increase the breathing resistance of the filter.

Usually, the respirator filter becomes more efficient for retention of particles during its use as the quantity of retained particulate increases. However, this may not always be true. The filtering efficiency of some types of filter materials may be adversely affected by liquid particles.

A wide variety of particulate-removing respirators popularly known as nuisance dust and nuisance paint spray respirators are available. They generally are recommended for protection against non-toxic dusts or non-toxic paint sprays. Many industrial hygienists and physicians feel that there is no such thing as a non-toxic dust or paint spray particulate, since inhaling copious quantities of so-called inert particles, especially for long periods of time, can result in adverse physiological effects. Most of these respirators have poor face-fitting characteristics. A recent publication by Revoir and Yurgilas shows that nuisance dust respirators permit particulate penetrations that are substantially greater than the penetrations allowed by dust respirators approved by the U.S. Bureau of Mines.[4] Unpublished test results obtained in the author's laboratory show that the nuisance paint spray respirators also permit significant penetrations of air-borne particulate. These nuisance paint spray respirators, of course, do not remove organic vapors present in paint sprays from inspired air and this can be dangerous. Therefore, nuisance dust and nuisance paint spray respirators are not recommended for respiratory protection.

Use of Chemical Cartridge Respirators

Chemical cartridge respirators consist of one or two small cartridge-shaped containers of granular adsorbents or catalysts attached to a half-mask facepiece or a full facepiece. These respirators protect against low concentrations of vapors or gases that are not immediately dangerous to life. They do not provide protection against airborne particulate or an oxygen deficiency. At the present time, the U.S. Bureau of Mines tests and approves chemical cartridge respirators equipped with a half-mask facepiece against organic vapors in air with concentrations up to 1,000 parts per million by volume.[5] The Bureau has proposed testing and approving these respirators for low concentrations of various acidic, alkaline, and other types of vapors and gases, but it may be another year before such testing and approving becomes official.[6] The Bureau is not considering the testing and approving of chemical cartridge respirators equipped with full facepieces because of the possibility of this device being used as a junior gas mask in a highly contaminated atmosphere which could result in serious injury or even death to the wearer.

The cartridge of a chemical cartridge respirator is designed for removal of a specific vapor or gas, a single group of vapors or gases, or a combination of two or more classes of vapors and gases. The cartridges may contain one or more adsorbents or catalysts in the form of granules or pellets for removal of vapors or gases from inspired air. Cartridges can vary somewhat in the quantity of adsorbent or catalyst they contain, usually 75 to 200 cubic centimeters. Much care should be taken in choosing the correct type of cartridge for the intended use.

Chemical cartridge respirators are useful for low concentrations of vapors and gases that may be discomforting, irritating, or toxic, but they should not be utilized for protection against concentrations of vapors and gases that are immediately dangerous to life. They should not be used against gaseous contaminants that lack the warning properties of odor or irritation in low, non-toxic concentrations. Following is a partial list of gaseous substances against which chemical cartridges should not be used because they may be highly toxic, lack adequate warning properties, or are not readily removed from air by adsorbents or catalysts: acrolein, acrylonitrile, arsine, boron hydrides, carbon dioxide, carbon monoxide, carbonyls, cyanogen, dimethyl sulfate, ethyl cyanide, fluorine, formaldehyde gas, hydrogen sulfide, methyl bromide, methyl chloride, methyl iodide, nitrogen oxides, nitromethane, perchlorethane, phosphine, phosphorus trichloride, stibine.

If a gaseous substance is irritating to the eyes, a gas-tight goggle must be used with a half-mask facepiece type chemical cartridge respirator or a chemical cartridge respirator equipped with a full facepiece should be used. A knitted fabric covering for the periphery of the facepiece that contacts the face should not be worn, since vapors and gases can penetrate the knitted fabric and enter the interior of the facepiece.

A chemical cartridge respirator provides respiratory protection for a period of time that depends upon the type and size of the cartridge or cartridges used, the type of vapor or gas, the concentration of the vapor or gas, and the activity of the wearer of the respirator. Cartridges must be replaced when an odor or irritation is detected.

Most adsorbents and catalysts are adversely affected by moisture. Thus, a chemical cartridge respirator must be equipped with an inhalation valve system to prevent contact of the adsorbent or catalyst in the cartridge with the moisture present in the exhaled air. The service life of cartridges employing adsorbents or catalysts detrimentally affected by moisture will be reduced when the respirator is used in a highly humid atmosphere.

The breathing resistance of a chemical cartridge usually does not increase during use. However, if it does increase, this may be due to a defective inhalation valve system, agglomeration of the granular contents of the cartridge due to chemical reaction with the vapor or gas, or the presence of particulate matter in the atmosphere. The breathing resistance of a chemical cartridge may be considered to be too high if the respirator facepiece distorts inwardly during inhalation or if inhalation becomes difficult.

If odor or irritation of the vapor or gas is detected immediately when the wearer enters the contaminated area, he should leave the area and check the facepiece fit and the tightness of the connection of the cartridge or cartridges to the facepiece. If the respirator offers a service life of only a very few minutes, consideration should be given to the use of a more effective device such as a gas mask or airline respirator for protection.

Use of Combination Particulate-Removing and Chemical Cartridge Respirators

Combination particulate-removing and chemical cartridge respirators offer respiratory protection against both airborne particulate and low concentrations of vapors and gases. They may be used for protection against volatile particulate that give off vapors or gases and against particulate that hydrolyze or decompose to emit vapors or gases. The appropriate comments given in the sections pertaining to the use of particulate-removing respirators and use of chemical cartridge respirators apply to the combination type respirator.

At the present time, the U.S. Bureau of Mines tests and approves combination particulate-removing and chemical cartridge respirators only against a combination of organic vapors in air with concentrations up to 1,000 parts per million by volume,

and airborne particulate in the form of dust, fume spray, and mist (including sprays of paint, enamel, and lacquer).[6] The Bureau has proposed testing and approving these respirators for combinations of dust, fume, spray, and mist plus low concentrations of various acidic, alkaline, and other types of vapors and gases.[6] Until recently, the Agricultural Research Service of the U.S. Department of Agriculture tested and listed as acceptable combination particulate-removing and chemical cartridge respirators designed to protect against pesticides during field handling.[7] As the result of a governmental interagency agreement, the U.S. Bureau of Mines will take over the testing and approving of respiratory protective devices for protection against pesticides.[8] It may be one or two years before this test and approval program of the Bureau becomes official.

Respirators with either independently replaceable filters for particulates and chemical cartridges for vapors and gases or chemical cartridges with built-in filters are available. Some people prefer the respirators with independently replaceable filters and cartridges because they find it more economical to replace filters and cartridges separately, depending upon which needs replacement. Others use the respirators employing cartridges with built-in filters, because they feel that these units reduce the chance for leakage of particulate around the filter due to a poor connection between filter and cartridge.

Use of Air-Purifying Mouthpiece Respirator

An air-purifying mouthpiece respirator is a compact device that can be carried on the user's body so as to be available for quick application if the atmosphere suddenly becomes contaminated. These respirators are available for protection against airborne particulate, vapors, and gases, or combinations of vapor and gases. At this time, the U.S. Bureau of Mines tests and approves an air-purifying mouthpiece respirator either for self-rescue against carbon monoxide gas in air with concentrations up to 10,000 parts per million by volume[9] or for protection against dust, fume, spray, and mist.[3] These respirators do not offer protection against an oxygen deficiency. The Bureau now is proposing that air-purifying mouthpiece respirators be tested and approved for protection against various organic, acidic, alkaline, and other vapors and gases, plus combinations of these gaseous contaminants and airborne particulate.[6]

The mouthpiece type respirators usually employ a small cartridge-shaped air-purifying element attached to a mouthpiece. However, some of these respirators have a large canister type air-purifying element attached either directly to a mouthpiece or connected by means of flexible tube to the mouthpiece. In use, the mouthpiece is held in the wearer's mouth, and a separate nose clamp is used to close the nostrils which means that the wearer breathes through his mouth. The mouthpiece respirator may be held ready for instant use by being suspended on the chest by means of a neckband passing around the wearer's neck, by attachment to the wearer's belt by means of a clip or a carrying pouch, or by being carried in a pocket of the wearer's garments.

The air-purifying mouthpiece respirator may be used for intermittent respiratory protection against low concentrations of air contaminants for short periods of time throughout the workday whenever the work area becomes contaminated with low concentrations of noxious contaminants. Another intermittent use of this respirator involves application of the respirator to pass through a work area having an atmosphere containing a low concentration of a contaminant. The air-purifying mouthpiece respirator may be applied for self-rescue whenever the work atmosphere suddenly becomes polluted with a hazardous concentration of contaminant. In the self-rescue application, the wearer immediately leaves the contaminated area, wearing the respirator. Inasmuch as a person cannot detect the odor of a vapor or gas when breathing through his mouth, the air-purifying element used against a gas or vapor in the intermittent application should be discarded at the end of a workday, and the air-purifying element used against a gas or vapor in the self-rescue application should be discarded after a single use.

Some air-purifying mouthpiece respirators employ an inhalation valve system, while others do not. The use of the inhalation valve system will protect the air-purifying element against moisture by preventing contact of the moisture in the exhaled air with the ingredients of the air-purifying element, and by preventing saliva which drains into the mouthpiece from entering the air-purifying element.

A person with dentures may have difficulty in retaining the mouthpiece respirator in their mouth. Thus, it is not advisable for such a person to use this type of respirator. Some users of air-purifying mouthpiece respirators claim that they can employ this type of respirator without using a nose clamp because they have trained themselves to breathe only through the mouth. This is a dangerous practice and it is not recommended.

Use of Gas Masks

A gas mask consists of a large size canister type air-purifying element attached to a full facepiece either directly or indirectly by means of a flexible tube. When the canister is connected to the facepiece by the flexible tube, a carrier harness is employed to support the canister on the wearer's chest or back. A canister may contain one or more adsorbents or catalysts in the form of granules or pellets to protect against a single vapor or gas, a single class of vapors or gases, or against a combination of two or more classes of vapors and gases. A canister also may contain a fibrous filter for protection against airborne particulate in addition to adsorbents or catalysts that protect against gaseous contaminants. A gas mask may protect against toxic vapors, gases, and particulate, but it does not protect against an oxygen deficiency. Therefore, it cannot be used in an atmosphere that lacks sufficient oxygen to support human life.

At the present time, the U.S. Bureau of Mines tests and approves gas masks equipped with chest-mounted or back-mounted canisters against various vapors, gases, and particulates.[9] Approvals are granted for protection against vapors and gases in concentrations up to 20,000 parts per million by volume and up to 30,000 parts per million by volume for ammonia gas. Canisters attached directly to the facepiece are smaller in size than the chest-mounted or back-mounted canisters, and the Bureau does not test and approve gas masks equipped with the smaller size canisters directly attached to the facepiece. The Bureau is considering testing and approving these units, but it may be a few years before this becomes official. Until recently, the Agricultural Research Service of the U.S. Department of Agriculture tested and listed as acceptable gas masks designed to protect against pesticides applied in the field during mixing, provided that such enclosures contained sufficient oxygen to support life.[7] As noted earlier, a recent governmental interagency agreement provides for the U.S. Bureau of Mines to assume the task of testing and approving gas masks designed for protection against pesticides.[8] However, one or two years may pass before the Bureau's test and approval program becomes official.

Canisters for protection against vapors and gases usually are made in three sizes: *small*, containing 200 to 500 cubic centimeters of adsorbent of catalyst (usually attached directly to the facepiece and commonly called a chin-style canister); *regular* or *industrial*, containing 1,000 to 1,200 cubic centimeters of adsorbent or catalyst; and *large* or *super*, containing 1,500 to 2,000 cubic centimeters of adsorbent or catalyst. The small or chin-style canisters usually are used for protection against vapors and gases in air having concentrations not exceeding 5,000 parts per million by volume. The regular or industrial canisters and the large or super canisters may be used for protection against vapors and gases in air with concentrations not exceeding 20,000 parts per million by volume or 30,000 parts per million by volume for ammonia gas. The service lives of the different size canisters containing the same ingredients for the same atmospheric conditions will be approximately proportional to the canister size. If protection is required against a single vapor or gas or a single class of vapors or gases, it is more economical to utilize a canister designed specifically for use against the single hazard than a canister designed for use against a multiple of hazards. A large size canister designed to protect against a combination of airborne particulate such as dust, fume, spray, mist, fog, and smoke and vapors and gases such as organic vapors, acidic gases, ammonia, and carbon monoxide is known as a Type *N* canister (sometimes called an all service or universal canister). Gas mask canisters are color coded for identification according to the hazards they protect against.[10]

A canister must be replaced whenever an odor or irritation is detected by the wearer or if the resistance offered to breathing becomes objectionable. The U.S. Bureau of Mines requires that gas masks for protection against carbon monoxide gas, including the Type *N* gas mask but excluding a self-rescue gas mask for emergency escape use, contain an indicator that tells when the canister ingredient that protects against carbon monoxide gas is exhausted. Indicators are in the form of a window panel in the side of the canister containing granular substance that changes color when the canister ingredient for carbon monoxide is exhausted, or in the form of a mechanical timer which has an indicating dial or which activates an audible or physical alarm. The window panel type indicator also is available for a few types of canisters for protection against vapors and gases other than carbon monoxide gas. The end seals on a canister should be left in place until the canister is attached to the gas mask. After a canister with a mechanical timer is secured to a gas mask, it must be replaced as soon as the mechanical timer indicates that it has been in use for the intended service life, even though it has never been exposed to a hazardous atmosphere. After a canister containing a built-in window panel indicator is attached to a gas mask, it must be replaced whenever the substance behind the window changes color, even though the canister may never have been applied in a contaminated atmosphere. The maximum time that any type of canister should be left attached to a gas mask is one year. Canisters which have been in storage with end seals intact for more than four years should be discarded. Some gas mask manufacturers date canisters with the recommended expiration date for canister use.

Mechanical damage which distorts a canister may result in leakage of a contaminant through the canister wall; crushing of the granules or pellets into finer particles, which increases the breathing resistance of the canister; or channeling of contaminants through areas of decreased resistance, which reduces the service life of the canister. Corrosion of the canister may result in leakage of a hazardous substance through the canister wall and thus reduce the canister's useful life. Mechanically damaged or corroded canisters should be replaced.

The gas mask wearer should enter the contaminated area cautiously. If he detects an odor or irritation or if he experiences difficulty in breathing, feels dizzy, or nauseated, he should go to an uncontaminated area immediately without removing the gas mask. He should ascertain the cause of failure of the device and correct the fault before returning to the hazardous atmosphere.

Gas masks are approved by the U.S. Bureau of Mines for use in atmospheres immediately hazardous to life, providing that the previously mentioned contaminant concentrations are not exceeded and providing that the contaminated atmosphere contains sufficient oxygen to support life. Fresh canisters should be used for protection in atmospheres immediately dangerous to life or health. A strict limit should be placed on the time period of use of a canister for protection against a contaminant that lacks adequate warning properties of odor or irritation.

Use of Airline Respirators

A source of compressed air, a compressor or a tank, is used to supply respirable air through a small diameter hose to the wearer of an airline respirator. Using this source of breathing air makes the wearer independent of the surrounding atmosphere. However, this dependence upon an external source of air which is not carried by the wearer means that there are definite limitations in regard to the use of an airline respirator.

There are three modes of air flow for airline respirators: continuous; demand; and pressure-demand. The continuous flow airline respirator supplies air to the respiratory inlet covering continuously even when the wearer exhales. The demand flow airline respirator supplies air to the respiratory inlet covering only when the wearer inhales. The pressure-demand flow airline respirator supplies air to the respiratory inlet covering until a predetermined air pressure is established in the respiratory inlet covering, and then supplies additional air when the wearer inhales, to maintain a positive pressure in the respiratory inlet covering.

The U.S. Bureau of Mines tests and approves airlines respirators.[11] The continuous flow airline respirator is approved for use with a tight-fitting respiratory inlet covering, such as a half-mask facepiece or full facepiece. The Bureau approves pressure-demand respirators equipped with suitable respiratory inlet coverings that protect the head and neck against impact and abrasion of rebounding particulate occurring in shot or sand blasting operations. These airline respirators are known as abrasive blasting respirators. The Bureau will not approve an airline respirator with a respiratory inlet covering which has a direct mouth or nose connection. The Bureau does not approve an airline respirator which utilizes a complete air-supplied suit.

Approved airline respirators may use up to 250 feet of small diameter air-supply hose. An approved continuous flow airline respirator must supply a flow of air not less than 115 liters (four cubic feet) per minute to tight-fitting and not less than 170 liters (six cubic feet) per minute to loose-fitting respiratory inlet coverings through a maximum approved length of air-supply hose at the minimum approved specified air-supply pressure. An approved continuous flow airline respirator must supply a flow of air not to exceed 425 liters (15 cubic feet) per minute to either a loose-fitting or a tight-fitting respiratory inlet covering through a minimum approved length of air-supply hose at the maximum approved specified air-supply pressure.

Airline respirators are approved by the Bureau for use in atmospheres containing airborne particulate, vapors, and gases that are not immediately dangerous to life or health or from which the wearer could escape without the aid of the respirator. The reason for this limitation is that the respirator wearer is dependent upon an external source of respirable air which is subject to failure under some conditions such as accidental stopping of a compressor, depletion of compressed air in a tank, or accidental rupture of the air-supply hose. However, the Bureau now approves a combination airline respirator with an auxiliary self-contained air supply carried by the wearer for protection in atmospheres immediately hazardous to life or health, including an atmosphere with a deficiency of oxygen. Also, the Bureau now approves a combination airline respirator and air-purifying respirator, and the limitations for application of this device are determined by the application limitations of the air-purifying portion of the device.

A recently published paper of the Joint Respirator Committee of the American Industrial Hygiene Association and the American Conference of Governmental Industrial Hygienists lists certain procedures which must be taken to allow the use of airline respirators in atmospheres immediately hazardous to life or health.[12] This information was published because the Joint Respirator Committee recognized that conditions of a routine process or operational designs may occasionally preclude the utilization of respirators approved by the Bureau for use in immediately dangerous atmospheres and may dictate the employment of an airline respirator. It is not possible to list the detailed procedures here. Respirator users are urged to refer to the publication for instructions.

The airline respirator is considered to be the most versatile type of respirator because it can be used against a wide variety of air contaminants, both particulate and gaseous, with the limitations previously listed. Most airline respirators are light in weight, comfortable to wear compared to other types of respirators, offer little or no resistance to breathing, and the flow of air to the respiratory inlet covering usually provides a cooling and refreshing effect. An airline respirator may be worn for long periods of time without appreciable discomfort for prolonged work in hazardous atmosphere.

A major disadvantage of the airline respirator is the trailing air-supply hose, which limits the travel of the wearer. The trailing hose must be arranged so as to minimize kinking, becoming entangled in objects, and tripping the wearer. Also, precautions should be taken to protect the hose against damage such as cutting, crushing, or burning. An armored hose may be necessary under some conditions. Prior to using an airline respirator, the user should always examine the air-supply hose for defects and test it for blockage.

The pressure-demand flow and the continuous flow airline respirators always maintain a slight positive pressure in the respiratory inlet covering to prevent inward leakage of contaminants. Thus, they offer a higher degree of protection than the de-

000743

mand flow device, which will have a slight negative pressure in the respiratory inlet during inhalation which could permit an inward leakage of contaminant into the respiratory inlet covering in case the covering is not tightly fitted to the wearer's face. When it is necessary to use a tank of compressed air, the demand flow airline respirator is preferred, since it will conserve the supply of respirable air to a greater degree than the other types of airline respirators. The pressure-demand flow device also may be used with a tank of compressed air, although it will deplete the air supply at a faster rate than the demand flow unit. The constant flow airline respirator is recommended only for use with an air compressor as the source of respirable air.

The quality of the compressed air used as breathing air is the responsibility of the airline respirator user. Precautions must be taken to insure a clean supply of respirable air is available at the proper pressure and in sufficient quantity. The U. S. Bureau of Mines states that the approval of an airline respirator is valid only when it is supplied with compressed breathing air that meets the most recent requirements of Compressed Gas Association Specification G7.1 for Type 1, Class 1) gaseous air and shall contain less than five milligrams of oil vapor or oil particulates per cubic meter of air. The most recent specification, G7.1, was published in 1966.[13] Analytical methods which may be employed to test the quality of the compressed air are given in those specifications. If tanks of compressed air are purchased for use with airline respirators, the purchaser should specify that the vendor furnish tanks of compressed air meeting the mentioned specification.

Most air compressor systems employ internally oil-lubricated pistons for air compression. Oil and water droplets, scale and other foreign particles, and oil vapor may be present in the compressed air. These contaminants can be removed by mechanical and chemical compressed air filters. This type of compressor should be well maintained to prevent it from overheating due to excessive friction. An overheated compressor may form harmful amounts of carbon monoxide gas. The compressor should be equipped with a high temperature actuated alarm which warns if the compressor begins to overheat, and a carbon monoxide alarm which gives a warning that a harmful concentration of carbon monoxide is present in the compressed gas. The compressor manufacturer should be consulted for aid in making sure that the compressor will supply respirable air.

Certain types of air compressors which may be water lubricated or which may utilize non-lubricated diaphragms, graphite rings, or graphite vanes for air compression are available. These compressors are superior to oil lubricated compressors in supplying respirable air.

The compressor intake should be located in an area where the air is clean and uncontaminated. The compressor intake should be kept away from all sources of air contamination including engine exhaust. Chemical and mechanical filters for connection to the compressor intake are available. An air storage receiver of sufficient capacity to allow the airline respirator wearer to escape from the contaminated area in case of compressor failure is recommended for use with the compressor. If possible, an air compressor separate from that used to supply compressed air for industrial equipment is recommended for supplying air to airline respirators. This should be considered for installation in new operations or where major alterations to industrial operations justify it.

Couplings for attachment of airline respirators to the source of respirable air should be incompatible with couplings for other gas systems, to prevent accidental connection of airline respirators with sources of non-respirable gases or oxygen. The couplings for connecting airline respirators to the respirable compressed air sources should be clearly labelled for identification. If more than one airline respirator is being used simultaneously and their connections to the compressed air sources are close together, these connections should be identified to eliminate the possibility of a respirator wearer disconnecting another wearer's supply of breathing air. Oxygen should never be used with airline respirators.

If a tank of compressed air is used as the source of respirable air, the airline respirator wearer should check the quantity of air it contains prior to entering a contaminated atmosphere. He should make sure that the tank contains sufficient air for breathing during the period the [illegible] dBA at the maximum air flow allowed pirator will be employed for pr[illegible] by the Bureau. Airline respirator users should be careful to select airline respirators that do not generate excess internal noise. Airline respirator wearers may have to wear hearing protectors for protection against noise generated by external work operations such as grinding, discing, shot blasting, and sand blasting.

It is important that the pressure of the supply air be maintained within the pressure limits specified for the airline respirator. Using too low a pressure may be dangerous because it may result in supplying an inadequate amount of air needed for breathing by the respirator wearer or it may result in a negative pressure inside the respiratory inlet covering to permit a significant leakage of contaminants into the covering. Too high a pressure may cause discomfort to the respirator wearer.

The airline respirator contains a quick-disconnect coupling for the air-supply hose which is secured by some means to the respirator wearer, often by attachment to a belt worn by the wearer. When this coupling is disconnected, the breathing tube connected to the respiratory inlet covering is left open to allow the wearer to breathe through the tube. Also, the portion of the coupling attached to the air-supply hose closes the outlet of the air-supply hose when the coupling is disconnected to prevent escape of the compressed air. If the source of compressed air fails while the wearer is in a contaminated area, he disconnects the coupling and breathes through the open tube while he quickly leaves the contaminated area.

Noise generated internally within an airline respirator by the flow of the supply air may be a problem with some airline respirators, especially those having respiratory inlet coverings that encase the wearer's head. Exposure to high noise levels is not only unpleasant but is harmful, since it can result in a loss of hearing. The American Conference of Governmental Industrial Hygienists has proposed a maximum level for broad band noise of 92 dBA.[18] Safety and health standards for Federal supply contracts under the Walsh-Healey Public Contracts Act issued by the U.S. Department of Labor list maximum permissable noise levels.[16]

Unpublished test results obtained in the author's laboratory indicate that some commercially available airline respirators equipped with hood type respiratory inlet coverings generated noise levels ranging from 86 dBA at the minimum air flow permitted by the U. S. Bureau of Mines to

Use of Hose Masks

Hose masks are respirators which supply respirable air from an uncontaminated source through a strong, large diameter hose to a facepiece worn by the user. Two types of hose masks are available. One type of hose mask employs an air blower, either hand-operated or motor-operated, which pushes respirable air at low pressure through the large diameter hose to the facepiece. The blower is designed so that it permits free entrance of air to the hose when the blower is not operated. Thus, if the blower fails to operate, the respirator user by normal breathing action can inspire respirable air through the hose and blower. The other type of hose mask does not have an air blower. The normal breathing action of the wearer of the hose mask without blower enables him to inspire respirable air from the uncontaminated source through the large diameter hose.

Hose masks, with and without blowers, are tested and approved by the U. S. Bureau of Mines.[11] The Bureau approves the hose mask with blower for use in atmosphere immediately hazardous to life of health, including atmospheres with an oxygen deficiency. The hose mask without blower is approved by the Bureau only for use in harmful atmospheres not immediately dangerous or from which the respirator wearer could escape without the aid of the respirator. Hose masks equipped with suitable head and neck covering and shielded facepiece lens to resist impact and abrasion of rebounding particulate are tested and approved by the Bureau for protection of personnel in shot blasting and sand blasting operations.

The principle parts of an approved hose mask with blower are: a hand-operated or motor-operated blower that allows free entrance of air to the hose when the blower is not operated; a strong, large diameter hose having a low resistance to air flow;

000744

a strong harness to be worn by the respirator user and to which the hose is attached; a life line attached to the harness for rescue of the user; and a full facepiece with both an inhalation valve system and an exhalation valve system. The principle parts of an approved hose mask without a blower are: a strong, large diameter hose having a low resistance to air flow; a terminal fitting for the hose which contains means to remove foreign matter suspended in the air and means to permit securing the fitting to a fixed position; a harness to be worn by the respirator user and to which the hose is attached; and full facepiece or half-mask facepiece with both an inhalation valve system and an exhalation valve system. An approved hose mask with blower may use air-supply hose up to a maximum length of 300 feet in multiples of 25 feet. An approved hose mask without blower may use a hose up to a length of 75 feet in multiples of 25 feet. The large diameter air-supply hose must be strong enough to resist collapsing and permanent deformation when a crushing force is applied against it. Also, the hose must resist attack by solvents such as gasoline.

Hose masks may be used for protection for long periods of time. The hose mask with blower may be used for respiratory protection in any hazardous atmosphere regardless of the type of concentration of contaminant and in an atmosphere with any degree of oxygen deficiency. The high degree of respiratory protection offered by the hose mask with blower makes it suitable for use in enclosures and confined spaces where very high concentrations of contaminants as well as oxygen deficiencies may exist. Hose masks with blowers are commonly used in tank cleaning operations in the petroleum, chemical, food, water, and transportation industries and in underground work by public utilities. The hose mask without blower may be used for respiratory protection against both particulate and gaseous contaminants but should not be used for protection in atmospheres immediately harmful or having an oxygen deficiency.

Whenever a hose mask with blower is used in an atmosphere immediately dangerous to life or health, at least one suitably trained standby man equipped with adequate respiratory protective equipment should be present in the uncontaminated area for emergency rescue of the hose mask wearer. The mobility and area of movement of the hose mask wearer is restricted by the large diameter air-supply hose and the wearer must emerge from the contaminated area in the same way as he entered it. The wearer must take care to prevent damage to the hose and to prevent it from becoming caught on objects.

Prior to using a hose mask, a number of precautions should be taken. It should be assured that the area where the blower or terminal end of the air-supply hose is located contains clean respirable air. The operation of the blower should be tested. The terminal of the air-supply hose of the respirator without blower should be firmly anchored to a fixed point. The air supply hose should be checked for defects and blockage. Hose connections should be inspected to insure that they are tight. Check for foreign matter in the hose and blower by operating the blower for a few minutes. Foreign matter may be eliminated by operating the blower at high speed for several minutes. Foreign matter in the hose of a respirator without blower may be checked and eliminated by blowing clean, compressed air through the hose. Inspect the life line to insure that it is in good condition and fastened securely to the harness. When the hose mask is being used, precautions must be taken to insure that the air-supply hose is not damaged and that the air supplied to the respirator is not contaminated by the exhaust from vehicles or any process.

Use of Self-Contained Breathing Apparatus

A self-contained breathing apparatus is a respirator which employs a self-contained supply of air, oxygen, or oxygen-generating material carried by the wearer to provide him with a respirable atmosphere. All self-contained breathing apparatus offers respiratory protection to the user against irrespirable vapors, gases, particulates, or combinations thereof, in any concentration and against any degree of oxygen deficiency. Self-contained breathing apparatus may be classified by design into the following classes and sub-classes: (1) closed-circuit (using oxygen only) — Compressed oxygen type; Liquid oxygen type; Oxygen-generating type; (2) open-circuit (using compressed or liquified air or oxygen) — Demand type; Pressure-demand type.

Self-contained breathing apparatus may be classified according to use: (1) for entry into or escape from oxygen deficient atmosphere or irrespirable vapors, gases, and particulates; (2) for escape only from oxygen deficient atmospheres or irrespirable vapors, gases, and particulates.

The U. S. Bureau of Mines tests and approves the various types of self-contained breathing apparatus.[1] The Bureau approves these devices for the periods of time that they will provide respiratory protection when the wearer is engaged in moderate work activities. Only apparatus classified for fifteen minutes or longer service life is approved for entry into and escape from a hazardous atmosphere. Only apparatus classified for thirty minutes or less service life is approved for self-rescue from a hazardous atmosphere. Apparatus classified for a service life less than one hour is not approved for use in underground mining, tunneling, and similar operations except as auxiliary equipment, which means that the wearer has ready access to fresh air and at least one crew of five or six men equipped with approved self-contained breathing apparatus preferably of two hours or longer service life is in reserve in an area of fresh air. Apparatus classified for a service life less than thirty minutes is not approved as auxiliary equipment.

A combination self-contained breathing apparatus for self-rescue having a service life of three or ten minutes and an airline respirator is approved for entry into a hazardous atmosphere providing that entry is made using the air supply of the airline portion of the device. A combination self-contained breathing apparatus for self-rescue having a service life of fifteen or thirty minutes is approved for entry into a hazardous atmosphere, proving that entry is made using the air supply of the airline portion of the device, or providing that not more than twenty per cent of the the available self-contained air supply is used for entry.

A closed-circuit self-contained breathing apparatus is a device in which the exhaled air is rebreathed by the wearer after the carbon dioxide in the exhaled air has been removed and the oxygen concentration of the air is restored. The compressed oxygen or liquid oxygen type closed-circuit self-contained breathing apparatus operates in the following manner: High pressure oxygen from a cylinder passes through a high pressure reducing valve and, in some devices also through a low-pressure admission valve into a breathing bag. Liquid oxygen from a container is converted to low-pressure gaseous oxygen and passes into a breathing bag. The wearer inhales from the bag through a tube containing a one-way check valve connected to a facepiece or mouthpiece. Exhaled air passes from the facepiece or mouthpiece, through another tube containing a one-way check valve, into a container having a chemical which removes the carbon dioxide, and then into the breathing bag. Oxygen enters the bag continuously or as the bag deflates to actuate an admission valve. The device contains a pressure relief system and a manual bypass system, and may contain a saliva trap. The oxygen-generating type closed circuit self-contained breathing apparatus operates in the following manner: Exhaled air passes from the facepiece or mouthpiece through a tube containing a one-way check valve, through a container having a chemical which removes carbon dioxide from the air and which reacts with the water vapor in the air to release oxygen. The air with a replenished supply of oxygen then passes into a breathing bag. The wearer inhales air from the breathing bag through a second tube containing a one-way check valve which connects to the facepiece or mouthpiece. The device contains a pressure relief system and may contain a saliva trap.

An open-circuit self-contained breathing apparatus is a device in which the exhaled air is not rebreathed but instead is expelled to the atmosphere. In the demand type open-circuit self-contained breathing apparatus, exhaled air passes into the atmosphere through a valve in the facepiece or mouthpiece. The device is equipped with a demand valve activated upon initiation of inhalation, which permits the flow of the breathing atmosphere from a container of compressed or liquified oxygen to the facepiece or mouthpiece only during inhalation. On exhalation, the pressure in the facepiece or mouthpiece becomes positive, and this closes the demand valve. The pressure-demand type apparatus is similar to the

000745

demand type unit except that it is equipped only with a full facepiece and a small positive pressure is maintained in the facepiece at all times. The small positive pressure is obtained by means of a spring-loaded or balanced demand regulator and a balanced exhalation valve. Both types of devices, except those used for self-rescue, employ a hand-operated bypass system to permit the wearer to breathe if the demand valve fails.

Self-contained breathing apparatus usually employ a full facepiece but sometimes a mouthpiece and nose clip are used. Apparatus using compressed or liquified air or oxygen, except those used for self-rescue, contain a gage visible to the wearer which indicates the remaining gas or liquid. A timer, which actuates an alarm, is used in the oxygen-generating device, except those employed for self-rescue. A remaining service life indicator or warning device is used by apparatus utilizing compressed air or oxygen, except those employed for self-rescue.

The U. S. Bureau of Mines states that a self-contained breathing apparatus is approved only if it supplies respirable breathing gas to the wearer.[17] Oxygen, both as a compressed gas and as a liquid, must meet the requirements of the United States Pharmacopeia for medical or breathing oxygen.[18] Compressed air must meet the most recent requirements of the Compressed Gas Association Commodity Specification for Air, G-7.1, Type II, Grade D, liquid air.[19] The breathing atmosphere supplied by the apparatus should never contain less than 20.5 per cent by volume of oxygen.

The self-contained breathing apparatus has no limitation in regard to the nature of the hazardous atmosphere in which it may be worn. It provides complete respiratory protection in any concentration of particulate or gaseous contaminant and in any condition of oxygen deficiency. Since the wearer carries his own supply of respirable atmosphere with him, he is independent of the surrounding atmosphere. The apparatus allows the wearer to move with comparative freedom and he is not limited to movement in a restricted area. The length of time that a wearer can remain in a contaminated area depends upon the amount of air or oxygen or oxygen-generating material in the apparatus and the activity of the wearer. The service life ratings of the devices should be used only as guides.

The chief limitations of self-contained breathing apparatus are high weight, bulkiness, limited service life, and the need for a high degree of training for both safe use and maintenance. The self-contained breathing apparatus provides only respiratory protection. Contaminants that are irritating or corrosive to the skin or which readily penetrate the skin and are absorbed by the blood of the circulatory system of the body require the use of proper protective clothing in addition to the wearing of the apparatus.

Open circuit type self-contained breathing apparatus are considered to be relatively inefficient when compared with the closed-circuit type unit since the open-circuit unit releases exhaled oxygen to the atmosphere instead of being reused.

The breathing atmosphere supplied to wearer by self-contained breathing apparatus using liquified air or liquified oxygen is cool, which may be an advantage when the apparatus is employed in hot atmosphere.

The demand-type self-contained breathing apparatus produces a negative pressure in a facepiece during inhalation which may permit inward leakage of contaminants into the facepiece. The pressure-demand type self-contained breathing apparatus maintains a positive pressure in the facepiece even during inhalation, which prevents inward leakage of contaminants into the facepiece.

The ambient atmospheric pressure affects the service life of open-circuit type self-contained breathing apparatus. Increased ambient atmospheric pressures mean reduced service lives. Doubling the ambient atmospheric pressure cuts the service life in half.

Oxygen should never be used in self-contained breathing apparatus that have previously employed air. The air might have contained a low concentration of oil. When oxygen contacts oil, an explosion or fire could occur. Partly used cylinders or containers of compressed air or oxygen or liquified air or oxygen should not be kept for reuse. Once a cylinder or container has been used, even for a short time, it should be recharged before reuse.

When a person wearing a self-contained breathing apparatus enters a confined space containing a highly hazardous atmosphere, he should wear a suitable harness with an attached life line. At least one suitably trained standby man equipped with a self-contained breathing apparatus should be present in an uncontaminated area for emergency rescue of the man in the hazardous atmosphere.

Use of Respirators in Dangerous Atmospheres

Procedures covering the safe use of respirators in atmospheres immediately dangerous to life or health encountered in normal operations or in emergencies should be established. Personnel must be thoroughly familiar with these procedures. Whenever a respirator is used in an atmosphere immediately hazardous to life or health, at least one suitably trained standby man with a self-contained breathing apparatus should be present in the nearest uncontaminated area for emergency rescue. The standby man should be trained in the methods of resuscitation. Communications by voice, hand signals, or signal line should be maintained between the respirator user and the standby man. The respirator used should be equipped with a safety harness and line for lifting or removing him from the hazardous atmosphere. The standby man should be provided with the means for summoning assistance if an emergency should occur.

Use of Respirators in Confined spaces

Confined spaces are enclosures having limited means of egress, such as storage tanks, tank cars, process vessels, boilers, ducts, sewers, underground utility tunnels, pipelines, pits, and tubs. Confined spaces may contain atmospheres that are immediately hazardous to life due to the presence of toxic contaminants or the deficiency of sufficient oxygen to support life. Before anyone is allowed to enter a confined space, tests should be carried out to determine the concentration of any flammable vapor or gas present, the concentration of any toxic airborne particulate, vapor, or gas, and the concentration of oxygen.

Forced ventilation should be used to keep the concentration of a flammable substance at a safe limit. A person should not be allowed to enter a confined space without wearing adequate respiratory protective equipment if the concentration of any contaminant is above the Threshold Limit Value or if an oxygen deficiency exists. Even the concentration of contaminants in a confined space is found to be below Threshold Limit Values and sufficient oxygen is present, the safest procedure is to constantly ventilate the enclosure and to continually monitor the concentration of contaminant and oxygen concentration if personnel are to work in the enclosure without wearing respiratory protective devices. Air-purifying type respiratory protective devices may be worn by personnel in a confined space if tests indicate that the atmosphere in the enclosure contains sufficient oxygen to support life and if the concentration of air contaminants is below levels of immediate danger to life or health. While personnel wearing air-purifying type respirators are in an enclosed space, the atmosphere in the space should be continuously monitored. If tests indicate that the enclosure contains a contaminant concentration that is immediately hazardous to life or health or has an oxygen deficiency, then personnel who are required to enter the enclosure should wear any of the following types of respirators: self-contained breathing apparatus, hose mask with blower, combination airline respirator and self-rescue type self-contained breathing apparatus. The best safety practice would be only to permit people wearing self-contained breathing apparatus, hose mask with blower, or combination airline respirator and self-rescue type self contained breathing apparatus to enter a confined space.

Use of Respirators in Low and High Temperatures

Low temperatures will result in fogging of the lens in a full facepiece by the moisture in the exhaled air. Coating the inside surface of the lens with an antifog compound will prevent fogging at low temperatures approaching 32°F but severe fogging may occur at temperatures below 0°F. Full facepieces are available with nose cups that direct the moist exhaled air through the exhalation valve without contacting the lens and should provide satisfactory vision at temperatures as low as –30°F. At very low temperatures, the exhalation valve of a respirator may freeze open due to moisture. Dry respirable air should be used with an airline respirator and self-contained breath-

ing apparatus that employ air when these devices are utilized at low temperatures.

A person working in an area of high temperature is under stress. Additional stress due to the wearing of a respirator should be minimized by selecting and using a respirator of minimum weight and low breathing resistance. Airline respirators are recommended for use in high temperature areas.

Skin Protection

Respirators protect only the respiratory systems against air contaminants. Some contaminants are very irritating or corrosive to the skin and may produce painful burns. Other contaminants are capable of penetrating the skin and then are absorbed by the blood, producing serious injury and possibly death. If the respirator wearer is exposed to such contaminants, he should wear protective clothing made of impermeable material along with the respirator. For such exposure, an air-supplied suit of suitable design and material should be considered for use.

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000746

RESPIRATOR TESTING AND APPROVAL

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Among other services to the mining, mineral, and allied industries, the U.S. Bureau of Mines tests and approves respiratory protective devices. These devices are accepted only from responsible applicants and must meet a variety of machine and man tests. In addition to providing respirator performance requirements, the approval system includes provisions for upgrading of respirators by manufacturers and a continual checking of the manufacturer's conformance to approval requirements. The following article describes this program in general terms. The interested reader may obtain additional information from the published testing and approval schedules and respirator lists mentioned in this article.

The Bureau currently is expanding its respirator testing and approval program and is making improvements in its basic testing procedures. The program expansion and changes are described briefly in this article.

Since 1918, the Bureau of Mines has tested and approved oxygen breathing apparatus for mine rescue operations. The first respirator approval schedule, No. 13, for self-contained breathing apparatus, was issued in March 1919. Schedule 14, for gas masks, was also issued in 1919. The Bureau was subsequently asked to expand its approval program to include other devices. Schedule 19 for supplied-air respirators and Schedule 21 for dust, fume, and mist respirators, were issued in 1934. Schedule 23, for chemical-cartridge respirators, appeared in 1944. Now, in 1969 and 1970, the Bureau is again expanding its respirator approval program.

Under the authority of these approval schedules or their revisions, the Bureau tests and approves or rejects devices that are submitted to it by responsible applicants. The adjective "responsible" is important. After approval, the applicant (usually the manufacturer) is held responsible for the quality of the approved respirator. It is not unusual for respirators to be used daily under hazardous or emergency conditions.

Each new respirator must be accompanied by a fee to cover testing costs, by complete drawings and specifications which serve as a record of the device tested and approved, and by the manufacturer's test data. The latter data prove that the applicant has performed or had performed for him the same tests which will be made by the Bureau, and serve as an indication that he will be able to control the quality of his respirator.

When the Bureau is satisfied that its preliminary requirements are met, it accepts the respirator for extensive and exhaustive tests to prove the suitability of the device. These tests, and the requirements on which they are based, insure reliable respirator performance. Only rarely are design requirements incorporated in the Bureau's schedules, since such requirements tend to restrict development and improvement in respirator design and function.

Current revisions of the Bureau's respirator approval schedules are as follows: Schedule 13E—Self-Contained Breathing Apparatus; Schedule 14F—Gas Masks; Schedule 19B and Amendments—Supplied-Air Respirators; Schedule 21B and Amendments—Dust, Fume, and Mist Respirators; Schedule 23B—Chemical-Cartridge Respirators. Copies of these schedules may be obtained from the Bureau of Mines, Publications Distribution Section, Pittsburgh, Pa.

When approval tests are satisfactory, the Bureau issues a certificate of approval to the applicant. This permits him to sell his respirator as being approved by the Bureau of Mines. It also obligates him to adhere to the approved drawings and specifications in production. To permit the manufacturer to improve his product, or make changes required by production, the Bureau will retest a revised device. If the changes are satisfactory, an extension of approval is issued to cover them. The manufacturer, however, must not make the change until it is approved by the Bureau of Mines.

To help the user ascertain that a device is approved by the Bureau, the manufacturer is authorized to affix an approval label on each respirator. This label describes the

000747

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000748

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000749

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1970
1971
1972
1973

NATIONAL SAFETY CONGRESS

OCTOBER 26-29, 1970 / CONRAD HILTON HOTEL, CHICAGO

The Congress is always a big week, a worthwhile week for the 14,000 safety people who attend.

At the '70 Congress you can meet other safety people, with the same problems and responsibilities as yourself. You can exchange views and ideas on accident prevention, health, hygiene, and fire prevention . . . on safety in industry, traffic, school, at home and on the farm.

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This four-day educational program, planned and presented by the National Safety Council, can be your most thought-provoking, most worthwhile safety experience in 1970.

Make plans early to attend the 1970 Congress and bring the other people in your organization who have safety responsibilities.

FUTURE CONGRESS DATES
1970 October 26-29
1971 October 25-28
1972 Oct. 30 - Nov. 2
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NATIONAL SAFETY COUNCIL
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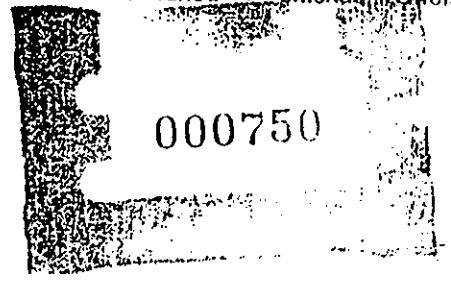

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*Deceased

000751

omitted. The grip strength of older men was better when they ate a basic breakfast. You will notice I said a basic breakfast. Research has shown that a basic breakfast is more conducive to efficiency in the morning hours than is a heavy breakfast.

Smoking is one habit we have been urged to break by the government because of the cancer scare. Another reason for fork lift operators and all of us who drive cars to bear in mind was pointed out by Dr. Mitchel R. Zavon, Assistant Commissioner of Health, Cincinnati, Ohio, at the National Safety Congress in 1965: "Cigarette smoking reduces night vision 10 to 15 per cent because it lowers metabolism." In normally darker plant areas, we need as good a vision as possible. This is another important thing to keep in mind when you climb on your truck or in your car and light a cigarette. There are other hazards involved with smoking while driving; the hot falling ash can distract our attention, and the means to light the cigarette can be a headache. There are several reasons why it would pay to give up smoking.

If we were starting out on a long trip with our families, I'm certain one of the prerequisites would be a good night's sleep. Therefore, does it not hold true to start a day's work equally rested?

In summation, for driver responsibility, learn your job, obey the law, be alert, and, most important, take care of yourself. Drive as though your family and loved ones are riding with you.

000752

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*Past General Chairman

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OCTOBER 26-29, 1970 / CONRAD HILTON HOTEL, CHICAGO

The Congress is always a big week, a worthwhile week for the 14,000 safety people who attend.

At the '70 Congress you can meet other safety people, with the same problems and responsibilities as yourself. You can exchange views and ideas on accident prevention, health, hygiene, and fire prevention . . . on safety in industry, traffic, school, at home and on the farm.

You can see the largest of all safety equipment exhibits at the Congress . . . an opportunity for you to make well-informed buying decisions for your company.

This four-day educational program, planned and presented by the National Safety Council, can be your most thought-provoking, most worthwhile safety experience in 1970.

Make plans early to attend the 1970 Congress and bring the other people in your organization who have safety responsibilities.

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70 October 26-29
71 October 25-28
72 Oct. 30 - Nov. 2
73 Oct. 29 - Nov. 1

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425 NORTH MICHIGAN AVENUE • CHICAGO, ILLINOIS 60611

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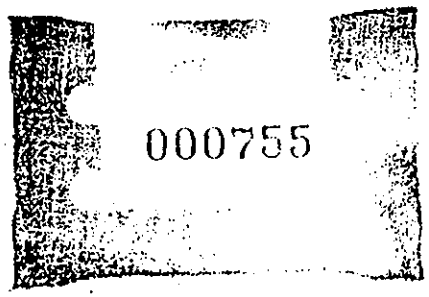
We feel that the $14,000 was a mean income for the members serving on the 02 Committee.

For man-hours tied up in this standard from travel through to the committee sessions themselves, there is a ratio of 7 to 1 in man-hours allocated for the development of standards. For every extra hour devoted to drafting this standard seven hours were allocated. The cost projection of $60,000 is conservative. However, the longer it takes to write a standard the higher the cost.

Time is of the essence in drafting a safety standard, as it is in any worthwhile chore. Time is a most precious thing. Once gone it cannot be retrieved, once wasted it cannot be salvaged. We are living in a time-compressed age, and time is becoming more valuable each ticking second.

Industry is willing to devote time, effort, and money to assist in drafting appropriate and quickly developed safety standards. It is the obligation of all organizations in the field of safety activities to design a program which encourages quick responses and expeditious processing of the product—the safety standard.

The 02 Standards Committee believes it developed and drafted a sound, reasonable, and enforceable standard for thousands of sawmills which encompasses the primitive "pecker woods" to the largest older mills and the modern newer ones. We believe the 02 Standard is sound from an engineering viewpoint and provides for safety and hygiene in all facilities. I am convinced that with adequate preplanning, preparation, organization, and scheduling, the time from recognition of the need for a safety standard to the accomplished result could be shortened considerably.



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Secretary — ROY G. BENSON, Mgr., Industrial Dept., National Safety Council, Chicago, Ill.

Committee Chairmen —

Associations — A. L. KLING, Loss Prevention Consultant, Baldwin, N. Y.

Audio Visual Aids — A. H. CHRISTIAN, Div. Safety Engineer, FMC Corp., Philadelphia, Pa.

Contests & Awards — C. E. WILSON, Safety Engineer, Bethlehem Steel Corp., Bethlehem, Pa.

Executive — R. M. HARTMAN

Nominating — M. F. BIANCARDI, Dir., Product Safety, Employers Ins. of Wausau, Wausau, Wis.

Occupational Health Hazards — H. W. RAPP, Supt., Travelers Ins. Co., Hartford, Conn.

Occupational Health Nursing — MARGARET BILLY, R. N., United States Steel Corp., Pittsburgh, Pa.

Off-the-Job Safety — I. W. Shutt, Safety Dir., Jos. E. Seagram & Sons, New York, N. Y.

Physical Hazards — N. McCallum, Supvr. of Safety, Chrysler Corp., Detroit, Mich.

Research Projects — G. B. Lemke, Vice Pres., Employers Ins. of Wausau, Wausau, Wis.

Standards — E. B. Locke, Vice Pres., Engineering Dept., Texas Employers Ins. Assn., Dallas, Texas

Technical Publications — R. M. Pryor, Dir. Safety & Fire Protection, Phillips Petroleum Co., Bartlesville, Okla.

Training — J. S. Sheiry, Ass't Vice Pres., Engineering Dept., Aetna Life & Casualty Co., Hartford, Conn.

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Association Consultants

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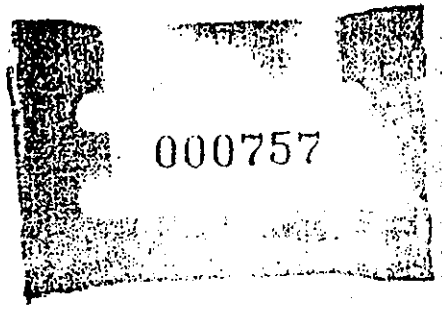
Midwest Area — Robert E. Collins, Exec. Vice President, Southern Cotton Ginners Assn., Memphis, Tenn., Leonard Freed, Mgr. Safety & Member Services, Ohio Contractors

lem. The chief informed me that he would have an inspector at the plant tomorrow. The inspector did arrive. A week later I received a response letter indicating that no safety and health violations were found. I subsequently found out that the inspector who visited the plant went to school with the superintendent of the department that I asked to have inspected. So, I went back to the chief of the division and said that I still had the same complaint and wanted it checked out further. He hesitated quite a while and finally agreed to send out another inspector to accompany the previous inspector. The two inspectors telephoned and made an appointment to make an inspection, and subsequently did. Again, I received a letter indicating that there were no violations found. I realized that the problem was still existing, so I went back to Columbus and again talked to the chief of the division. I informed him that I was tired of getting the run around, and that I had proof from past court cases that this type of an operation is hazardous. I asked that he himself come to the plant and meet with us, relative to this problem. He finally did call me and set up an appointment for the meeting. This time, management, the chief of the State division, and myself inspected, the work areas under question. He went back to Columbus and wrote me a real nice letter riding the fence and not being committed in any way. I answered his letter by indicating that he must get off the fence and provide a solid, honest opinion because the members of our local really wanted to know. I also informed him that the local union was ready to sue the State of Ohio, based on the results of a past court case pertaining to the same problem. Then the chief of the division suddenly got real cooperative. He responded with a long letter, with the first half of the letter still riding the fence. However, in the second half of the letter he finally agreed with me and the union viewpoint relative to the company's operation and instructed them to correct the condition. This is the way the State of Ohio operates.

GREENE: This is just an example, in my estimation, of why it is so important that all of the employees and the division heads be civil service in state safety inspection departments. When this is the case, the person can conduct his work in a morally responsible manner, rather than worry about political influence and reprimands. This is why it is so important for labor to be active in the various states to insure that this protection is provided to the staff of the safety and health inspection department.



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*Deceased

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NATIONAL SAFETY CONGRESS

OCTOBER 26-29, 1970 / CONRAD HILTON HOTEL, CHICAGO

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You can see the largest of all safety equipment exhibits at the Congress . . . an opportunity for you to make well-informed buying decisions for your company.

This four-day educational program, planned and presented by the National Safety Council, can be your most thought-provoking, most worthwhile safety experience in 1970.

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DUST, MIST, AND FUME RESPIRATORS & UNITED STATES BUREAU OF MINES SCHEDULE NO. 21B

By R. H. MOULTON
Respirator Product Mgr., American Optical Co., Southbridge, Mass.

In 24 years of working with the mechanics of respirators, it seems that those people in safety who know and understand respirators best are those who know and understand the United States Bureau of Mines test and approval schedules best. And so it is that we take a look at the very latest Schedule No. 21B covering Dust, Mist, and Fume Respirators.

First, though, what is a respirator? My favorite definition is "A respirator is a device designed to make inhaled air respirable." And when you think about it, that statement covers a multitude of products in the respirator field. There are three major classes of respirators: atmosphere - supplying respirators; air-purifying respirators; and combination atmosphere-supplying and air-purifying respirators. These break down into six basic types of respirators:

1. Mechanical filter type for dusts, mists and fumes. (BM 21B)
2. Chemical cartridge type for vapors and gases. (BM 23B)
3. Gas masks. (BM 14F)
4. Airline respirators. (BM 19B)
5. Self contained demand type. (BM 13E)
6. Self-generating oxygen breathing type. (BM 13E)

Along with these six, we now find appearing on the market a new filter-blower battery powered respirator that may soon appear in quantity. If the filter-blower respirator is submitted to the Bureau of Mines, it would be eligible for testing and approval under Schedule 21B, and maybe under other schedules, too, in the future.

The U. S. Bureau of Mines test and approval schedules originated on the following dates: Schedule No. 13 — March 5, 1919; Schedule No. 14 — May 22, 1919; Schedule No. 19 — April 28, 1927; Schedule No. 21 — August 20, 1934; Schedule No. 23 — November 13, 1944. The Bureau is part of the Department of Interior, and their work on equipment to protect miners is well known in the safety field. The test and approval schedules they have developed covering equipment for miners and others have resulted in extremely high quality merchandise and equipment being available for mining operations. Their fine work has overlapped into industry to such an extent that today it is only natural for those who are responsible for the health and safety of industrial workers to call upon this equipment that has been approved by the Bureau of Mines under their many schedules.

Today, the seal of the United States Bureau of Mines on respirator approval labels is one of the most respected throughout the many industries of America. Without Bureau of Mines approvals, a respirator manufacturer simply isn't in the respirator business. To design, develop, test, and manufacture respirators with the aim of obtaining Bureau of Mines approval takes a lot of time, people of special skills, and a fortune in laboratory equipment. A tremendous amount of research goes into the development of respiratory equipment in order to get approved units on the market for the consumer.

What is the customer looking for besides the Bureau of Mines approval? Protection, of course; that's why the respirators are made. Comfort is a must, if the mask is to be worn. For economy, today all or most manufacturers promote the use of air-purifying respirators which employ one basic mask with a choice of many filters or cartridges to help the safety man hold his budget down and to keep the plant economist happy.

However, the toughest nut to crack is what we call worker acceptance — comfort. Is it easy to breathe through that respirator? This matter of breathing resistance is often not well understood. How many times have you failed in your efforts to blow up a small rubber balloon simply because you do not have the strength to expel air into

the balloon with enough pressure to make it expand? Yet, you may take a small piece of that very same rubber balloon, stretch it across your mouth and inhale the rubber into the mouth to create a small "bomb" for your child or grandchild to squeeze until it blows up with a bang. What this means, you see, is that we expel air from our lungs by relaxing our rib cage muscles and our diaphragm. We inhale by muscular expansion of the rib cage and lowering of the diaphragm. To state it very simply, we are weaklings at exhaling and quite strong at inhaling. The Bureau of Mines takes this into account in establishing maximum values for both inhalation and exhalation resistance of respirators. In the new Bureau of Mines Schedule No. 21B, there are several new resistance requirements for respirators, and these will be reviewed in this paper.

But now, let's look at some of the approvals that are available under this new Schedule No. 21B. There are, as I see it, at least 13 approvals available under Schedule No. 21B should any or all manufacturers desire to obtain these either in single filter or twin filter respirators that are prevalent on the market at this time:

1. For dusts having a TLV not less than 0.1 milligram per cubic meter; (a) single-use filter; (b) reusable filter. A few of the old-timers in the respirator area might not recognize this one as the Type "T" approval for toxic dusts of many years ago. Later on, it became the approval for toxic dusts not significantly more toxic than lead. You will note that today we no longer talk about MAC, or maximum allowable concentrations, but work now with TLV, which stands for threshold limit value. So, today, your Bureau of Mines approval will be given on "toxic dusts having a TLV not less than 0.1 milligram per cubic meter." It is still possible to get this approval on single-use filters commonly known as the throw-away type, and the approval is still available on a reuseable filter, or, in other words, a filter that may be used and, after it has become plugged with particulate, may be cleaned by compressed air or other means and used again and again. It is first tested, cleaned, tested, cleaned a second time, and then tested for the third time. Today, we find the single use filter or the disposal throw-away type outnumbering the reuseable filters by a huge margin.

2. For dusts having a TLV not less than 2.4 million particles per cubic foot: (a) single-use filter; (b) reusable filter. This approval you might recognize as the old Type "A" approval for dusts such as silica. It is also referred to as the pneumoconiosis-producing dusts plus nuisance dusts approval. Today, the Bureau of Mines approval label will list pneumoconiosis-producing dusts as well as dusts having a TLV not less than 2.4 million particles per cubic foot and, again, we have the approvals for the single use filter and the reusable filters.

3. For dusts having a TLV not less than 0.1 milligram per cubic meter or 2.4 million particles per cubic foot; (a) single-use filter; (b) reusable filter. Many years ago, this was called the "AD" or all dust approval for silica and lead type dusts. Later on, it became an approval for dusts and still later it became approval for dusts not significantly more toxic than lead. Today, the approval label reads, "For dusts and also for dusts having a TLV not less than 0.1 milligram per cubic meter or 2.4 million particles per cubic foot," with approvals available on either the single use or reusable filters.

4. Fumes of various metals having a TLV not less than 0.1 milligram per cubic meter. Originally, this metal fume approval was for fumes consisting of solid dispersoids or particulate matter formed by the condensation of vapors such as those of heated metal and other substances. Later, the words "not significantly more toxic than lead" were added. Today, the approval label lists "fumes of various metals having a TLV not less than 0.1 milligram per cubic meter."

5. Dusts having a TLV not less than 0.1 milligram per cubic meter or 2.4 million particles per cubic foot, and fumes of various metals having a TLV not less than 0.1 milligram per cubic meter. This type of approval covers dusts such as lead, dusts such as silica, and metal fumes such as lead.

6. Mists of materials having a TLV not less than 0.1 milligram per cubic meter. This approval you should recognize as the approval for chromic acid mist respirators.

7. Mists of materials having a TLV not less than 2.4 million particles per cubic foot. This approval covers the pneumoconiosis-producing mists such as silica mist.

8. Mists of materials having a TLV not less than 0.1 milligram per cubic meter or 2.4 million particles per cubic foot. This type of approval would cover both chromic acid mist respirators and silica type mists respirators.

9. Dusts and mists of materials having a TLV not less than 0.1 milligram per cubic meter or 2.4 million particles per cubic foot. This is the most common type of respirator approval and is commonly referred to as "the dust and mist approval." It actually is four approvals in one, since it covers lead type dusts, silica type dusts, chromic acid mist, and silica type mists.

10. Dusts and mists of materials having a TLV not less than 0.1 milligram per cubic meter or 2.4 million particles per cubic foot, and fumes of metals having a TLV not less than 0.1 milligram per cubic meter. This is another common approval covering respirators for lead type dusts, silica type dusts, chromic acid mist, silica type mist, and metal fumes such as lead fume. Most metal fume respirators are also approved for dusts and mists and, therefore, are in this tenth category.

11. Dusts, fumes and mists, having a TLV less than 0.1 milligram per cubic meter, or for radio-nuclides. This type of approval first appeared in March of 1965. It covers highly toxic dusts, fumes, and mists plus radioactive particulate in the form of dust, fume, or mist.

12. Radon daughters and radon daughters attached to dusts, fumes, and mists. This is a brand new approval covering radon daughters and these radon daughters when attached to particulate such as dusts, fumes, and mists. It is expected that approved units will soon appear on the market for use in such places as uranium mines. Uranium and other heavy metals such as thorium and radium, which are radioactive, disintegrate, and one of the products of disintegration is a radioactive gas called radon. Radon gas disintegrates into radioactive metal atoms which in turn disintegrate into other radioactive metal atoms until finally a non-radioactive stable lead atom is formed. All of these disintegration products are called radon daughters. Some radon daughters will remain suspended in the air as individual radioactive atoms while most will attach themselves to inert dust, mist, or fume particles in the air.

13. All dusts, fumes, and mists. This approval really covers the waterfront. It applies to: silica type dusts, lead type dusts, silica type mists, chromic acid mist, metal fumes such as lead, highly toxic dusts, mists and fumes including radioactive dusts, mists and fumes. With these 13 previously listed potential approvals, it is important to make note of the fact that there is provision in Schedule 21B for testing very complicated units, extending approvals of previous approved respirators, or other testing that might be requested of the Bureau of Mines. This keeps the door open for approvals of devices that may yet be invented and that would not be covered in the previous 13 categories.

Before discussing the actual tests in Schedule 21B, we should review the materials used and the size of the particulate involved. A yardstick is needed to give us an idea of just what we are working with in the respirator laboratories.

Particle Sizes

1 meter = 39.37 inches

1 micron = $\frac{1}{1{,}000{,}000}$ of a meter

Silica dust = 0.6 micron

Lead dust = 0.6 micron

Lead fume = 0.3 micron

Silica mist = 1 to 5 microns

Chromic acid mist = 3 to 10 microns

DOP = 0.3 micron

Fitting Tests

Coal dust — 1.2 microns

Isoamyl-acetate vapor — 100 ppm; 1,000 ppm

Generally, with normal vision, the smallest particle that can be seen with the naked eye is somewhere between 10 and 20 microns in size. When you look at the particle size of silica dust (0.4 to 0.6) which we round off at 0.6 micron in diameter, you will realize that this dust is about 20 times smaller than can be seen with the naked eye. Likewise, lead dust is about 20 times smaller than can be seen with the naked eye, and the lead fume generated for use in testing rspirators is approximately 30 times smaller than can be seen with the naked eye. The silica mist used in the silica mist test is from two to 10 times smaller than could be seen with

000763

the naked eye, and the chromic acid mist particle size ranges from the particles that might be seen with normal vision down to those that are about three times smaller than could be seen without the aid of an optical instrument. In the DOP or dioctyl phthalate smoke used in testing filters for radioactive particulate, the particle size of the DOP smoke is about 30 times smaller than could be seen with the naked eye.

In the new respirator fitting test involving coal dust, the coal dust is about 10 times smaller than can be seen with the naked eye. Isoamyl-acetate vapors are used for fitting tests on certain respirators.

The materials for testing are placed in test chambers for efficiency tests, with many pieces of equipment such as air pumps, precipitators, and monitoring equipment being used during the actual conducting of the test.

A review of the 21B test requirements will point out to you several new changes in the breathing resistance requirements since there are now limitations on the initial resistance to inhalation at 85 liters per minute and several adjustments have been made in the allowable exhalation resistance at 85 liters per minute. All of these new requirements will result in respirators being developed that are very comfortable to the worker as far as ease of breathing is concerned.

There are, however, new tests involved for respirators, and some of them could become controversial since it appears that it might be necessary for manufacturers of respirators to make face masks much larger than those that workers are familiar with, and there is a tendency for workers not to accept face masks that are rather large in design. Perhaps modern day technology will allow respirators to be constructed that will meet all of these new requirements and still meet the very important worker acceptance requirements. Following are some of the special tests required of various dust, mist and fume respirators:

1. Dust, Mist and Fume Respirator Facepiece Pressure-Tightness Test. Fifteen to 20 people — variety of faces. Respirator fitted — exhalation valve held closed — exhale gently into facepiece — positive pressure created in mask — no leakage — respirator fits. This test is the simplest one of all and is a test that is standard operating procedure for most respirator wearers to make sure that they have the mask properly seated on their face before entering a contaminated area. Other tests, however, are not so simple as this one, as we shall see as we look at the following test.

2. Coal-Dust Tightness Test for Dusts, Mists, Fumes and Radon Daughters Respirators. Three people — six respirators — two respirators per person. One person can perform only one test per day. Coal dust concentration: 75 ± 25 MG/M³. A probe is placed inside the respirator facepiece. Two lpm of air drawn from mask for 30 minutes. The test subject will spend: Three minutes walking and turning and nodding head; 1½ minutes smiling; 1½ minutes frowning; three minutes reciting alphabet; three minutes talking; three minutes shallow and deep breathing. Then the test subject will repeat the above 15-minute schedule. During 30-minute test period, air is continually sampled with second probe located near mask in breathing zone. After test is over, leakage into facepiece must not have exceeded the following:

Respirator	*Max. per cent of Ambient Conc.*
Dusts and Mists	10
Fumes	5
Radon Daughters	5

This is a new fitting test that is appearing for the first time in the Bureau of Mines Test Schedule 21B. The mask is called upon to withstand such things as smiling, reciting the alphabet and talking, with repeat performances and with maximum allowable leakages into the facepiece held to such a low level that it appears certain that many respirators that are presently on the market with old Schedule 21 approvals could not possibly stand up to the requirements of these new fitting tests against coal-dust. Thus, it would seem that truly "bigger and better" respirators will soon be appearing on the market.

3. Isoamyl-Acetate-Tightness Test for Fume Respirators That Protect Against Fumes of Metals Having a TLV Not Less Than 0.1 Milligram per cubic Meter. Adapt mask to organic vapor cartridge(s) or canister. Fifteen to 20 people must wear respirator for two minutes in test chamber containing 100 parts by volume of isoamyl-acetate vapor per million parts of air. [illegible] isoamyl-acetate shall not be detected by test subjects. The above is another fitting test designed especially for metal fume respirators and its description is quite self-explanatory.

4. Isoamyl-Acetate-Tightness Test for Respirators Designed to Protect Against Dusts, Fumes and Mists Having a TLV Less Than 0.1 Milligram per Cubic Meter, or Against Radionuclides. Adapt mask to organic vapor cartridge(s) or canister with similar size and resistance.

a. Test for respirators where the contaminant concentration is known not to exceed 10 times the TLV or 10 times the concentration limits for the radionuclides involved. Twenty persons wear mask five minutes each; 100 ppm isoamyl-acetate vapor in air. Two minutes walking, nodding, shaking head in normal movements. Three minutes exercising and running in place. Isoamyl-acetate odor must not be detected by anyone.

b. Test for respirators where the contaminant concentration is known not to exceed 100 or 1,000 times the TLV or 100 or 1,000 times the concentration limits for the radionuclides involved. The canister or cartridge(s) will be used in place of the filter unit. Twenty people will wear respirator five minutes each in test chamber containing 1,000 ppm of isoamyl-acetate vapor. Two minutes walking, talking, nodding and shaking head in normal movements. Three minutes exercising and running in place. Odor of isoamyl-acetate must not be detected by test subjects.

5. Special tests for respirators designed for respiratory protection against dusts, fumes, and mists having a TLV less than 0.1 milligram per cubic meter or against radionuclides.

DOP Man Tests and Chamber Tests. Take three complete respirators with sampling probe in mask. Six people each wear all three masks (total 18 wearings); 100 micrograms of DOP per liter of air in test chamber — eight liters of air per minute drawn from probe in mask. Two minutes facial movements*; one minute talking*; two minutes running in place.

The one respirator with the highest DOP penetration will be worn by three people for two hours each while performing following tests in chamber concentration of 100 micrograms of DOP per liter of air:

0-15 minutes: test subject seated in chamber. Eight lpm drawn from mask probe. If excessive leakage detected, subject will leave chamber and a stream of DOP will be directed at respirator to determine the source(s) of leakage into respirator.

15-60 minutes: leave chamber and carry on normal activities without adjusting facepiece.

60-75 minutes: return to chamber containing DOP. Eight lpm drawn from mask probe. Test subject will: cough**, turn head from side to side, smile**, frown**, recite the alphabet loudly**, talk**, breath shallowly and deeply.

75-105 minutes: leave chamber and engage in normal activities.

105-120 minutes: enter chamber and repeat the 60-75 minute routine.

Performance Requirements

Where the contaminant concentration does not exceed the TLV or concentration limits for the radionuclides involved by a factor of:	Maximum allowable penetration for the respirator—percentage of ambient concentration	Maximum allowable penetration for average of all tests — percentage of ambient concentration
10	1	0.5
100	1	0.5
1,000	0.1	0.05

*For respirators used in contaminant concentrations up to 10 times the TLV or 10 times the concentration limits for radionuclides substitute turning head from side to side for facial movements and substitute shallow and deep breathing for talking.

**For respirators used in contaminant concentrations up to 10 times the TLV, or 10 times the concentration limits for radionuclides, the test subject will not engage in activities marked with double asterisk.

You will note the tests required for respirators to protect against very toxic dusts, fumes, and mists, or radionuclides are very severe. It is interesting to note that there are respirators on the market that have been approved for protection against radio-nuclides where the concentration does not exceed the threshold limit value or concentration limits by more than 10 and more than 100 times. However, no mask, at the time of writing this article, has been approved by the United States Bureau of Mines for protecting against radionuclides in a concentration from 100 to 1,000 times the TLV.

Although the Uranine Chamber Test is in Schedule 21B, it is no longer used by the Bureau of Mines or most manufacturers since uranine contaminates the laboratory and the equipment, making it almost impossible to get accurate test results.

A review of all of the previously described test procedures and requirements will give you an idea of the tremendous amount of laboratory work that lies behind an approved respirator. You can see that, if you pass all the necessary tests as we have reviewed them and you have a Bureau of Mines *approved respirator, then,* as a manufacturer of respirators, you need a little bit more. To the approved respirator you must have added suitable packaging to meet Bureau of Mines standards, proper advertising, suitable literature or catalogs for the users to use as reference, proper quality control for all components *during manufacturing,* a sales and distribution setup, and you are set to do business.

It is important to note that the United States Bureau of Mines does not condone anything that is improper in any category involving an approved respirator, and this is as it should be.

A look into the laboratory of a well-equipped manufacturer of respirators would provide you with a view of a dust chamber or metal fume chamber that duplicates those of the United States Bureau of Mines in *Pittsburgh, Pennsylvania.* You would see amazing instrumentation for use in conducting various tests and monitoring them. You would also see in the laboratory a special mist chamber or chambers, instruments for chemical analysis, microbalances for weighing, DOP smoke testers, chambers for conducting man tests and coal dust tests, plus hundreds of other items so vital to the design, development and production of respirators capable of meeting the requirements of Bureau of Mines Testing Schedule No. 21B for dust, mist, and fume respirators.

So, if you need respiratory protection determine just exactly what that protection should be and get that protection from a reputable source. Above all, make sure that it has the United States Bureau of Mines approval.

INDUSTRIAL SAFETY IN METALS INDUSTRY

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The seeds of safety are sown with care; let us all cultivate the plant! G.M. has the seven basic principles of safety: provide active top management support; maintain adequate safety personnel; develop safety instructions for every *job; instruct each new* employe; operate through supervision; make every employe safety-minded, and extend efforts beyond the plant. At the 25th anniversary G.M. Safety Conference, we of Harrison Radiator were afforded the opportunity to propose the six senses of safety: use common sense; see clearly; *hear acutely;* respond promptly; standardize consistently; and learn constantly. We offer now the seven safety systems: "Partners in Safety System;" "The Defensive System;" "The Technical System;" "The Suggestion System;" "The Maintenance System;" "The Statistical System;" and "The Quality System."

Let us expand these systems, thus further developing safety standards. Let us *also,* in this review, recognize and stipulate the effect [illegible] modern equipment can have on our [illegible] systems control.

000764

First, the "safety for others" system. What do we mean by this expression? Frankly, we mean just that! Wherever there is work to be done, especially dangerous work (and all work can be dangerous), promote the concern for the other guy's safety—in short, any two people or organizations should feel responsible for each other's safety simply because they want to protect their fellow man. This is the first true application of "partners in safety."

Now, let us take the second step. Management has always required the supervisor to look out for his men; so, why not the reverse? Not that we think the supervisor will trip and fall if his employees do no watch out for him, but *rather that all employees,* with management, promote all types of safety for their mutual benefit.

Third, let us eliminate the causes for complaint and create a standard communication for use between the manufacturer and the user. You in manufacturing should not be so quick to defend your product that you overlook some constructive safety *features buried in an accident. And users should* not always be ready to sell any dealer down the river because they have a safety problem. Rather, let us pool our efforts and be "partners in safety"—buddy problem solvers, if you will—but always working together!

Let us accept the challenge to promote and encourage the defensive driving system, the same *philosophy* that helps to save lives on the highway. We, too, can save lives and reduce accidents in our plants by driving defensively.

The Defensive System. We speak of a defensive system, and immediately everyone says to himself, "Oh, sure!" The fork truck operator must drive defensively, undoubtedly so, but why stop there? Is not the pedestrian also responsible for his actions? Of course he is! Yes, *all* must be instilled with the desire to make their operation safe for the other fellow as well as for himself.

How about sign knowledge—are they clear? Are they placed so they can be seen? Are they standardized? Are they obeyed before the last second? Are the violation corrections enforced?

Preventive maintenance is defensive safety. Power equipment operators should be trained to thoroughly understand the vehicle they are controlling. They also should be educated to the extent that they can apply general defensive safety, be alert, and react *to danger signs—for example: decrease in* normal speed; lack of power; apparent lack of lubrication; worn or damaged tires; poor brakes; missing parts; excessive wear; oil leaks; difficult steering; unusual noises; overheating of motors and controls; erratic operation; failure of safety or warning devices; or poor acceleration. These are not only cost prevention items, but in reality are *the forerunners to accidents.*

The skillful operator lets the other fellow know what he is doing and what his intentions are. Timing is of great importance, and is a result of planning ahead and executing as planned; on time, in time. This also means controlled time and controlled action and reaction. This is known as communications.

The Technical System of safety control has two major divisions: what has been done; and what potential controls, or safety devices, can be applied to future industrial *trucking safety.* We suggest that computer systems will play only 50 per cent of the future major role in material handling control. We further suggest that sensors will play the other 50 per cent. However, these systems in no way eliminate the decision and attention of the human mind! Safety-minded engineers and designers will undoubtedly call upon the simple and sophisticated *sensors for safety control long* before the computerized program goes into effect.

The technical system is personified by the sensors. The safety of present and future material handling systems is and will be dependent upon sensors. There are just four basic types of mechanical sensors: limit switches; pressure sensors; tilt switches; rotating paddles. There are three prime magnetic sensors, namely: magnetic; radio frequency; and capacitance.

The Suggestion System evolves around *more than people vying for an award, or* occasionally not liking some part of their job and as a consequence coming up with a safety suggestion. The real meat of this system is getting all personnel actively en-

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000765

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000766

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000767

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000768

000769

comprehensive well planned health program saved each an average of $30,000 annually on operating costs and that 239 of these companies reported employee absenteeism, due to accident and disease, reduced as much as 30 per cent. Good health is a business asset.

Industrial Hygiene and Toxicology. Industrial disease is directly attributed to exposure to harmful materials or uncontrolled conditions in the work environment. There are more than 900 occupational exposures to toxic substances and conditions that may impair the health of the worker. Among the more important of these toxic substances are the alkalies, corrosive salts, acids (chromic acid in particular), fat solvents, dehydrators, dyes, beryllium, silica dust, radioactive materials, etc. The practice of industrial hygiene control and an intimate knowledge of toxicology can reduce the incidence of occupational disease. The techniques used are: the maintenance of clean work rooms and machines; enclosure of hazardous processes; exhaust ventilation over dusty, vapor, or fume producing operations; provision of protective clothing; measuring and monitoring of contaminated or suspicious work areas; institution of controls to bring conditions within known established tolerable levels. New and untried substances must be studied for their effect before they can be put into production by the worker.

Incidence of infection may also be reduced through close analysis of the physical condition of employees placed in potentially harmful industrial environments. About 70 per cent of occupational disease conditions are dermatosis. By early diagnosis, treatment, and institution of protective measures, the majority of these conditions can be prevented and the physical discomfort and compensation expenses can be eliminated.

Strict supervision of the industrial environment by attention to proper heating, lighting, ventilation, sanitation, and elimination of excessive noise — all are essential for healthy working conditions and high morale. Management today has come to realize that employees are social beings, not economic pawns. They live at their work, and the better the working environment, the better their production and loss prevention record.

Safety-Loss Prevention. Prevention of industrial accidents or disease is a major problem in the United States. It is estimated that the average cost per injury is [illegible] times the figure of the wages involved. Safety programs and industrial medical services have reduced the number and severity of accidents but much more remains to be done.

Competent safety engineers state that more than half of all industrial accidents are preventable. Medical care is obviously indispensable once an injury has arisen. However, the medical department can also help prevent accidents and reduce the incidence and severity of accidents by detecting the accident-prones and observing the physical defects which produce chronic sub-standard health, showing awareness and reaction time. The human factor of worry may produce fatigue and inability to concentrate, and this again can be anticipated and controlled by competent medical advice. With rising workmen's compensation cost and increasing [illegible] occupational hospital-surgical-medical [illegible] it becomes more imperative that we have the highest type, best qualified medical [illegible] available to control our costs and keep abreast of our industrial medical problems. A program of expanding medical [illegible] benefits and higher workmen's compensation costs calls for tighter controls beginning with the pre-employment medical examination and carrying through to severance or retirement.

Finally, it seems clear that healthy workers, both physically and mentally, have fewer accidents, are less susceptible to infection, produce at higher levels, and have a lower absentee rate. This is worthwhile not only to the employee but also the employer. A reduction of absenteeism due to occupational disease, injury, or otherwise results in lower compensation costs, freedom from disruption of continuous processes, and reduced spoilage or spoilage of machines and materials. Sound and effective rehabilitation procedures guided by the Medical Department will provide for lower workmen's compensation costs and provide for early restoration of function and return to work. Furthermore, the practice of industrial health and hygiene raises morale, leads to more efficient performance, provides for better human relations, lessens labor turnover, and improves industrial labor relations, whether it be in the utility business or any other type of market.

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00070

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000770

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