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NATIONAL SAFETY CONGRESS

TRANSACTIONS

GENERAL SESSIONS

ANNUAL MEETING OF MEMBERS

CONGRESS BANQUET

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57th NATIONAL SAFETY CONGRESS

Papers Delivered in the

GENERAL SESSIONS

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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.

American Optical Corp., 14 Mechanic 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. Sky 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 recorders. 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, vehicle alarms, air purifiers, and ear plugs.

CAH Industries, 10245 Pacific Ave., Franklin Park, Ill. 60131
Self-extinguishing waste receptacle.

Calgon Commercial Div., Calgon Corp., 7501 Page Ave., St. Louis, Mo. 63166
Hand cleaning products.

Canrad Precision Industries, Inc., 630 Fifth Ave., New York, N. Y. 10020
Safety signs.

Cardox Div., Chemetron Corp., 840 N. Michigan Ave., Chicago, Ill. 60611
Fire fighting equipment and supplies.

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 F. 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 Official Road, Addison, Ill. 60101
Gas vapor alarm systems.

Falcon Safety Products, Inc., 1137 Route 22, Mountainside, N. J. 07092
Fire alarms, sirens, horns, bells and other signaling devices.

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 pins 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.

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., Emmanus, 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 Stephen St., Ridgewood, Brooklyn, N.Y. 11227
Warning and safety lighting for municipal industrial and utility use.

Machinery Center, Inc., 1201 S. 6th West, Box 964, Salt Lake City, Utah 84110
Sala Safety Block.

Magid Glove Mfg. Co., Inc., 2201 W. Wabansia Ave., Chicago, Ill. 60647
Industrial gloves.

Maico Hearing Instruments, 7375 Bush Lake Rd., Minneapolis, Minn. 55435
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 St., Warsaw, Ind. 46580
Safety pliers, lockout devices, mufflers and stretcher cases.

Pacific Plantronics, Inc., 111 Josephine St., Santa Cruz, Calif. 95060
Communication headsets.

Pac-Kit Safety Equipment Co., 1 Seneca Place, Greenwich, Conn. 06831
First aid kits and supplies.

Paralta Equipment Co., 2036—164th Pl., Hammond, Ind. 46325
Flashing lights, barricades, traffic cones, vests, flags, trouble lights, signs.

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 Equipment Co., 1990 E. 69th St., Cleveland, Ohio 44103
Safety clothing and equipment for industrial workers.

Safety First Products Corp., 175 Saw Mill Road, Elmsford, N. Y. 10523
Portable stored pressure dry chemical fire extinguishers.

Safety First Shoes, Inc., 8th and Greenleaf Sts., Allentown, Pa. 18105
Safety shoes for industry, railroad, 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
Safety hats and caps, face shields, accessories.
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
Dunking station smoking receptacles.

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
Press guards.

Survivair, Division of U. S. Divers Co., 3323 W. Warner Ave., Santa Ana, Calif. 92702
Self-contained breathing equipment. Wet pick-up vacuum unit. Voice amplifiers.

S. G. Taylor Chain Co., Inc., 3-141st., Box 508, Hammond, Ind. 46325
Alloy steel chain and fittings.

3M Co., Retail Tape & Wrap Div., 2501 Hudson St., St. Paul, Minn. 55119
Filter masks and industrial tapes.

Titmus Optical Co., Inc., 1015 Commerce St., Petersburg, Va. 23804
Safety frames, safety lenses and vision tester.

Toledo Pressed Steel Co., 397 Phillips Ave., Toledo, Ohio 43612
Traffic safety devices.

Trans Continental Electronics Corp., 865 Roosevelt Ave., Secaucus, N. J.
Safety shower—eyebath combination.

Trippe Mfg. Co., 133 N. Jefferson, Chicago, Ill. 60606
Warning lights.

Tri-Tix, Inc., 6411 N. Mequon Rd., Mequon, Wis. 53092
Safety cones traffic posts.

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
Safety hardware.

United States Safety Service Co., 1535 Walnut St., Kansas City, Mo. 64108
Industrial eyewear and hearing protection.

U. S. Safety Trolley Corp., 1070 Banksville Ave., Pittsburgh, Pa. 15216
Electrical conductors on crane and runways.

Velcro Corp., 681 Fifth Ave., New York, N. Y. 10022
The Velcro fastener.

Wagner Sign Service, Inc., 3100 Hirsch St., Melrose Park, Ill. 60160
Changeable copy displays for employee relations and safety programs.

Watchemocket Optical Co., Inc., 232 W. Exchange St., Providence, R. I. 02903
Safety goggles, respirators, face shields and safety signs.

Welsh Mfg. Co., 9 Magnolia St., Providence, R. I. 02909
Respirators, safety spectacles, goggles, safety hats, faceshields, and welding helmets.

Western Drinking Fountains, Inc., 45563 Industrial Pl., Fremont, Calif. 95438
Eye wash fountains and drench showers.

Western Optical Supply, 1200 Mercer St., Seattle, Wash. 98109
Eye protection and hand protection.

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
Emergency and warning lights, flashers, and beacons.

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
Personal protective equipment for industry.

Wolverine World Wide, 9341 Courtland Dr., Rockford, Mich. 49341
Hand and head protection.

Worklon, Inc., 64 New York Ave., Huntington, N. Y. 11744
Special purpose clothing — acid-resistant, lint-free, static free and fire retardant.

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 80840
USAFA Cadet Wing safety program.

AEROSPACE SESSIONS

IMPROVEMENTS IN SPACECRAFT FIRE PROTECTION

By WILLIAM L. HANBURY
NASA Safety Office, Washington, D.C.

It must be remembered that decisions regarding the spacecraft program are not easy — in many cases, ignorance is bliss in that persons not responsible for the program will not be inhibited by knowledge in making decisions. Often, an item is seen as black or white — no gray areas. Because of the extremely complex systems and interfaces involved, I would like to suggest that there are three fairly distinct levels for major decision making. First is the easiest — the staff — technical — specialized level; next is the management level where constraints on goals, objectives, money, manpower, resources, and priorities meet; and last comes the involved personnel — what will the astronaut actually do? Will he do what you tell him?

A few statistics may help illustrate the scope of what I mean. Over 400,000 people worked at one time on the Apollo Program. A great many of the fire safety improvements in spacecraft are a joint accomplishment. NASA started some work in-house and then contracted for a more extensive program. Or, private industry made proposals or contributions on their own.

There are over 5,600,000 parts and 1,500,000 systems, assemblies, etc., in an Apollo spacecraft. If all of these operated with 99.9 per cent reliability, we could expect 5,600 failures!

There are a wide variety of conditions and circumstances for which spacecraft must be tested. For example, gravity forces will vary from zero to 10 G's for Apollo spacecraft pre-launch, ascent, coast, reentry, and recovery conditions. Pressure will vary from 5 psi absolute to 20 apia; oxygen from 20 per cent to 100 per cent concentration; and temperature from 60°F to 100°F.

H. M. Clancy of North American Rockwell recently summarized many of the changes made in spacecraft design, materials, and operations to improve fire safety. Included were: materials testing, review, and substitution program; redesign of spacecraft's hatch; emergency retreat facilities and procedures for crew; change of atmosphere of spacecraft on pad; beta cloth development and use to replace fabrics; use of polybenzimidazole (PBI) as a fire resistant material for crew harnesses; quick development of carboxy - nitroso - rubber (CNR) water resistant coating material; development of nonflammable ladicote and melcoat materials; and the present extensive materials testing and data outlet point developed to provide for exchange of information on flammability and toxicity of materials.

Hundreds and hundreds of people have been and still are involved in upgrading fire safety aspects of spacecraft. There is no possible way to adequately cover all of this work in a short discussion. Some highlights will have to illustrate the much wider spectrum of coverage.

Flammability studies of spacecraft materials were underway prior to the spacecraft 012, or Apollo 204, accident. These included:

1. Development of a guideline for testing and performance requirements, and thousands of tests were run.

2. Change in Gemini wire insulation. Teflon nine mils thick was substituted for polyolefin and later reduced to six mils in Apollo, with about a 400 pound saving in load.

3. Zero flammability studies were conducted to observe fire phenomena and spread in zero G.

4. Fire extinguishment tests were run using water, Halon 1301, and other agents.

The Apollo 204 Accident Review Board recommended many changes as a result of their detailed investigation. Their complete

report, together with their testimony before Congressional committees, gives a very comprehensive view.

The basic criteria they assigned to nonmetallic materials for manned spacecraft operations, both in ground and in flight, were:

1. To minimize the possibility of ignition through material selection and placement; to so place nonmetallic materials that any fire that does occur will be restricted to a small and definable area; to so limit the weight of nonmetallic material used in the cabin that its burning cannot increase cabin pressure or temperature to the point of damaging the spacecraft.

2. To protect the crew from the effects of potential fires.

3. To choose materials that, if burned, do not produce toxic fumes that could injure the crew.

Although not specifically stated, detection, notification, and corrective action for emergency conditions, including fire, have also been included.

Classification and selection guidelines for materials were quickly established. Material substitution was made for such items as teflon or steel velcro to replace nylon velcro; aluminum to replace plastic knobs and switch levers; fluorel covering for silicon oxygen umbilical hose; poly-I-Mide laminates are used in place of epoxy and silicon laminates; and many more. The astronauts' space suits were changed to provide a beta cloth layer for fire resistance, instead of nylon. Full scale testing of materials in full scale mock-ups was continued and expanded.

The basic and continuing documentation of information on the selection of nonmetallic materials for application in manned spacecraft is handled in the Manned Spacecraft Center's *Nonmetallic Materials Design Guidelines and Data Handbook*. This document contains test results and interpretations on offgassing and combustion test requirements, the latest criteria for the selection of material based on flammability and toxicity, and information and experience gained from the Apollo Spacecraft Program and other related programs. The latest issue of this document was published on August 29, 1969 as Revision "E." Results are reported by COMAT, or "Characteristics of Materials Test Data Listing," and are computerized. There are about 3,000 listings. Results are listed both by generic and manufacturer's identification.

As mentioned, the design of the spacecraft's hatch was changed. There were two hatches, with the inner one opening inward. It could be stored inside the spacecraft, but it had to be operated by the crew. The pressure relief opening was very small and had to be used to equalize pressure before operation. The outside hatch opened outward. The new hatch is one piece and can be quickly operated. It took more than 20 seconds to operate the two hatches; the new one is designed for operation within about 5-6 seconds.

An lem circuit breaker panel before the Apollo fire contained quite a bit of RTV (silicone-rubber polymer), also melimine circuit breaker boxes. Both of these materials are quite flammable, and the contention of the contractor was that these would not burn at fire point in eight psia oxygen environments. So, a panel was obtained and tested. After the test fire it was quite severely burned. It actually melted out aluminum panels.

The fix was accomplished in two ways. One was to cover the circuit breaker body — the melamine material — with little beta cloth bootees (little bags that slip down over the circuit breakers and then are tied shut with just an exit for the wires to come out). In addition, all the RTV conformal coatings were covered with a non-flammable coating material which had the contractor trade name of Melcoat.

One of the fire retardant wire insulative coatings developed is ladicote — by North American Rockwell. It looks and acts almost like a thick plastic paint, light blue in color. It will prevent electrical components from catching fire from an adjacent blaze. A similar material was developed by Grumman and called Melcoat.

RTV is a silicone-rubber polymer used throughout the command module as a potting material.

Flame resistant polybenzimidazole (PBI) polymer was offered by the Air Force to NASA for use in webbing, harnesses, and the like. It cost about $1,000 per pound at that time, since the Air Force had had it developed by contract and was the sole user.

Carboxy - nitroso - rubber (CNR) was quickly developed from the test tube stage to pilot production to meet spacecraft needs. It used to cost about $2,000 per pound. It was developed by Thiokol and provides a water resistant coating which is then coated by a fire resistant material. It is used on breaker panels and perhaps could be used more extensively, except that between 300-400°F it sublimes (it does not burn) and liberates phosgene and other toxic materials; medical personnel have curtailed its further use to date. This material did allow use of existing materials by its use as a water tight coating.

A problem was identified in the use of fluorel material in the eye piece of the command module space sextant. The fluorel was wrapped around the eye piece to serve as a buffer when it was packed in a box. It didn't serve as insulation or anything like that, it was merely a buffer to keep the eyepiece from rattling around in the storage box. Also, it did have an ignition source in the eye piece in that there was a little electric heater in there. This heater keeps the optics from getting moisture in them.

This configuration was tested. It is, of course, just a flight configuration — the only time the eye pieces will be installed is during translunar phases. During earth orbit it would not be out, nor during launch. So, this is strictly an orbital phase when there is a maximum of 6.2 psia oxygen in the cabin. Along with these optics there might be star charts or earth tracking maps on a little table beneath this region. This was simulated. After ignition, we had some spattering of material from the fluorel onto the table and onto these other materials, and we had fairly rapid propagation. This situation was corrected by eliminating the fluorel material on the eye pieces and using an aluminum buffer.

Fire extinguishing has been investigated for spacecraft. Several agents have been tested for application to spacecraft. It was quickly learned that some agents, such as Halon 1301 (bromotrifluoromethane), were not effective in oxygen atmospheres. Water foam and carbon dioxide have been tested. There is also a procedure for extinguishing a fire by exhausting to vacuum under certain closely controlled situations.

The fire extinguisher designed for the command module uses water foam. It is required to generate a little over two cubic feet of foam after going through a simulated space flight. Initially the extinguisher will produce a little over four cubic feet of foam. Astronauts are given training in the use of fire extinguishers and rescue procedures at Cape Kennedy as part of their required preparation training for space flight.

There are a number of fixed fire protection systems provided for launch complexes. Halon 1301 can be used to inert areas; water deluge systems are provided at various levels; standpipe hose stations and hand fire extinguishers are provided at various points; protective clothing and emergency breathing apparatus are also provided. There are also emergency egress by slide wire and emergency rescue teams available to rescue the astronauts.

It should be noted that the spacecraft atmosphere while it is on the pad at 16.5 psia has been changed from 100 per cent oxygen to 60 per cent oxygen and 40 per cent nitrogen.

What are some of the advances made in this program?

The family of fluorocarbons has been developed. These are very resistant to burning except in pure oxygen atmospheres of 6.5 psia or greater. These fluorocarbons include vitons, fluorels, and the like.

There has been established a focal point and a mechanism for a closer and more complex exchange of information on the flammability and toxicity of non-metallic materials. This has been a cooperative program with Federal government and private industry participating.

The knowledge and technology gained has application to other phases of the space program, the Navy's underwater exploration program, our nation's medical program with oxygen-enriched atmospheres, etc.

We have seen better fire testing developed for spacecraft, the various pressures, oxygen atmospheres, zero gravity, and full-scale. Emphasis has been placed on fire ignitor point testing and compartmenting or minimizing fire effects. Training in fire fighting and rescue techniques and equipment has improved and expanded. System

safety techniques are being adopted more for use in fire protection and industrial safety applications.

What are our problems? Haven't we shown that everything is taken care of?

We will always have combustibles — food, people; and we still don't have good fire detection systems that won't give false alarms. Just as in aircraft, we don't want false alarms to dull response times, and just as on ships, the astronauts have to stick with the ship, so we want long lead time in notification. Remember, it may take 20 minutes or longer to don spacesuits, and this could be more than enough time for heat, toxic fumes, or lack of oxygen to prove fatal. Also, we are building the hardware to fly now and we have little lead time for equipment development.

How about fire extinguishers — aren't there peculiar problems that zero gravity introduces — and the pure oxygen or high oxygen content presents — yes, there are, and we don't know all the answers, either.

What kind of detection system would you think suitable for space stations where there will be a population of zero to say 50 people? The station will be inhabited for 30 days and then vacant for 30 days; inhabited for 60 days, say, and then vacant for 30 more days. Be used for 10 years — and how about all the experiments that will be going on — no one can tell you the exact nature of what they might include, but they are bound to have a significant impact on the fire safety of the station, and even on the false alarm and sensitivity settings of the fire detectors.

If you could start from scratch, how would you design a space station to minimize or exclude unwanted fire? This is the challenge some people in NASA are faced with, plus all the unknowns that have such a direct impact on such a proposal. There is a Spacecraft Fire Hazards Research Steering Committee operating within NASA on these problems. I think you will agree we have a long way to go.

HAZARD RECOGNITION

By ERNEST LEVENS
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A discussion of hazard recognition with safety professionals may seem excessively elementary. There are, however, a number of deficiencies in the conventional analytical process and some valuable recent conceptual and methodological advances which warrant exploration. Proficiency in the early identification of hazards is a fundamental prerequisite to hazard evaluation and elimination (or control) in the conduct of effective programs of loss prevention. However, the prevalent method of hazard recognition, despite the evident skill of many of its practitioners, suffers from several serious limitations:

1. Recognition of hazards is highly dependent on the experience and skill of the individual analyst. His available store of hazard information, whether acquired personally or from the recorded experience of others, must provide him with enough insight into the accident potential of a given combination of events to be useful in predicting that there is some level of risk associated with that particular combination. As a result, the experiential approach to hazard recognition, at its best, is practiced as an intuitive art in the hands of the skilled safety professional, with a correspondingly restricted availability. This presents a problem in manageing loss prevention, since the quality of the analyst's work and his frequently obscure thought process are not independently monitorable, short of having them checked in stepwise detail by someone of at least equal capability.

2. Some arbitrary weighting or criticality scale may be applied to the consequences of failure, leading us to rate a risk as, perhaps, high, moderate, or low. On this basis, we sometimes confidently talk about taking a calculated risk, when it would be far more accurate to recognize that only a qualitative assessment has been made.

The fact is that, in the absence of a mathematical model, the conventional hazard analysis cannot be quantified for use in evaluating the relative safety of alternative designs or procedures. It is thus of limited value as a tool for management decision-making in accepting or rejecting a given risk.

3. The conventional analytical method is reasonably successful in identifying fairly simple, readily apparent, sequential combinations of hazardous events taken one or two at a time. But the method is not readily applicable to new hazard combinations in state-of-the-art situations for which no experience (i. e., hindsight) is yet available, or to subtle, complex, or parallel events; these are likely to remain undiscovered, unevaluated, and uncorrected.

4. A graphic form for showing the thought process involved in a hazard analysis has not been available. Such a formalized visual aid would be valuable to enhance understanding, to instruct, or to persuade.

5. The lack of a unifying concept for hazard recognition requires the analyst to commit to memory, or search for, the possible outcomes of thousands of apparently unrelated combinations of events. The very terminology used in hazard analysis has a feed-back effect in constraining the perceptual and integrative skills of the analyst and in later communicating the analytical results to others, particularly to management. The handicap thus imposed by formative language is especially severe on the novice until he acquires some liberating intuitive skills.

6. We should not overlook the persistence in our culture of a folklore and mythology about hazards and accident causation. The word "hazard" is derived from an old game of chance played with dice. The same sense of chance, unexpectedness, or unforeseeability can still be observed in attitudes about accidents, and safety professionals are by no means exempt from their cultural heritage. As a result of this cultural and linguistic influence, there is a strong undercurrent, even if subconscious, of feeling that accident causation is somehow involved with uncontrollable, possibly malevolent, forces in nature, about which we can do very little. Thus, we commonly talk about acts of God, one's number being up, the breaks of the game and the like. This fatalism may play a strong role in failures to take simple precautions to identify and neutralize hazards, as well as in hero-worship of the chance-takers, the defiers of fate.

The thought process involved in the conventional type of hazard identification exercise goes something like this (greatly simplified, of course): if the guard is left off this in-running nip point and if an employe is working on the machine and if he somehow gets his fingers in the nip, then he will be seriously injured; the nip point is labeled a "hazard," or perhaps a "potential hazard." Or we may think: if this alkali metal perchlorate is contaminated by a spill of lube oil and if sufficient energy is somehow applied to initiate a redox reaction, then there will probably be an explosion; the strong oxidizer is labeled a "hazardous substance." In other words, of all the contributing events in a particular dynamic sequence which together generate a specified *outcome:*

$$\text{If } A \xrightarrow[\text{by}]{\text{followed}} B \xrightarrow[\text{by}]{\text{followed}} C \xrightarrow{\text{then}} D$$

the one perceived as the pivotal function (*A* or *B* or *C*) is tagged "hazard." Which function is seen as pivotal may become the subject of disagreement.

What we usually do, then, as a convenient oversimplification, is compress the analysis of a whole sequence of events (a process) into a single event, then label the single event as an object or thing. A mechanical analogy is the repeated folding of a long, narrow strip of paper until it is in the form of a small pellet; the original strip can be recovered undamaged (except for the creases) by unfolding. This operation ordinarily poses no conceptual or practical problems when, for example, we consider a chair only as an object, neglecting the unending processes of change within the wood, metal and fabric of which the chair is made. But relying for support on an antique chair partly disemboweled by moths, termites, and dry rot can have unwanted consequences which awareness at the event or process level might have precluded. In still other situations, the major events of immediate concern may not be found at the macroscopic level, but be occurring at microscopic, molecular, atomic, or even subatomic levels.

The distinction between dynamic "events" and static "things" is of such fundamental importance in hazard recognition as to justify further exploration of the concept. Scientists infer that what is going on in the universe consists only of electromagnetic events. At this level, there are no qualities and no things—no color, taste, shape, sound. What we perceive directly by way of our senses represents a first order of abstraction from what is going on. From these limited sensory experiences, we construct conceptual models of atomic structure and act as though the universe has this structure; we project our sensations onto the outer world. Giving our perceptions labels (i. e., names) represents a still higher level of abstraction. As we move from the lowest verbal level of description, factual statement and naming, into successively higher levels of abstraction, we move further and further away from direct sensory experience. The patterns of linguistic usage tend to lead us to confuse these different levels of abstraction; we act as though inferences were facts or as if words were things.

The point is that categories, classes, laws of nature and the like are higher-order abstractions invented—not discovered—by man; they do not exist out there. We can put an individual thing into as many categories as we please; none is more real than another. When we ask "What is it really?" we mean, "What do we call it?" The value in being able to invent new categories freely will be discussed later. A limitation on our freedom, of course, is that some degree of agreement about the categories selected is necessary for communication; if my "dog" equals your "horse," we will have a problem unless we can both see and point to the same animal.

It will not do very much harm to continue the comfortable short-cut of thing-ifying, provided that, in analyzing hazards, we keep in mind that the things we attach names to are actually in a state of dynamic equilibrium rather than static. What we are concerned with are stresses which cause changes that exceed the expected limits of variability and thus upset an accustomed or controlled equilibrium. These are variables of frequency, duration, amplitude, and polarity, for example. Thus, we will be thinking of hazards in terms of events, states, or conditions, rather than as things or objects; and we will be looking for stresses resulting in nontolerable changes that upset equilibria.

If we want to describe an event fully, we will have to locate it in both space and time. The Golden Gate Bridge in 1968 is not the same as the Golden Gate Bridge in 1958; nor is John Doe driving to work on Monday morning after a big weekend the same as the John Doe who left for home on Friday afternoon.

It is also necessary to recognize that every event has associated with it a certain probability of occurring within some particular time span. Occasionally, we are able to visualize all the possible outcomes of some simple physical process (e. g., the toss of a coin or a die) and from this readily conclude that, if the process is unbiased and if we repeat it enough times, the probability of a specified outcome is 1 in 2 or 1 in 6. It is not necessary, of course, to toss a real coin to discover the possible outcomes of tossing one. We can itemize the possible outcomes (in relation to some specific question we have in mind) by simply imagining that a coin has been tossed. The experiment, then, is a purely conceptual one for which we have selected the sample space. We have analyzed a *model* of an event of interest: tossing a coin. In the real world, of course, coins are not weighted precisely the same on both sides, and the relative frequency with which heads appear may prove to be 0.476047, instead of 0.50000. It is vitally important that models and reality not be confused with one another.

The complexity of most events is so great that we cannot deduce any theoretical probabilities of occurrence simply by analysis of a conceptual model. We are forced to wait until a large enough sample has been studied, or enough collective experience accumulated, before an after-the-fact empirical probability can be assigned. What is often not realized is that, even though the probability of any single occurrence of a given event may be very small; with enough repetition the chance that it may happen at least once within some given period of time approaches certainty. To illustrate this point, consider the probability that *at least* one head will turn up on repeated, fair tosses of an unbiased coin (or on one toss of a number of coins).. We

can show the possible outcomes by listing in order the outcome for the first toss (or coin), the outcome for the second toss (or coin) and so on.

There are two possible outcomes for a single toss of one coin: heads (H) or tails (T). For two tosses of the coin (or one toss of two coins), there are four possible outcomes: HH, HT, TH, TT; the probability of each permutation is $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$. There are three permutations containing at least one head, so the probability of turning up at least one head in two tosses is $\frac{3}{4}$. For three tosses, the probability of each permutation (i. e. HHH, HHT, HTH, etc.) is $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{8}$, and the probability of at least one head turning up is $\frac{7}{8}$ since at least one head occurs in seven of the eight possible outcomes. For eight tosses, the probability of turning up at least one head becomes 255/256 or 0.9961. The duration of the event of interest, or how often it is repeated, is thus of critical importance.

Usually, we do not deal with coins or dies, but are confronted by extremely complex situations with largely unknown outcomes as well as unknown probabilities of occurrence. About the best we can do is to concentrate on the relatively few events that, from experience, we know we would most prefer *not* to have happen; it seems easier to look for failure than for success. For these key undesired outcomes we can, through test or personal durability, gradually acquire data on the relative frequency of occurrence. The frequency and severity rates for disabling work injuries fall into this category.

In recent years, a great deal of effort has gone into determining the reliability of hardware items from tests and from maintenance and repair data (i. e., relative frequency of failure and the outcome or failure mode). This effort is now being extended to the problem of human error, but the very limited information available is not immediately applicable to the industrial work-place. More useful data may be developed in the next five years or so. This lack of failure rates is not serious in industry where the primary need is for a more powerful tool for qualitative analysis. In the design of military weapon systems, failure rates have been used successfully as a measure of the relative safety of the system; they have also been misused by applying data of minimal statistical significance in an absolute sense.

Summarizing the discussion to this point, we can broadly consider hazards to be any events we happen to be interested in because, in combination, they have some probability of resulting in an undesired outcome within a time-period of concern to us. But we still need to decide which events we ought to be interested in and how concerned we should be about them.

The advent of increasingly complex weapons in the past few years made it essential to develop hazard evaluation techniques with correspondingly increased capabilities. Individual designers usually performed comprehensive hazard analyses of their own particular parts of a system. But, partly because of arbitrary contractual or jurisdictional boundaries, little attention was paid to either the interfaces between the parts or their interfaces with people and the environment. It was also realized that safety is a measureable attribute of a system, provided there is an integrated approach to the evaluation of all possible "hazard interactions of facilities, equipment, procedures, and personnel, either singly or in combination."

The concept of a system is certainly not new. We have transportation, religious, communications, and educational systems, for example. What we have in mind when we speak of a system is an orderly arrangement of components or elements which are inter-related, and which act and interact to perform some specified task or function in a particular environment and within some particular time period. More definitive descriptions have been given by the Air Force, the prime mover in the recently accelerated development of systems engineering:

"A system . . . is a composite of equipment, skills, and techniques capable of performing and/or supporting an operational role. Through practice, the elements of a system have come to include the organizational equipment required to perform the operational mission, equipment for checkout, maintenance, and training; facilities required to operate and maintain the system; personnel trained and possessing the proper skills to operate and maintain the system; and the computer programs and procedures necessary to operate and maintain the system. In addition, the term system encompasses

all the ancillary equipment required such as instrumentation, depot tooling and test equipment, installation and checkout equipment, etc.

"All parts of a system must work together and have a common unified purpose; namely, to contribute to the production of a single set of highest outputs based on given inputs. This absolute necessity for coherence requires an organization of creative technology which can lead to the successful design of a complex military system. This organized creative technology is called system engineering . . . system engineering encompasses terms such as system approach, system analysis, system integration, functional analysis, system requirements analysis, reliability analysis, maintenance and maintainability task analysis, and similar functions."

Systems are assemblages of subsystems, and subsystems are made up of components. One example of a system is the one for waking you up in the morning at a specified time. The system components (or subsystems in this case) consist of an alarm clock, you, and the environment. The clock must be in good working condition, but you must perform the essential operations of winding, setting the time, and activating the alarm mechanism. Failure of the alarm system can occur if the clock is affected by abnormal environmental conditions: heat, moisture, dust, corrosion, etc.

The application of the terms "system", "subsystem" and "component" depends on the analyst's point of view. An automobile carburetor is a system to the carburetor manufacturer; a subsystem to a designer of systems which include the accelerator, fuel pump, etc.; and a component part for the automobile manufacturer. In an analysis, the definition of a component may thus vary between systems and even within a given system, depending on what is of interest at the time. This, then, is the value, noted before, in being free to invent new categories.

But a system cannot be understood simply in terms of its individual elements or component parts. Every system has assigned objectives, a mission. If the operation of the system is to be effective, if the system is to accomplish its mission, then all of the parts (subsystems and components) must *interact* in a predictable and measurable manner, within specific performance limits and operational and design constraints.

In analyzing any system, three basic components must be considered: (1) the equipment (or machines); (2) the operators; and (3) the environment in which both men and machines are performing their assigned functions. All of these are in continuous, dynamic interaction with one another within some predetermined limits of variability. If these limits of variability are exceeded, then the system may be incapable of operating or become damaged, it may deteriorate too fast, it may perform its mission poorly, or someone may get hurt.

As an interacting subsystem, man has certain general characteristics which must be taken into account: (a) physical dimensions, (b) capability for data sensing, (c) capability for data processing, (d) capability for motor activity, (e) capability for learning, (f) physical and psychological needs, (g) sensitivities to physical environment, (h) sensitivities to psycho-social environment, (i) capability for coordinated action, and (j) variability within and between individuals with respect to all these characteristics. Stress leading to human error can occur when man's physical, physiological, psychological, or biomechanical limitations are exceeded.

Man and machine interact through procedures, spelled out as functions. Functions are described in terms of tasks, and tasks in terms of elements. This convenient subdivision provides a basis for determining whether or not tasks are within human capabilities; what knowledge, skills, and numbers are required to perform them; what information is needed to carry them out; what hazards or risks are involved, and so on.

Those variables in the environment which may affect the system and its performance must also be taken into account: the weather, air turbulence, temperature, humidity, pressure, chemical composition, time of day, geography, and many more. The performance of both men and machines can be profoundly influenced by environmental variables which exceed their normal limits and thus place a stress on the system.

The effects of the interactions of man x machine x environment on the accomplishment of the system's mission are certainly

related to system reliability. But, it is not always recognized that a mechanically reliable system is not necessarily a safe one. A hand grenade, for example, is a highly reliable device, but in a man *x* machine system it is not safe unless the human subsystem is well-trained in its use and does, in fact use the grenade as he was trained. A cotter-pin is a very reliable mechanism when properly installed; but a fastener specifically designed to compensate for human frailty is not only reliable, it is safe.

Thus, analysis of human reliability is as essential as analysis of hardware reliability in the systems approach to accident prevention. Human errors which can degrade system reliability include: (a) failure to perform all or part of a task; (b) performance of the task or step incorrectly; (c) introduction of some task/step which should not be performed; (d) performance of some task/step out of sequence; or (e) failure to perform the task/step within the allotted time period. Any of these human errors can degrade system safety. It should be emphasized here that the term "men" includes operators and maintenance men, as well as those who manage the system, those who design it, and those who establish the requirements.

For setting system safety goals, that is to decide which are the key events, we can turn for guidance to *MIL-S-38130A*, the basic military specification establishing the requirement for system safety engineering in the development of all DOD aeronautical missile, space, electronic, vehicular, and weapon systems, and their associated subsystems and auxiliary equipment. The DOD goal is "to minimize personal injury, material failures and malfunctions, and monetary losses." Safety is defined in this document as "freedom from those conditions which can cause injury or death to personnel, damage to or loss of equipment or property." These, then, are the ultimate undesired outcomes of primary concern upon which we should concentrate our preventive efforts.

There remains the question of how concerned we ought to be. Here, we can also adopt the DOD classification of a system hazard relative to the severity of the consequences of personnel error, design characteristics, procedural deficiencies, or subsystem/component malfunction. Use of such a classification scheme amounts to applying a criticality index to undesired outcomes; other indices could be used if preferred.

I. *Negligible:* Condition(s) such that environment, personnel error, design characteristics, procedural deficiencies, or subsystem or component malfunction will not result in major system degradation, and will not produce system functional damage or personnel injury.

II. *Marginal:* Condition(s) such that environment, personnel error, design characteristics, procedural deficiencies, or subsystem or component malfunction will degrade system performance but which can be counteracted or controlled without major damage or any injury to personnel.

III. *Critical:* Condition(s) such that environment, personnel error, design characteristics, procedural deficiencies, or subsystem, or component malfunction will cause equipment damage or personnel injury, or will result in a hazard requiring immediate corrective action for personnel or system survival.

IV. *Catastrophic:* Condition(s) such that environment, personnel error, design characteristics, procedural deficiencies, or subsystem or component malfunction will severely degrade system performance, and cause subsequent system loss, death, or multiple injuries to personnel.

We can now visualize an undesired outcome as the end result of one or (usually) more sequential (sometimes parallel) malfunction events, each with its own probability of occurrence, initiated by some kind of stress on a specified system which has previously been in a state of dynamic equilibrium (i.e., under control). Event interaction occurs within some finite time, ranging from microseconds or less to many years. A stress on the system can be anything which tends to disturb normal (i.e., planned) functioning: excessive pressure, power failure, sudden change in pH, corrosion, release of toxic material, a hurricane, pushing the wrong button, etc.

If a possible system stress can be anticipated by analysis of a model of a system well in advance of operations, then adequate means of preventing either the stress itself or its undesired effects can be built into the system. Alternatively, although not as de-

sirable as preventive design, the hazard sequence can be interrupted by taking some appropriate corrective or protective action, provided there is a means of monitoring for the occurrence of an early malfunction and detecting it soon enough and reliably enough.

Since the thrust of hazard analysis is to identify interacting combinations of events within a system, we will find useful the concept of "set." A set is any collection of items (events, objects, labels, people, time intervals, numbers, etc.) defined by specifying which items are elements of the set. This may be done by stating some rule by which the elements can be identified, or by actually putting the elements on display. For example, we can specify as a set: {the integers which appear on the six faces of a die}, or {1, 2, 3, 4, 5, 6}.

We are now in a position to define a hazard in terms of interacting events involving man $\times$ machine $\times$ environment, probability, undesired outcomes, systems, and sets:

Hazard: In a system defined in both space and time, a real or potential set of identifiable events which, on interaction of the elements of the set, have some likelihood of generating an undesired outcome.

Undesired Outcome: Injury or harm to persons, system functional damage, degradation of system performance, or contribution to an undesired outcome in another system.

When an accident has occurred, the hazard set has interacted, with an overall probability of 1.0, to generate the observed undesired outcomes. We can thus define a safe (or successful) system as one in which the likelihood of occurrence of all identifiable (i.e., recognizable within the state of the art) undesired outcomes is kept within acceptable limits. What limits are acceptable is a matter for management decision, guided by the best possible analysis that can be performed.

The success or failure of a real system is best demonstrated by actually operating it; unfortunately, this is time consuming, often impossible or excessively costly. Next best is to perform limited testing of all or parts of the system under controlled conditions which simulate actual operations as closely as ingenuity can devise; this, too, can be expensive and time consuming. The next alternative is analysis of a model of the system confirmed by a few tests. The least desirable method is analysis alone, but it is the only recourse when no testing can be done; it has the advantage of least cost.

The following scheme for an effective hazard analysis embodies the concepts developed in this paper:

1. Define the system in space and time, including its objectives, the location of its interfaces with other systems of interest, and the analytical limits of resolution within the system (may vary, depending on the analyst's interests).

2. Specify the identifiable undesired outcomes, states, or conditions within the defined system.

3. Select the key system-characteristic undesired outcomes that serve as the basis for decision by comparing them with index of criticality (e.g., negligible, marginal, critical, catastrophic); record the results.

4. Determine the possible modes of occurrence of the selected undesired outcomes.

5. Evaluate the likelihood of occurrence of the possible modes of occurrence. This can be done with logic alone; failure rate data are not needed in most industrial systems. An estimate of mission success can even be made on the basis of events being likely or unlikely to occur.

6. From the foregoing, decide if the system design is adequate to prevent failure and, if not, what design changes are required to improve the relative safety of the system.

7. Analyze any system revision as above, and repeat as often as necessary until the optimum design is achieved.

The usual intuitive method of analysis, discussed at the beginning of the paper, should not be entirely discounted. It works very well in many situations, particularly when it is not pushed beyond its limitations. Intuitive analysis seems to be a subconscious mixture of two basic, formal methods, inductive and deductive analysis, either or both of which can be used in the scheme outlined above.

The inductive method of analysis involves a "what happens if" approach, in which one reasons from the particular to the general. In terms of the previous discussion, the analyst identifies the possible state of existence of the system elements and, sequentially, tries to determine the possible effects of each on the overall system (undesired outcome). Job hazard analysis, gross hazard analysis, fault hazard analysis, failure mode and effect analysis, and failure mode, effect, and criticality analysis are all inductive methods.

The deductive method of analysis involves a "how could this have happened" approach familiar to friends of Sherlock Holmes, reasoning from the general to the particular. The formal process, widely used in the aerospace industry, is called Fault Tree Analysis, since the resulting logic diagram somewhat resembles a multi-branched tree. FTA provides the only method known for the overall quantification of risk. In terms of the previous discussion, the analyst specifies a state of existence of the overall system (undesired outcome) and tries to identify the system elements that could contribute to its occurrence.

There is a growing literature about these formal analytical methods, so they will not be discussed further here. All have their place. Each, to a greater or lesser extent, provides a means for overcoming the limitations of intuitive analysis listed at the beginning of the paper. Regardless of the method used, the systems concept of hazard recognition and analysis makes available a powerful tool of proven effectiveness as the basis for informed management decision-making about the acceptability of risks. The safety professional can make use of this concept today. No more is needed than a sharp pencil, intelligent curiosity, and persistence.

WHAT MUST BE DONE TO RECOGNIZE THE VITAL FEW

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We are all keenly aware of the vast changes sweeping our world today; changes not only in our technology but in the basic structure of society. The rate of progress forces us to run to stay even — and run hard to hold a competitive edge.

There are changes sweeping the world of occupational safety too. In order to keep abreast of these changes we must regularly evaluate our thinking, our objectives, and our techniques for reaching those objectives. We must refocus on our targets. We must take a long, hard look at the results we are achieving — or failing to achieve. Our decisions must be guided by hard-rock facts instead of opinions. And one hard-rock fact that we must constantly remember is that nothing is so fatal as obsolescent thinking and resistance to change.

It is in the framework of this fast-moving world, where nothing is constant except change itself, that I want to relate what our company has launched as one specific change — a change demanding a basic alteration in the thinking of those in the occupational safety profession. Batten, in his book, *Tough-minded Management*, said, "The effective executive doesn't wait for things to happen; he *makes* them happen." We believe that our new approach will provide business management with information that will make things happen in the control of losses.

Our technique was developed not for the sake of change but to increase the effectiveness of those who work to control losses. We believe that such an approach is the only way to maintain open communication lines between loss control specialists and those in other areas of management. Even more important is our conviction that this technique will not only reduce injury costs, but will also reduce human suffering and disability.

Finally, let me startle you with the fact that this change which we advocate can be carried out with no increase in your costs. In the midst of today's inflationary spiral, it is no small thing to be able to increase output without increasing input!

In a nutshell, our proposal is this:

Let's put occupational loss control — both its direction and its measurement—onto the dollar standard!

For nearly half a century the only standard measurement unit available to the safety profession has been accident frequency and severity. What, precisely, do frequency and severity mean to the modern, dollar-oriented manager?

The frequency and severity measurement method was first developed in 1920. It was later adopted as an American National Standard in 1937. The method was revised in 1945, 1954, and 1964, but these revisions produced only minor changes in the measurement technique.

Frequency and severity represent a strange measurement unit; it stands alone in the safety field; it has no correlation with any other industrial unit of measure. Therefore, the system has in it an inborn communications gap! Let me illustrate by describing my company's experience in exploring this area in the early 1960's. As a part of our loss control research we plotted a curve to show the distribution of losses by loss size. We were amazed at what we found. All of us had assumed that there would be a straight line relationship between numbers and dollars — but not so! It turned out to be a unique curve — in fact, a family of unique curves for each kind of industry we were studying. The curve is shaped somewhat like one side of a mountain with a long, gradual approach — and then suddenly a steep and abrupt rise to the peak. What does this tell us? That using injury frequency as our unit of measurement is like trying to measure the height of a mountain by measuring the slope of its foothills. There is no correlation between injury frequency rates and costs. In our terminology, the foothills represent the large numbers of small losses which we call the "trivial many." The large losses — a small percentage in number, but a large percentage in total cost — we call the "vital few."

The "vital few" approach, we are convinced, will help close that communications gap previously referred to. It is our contention that we must speak and write a common language if we are to communicate effectively in the industrial world. The language of business management is simple, direct, effective. Its terms are very similar to the language used in every household. The measurement methods used by management almost always relate to cost, whether in dollars, man-hours, or machine time. Why shouldn't the measurement technique of loss control do the same thing? Why shouldn't injury costs be the guiding factor in determining both loss prevention performance and the direction of future efforts?

Our analysis involves about $200 million of injury cases reported to the insurance carrier. We advocate and utilize the cost of injuries as the unit of measurement which provides clear communication between safety professionals and management. We have used the vital few approach to pinpoint the major causes of injury costs in all of the various industries where we have a substantial number of policyholders. Our analyses of cost distribution revealed that 67 per cent of the injuries in any industry could be classified as medical-only, contributing only six per cent to the total injury costs. We found that the average cost of these medical treatment injuries is $25. Injuries sufficiently serious so that compensation payments for loss of time were involved accounted for only 33 per cent by number of injuries, but for 94 per cent of the cost. Even more startling was our discovery that injuries costing over $2,000 accounted for only two per cent by number of injuries, and for 50 per cent of the total cost.

These vital few injuries — 33 per cent that account for 94 per cent of the total injury cost (including the two per cent that account for over 50 per cent of the cost) — are truly the vital ones! We must control the causes of the vital few if we are to accomplish anything significant from both a human and economic standpoint. Control of these vital few will accomplish the greatest good in the least time and with the least effort!

Our next step was to collect information that would enable us to identify the causes

of those vital few injuries in the major industries. We established a system whereby each injury reported to us was classified; first, according to the workmen's compensation classification applying at the time of injury; then, by accident-type, mechanical agency involved, body part affected, and kind of injury. The difference from most other statistical attempts is that the four-point description provided us with the following picture of each injury-producing situation:

"Fall from scaffold, fractured leg."

"Caught between punch press dies, amputated finger."

Furthermore, classification of pertinent injury data was performed, not by clerks, but by our safety consultants, who were able to get first-hand information from our policyholders. These details were then coupled with injury cost data for the particular claim and stored in our computers for future retrieval. We presently have such information on about one-quarter-million lost-time, disabling injuries, costing in the vicinity of $185,000,000. We are now able to withdraw summaries from our computers, as needed, by injury cause-cost data, by workmen's compensation classification, by accident type, agency, body part, and injury. This information can be obtained in various combinations, making it possible to examine the data in various ways and to identify major injury cost-producing accident types, along with the corresponding agencies and body parts involved. Analysis of an injury cause-cost tabulation by a person familiar with the industry can provide a most remarkable insight into the major causes of injuries.

As a typical example, in the concrete construction classification we analyzed 2,199 injuries costing a total of $2,400,000. We found that falls from elevations accounted for 18 per cent of the injury cost; material handling injuries, 15 per cent; falling objects, 10 per cent. Further analysis revealed that in the accident type "falls from elevations" the most closely associated mechanical agencies were scaffolds, ladders, and roof and floor openings. In the accident type "handling" we found that forming lumber and tools were the agencies most commonly involved. We also learned that one-third of the handling injury cost involved back injuries. The most common falling objects were building and scaffolding material and tools. With these findings it became obvious that the first line of defense should be the control of falls — particularly falls from ladders, scaffolds, other elevated surfaces. An equally obvious secondary defense was the mandatory use of head protection to guard against falling objects.

Now let's cross-examine our "vital few" approach and its results. Some people ask: "Couldn't one big injury throw the entire analysis askew?" Since some 2,199 disabling injuries costing $2,400,000 were involved in our study, it's logical to assume that any so-called unusual injury which appeared in this sample would appear in subsequent samples. As a control device we did analyze smaller samples of injuries occurring in geographical areas representing our 15 operating branches. We generally found an injury-cause-cost trend very similar to that found in our national analysis. This is a probabilistic world, and the man who thinks his plant's severe accident is unique thinks so only because his horizons are limited. There are more similarities than differences, and since the work processes in a given industry are pretty much the same throughout the country, the injury exposures must also be similar. It then follows that the cause and cost of injuries must also be similar if the exposures are not controlled.

A review of the work processes included in the concrete construction classification and their inherent hazards makes this point quite clear. The work includes the pouring of concrete for the foundation, columns, beams, even the floor and roof slabs of multi-story buildings. Also included is the setting of forms, placing reinforcing steel, and removing forms. This involves a considerable amount of climbing on ladders as well as working from scaffolds and other elevated surfaces. All this adds up to a continuous high potential or severe exposure to injury.

The severity of exposure is directly reflected by an average injury cost of $5,000 for falls. Because there is no other economically sound method of carrying out concete construction work, it is essential that the safety professional concentrates upon the control of falls. In doing this he must see that ladders are properly selected and

used, that scaffolding is purchased and erected in accordance with applicable codes, that there is perimeter guarding of floor and roof openings, and that all other necessary fall prevention measures are taken.

By now, you undoubtedly realize that the basic factors contributing to the vital few are the severity of the hazard and the frequency or duration of exposure. The degree of hazard is important because it relates directly to the potential loss. For instance, consider the difference between the potentials involved in the operation of a chain saw and a hand saw, or a pocket-knife and an axe.

The duration of exposure is also important because it relates directly to the probability of loss. The more frequent or prolonged the exposure, the greater the chance of an accident occurring. For example, suppose that only once every year a carpenter catches a ride on a crane hook to get to an elevated work station. This is clearly a very hazardous practice which could lead to an extremely serious injury. But if we evaluate this exposure from the standpoint of its frequency or duration, we recognize that there is little likelihood that it will be one of the vital few causes of injury. This doesn't mean that we would ignore such an exposure, nor that the injury that could result would not be very costly in both dollars and human suffering. We are only saying that because of the limited frequency and duration of exposure, it will not produce injuries on a routine basis and is therefore unlikely to be one of the vital few injury causes.

Looking at this same hypothetical situation from an annual exposure standpoint, based on a 40-hour week, this carpenter is ordinarily exposed to falls from ladders, scaffolds, or other elevated work stations for 1,000 hours per year — or one half of his working time. He would be exposed only a few minutes per year to the special hazards of his annual ride on the crane hook. Thus, the answer to meaningful injury control is not constant attention to eliminate the dangerous crane hook ride; rather, it is constant direction of effort toward the prevention of falls from elevated work stations. This is the key to the vital few concept — long-term, intensive control of repetitive severe exposures.

The occurrence of the vital few injuries in a given industry is predictable, and can be anticipated unless effective control measures are instituted. If any one organization has not yet encountered serious injuries of the type identified as the vital few, it's because of one of the following reasons:

1. The company has exceptional injury controls in effect.

2. The exposure or sample size has been relatively so limited that the law of probability has not yet caught up with them.

3. A combination of (1) and (2) above.

The severity of the vital few injuries cannot be emphasized too much. Remember that the vital few are the high-cost injuries of that group which we call "disabling." The average cost of a disabling injury nationally is $720. In comparison, the average cost of a fall from a ladder in the concrete construction industry is $6,800. The average cost of a fall from a scaffold in the same industry is $4,200. In view of such high costs as these, it is clear why effective controls must be developed and maintained for the vital few! The prevention of the majority of injuries — the "trivial many" — will not have much bearing on the ultimate loss control performance if a single one of the vital few high-cost injuries takes places.

Although the vital few principle (with a few rare exceptions) may be new to occupational safety, it is not new in the field of business management. The principle was first brought to light in 1890 by Vilfredo Pareto when he discovered that 10 per cent of the Italian population controlled a very large percentage of the total national income. From this finding came *Pareto's Law*, which states that the "significant items in any group will normally constitute a relatively small portion of the total."

Many applications of Pareto's Law are found in modern-day business. A very common one is inventory control, in which case the inventory of high cost items is managed very closely, whereas the inventory of low cost items can be maintained on a periodic ordering basis. If you want more information about Pareto's Law, write for a copy of our *Technical Information Guide* which describes it.

A second principle of business management can be applied once we have isolated the vital few; this is the principle of refine-

ment which states that "As we increase our capacity to discriminate, we can increase output in the areas under study." This is the all-important challenge: to learn how we can increase our discrimination and thus our loss-control output! And when management is provided not with more data but with discriminating injury cost data, it is relatively simple for management to increase its sphere of injury-control influence by passing this information on to line supervision.

We, as a company, have seen dramatic results from the application of the vital few concept. We are sold on the fact that *Pareto's Law* and the principle of refinement have played — and will continue to play — a large role in directing our safety consultation services. I will cite one example. In Wisconsin, we provide workmen's compensation insurance for most of the logging industry. Our injury cost analysis of this industry pointed out that about one-third of the injury cost in logging arises from injuries occurring during the tree-felling process. This cause-cost relationship holds true in logging throughout the country. The size of the timber does not alter the basic exposure. If a man is going to log he must fell trees, and as long as he stands at the base of a tree and proceeds to cut it down, he has a very severe exposure to a great many predictable but uncontrollable hazards with a very high potential for major and costly injuries.

The Wisconsin forest industries are now enjoying the lowest workmen's compensation rate in the state's history. This in spite of the greatly rising medical costs, as well as workmen's compensation benefits. What's the answer? We think that, in large part, it is the logging industry's diligent application of controls to the vital few injury causes. These major controls primarily involve safe tree-felling practices and consistent use of hard hats.

Hard hats will eliminate some injuries and reduce the severity of others, but they do not minimize the exposure. Safe tree-felling techniques do minimize the exposure. Here again we have a repetitive exposure, and one that is inevitably involved in the production process. Controls for such exposures must be worked on energetically, shrewdly, and consistently if results are to be obtained. It cannot be a one-time application! Once the major loss source is known, the challenge is to be persistent and imaginative enough in our control efforts to whip the problem. The Wisconsin logging industry *did* tackle the problem with persistence and imagination. And the results? Their current workmen's compensation insurance rate is $7.79 per $100 of payroll — down from $16.78 in 1962. We are convinced that dramatic results such as these are eloquent testimony to the effectiveness of the vital few approach.

There has been much written and spoken in recent years about the diminishing rate of work injury reduction as based on national reporting. There are undoubtedly many reasons for this alleged slowdown. The law of diminishing returns is certainly a factor. Improved reporting procedures must also have some effect on the comparison. But, what is being mirrored more than anything else is the need to find better direction for injury control, based on cost analyses. In this way, the vital few will be pinpointed and concentrated upon.

Loss control must become a planned, logical, and systematic procedure. It must start at the top. It is one of many business management procedures, and it must be conducted as such. Loss control cannot be an on-again-off-again activity; it must be an uninterrupted effort toward greater profitability, as are other management processes. The direction for loss control must be founded on fact; not opinion, or hunch, or fantasy. It must be founded on probabilities, not mere possibilities. Gantt, a pioneer of modern management techniques, said it this way: "We have no right morally to decide as a matter of opinion, that which can be determined as a matter of fact." This does not, of course, preclude or eliminate the need for astute professional safety engineering judgment, especially in research and development work.

A cost relationship is essential for economic as well as humanitarian reasons. Unless this checkrein is maintained we are very likely to get carried away by our personal enthusiasm for one phase of activity, and lose sight of the problems causing the greatest injury cost and the greatest human suffering.

The cost of injury-control efforts for a given accident cause should be proportional to the cost involved, in relation to total loss

costs. If we are to adhere to the tenet that management intensity should be proportional to the cost involved, then management must have injury cost information to properly direct injury-control efforts.

We believe that in the vital few approach we have a substantial part of the answer to the difficult problem of better performance in occupational loss control. Our big job now is to sell the occupational safety profession on changing over to the dollar standard — both for the direction of their efforts and for the measurement of their accomplishments. This is what must be done if we are to recognize the meaning and the potential benefits that are awaiting us in the vital few approach to loss control.

Question: What relationship is there between what you classify as "medical treatment" and a plant's "minor," "serious," and "lost-time" injuries?

Answer: Semantics does pose a problem. What we, from an insurer's viewpoint actually refer to as "minor" or "medical treatment" are those injuries reported by industry to their insurance carrier which do involve medical treatment but do not generally involve compensation payments for loss of time. They may include some of what many plants call "serious" injuries and outside medical treatment. They do not include all of the so-called "serious" injuries nor any of what occupational safety refers to as "minor" or first-aid cases, all of which would swell the numbers of the "trivial many."

Question: What, if any, relationship exists between the "vital few" and the "high potential" or HIPOS?

Answer: There is again the serious problem of semantics. I only know that Mr. Allison and I use different injury classifications, different sampling techniques, and different data. Nevertheless, I am sure that there is some relation between his findings that "Only two per cent of all injuries and only two per cent of all accidents have a real cause-relation to those accident-prone situations, processes, or procedures which do have a high potential for resulting in major injuries or major losses" and our "vital few" findings. Since he arrived at his two per cent by including the first-aid cases and many normally non-reportable cases that are not in insurance data, it is even possible that my 33 per cent may be comparable to his two per cent. I still hope to join with him and other progressive leaders in pursuing this further.

Mr. Allison and I do clearly agree on the tremendous savings made possible (1) not by more data, but by emphasis and concentration on the really significant data that does reveal the real severity or high potential; and (2) by the use of dollar costs as a measure of accident prevention performance. Generally speaking the "high potentials" could include the "vital few."

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PROMOTIONAL IDEAS AND PROGRAMS THAT HAVE INCREASED OUR SAFETY SHOE SALES

By RICHARD W. PASCOE
Safety and Securities Facilities Coordinator,
Ford Motor Company, Allen Park, Mich.

The Vietnam war has been an excellent training ground for developing footwear protection against bamboo sticks and metal spikes that the enemy has been using to disable the walking servicemen.

In researching statistical data in the various trade magazines I have come up with some interesting facts. Last year this country lost $140,000,000 as a result of foot injuries. This is 12 per cent of the total disabling injuries recorded! Of the 12 per cent, 45.8 per cent could have been prevented had they been wearing safety shoes. Think what you could do with just a small part of this $140,000,000 to increase your safety promotion!

The Automotive Assembly Division of Ford Motor has a six-point safety shoe in-plant fitting program. Through experience, we have found that in order to achieve a 100 per cent safety shoe coverage on a voluntary basis it is necessary to stage an intensive promotional campaign. The total cooperation of the supervisors or foremen is essential to the success of this program, and without their wholehearted support no campaign can succeed.

Step 1. Be completely familiar with the present procedure to be followed in selling safety shoes and shoe store operation. We are audited and, therefore, there cannot be any deviations from the established procedure.

Step 2. Set a target date which is most practical from the standpoint of influencing the employees (Easter, Christmas, summer vacations, etc.). Normally, the fitting would last from several days to a month depending on the size of the plant.

Step 3. Approximately two or three weeks before the target date a supervisory meeting of your supervisors or foremen should be called. This meeting should be held in groups convenient for the safety engineer. At this meeting the foremen may be shown the latest shoe films and hear a short talk given by the safety engineer telling them why employees should wear safety shoes. Your local sales representative will be pleased to assist in these meetings. This meeting would be the most advantageous time to distribute the special foremen's catalog (provided by shoe supplier) so that he may become familiar with the style and type of shoes that will be available. Also, you could distribute a sample of the identification card (supplied free by shoe supplier) and explain the mechanics so that when the fitting begins all foremen will know what is expected of them. At this meeting you could provide a small gift for the foremen such as a pen or notebook, shirt pocket protector, etc.

At the foremen's meeting each foremen should be urged to be fitted for a pair of safety shoes if they are not already wearing them. In this way it will be easier for them to recommend safety shoes to their men. If the foremen desire, they can be provided with safety shoe talks so that they can talk more logically to their men (obtainable from your local sales representative).

Step 4. Following the foremen's meeting, it would be helpful if a letter on company stationery signed by the plant manager and publicizing the campaign be mailed to the employees at their home. At this time, posters announcing the special fitting should be posted around the departments so that each employe will be informed and reminded of the special fitting service and gifts which can be given at the close of the program. These posters are usually the foremen's catalogs which are also suitable for bulletin board posting.

Step 5. Your supplier can ship additional shoes into the plant for the fitting. Normally, the plants like to acquire additional styles which they cannot carry in stock all year round because of space problems, so the supplier will allow the plant to return any unsold shoes at the end of the program. These extra shoes are shipped and invoiced in the regular way with return privileges granted.

Step 6. Finally, on the day of the fitting each foreman gives his men an identification card which should be retained by the individual as a record of size, width, and style purchased. The identification card will also help the foreman control his employes so that not too many are in the fitting room at one time.

A portion of this card should be kept by the foreman even if the worker is wearing safety shoes. This enables the foreman to maintain a record of his department until it is covered 100 per cent. The other portion of the card should be dropped into a box for an award to be given at the end of the program.

Many plants have ideas of their own which they inject into the program; however, basically this is the procedure which is followed. Now let's look at some other pertinent factors.

We have glossy print catalogs that are eye-appealing and are provided by the shoe supplier. Our shoes listed in these catalogs are picked for job analysis; therefore, not all shoes made by the supplier are approved.

Division and Central Staff also have a responsibility in the promotion of safety shoe sales. Central office staff sends out a yearly data sheet showing disabling injuries —head, body, arm, leg, and foot. We usually, at Division, put a cover letter on this, urging sales promotion campaigns at our plants.

At this point, you may feel that all of our plants sell a tremendous amount of safety shoes. Not so — some plants have sold 450 pairs per year, yet have 5,000 employees. Others sell that many monthly. So unless you *sell* your program it will not succeed. It is a rewarding experience and I can't remember the last "lost timer" but I can recall several instances where safety shoes prevented injury. The one all of us have heard about is that one who "always wears safety shoes but was not wearing them at the time of injury."

FIRE PROTECTION FOR STORAGE AREAS

By GUNNAR E. BERGLUND
Corporate Fire Control Engineer, Ford Motor Company, Dearborn, Mich.

The development of improved material handling techniques and equipment in recent years has resulted in new concepts of handling and storage of materials. Warehousing design, rack support structures of various configurations, stacker-retriever cranes either manually or computer controlled, among other considerations, now present a new challenge to fire protection. The number and size of recent fires in combustible materials under high piling conditions indicates that ordinary automatic sprinkler installations will not extinguish or even control such fires.

The Ford Motor Company insurance carriers have developed tentative standards of fire protection for high rack storage areas. These standards generally contemplate the installation of automatic sprinkler systems at the ceiling level and numerous intermediate layers of sprinklers which require, in many instances, a very large water supply. It appears that very little consideration has been given to the requirement of a more effective extinguishing media or to minimizing the potential severe water damage that may result from the operation of a multi-layer sprinkler system in rack storage with sophisticated and costly material handling equipment. The insurance carriers' standards are presently based on small scale fire tests and interpolations and empirical factors derived from limited loss and test experience. It is significant to note that the concepts of fire protection for high rack warehousing of two major fire insurance underwriters are at variance.

Presently, a series of fire tests on storage racks of various heights are being conducted by a knowledgeable group of fire protection specialists at the new Factory Mutual Research Center, West Glocester, Rhode Island. The findings of these tests may result in uniform standards of fire protection within the next year or so.

Since no meaningful or consistent approach to the provision of effective fire protection for high rack warehousing was available to our company, a detailed research of the problem was conducted by company engineers on a full time basis during the first three months of 1967. The objective was to develop an effective and practical company fire protection standard.

Many modern high rack storage warehouses were visited throughout the Midwest. Various fire extinguishing and fire detection methods were studied. Concise analysis of fire reports, existing test data, technical reports, loss analysis, coordination with major rack manufacturers, and personal observations of fire tests were made.

The results are briefly outlined as follows:

Fire Hazard Classification of Commodities

Three fire hazard classifications were established which categorize the relative combustibility of materials as low hazard, average hazard, and high hazard storage.

Low Hazard storage consists of sheet metal, castings, stampings, and other noncombustible materials, not more than 10 per cent fill of individual racks or total storage volume in combustible materials. Paper clip sheets, paper wrapping, and wood pallets are acceptable but must not exceed the 10 per cent fill limitation. No paper cardboard container materials, rubber, foamed rubber or plastic, vinyl, or upholstery material are permissible in the low hazard classification.

Average Hazard storage consists of Class A combustibles, wood pallets, crates, upholstery, paper or cardboard containers. Again, no rubber, foamed rubber, or foamed plastic materials are permissible.

High Hazard storage includes rubber tires, rubber products, foam rubber, and flammable liquids in closed containers.

Methods of Fire Protection

Automatic Sprinkler Protection when properly designed and installed will control and, in many instances, extinguish fires in storage areas. There are limitations regarding the effectiveness of one level of sprinklers at the building ceiling only when high rise storage methods are used. Intermediate levels of sprinkler protection must be considered and are practicable in fixed high rack storage. The use of strategically located vertical and horizontal baffles are also recommended with intermediate sprinklers.

Carbon Dioxide Gas Fire Protection may be effective if installed on a total flooding basis with connected gas reserve supply. The quantity of gas required would be very large, as a gas concentration of 75 per cent or greater would be required for deep seated fires. An additional amount of gas would be necessary to provide a good soaking period of inert gas. Building sprinkler protection would also be required. The cost of a properly engineered total flooding carbon dioxide fire extinguishing system would undoubtedly be very high, based upon company experience in the United States.

High Expansion Foam fire protection, initially developed for fire fighting in coal mines by the Safety In Mines Research Establishment of Buxton, England, has many advantages as a fire fighting media. The expansion of an aqueous surface-active agent solution to a semi-stable foam of about 1,000 times the volume of the original solution through a proportioner or a screen and blower device provides a means for transporting water to inaccessible places, for flooding of confined spaces, and volumetric displacement of vapor, heat, and smoke.

Class A fires (ordinary combustible materials) are controlled when the foam completely covers the fire and burning material. Class B fires (flammable liquids and rubber products) are extinguished by providing a foam blanket of sufficient depth over the fuel surface to be maintained for sufficient time to prevent reignition.

High expansion foam fire protection systems have the following advantages for application to high-rack storage installations:

1. Generally reduced water requirements compared to multi-layer sprinkler systems within the rack structure, resulting in less water damage.

2. Racks may be constructed for maximum efficiency. Features such as fire stop baffles, draft curtains, and clearance allowance for water distribution may be omitted.

3. A limitation of the extent of fire involvement and probable loss due to cutting-off air supply and for cooling effect.

4. High stock salvage potential as well as negligible damage to racks, stacker cranes, and control circuitry.

When high expansion foam is provided as the extinguishing media, roof level automatic sprinkler protection is also required.

There are three company locations where average hazard storage is 40 feet high, protected by hydraulically designed automatic sprinklers at the ceiling level and at the midpoint intermediate level. The use of noncombustible baffles, both vertically and horizontally, complements this protection. We have one automobile selectivity tower 125 feet high, with intermediate sprinkler protection at each level above the automobiles.

Now under construction at Brownstown is a 3,000,000 square foot automotive parts warehouse where stock will be stored in racks to a height of 24 feet. Ceiling sprinklers alone, of proper density and water volume, are provided for fire protection. To determine whether our fire protection design criteria was adequate, our Autolite-Ford parts division sponsored relatively large scale fire tests at the new Factory Mutual Research Center.

The planning and method for the fire tests were thoroughly coordinated with the Factory Insurance Association, Factory Mutual Research Corporation, and interested Ford Motor Company operational and staff personnel. These operations simulated accidental fire in a three double rack row array of automotive parts storage, 24 ft. high, with ceiling level sprinkler protection representative of that proposed for the new storage building. Ford and the underwriters agreed to criteria for determining success or failure of the fire test outcomes based on: extent of fire spread, fire exposure to building structural elements, and sprinkler water demand. The tests were conducted with the same physical and procedural conditions to establish reproducibility. In both cases the outcomes met all requirements for judging that the performance of ceiling level sprinkler protection was successful.

The first meaningful fixed installation of high expansion foam was at the Ford Motor Company Fostoria plant, where we make spark plugs. A warehouse attachment to an exterior was erected. Its dimensions were 50 x 272 x 50 feet high.

Automatic sprinklers were provided at the ceiling, and high expansion foam on a total-filling basis to fill in seven minutes was installed. A full foam test was made to prove the integrity of the alarm system and the foam generating equipment. The effect of foam on building, electric circuits, automatic stacker crane, and cartonized stock was observed.

There was no damage to the structure, the electric power, or the automatic stacker crane. Some cartonized stock was slightly damaged. Salvage was very large.

Clean up of foam offers a challenge which is not insurmountable. A 20,000 square foot rubber tire warehouse may be cleaned of Hi-ex foam in three hours at a cost of $1,000, with no interruption of production.

I have indicated that many types of automatic fire protection may be used for protection of warehousing. The kind of fire protection best suited is a matter of judgement: whether stock is stored in high rack structure; the susceptibility of the stock to water damage; and the economics of the installation.

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57th NATIONAL SAFETY CONGRESS

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create a more serious hazard exposure than the peroxide itself.

MEK peroxides and hydroperoxides exhibit more pronounced irritant properties on skin and eyes. Prolonged contact with skin may cause a rash, accompanied by a burning sensation. Cyclohexanone peroxide may cause dermatitis on those who are allergic. Injuries to eyes could be serious and permanent unless the eyes are flushed with water immediately. Oils or ointments should not be used as they tend to "seal in" the irritant. Safety glasses or face shields should always be worn when handling peroxides, and an eye-wash safety fountain must be installed in these locations.

In general, benzoyl peroxide is considered to have the least skin irritation. In fact, ointment preparations containing as much as 5-20 per cent benzoyl peroxide are available commercially for treatment of acne.

Some organic peroxide vapors when inhaled, cause irritation of the eyes, nose, and throat and, in higher concentration, cause inebriation similar to the effect of alcohol. Prolonged exposure to IPP vapors may cause eye irritation and lung edema. Several cases of accidental ingestion of commercial MEK peroxide formulation have been reported; one death occurred several days after such ingestion.

Summary

Although organic peroxides are placed in the hazardous chemical class, they are by no means in the class of explosive compounds. Peroxides are, generally, thermally unstable, and extra care should be taken in their storage.

Most of the tests described here were developed or modified by LUCIDOL during the past decade. New tests are being devised to fully understand all aspects of the safe handling of organic peroxides from manufacturing to the end users. The information would also help the shippers, insurance agencies and the fire fighters. Development of these tests will also help in making safer formulations of peroxides available commercially. The research toward the understanding of the hazards of organic peroxides continues.

A new group, the Organic Peroxide Producers Safety Division (OPPSD), formed within the auspices of the S.P.I., is studying these safety tests and others to make recommendations for the handling of peroxides and to implement the procedures on an industry wide basis.

PILOT PLANT ELECTRICAL HAZARDS

By RICHARD W. PRUGH
Safety Engineer, E. I. duPont deNemours & Co., Wilmington, Del.

Many of the electrical hazards which may be encountered and should be considered in the design, construction, operation, and maintenance of a pilot plant can be eliminated by an "ounce of prevention" in the form of properly applied articles of the National Electrical Code, safety rules and design procedures provided by your organization, and personal and corporate experiences described in technical and safety journals. Also important in the preventive concept are imagination, common sense, and "safety forecasting," through which emergencies and other contingencies are anticipated, and corrective actions are taken before the pound of cure becomes necessary.

Pilot plants may be particularly susceptible to hazards because of the desire to obtain cost and performance data quickly and with a minimum expenditure of labor and equipment. However, the designer and operator must bear in mind the monetary loss and delays which could accompany a fire or injury to personnel.

Shock Hazard

Certainly the most serious of electrical hazards is the unintended exposure of personnel to dangerous voltages, which could cause electric currents to pass through the body. Unfortunately, the type of electricity usually used for power and heating (60 cps)

also is about the most dangerous form of electricity. The current flow is the result of contact of two body extremities with objects at different voltage levels, and can vary widely at a given voltage, depending upon the resistance of clothing and skin (which can be lowered by apprehension, perspiration, and humidity), the area of contact, and the pressure of contact.

The chief effects of electric shock are reflex actions (which could cause falls and otherwise compound the effects of minor shocks), asphyxiation (from loss of muscular control), and ventricular fibrillation (the loss of the normal self-actuation of the heart muscles). Electric shock can occur through contact with normally-innocuous equipment if it has become electrified through power sources, static electricity, or lightning; if wiring or terminals are unprotected through absence of guards or failure of insulation; or if circuits are "live" when they are thought to be "dead."

The first hazard (electrified equipment) can be eliminated by the proper grounding of every electrically-powered or potentially-electrified metal object. This includes electrical equipment; process equipment in which electricity is used to agitate, mix, blend, stir, scrape, heat, or instrument; metal platforms, scales, and tank supports; and building steel and metal siding which might become electrified by static electricity or lightning discharges.

The second hazard (exposed wiring) can be reduced by covering exposed terminals or wiring, by protecting power cables from heat, chemical attack, weather, and mechanical abuse, and by frequently inspecting portable equipment and extension cords for broken parts and frayed insulation.

The third hazard (unexpectedly live circuits) can be reduced by proper shut-down and lock-out procedures, with operational and voltage checks to assure working only on dead circuits.

Grounding

To be effective, a ground must be permanent and must reduce any voltage on an object to a non-hazardous level or must limit the duration of a hazardous voltage. The electrical resistance between the object and ground will depend on the objective. To reduce the voltage produced only by the microscopic currents generated by static electricity, a resistance to ground in the thousands of ohms or less would be satisfactory; to reduce the voltages induced by lightning strokes traveling down a grounding cable, a resistance lower than 25 ohms would be acceptable; to reduce the duration of a short-circuit voltage to the case of portable equipment, motors, etc., the resistance should be as low as is practical.

The reason for the low-resistance requirement is that the current-interruption device (fuse or circuit breaker) is being asked to serve two functions: first, a primary purpose, to prevent overheating of equipment with a possible subsequent hazard of fire or explosion; secondly, to prevent electrification of the equipment container and associated apparatus. The second function can be realized only if the resistance from the equipment container to ground is low enough to cause the protection device to operate and thus break the circuit. In fact, the resistance to ground must be so low that the protection device operates very quickly, so that the brief electrification of the container would not seriously shock anyone touching the container while it is being energized.

Except for unreasonably-low ground resistance, the current resulting from a hot-to-case fault or short circuit would be sufficient to cause a grasping action which would continue until the voltage was cut off. If the ground resistance was about 0.05 ohm (about the same as the resistance of the power cord), the fuse or circuit breaker would interrupt the power quickly, and the shock and its effects probably would be minor. If the resistance was greater than 0.5 ohm, the flow of current would continue for a significant length of time, and the shock would be severe, possibly causing fibrillation or asphyxiation.

A ground resistance less than 0.5 ohm would lead to a fault current greater than 200 amperes. Thus it must be kept in mind that electrical-equipment grounds must be capable of carrying very substantial amounts of current. Corroded or loose ground connections, broken strands in the ground wires or ground wires partially cut through, or grounding through improperly connected conduit may povide no acceptable protection against internal faults. For a ground wire integral with the power leads, a ground-wire size equal to the power-wire size is satisfactory. A flexible grounding wire attached

to a two-wire power cord must be No. 14 or larger, but this method is generally unsuitable for portable equipment because of possible damage to the grounding conductor. The minimum wire size for fault grounding of electrical equipment or process equipment to which electrical equipment is attached is No. 8. Of course, the surface at each of the grounding connections must be cleaned of rust, paint, or enamel to provide the necessary low-resistance ground.

Inspection

Every attempt must be made to protect the user of electrical equipment from contact with live wiring or components. Thus, frequent (e.g., monthly) inspection of wiring, particularly on portable equipment and extension cords, for frayed or cracked insulation (visually, and using a Megger) and of equipment for loose switches, receptacles, or other components, and ground continuity is a necessity. New equipment should be inspected to assure that accidental contact with voltages above 40 volts AC or 70 volts DC cannot occur during normal operation or during adjustments or maintenance normally performed by the user. In high-voltage equipment, power-circuit interlocks should be provided on removable panels, so that normal operation is not possible with the protective panels removed.

The atmosphere around chemical processing vessels occasionally may contain significant amounts of moisture, corrosive vapors, or dust, and may have a higher than normal temperature. Electrical equipment in such atmospheres should be inspected frequently to assure that grounding wires are and will be serviceable, that electrical insulation is not being degraded, and that solids and liquids are not accumulating in electrical apparatus, junction boxes, conduit, and switches.

Electrical Shut-Down and Lock-Out Procedures

Most electrical equipment requires frequent repair because of rapidly rotating or vibrating parts, wear of electrical contacts, or thermal degradation of insulating or structural components. Dismantling of such equipment for repair should not involve any risk of electrical shock. This can only be accomplished by properly de-energizing the correct circuit; assuring that the circuit will not be re-energized, intentionally or unintentionally until the repairs have been completed; and treating all exposed circuits as though they are live until they have been positively qualified as being de-energized.

To assure that the correct electrical circuit (and no other) is de-energized, all of the pertinent switches should be shut off and tagged by the operating personnel. The tag should be signed by the operator and dated, should show the reason for the tagging, and should emphasize the fact that the device should not be operated. One or more of the tagged switches should then be locked in the OFF position by the electrical repairman, using a lock for which he has the only key or keys. Each individual involved in the repairs should attempt to energize the equipment, using all of the pertinent switches and with all interlocks cleared, to assure that the equipment is positively locked out and not merely inoperative temporarily. As soon as any wiring is exposed, a voltmeter should be used to assure that the circuits are, in fact, de-energized. Disconnection, dismantling, or repair can then proceed.

Fire and Explosion Hazard

Second in importance to the prevention of electric shock is the prevention of personal injury and damage to equipment which might occur through electrical initiation of a fire or explosion, through sparks, arcs, flames, overheating, and static electricity. One of the purposes of the National Electrical Code is to provide guidance in the selection of electrical equipment for use in atmospheres which do or may contain flammable gases, vapors, or suspended or accumulated solids.

The National Electrical Code—Power Circuits

The intention of the Code is to quantify the hazard, to assist manufacturers and users of electrical equipment in arriving at an economic agreement on the types of equipment which must be made and used. The Code applies primarily to power circuits, in which arcs, sparks, explosions within equipment, or overheating of equipment could initiate large-scale fires or explosions. To prevent such initiation, explosion-proof, dust-proof, purged, and intrinsically-safe equipment is available for a wide variety of applications.

The Code was developed for adoption and enforcement by local and area administrators. To date, though, the Code has served primarily as a guide to good electrical practices. Thus the responsibility for safe design and operation of a pilot plant and its electrical facilities lies with the operating or line supervision. Safety committees and inspection teams may serve as a conscience and may suggest compliance with the Code, but do not have the authority or the responsibility for assuring safe operation of chemical processes and thus cannot be made a scape-goat in the event of misfortune.

Static Electricity

The chief hazard from static electricity is the ignition of flammable vapors; a secondary hazard would be electric shock, which could result in an involuntary reflex action and subsequent injury. Static electricity can also cause operating problems such as pinholing in films and the formation of agglomerates of solid particles, sheets of paper, and dust, which might be indirect causes of personal injury or equipment damage.

Static electricity is generated whenever two dissimilar materials (except gases, apparently) move relative to each other. This includes the flow of liquids in pipelines, the pneumatic conveying of solids (including the discharging of CO_2 fire extinguishers), the filtering of liquids, moving belts or tires, atomizers, and agitation in non-conducting tanks. The magnitude of the electrical current thus generated depends on the nature of the materials and increases with the rate of movement. The voltage developed by this current increases with the resistance to ground and with the resistivity of any liquid involved. The energy available for the ignition of a flammable mixture is related to the square of the voltage and to the electrical capacitance of the charged equipment. These relationships may be combined to give

$$E = \frac{1}{2000} C R^2 I^2$$

where E is the spark energy in millijoules (or milliwattseconds), C is the capacitance in microfarads (10^{-6} farads), R is the total electrical resistance to ground for the oppositely-charged surfaces (in meg-ohms), and I is the electrical current in microamperes. Using values representing severe operating conditions *($E = 0.1$, $C = 0.1$, and $I = 10$)* indicates that a ground resistance less than four million ohms probably would be sufficient to preclude electrostatic ignition. However; resistances of this or lower magnitude cannot be consistently attained except where good grounding practices are followed (removal of rust or paint, tight clamps, and inspections for integrity) or where leakage paths are maintained by constant humidification above 60 per cent, or where the conductivity of large volumes of flammable material is increased through the use of appropriate additives.

The removal of static-electricity charges from poorly-conducting liquids can be a major hazard in some processes. Many common chemicals have the combinations of dielectric constant and resistivity which can result in the hazardous accumulations of static electricity in storage tanks. Unless special precautions are taken to allow no air into these tanks (by using floating roofs or inert atmospheres), to reduce charging (by using dip legs and by avoiding multiphase mixing), or to discharge continuously the electricity mechanically (with vertical rods), chemically (by conducting additives), or electronically (by ionizing rays or radioactive materials), explosions of the flammable materials could occur.

Malfunction Hazards

In the design of pilot plants, the effects of electrical power failure on the process are and should be taken into account, so that the process equipment fails in a safe condition. In particular, any solenoid valves in instrument-air lines should either allow control through the de-energized solenoid valves or allow the control valves to assume a safe condition. Similarly, electrically-operated valves must move to a safe position when electrical power is removed, or alternative valves which do fail in the safe position must be incorporated in the process line.

It is important, however, to consider what might happen to the process if electric power is restored unexpectedly. Each interlock circuit should be examined to determine whether a "latching" circuit which requires a manual reset should be used to prevent unintended restarting of portions of the process. This applies particularly to feed pumps and agitators, for processes in which sudden changes in ratio or agitation can produce substantial changes in reaction rate. Also to be considered is reset windup in instrument controllers; for example, a con-

troller maintaining constant above-atmospheric pressure in a reactor would tend to shut a vent valve as the pressure drops toward atmospheric in response to an electrical-failure opening of the vent valve. If electric power were suddenly restored, the vent valve would slam shut and may remain closed, regardless of the reactor pressure, for several seconds or minutes until the reset unwinds. Special attention should be given to these control aspects for operations running unattended.

Simulation of malfunction incidents should be included as a part of the pre-startup inspection of new processes, particularly those processes involving flammable or reactive materials at elevated temperatures or pressures. Additions of electrically-actuated devices to existing processes should also be checked for performance in power-failure situations.

Resuscitation

Electricity is such a useful servant in the chemical industry that there are few processes which do not use it in a wide variety of applications. In spite of all efforts to reduce hazards, an inadvertent lapse in design, construction, operation, or maintenance may result in contact with a hazardous voltage and electric shock. There are many dozens of people alive today who have received severe electric shocks but have survived only because others have given them the breath or pulse of life.

The techniques have become so simplified and efficient that no one should be unable to provide such assistance if necessary. There are some dangers involved in resuscitation, but none are so invariably fatal to the victim as no attempt at all. Knowledge of these methods is becoming widespread and is encouraged for all who come into even remote contact with electrically operated equipment.

An excellent film which describes respiratory and cardiac resuscitation is "To Save a Life," distributed by the American Gas Association, New York City.

SAFETY RECOMMENDATIONS FOR HOSPITAL ELECTRONIC EQUIPMENT

By L. H. MONTGOMERY
Ass't. Prof., School of Medicine, Vanderbilt University, Nashville, Tenn.

The problem of safety in the medical electronic equipment field is a favorite subject to bring up if you want some astounding publicity. I have spent many years running down sensational stories only to find out that they were hearsay embellished with each repeat.

Recently, there have been a number of papers claiming large numbers of deaths from electrocution in hospitals. Frankly, I do not believe this. It is extremely rare that you can obtain any first hand information from anyone who has seen such an accident. A few days ago I was talking with Dr. Gilbert Devey of the National Science Foundation in Washington. He has just returned from Europe where he has been checking on this subject. He reports that records of deaths in European countries appear to be much more complete and detailed. He also reports that they show very few accidental electrocutions in hospitals.

However, you may say that one accidental death is one too many, and I agree. I just want to sound a warning to take a long look at the authenticity of the stories you may read. On the other hand, I would be very interested in any first hand information on the subject.

Looking at the other side of the coin, what can we do to help reduce the risk we have to live with? Not long ago, I was asked to compile a few recommendations to serve as interim safety standards for use by the profession until more formal standards could be prepared. This I did with the assistance of a carefully selected committee composed of a medical school professor and department head, an M. D. interested in equipment

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Driver Improvement

LET'S SPEAK UP FOR DDC

By EDWARD R. KLAMM
Accident Prevention Manager, Allstate Insurance Co., Northbrook, Ill.

The passage of the Highway Safety Act of 1966 was hailed by many persons and agencies as if drastic reductions now would be immediately achieved. Unfortunately, the passage of a bill or law alone just does not achieve this result. The important element is the need of adequate appropriations and the intelligent implementation of the law by the private and governmental authorities.

It's recognized that lip service will not stop the appalling casualty rates on our highways — "Action speaks louder than words." That is one reason why we in the casualty insurance industry strongly support the driver education standard of the National Highway Safety Bureau. This support is demonstrated by our action program in financially helping high school teachers of driver education to become better qualified for giving this instruction to high school students and in expanding the number of persons properly trained in defensive driving courses.

Many persons have stressed the need of in-depth research before taking any action. I'm convinced that we know enough about traffic crashes now to reduce them greatly if present knowledge were generally applied. I do recognize the urgent need for research to extend and refine what we now know and to confirm or correct what we now believe. Nevertheless, I do not feel that we must await further research before we initiate action in driver education, driver licensing, etc.

Yes, we must proceed full speed ahead in driver improvements. We know we need safer roads and safer cars but, of even greater importance, we need well trained drivers. It's a tragic irony to realize that the ways and means, long known to us, have not been applied for the lack of adequate direction and funds. The whole area of driver control—from driver education in the high schools, to defensive driving courses for adults, to responsible traffic courts, to driver suspensions and revocations—is the area of the greatest weakness in our pursuit of highway safety.

So, I place great emphasis on three little words. No, not the old favorite, but "Let's be practical." There are some individuals and agencies who have been loud exponents of the need for greater public education in the use of seat belts or in the dangers of drunk driving or following too closely. The research in communication stresses that this type of education cannot be achieved by hit or miss tactics, by slogans, or an occasional news or magazine article. The personal discussion is the best practical means of convincing drivers on certain points. Consequently, the Defensive Driving course offers a perfect opportunity for eye to eye contact in public education in highway safety matters. I have found these sessions excellent for discussing the alcohol and highway safety standard and to distribute materials dealing with the imperative need to rid ourselves of drunk drivers. The Defensive Driving course enables a competent instructor to deal with the alcohol and driving situation head-on, thus helping to avoid a head-on crash causing an innocent victim to be killed by a drunken driver.

I have also used the DDC films and instructional opportunities to sell the value of the use of seat belts. Here again, in every class, I have found disbelievers in the use of the seat belt and so have made a strong pitch for their use. The salesman must have an opportunity to discuss and demonstrate his product if he is to make the sales. We in highway safety must be in personal contact with drivers if we are to sell them on the many facets of safe driving. The Defensive Driving course does enable many instructors to have their innings with drivers under safe conditions.

Yes, the instructor must be well qualified for his teaching (and convincing) role. He must be knowledgeable about his subject, such as the adverse influence of alcohol, if he is to convince students of this danger.

He cannot be just a volunteer with no special background or qualifications in the highway safety field. He needs to know more about his subject than the students in the DDC class.

I'm also strong on the use of up-to-date audio visual aids. We cannot stand pat on the original films. We must revise, up-date, and improve each film as time elapses; otherwise, like any all-American who doesn't stay in shape and improve, our program (DDC) can fall by the wayside. We must stay abreast of the times, and this includes the vehicles and their new safety devices, the highways and their controls, the laws and their revisions in the states—and great consideration must be given to the human element. So, I strongly advocate that the National Safety Council continue its plan to regularly update the films, the student's workbook, and the various aids. We must persevere in this direction if our program and efforts are to be accepted by the professionals and the general public.

My last recommendation deals with the evaluation of the training course program. First, we must recognize the same research difficulties in evaluating the DDC as confront those who are researching the driver education program in the high schools. The many variables prevent a perfect-plus research of DDC. We must rely on judgment for most of our evaluation. Everyone readily agrees on the need and value of quality training. Our task is to be doubly sure that we have competent instructors who are equipped with up-to-date effective audio visuals so that the students do receive quality defensive driving instructions. This is our challenge. This is your opportunity. We must generate our action program so that we can stop the needless slaughter and waste on our highways.

Use your common sense and good judgment. A properly conducted Defensive Driving course presented by a qualified dedicated instructor will prove its worth. So, let's be practical and speak up for DDC—for everyone, everywhere. It's an excellent medium for highway safety communicators.

SELLING DDC IN A COMMUNITY

By WALTER DE FELICE, JR.
Executive Vice Pres., San Diego County Safety Council, San Diego, Calif.

How does one effectively sell DDC in a community? Become personally involved in the program. I don't mean the kind of involvement that comes from calling your office and saying, "John, I want you to completely investigate that DDC thing." You do it! You investigate what it's all about! Then, and only then, will you be able to find out for yourself what it is all about.

The Viet Nam war has been, and still is, a very controversial conflict. Yet, our government seems to be quite united in the handling of that conflict. Why can't we be as united in training the drivers of our country? Perhaps one reason we aren't united is because we don't have every local constituency promoting the Defense Driving Course as it should. I realize not all individuals in all communities think of DDC as I do. However, that is the failure of the local chapters of the National Safety Council and other safety movements where there are no safety councils—a failure in selling the merits of DDC. The involvement of a community must be a total one, or we shall continue to see the death toll from the automobile rise in this country.

How does one effectively sell DDC in a community? It requires a great deal of effort, imagination, and personal dedication. It must be a total commitment, a continuous, on-going program for those who undertake it.

With any program, if you are to be successful, you must know the ins and the outs of that program. So it is with DDC. If you aren't a graduate, instructor, or instructor trainer of the DDC program, you aren't familiar enough with the program

and certainly not able to effectively, as well as emotionally, promote it. Yes, I said emotionally. I would suggest you become emotionally involved, become a graduate, instructor, or instructor trainer; then develop your program, cultivate your local media, and sell the program to your community.

Let's consider the hypothetical development of a DDC program in your community. Basing the development on the establishment of a Defensive Driving Course Committee and a corps of properly trained instructors, media involvement, combined, you are ready to sell your community.

Recruitment and retention of experienced instructors is the backbone of your program once you convince the community that the program is needed. These instructors will sustain and enlarge upon your program immensely, so choose your instructors wisely. Solicit business and professional people who have expressed a desire to assist you in safety programming. With their interest in safety they will be a natural to become involved in the Defensive Driving Course program. Consider attorneys, salesmen, (especially those in the insurance field who by the very nature of their business have an interest in promoting safety), psychiatrists, psychologists, sociologists, military officers, and enlisted personnel, because of their intense interest in the community in which they reside.

Having selected them, indoctrinate them wisely. Set a standard or a prerequisite in instructional methods and techniques, in order to produce the DDC program in the standardized format recommended by the National Safety Council—with a high degree of quality instruction injected into it! To do this, I would suggest you develop an instructor portfolio. Have each prospective instructor indoctrinated in what you expect of him and state in that portfolio that your policy will be strictly adhered to. Submit an outline of a presentation of the promotion of the defensive driving course utilizing the film "A New Way to Drive." Present this program to them in the manner in which you would like it put to groups, organizations, and associations. From that, you can surmise that my intention is to convince you to use your instructors not only to teach the defensive driving course, but to sell the program. We have found that approach quite effective in our part of the country. Proper selection, training, and organization of your corps of instructors is a must to embarking on training your community in the concepts and techniques of defensive driving.

Next, approach the media in your community (or, for that matter, your in-house executive officers) to convince them of the merits of the Defensive Driving Program and why it should be given to every employee who drives an automobile; not just company cars, but everyone who drives. When we first entered into the Defensive Driving Program we utilized home-made slides for TV promotion, together with Metro-Medias campaign. However, even with home-made slides, with proper coordination and a sales job by our defensive driving coordinator we realized many classes from the promotion of Defensive Driving Courses during those early days. If properly coordinated and sold to the media, a great deal of cooperation will be extended by them in promoting the Defensive Driving Program. From the early days of using the home-made slides, we have graduated to where our local TV stations now produce these slides for us for airing as public service announcements.

Six months ago, we hosted every individual concerned with the news print and broadcast media in our county to a luncheon in the county jail, with the full cooperation of the county sheriff, who, by the way, requires that DDC be given to all his personnel, uniformed and civilian, and at that luncheon gave the 20 minute presentation previously mentioned, together with the film "A New Way to Drive." It was difficult to come up with a gimmick to bring some 50 celebrities, if you would call them that, together for a luncheon/briefing session on the DDC story. Fortunately, serving on our public information committee was a gentleman from the broadcasting media who suggested that perhaps a subpoena would bring them out; from that we developed a unique subpoena to what we called "The Jester's Court." Because of this novel approach, our county sheriff volunteered the services of his deputies to serve those subpoenas. It was a huge success, and as a result we now enjoy better rapport with our media than we ever have had before.

Now, with the combination of an educated volunteer corps of DDC instructors and the cooperation of the local media, we should be ready to sell our community; yet I am sure there are those who have had these two combinations worked out and find themselves wanting for individuals to teach. If that be the case, all I can say is that entreprenurial ability is not present, or it is not utilized properly. Selling DDC in your community is a matter of just that: selling it daily, not hapazardly. It must become a household word and a part of every speech you make. You or your volunteer corps of instructors should promote defensive driving courses to everyone you approach. That is how a community is sold —by the never ending selling and promotion of the program.

It is difficult to specifically cover everything on how we sell DDC in our community, because it involves every day dealings with people, whether in business or industry, in civic groups, organizations, or with people you happen to meet. Sell, sell, sell is the name of the game! A never ending salesmanship program is what must be developed by you.

Just as any salesman worth his salt sets up and maintains a suspect and prospect file to enhance his sales and insure the likelihood of his doing a professional job in promoting his product, so should the safety council, or cooperating agency, develop a system of developing prospects whom DDC would benefit. By developing those prospects professionally, you sell them DDC. I am sure that the mass marketing approach being programmed by the National Safety Council and the concept of establishing regional Defensive Driving Course training centers will do more for the spreading of the DDC word and for training our fellow Americans to become defensive drivers than any two projects I know of! Even at that, these programs require an approach that is professional in nature. You must know what you are talking about in order to effectively sell it. That is the approach that we utilize in San Diego County. A high degree of professional salesmanship is the prerequisite to induce anyone to take the Defensive Driving Course based on the fact that no one will sit in a classroom or for that matter, even enter into a course without being fully convinced that they will be taught in a professional manner and benefit from that instruction. No salesman truly sells without stressing benefits involved. Professionalism breeds a trust in those you associate with. You will find graduates of the Defensive Driving Course who by the very nature of being taught in an interesting, motivating, and professional manner have induced many others to take the course. So it should be with the way the program is promoted: in a professional way.

Many years ago, during the Spanish-American War, as our naval vessels were passing the burning and sinking hulks of Spanish warships, the men of our vessels were laughing, singing, and cheering. From the bridge of his command ship the admiral shouted to his men, "Don't laugh men, those poor devils are dying." People are dying and DDC can do something about it. Are you willing to do something about promoting DDC? If you are—sell it, don't just think about it!

SELLING DDC IN THE STATE

By DEAN DICKENS
Director Defensive Driving, Georgia Safety Council, Atlanta, Georgia

Selling DDC in the state is a pleasure and a privilege when you are bitten by the missionary spirit. However, there are certain obstacles which loom large for even the most ardent enthusiast. Distance is a great diluter. When you must reach from the center to the perimeter through many spokes of the wheel, it is apt to turn slowly. So in selling DDC to the state, you must be equipped with plenty of gasoline in the form of energy and enthusiasm, patience and initiative.

If your gasoline is too short and the distance too far, selling is a difficult drag. In order not to drag anything, let's look at the distance problem and how to overcome it. Let's make the letter "C" the common denominator: Contact; Communication; Centering; Continuity; Control.

Contact

How do we make contact and get the DDC message across? The wires at our command are letters, phone, publicity, personal contact, and word of mouth. By far, the most effective are the last three.

Under publicity we naturally think first of newspapers, radio, and TV. However, there are other avenues we need to consider. The Municipal Association, the County Commissioner's Association, Peace Officer's Association, Associated Industries, Trucking Association, Chambers of Commerce, all have publications and a deep interest in safety. Articles in these publications are effective, as we have discovered.

Many states, like Georgia, have an Industrial Editors Association which represents dozens of publications. They are doubly valuable because they reach management with the idea of DDC as in-plant training, also the employees and their families.

The endorsement of your PTA Congress, a place on their program, and an article in their publication can reach a large number of prospective DDC sponsors.

A talk with the top level Rotary and Kiwanis officials can elicit their support and spread the word. It is advisable to have a package ready with costs, savings, testimonials, etc. This detailed presentation of why and how is of value for all contacts. The hurry of today makes it imperative that we have the promotion plans instantly available.

The backing of the Bar Association is a tap from the top which we can seek and find. An article in their state publication which points out the improvement in drivers taking DDC and the successful use of the course in courts throughout the country can be effective. If these same lawyers could be persuaded to advise their clients who have lots of wrecks to take the Defensive Driving Course, an avenue of service is at once opened. A list of classes could be included regularly in the publication.

Recently the Pilot Club proved most useful in obtaining the giant sized list necessary to spread the DDC word through their membership concerning seminars and other mailings. Their National Safety Chairman wrote a personal letter to each Pilot Club in the state, asking for the list of clubs, organizations, and PTA presidents in their area. We received over 2,000 names. Through this mailing, we reached important organizations such as Lion's Club, Rotary, Jaycees, Civitan, and Kiwanis, and the Business and Professional Women's Club groups.

What ever happened to our push for recognition from the insurance companies? We need to help on the state level to make this recognition an accomplished fact. These are a few additional avenues of contact open to us. Now — the ways and means.

After full use has been made of letters and publicity, there is still no substitute for the personal contact. Enthusiasm just does not carry as well over long distance as it does face to face. It is impossible to go everywhere and meet with everyone, but it is possible to meet with key people and then retain contact through letters and the telephone. A monthly list to call will do a great deal to maintain interest and help locate spots where a special push may be needed. It is an even better idea to meet with a group of key people and talk to them about DDC.

An organization recently formed in Atlanta, called Women SOS (Sold on Safety), has proven invaluable. It is composed of women from the Red Cross, PTA's, civic organizations, and home economists who will work together in all the safety areas. By drawing these women together into one safety group, they can share safety knowledge, promote seminars on safety, and spread the word on DDC. This one group has formed three more in the state. "Never under estimate the power of a woman." Put them together and there is no mountain they cannot move.

Additional avenues of contact are to initiate DDC into the programs of large companies such as power, gas, and insurance companies, also the post office, city maintenance departments, school systems, and highway departments. They, in turn, will train their employees and make DDC equipment and teachers available to the community.

Military establishments have top position as DDC trainers, of course. They can say, "Go, take," and it is done. They should be your number one target for trainees. They are interested, able to go ahead, and have the command. Be sure to contact and work with this group.

Communication

Here we find an important ingredient in the sales picture. Contact opens the door but proper communication keeps it open. Not only must the contacts become infected with your DDC enthusiasm, but it is also well to share your common problems. They may be crushed by the indifference they meet in the "I already know how to drive and don't need to learn any more" response if they are not aware of the fact that they will meet it and must find in it a challenge to greater salesmanship. The problem is more easily overcome if it is shared.

Ways and means of breaking down this barrier can also be shared to your advantage as well as theirs. Perhaps they would like to know of the PTA chairman who overcame indifference by sending home with each child a question to be answered in 25 words or less—"Why I Think My Parents Should Take the Defensive Driving Course." Quite a few parents had a rude awakening when the answers arrived. One very penetrating one said, "My father drives so fast it makes the dog sick and then mother has to drive and that makes my father sick. I think they should take the Defensive Driving Course."

The parental attitude of listen, share and praise, reward and rejoice together is an unbeatable quality of communication.

We must never lose sight of the size of our united adversary . . . death on the highway and the opportunity we have to alleviate it through DDC. The missionary spirit will carry strength if we communicate it and continue to communicate it. DDC, like life, gets "daily" if we do not keep the spirit which inspired it alive.

On our communication wire must be news and new ideas such as those we receive through the DDC Bulletin.

It is a real boom to communication if the governor of your state is behind you. A class at the Capitol for those high in command could well lead, as it did for us, to safety meetings throughout the state, which is a very effective way to open the door for DDC.

Centering

Establishing a positive, vital center for DDC is not easy. National must face this problem all the time. It is greatly to be hoped that the city which has started DDC classes will develop the power to move under it's own steam. That is the goal because you cannot always be there to fan the flame. In many cases, we have found that the city authorities or some business firm will buy the kit, train the instructors, and promote the course. The Kiwanis Club has been useful in this capacity as has the Chamber of Commerce. In order to keep these centers continually working, enthusiams must be continually flowing, primarily from you through visits, calls, and letters.

Good volunteer teachers are the life line of DDC. They are, however, volunteers with paid jobs elsewhere. Therefore, it is important to have them in abundant supply so each one will not be called upon to teach too often.

The Instructors Development Course, given for instructors who have been teaching for a year or more, has proven of great value. Problems shared, new ideas and stories exchanged, rewards given gives added and renewing strength to your core of volunteers. This would also form a part of continuity.

Continuity

This is a crucial point where contact and continuity must play an important part and, whenever possible, personal assistance.

We have found the availability of a rental and film set of great benefit. Many groups cannot afford the purchase of a kit or do not have the number of personnel necessary for the purchase of the kit. This is also of benefit in securing membership in the Council. It is used on a reduced basis available to members and is a service from the Council.

Continuity can also receive a boost through a Safety Week carried out by the Council in the larger cities of the state. The week includes contacts and talks with industries, meetings with leaders in the city, organization of Women SOS. (There is talk of admitting men.)

After the DDC has been presented, what then? Many companies have already started their own review course. It is handled in various ways. When accidents occur in the company such as passing, backing, intersection accidents, a review is given on this portion of the DDC manual. Pictures are taken of the accident and they are discussed in the class.

The Atlanta School Department held a course for their drivers; then from this class, a panel was selected as an accident review board. The DDC training formed a basis of communication to review the accident in the light of the knowledge gained in class.

Control

Most difficult of all! You cannot be everywhere and there is always the tendency to want to shorten the course or give it without the workbooks. Control is largely a matter of close communication and continued statement of policy.

DDC is not a product you can sell and forget. It requires continued concern and supervision. Each new center is a child with a will and a way of its own which must be considered as to its individual need and coerced into proper participation in the family. We have to be a back seat driver whether we like it that way or not.

It sounds like work doesn't it? It is! But, can you think of anything more worth doing? People alive, because you made it safer to drive, men and women walking around uninjured because you said something to make Defensive Driving a part of their life.

We are apt to under estimate our powers as an individual. Little voice and big state to listen! An old mountaineer had a very intelligent prayer. He said, "Lord, I don't ask for faith to move that mountain. If I want it moved, I can get a bulldozer and some dynamite and I can move it. Just give me faith to move myself."

After we have moved ourselves we will find we do not work alone. Our voice is joined by many others. Together we will reach our states, the nation, our world. Who knows, perhaps we, too, will be heard on the moon.

SELLING DDC IN THE STATE

By MARVIN H. POWELL
Deputy Manager, Utah Safety Council, Salt Lake City, Utah

It is said that if you build a better mouse trap the world will beat a path to your doorway. The Defensive Driving Course is the better mouse trap in traffic safety, but let me assure you that I have not had to beat a crowd away from my office door to report in on time.

We are still facing the same apathetic feeling drivers have displayed over the last several decades: they don't need training; they are the best drivers on the highways today; there isn't anything new they can learn; and the Defensive Driving Course is only for the complete idiot who is causing all the trouble. Our task is to break down this apathetic feeling in many millions of drivers throughout this country, to impress upon them that the Defensive Driving Course is intended to bring their driving techniques into line with the engineering and technological advancements that have been achieved in highway and automobile construction.

In many instances, the fault lies with the cooperating agencies. They have set the scene, so to speak, and many individuals interested in bettering their driving technique believe that the course is intended only for real problem drivers, not for the ordinary, law-abider and, therefore, is not available to them.

Utah is a prime example of this situation: the Course is used as the basis of its Driver Improvement Program. Many persons think one must be a problem driver to become eligible to enroll in the course. A case in point is the lady who stopped behind a highway patrol car and asked that the officer

issue her an arrest citation. Rather puzzled over the request, he asked her why and for what violation. She replied that she didn't really care why he arrested her, all she wanted was a ticket to appear on her driving record so she could enroll in the Course.

Now this situation has been remedied. While we still use the course as a tool in the State's official driver improvement program, we are urging individuals to enroll on the merit of the Course. We stress that it is intended for any already-licensed driver and they will become more familiar with the evasive actions so necessary to prevent traffic accidents.

How has this been achieved? Primarily through good publicity. Our relations with the media are extremely good in the state, and our usual canned news releases get good use. Probably one of the better and most recent examples of this cooperation occurred on the last Sunday in September when an announcement of the October Defensive Driving Class appeared in the Salt Lake Tribune. This was followed up by an editorial on Monday and on Tuesday, the Deseret News, our other daily, ran a similar story. Needless to say, this type of publicity brought many personal and telephone inquiries and enrollment in the class.

Our first approach was a series of articles, spaced over several months, describing the course content and the benefits the student would receive. Through this we laced the results of a before-and-after study of 218 problem drivers revealing that during the year following completion of the course, 71 per cent had driven violation free, and 51 per cent had driven traffic-accident free. This points up rather graphically that the course is beneficial.

For the first time since launching into the Defensive Driving Course Program, we now prepare a news release announcing the start of every course in the state. In one case, the course was starting with 30 students; following the appearance of the announcement that the course was to start on a specific day and location, the instructor was swamped when an additional 20 persons appeared to enroll. This necessitated a second class; when the announcement of this course appeared, once again the instructor was swamped with an additional 20 students. We have found that a pre-course release has stimulated participation in the program from individuals other than those referred to the course by the Drivers License Division. This approach has been started within the last six months and we feel that it has proven to be of great assistance in increasing class enrollment.

As I indicated, the course is used by the Driver License Division as part of their Driver Improvement Program. When an individual has amassed 150 points on his driving record, he is notified of this situation and is urged and encouraged to enroll in the Defensive Driving Course program. Those successfully completing the course are given a 50 point reduction, which should be an incentive; however, here again we don't have them beating down the door. The work slips, used in the initial letter, are now secured from Drivers License and our office mails a follow-up letter. In this we don't mention the driving record, points reductions, etc. It is just simply a letter announcing the next class in their area. This we have found to be helpful; we have not checked recently, but when first launched, we were picking up an additional 25 per cent participation from this controlled group. Every ninety days, we will go back and pick up once again all those whom we know need to enroll in the course, yet have not done so. After three notices of the class, then the group will be dropped as definitely not interested.

In another promotion, the office prepared and mailed to all the service clubs in the state a letter explaining the Defensive Driving Course and urging them to encourage their members to participate in the program. While this has not been the most successful venture yet undertaken, we know of a number of definite successes in this effort. Several groups have enrolled en masse in the program. However, we do not know how many individuals enrolled as the result of the initial letter.

We believe that the Defensive Driving Course is probably one of the best public relations tools yet to be afforded to law enforcement agencies. Because of this belief, we prepared a pamphlet which was distributed to all law enforcement agencies and titled it "Building Your Public Image." In this, we attempted to paint a picture to encourage law enforcement agencies to pro-

mote participation in the DDC program. We feel that it affords an officer an opportunity to talk to people under ideal conditions. Ninety per cent of the contacts made by enforcement agencies are done under adverse conditions, and across feelings of dislike or hatred on the part of the individual who has been arrested.

We selected some seventy small firms which operate fleets, and offered this program to them as an "in-plant safety program." Here again the results were difficult to ascertain. We have had some success in getting these firms to enroll their employees en masse; however, others have had their employees enroll as individuals. Only when the firm is a member of our Council do they take advantage of enrolling all employees, for then they get a discount on the enrollment fee.

We believe that we have made fairly good use of the Scholarship Certificates. These are being provided to interested firms which are charged only for those certificates which are used by employees. We have had some success with this endeavor.

In Utah, instructors are paid at the rate of $5 per hour of instruction. With the Driver License Referral program, we have presented the instructors with a ready made class. Few have taken the time or expended the effort to develop classes on their own. So to encourage instructors to get busy and build up their own classes, we have recently adopted a program whereby they will be reimbursed at the rate of $7.50 per hour for classes that they themselves develop. Qualifications for this program are that they must have a minimum enrollment of 25 students. While nothing has actually materialized from this new venture, a number of instructors have indicated that they are working on developing classes on their own.

Further efforts will continue to be directed toward getting any already licensed driver to enroll in the course. A leaflet is being prepared which a number of insurance companies have indicated they would mail out with their premium notices. We have developed a leaflet which describes the course, contains an enrollment form and points out the benefits to be derived from participating in the course.

If the program is to go forward, we believe that it is essential that the classes be established on a definite routine, particularly in the more populated areas. Here, too, we have established a regular routine and we can fairly well tell any student when a class will commence within the next six months.

Coupled with our publicity and promotional program, considerable effort will be expended by the Council staff in making personal contacts. Since the staff size is limited, we cannot do all the promotion ourselves, we must rely on others to assist. If the council staff themselves had to contact every interested or eligible group in any state, it would be a never ending, impossible task. This is a fundamental distinction between the problem of a state compared with a city or metropolitan cooperating agency. The Seattle-King County Safety Council has had one of the more successful programs in soliciting participation from among business and industry. This has entailed considerable effort and required constant follow-up to secure the success that has been achieved.

We have a good product to sell, yet selling it will be difficult unless we clear up any misconceptions that the course is available to only problem drivers or to business and industrial firms. We should open the door, encouraging any single individual to enroll in the course. Our experience has been that, following a news release announcing the availability of the course, our enrollment has increased.

DEFENSIVE DRIVING COURSE IN DRIVER IMPROVEMENT CLINICS FOR VIOLATORS

By LEBERT A. HOWES
Driver Education Representative, North Carolina Dept. of Motor Vehicles

As an agency of the state, the Driver Education Division of the North Carolina Department of Motor Vehicles has assumed an unusual and unique role in aiding the state in its effort to reduce accidents, injuries, and deaths on our highways and streets. Working with the Driver Education Division are 60 college graduates with experience in public school teaching and curriculum development. The driver education oriented representatives' main responsibility is that of driver improvement. While nearly 65 per cent of the work of this division is devoted to the training and supervision of drivers and substitute drivers for the state's 10,000 public school buses and around 4,000 private, parochial, church, and activity buses, nearly 30 per cent of the work of our representatives is that of adult or licensed driver improvement. North Carolina presently operates 38 traffic violator schools.

Several years ago, the state legislature enacted into law a system by which, for certain traffic violations, licensed drivers received penalty points against their driving records. The seriousness of the violations was reflected in the number of points assigned. The state legislature also provided in the law an opportunity for licensed drivers who accumulated seven or more points against their driving record to take an eight-hour course of driver improvement. Upon satisfactory completion of the course, the points on the offending driver's record would be reduced by three points.

The original course was mostly oriented to the individual instructor or instructors. These instructors were selected from the ranks of the highway patrol, Driver License Division, and the infant Driver Education Division of the Department of Motor Vehicles. The course was outlined, and a format for all instructors was provided. Contents of the course in its original form were built around the traffic problem, "Deaths on Our Highways." The first hour dealt with the problem and brought out statistical facts of registered vehicles, licensed drivers, motorized deaths, injuries, and kinds of roads. The second hour was spent entirely on the driver license; that is, licensing laws, purposes, requirements for operator and chauffeur's licenses, grounds for suspension and revocation, periods of suspension and revocation, and the driver license point system. One film, "Your Permit to Drive," was recommended for use.

The course was taught in four two-hour sessions. The first hour of the second session was centered around the driver. Factors which affected driving and drivers were brought out, such as physical factors, temporary and permanent disabilities, and psychological factors relating to motor vehicle operation. At this time, the term "Defensive Driving" was introduced. The effects of alcohol on traffic safety were discussed for approximately six or seven minutes. During the second hour of the third session, about ten to fifteen minutes were spent on insurance, the North Carolina Point System, and the three basic kinds of automobile insurance, along with the North Carolina Financial Responsibility Act. The laws of nature which affect driving were also covered during this session. The last fifteen to twenty minutes of the third session were devoted to man-made laws and rules of the road.

The last two hours of the course were devoted to the art of driving—(speed and its effects, emergency situations, night driving, adverse weather conditions, and expressway driving). In addition to the instructional program, interviews with the violators were held to determine any specific problem of the driver and to ascertain the attitude of the participant.

Realizing that very few changes had been made in the course content and instructional methods, this division began a directed effort of improving the course content and teaching techniques. A few films and transparencies were added to the instructional paraphernalia. Of course during the succeeding years, the course and techniques of instructors were greatly changed. The highway patrol instruc-

tors were withdrawn and more teaching responsibility was placed upon the Driver Education representative.

With the introduction of the Defensive Driving Course by the National Safety Council, our instructors realized the professionalism in instruction and techniques of the national course. Innovators of the Department began, over a period of months, to plan and formulate a 'new' course similar in many respects to the course by the National Safety Council. About one-third of our representatives are teaching this course. The other twenty-six are teaching the National Safety Council's Defensive Driving Course.

Even though we have greatly improved our Driver Improvement Course for traffic law violators and accident repeaters, we realize that of the three "E's" in accident prevention—enforcement, engineering and education—education is now playing a more important role in preventing accidents. We feel that the approach and techniques in our course may be offensive to the participants who are assigned to our clinic. It is felt that many participants develop and consequently set up mental blocks to inhibit reaching them in accident prevention. Knowing that accident prevention is a direct result of violation prevention, we feel that the indirect approach to these often-times habitual violators may be of immediate benefit as well as causing some long range benefits in driving habits, behavior, and attitude of the offensive driver. The indirect approach of evaluating his driving in a positive sense with the driving of professional drivers stimulates interest and gives participants less reason to block us out.

By using the various teaching aids, audio and visual materials, we are confident that the National Safety Council's Defensive Driving Course greatly enhances our Driver Improvement Program, and especially our course taught in Driver Improvement Clinics. The feeling and concept that the traffic violator participant can and will become personally involved in his own improvement is encouraged with the use of the Defensive Driving Course workbook. The workbook very ably involves the participant in self-analysis and personal identification with accident prevention. The manner in which the workbook and course is presented reduces the probability of the student blocking out instruction because of some pre-conccived assumptions about law enforcement and enforcement agencies.

The idea of "who's to blame" in the first film very ably sets the stage for what "I" can do to prevent accidents—not who broke the law or that the participant is a violator. This concept of personal offenses would have a detrimental effect on almost any learning situation. The fact that our Driver Improvement Clinic participants represent various walks of life and occupations emphasizes that our techniques of instruction should be as impersonal as possible. In North Carolina, our violator classes consist of court assignees, Department of Motor Vehicle assignees, and about five per cent volunteers.

After setting the frame of reference for the individual, session two of the Defensive Driving Course gets right into the meat of accident prevention. The six conditions are so vividly described that the participant develops a sense of vicarious relationships at the very beginning. The succeeding films enrich the concept of preventability by the other person. Accepting this outlook, the students, in our opinion, tend to relate direct errors or violations by association, even though the indirect approach is used extensively in the course as a technique of instruction.

By giving the participant concrete concepts of prevention as is illustrated in the next six films, the participant has less a tendency to become bored and disinterested in the course. Introduction of the six positions of the other vehicle before a crash and the defensive actions hold the interest and concern of the participant.

The "Mystery Crash" film very emphatically attracts the interest of the student and increases his interest as to the causes of the run-off-the-road or, one-vehicle accident.

The Driver Education Representatives of the North Carolina Department of Motor Vehicles are most grateful for the National Safety Council's Defensive Driving Course. We are proud to present to our public and offending drivers a course so ably developed and effective.

ESTABLISHMENT OF DEFENSIVE DRIVING TRAFFIC SCHOOL

By ROBERT R. ROBBINS
Judge, Anderson City Court, Anderson, Ind.

It would appear that most communities are interested in traffic safety. With today's large volume of highway travel and rising number of automobile accidents, each community is seeking ways to reduce the number of accidents. We all realize that traffic accidents result in many billions of dollars in property damages, plus personal injuries and fatalities.

Many communities have safety programs. Many others are interested, but have been unable to formulate and establish a program. In many communities there is a lack of personnel to staff a program. In still others, problems concerning the proper place to hold the traffic school and questions of what material to use has held up the establishment of a program. Many communities have asked for assistance in setting up a local traffic safety program. I am very pleased to say that Anderson, Indiana, has solved its problem. We chose to use the National Safety Council's Defensive Driving Course.

Anderson, Indiana, was first exposed to DDC at the Delco-Remy Division of General Motors Corp. The course was offered on a volunteer basis to the employees and was presented by personnel from the Safety Department. Many employees completed the course.

The chairman of the Traffic Safety Committee appointed me to chair a sub-committee to institute and establish a Traffic Safety School in Anderson. The committee was to determine what kind of material would be used, who would serve as instructors, where the classes would be held, how the program would be financed, who would attend the classes, and when the program would begin.

The committee was not long in solving its assignment. The committee agreed to use the National Safety Council's DDC, because of the type of materials offered. Ten instructors volunteered from Delco-Remy Division of General Motors. Our Adult Education Division agreed to handle registration. It was also agreed to hold the classes at the Anderson High School building, and that the person attending would pay a registration fee. As Judge of the Anderson City Court, I agreed to supply student volunteers from the traffic violators appearing in City Court. Everything just seemed to fall into place and our project was begun.

In setting up our program the committee decided to use four two-hour class sessions scheduled on Monday and Wednesday nights for two classes a month. An additional class meets on Tuesday and Thursday nights. Classes are held from 7:00 PM to 9:00 PM. The committee decided that it was best to use paid personnel as instructors for the classes. We established five two-man instructor teams to present the program.

In determining the cost of materials and instruction for the classes, we settled upon a registration fee of $5 per person. This was to be paid at the time of registration on the first night of classes. The school administration agreed to advance monies needed for purchase of the materials and supplies for the classes. We found that a minimum of 17 students would be needed in each class in order to meet the cost of the program. Some of our first classes had 35 to 40 students. At present we are attempting to limit the class size to 25 students. A projector and screen were borrowed for a while until the Anderson Noon Lions Club bought a new projector for the Traffic Safety Program.

Newspaper articles were written and radio news coverage was given to the new project. My desire to have a Traffic Safety Program as part of my court became a reality.

In establishing administrative control over the program, I had a printed form prepared which stated the person's name and age; court case number; the dates, time, and place of class meetings; the notice of the $5 registration fee; and the time for the traffic violator to appear back in court. The form was so drafted that it became a signed court order requiring their attendance and

completion of the Defensive Driving Course. The original copy was given to the traffic violator, and two copies were retained by the court for control and record keeping. The class instructors prepared and returned to the court a list of students attending each class, information on overall attendance, class attitude, and quiz scores.

The court clerk was asked to prepare class lists. These were used to check the traffic violators returning to the court to exhibit their DDC cards upon completion of the classes. Normally, a week intervenes between the last day of classes and the date set as a deadline for showing cards at the clerk's office.

I have established a policy of giving opening remarks at each court session. Among these remarks are facts regarding a safety program and the use of DDC. Each person is advised on the requirements as to class attendance. They are also advised as to their constitutional rights regarding their particular case. In the past I was having some difficulty in regard to violators appearing in court who worked evening hours. I am happy to say that we have now completed our first day class of 21 students, established for the evening and night workers. The class meets from 9:00 AM to 1:00 PM for two sessions which are held on Tuesday and Thursday, once each month. With the addition of this day class, we are presently holding four classes per month.

In reviewing our program I find that 808 traffic violators attended DDC in 1968. Of these, 648 (80.2 per cent) were males and 160 (19.8 per cent) were females. The records through September 30, 1969, show a total of 571 persons attending class this year—449 (78.6 per cent) were males; 122 (21.4 per cent) were females. Our records indicate the following by age groups for this year.

Age	Male	Female	Total
16	20	5	25
17-19	117	22	139
20-25	140	34	174
26-40	101	35	136
41-60	64	25	89
60 and Older	7	1	8

The above figures only reflect the number of each age group assigned to traffic classes. Until such time as we obtain more coverage in our classes we will be unable to draw any final conclusions from them.

The DDC program in the Anderson area has received many compliments. Some of the most common remarks are, "I think it is a good program;" "I learned things that I never thought about before;" "It has a lot of good points in it;" and, "I think it is a wonderful program; everyone should go."

In one instance a truck driver of 20 years experience stated that the course was a good refresher to him. Of course, like any other project, we have a few persons who resent being ordered to traffic school, and just plain don't go. In these cases we issue notice for them to appear in court. I inquire as to why they did not attend classes and in some cases have taken their driver's license for six months or more on a suspension. On still other occasions, I warned them and ordered them back to the school again. I am pleased to say that none of these persons failed to attend the classes for the second time. Needless to say, I am very pleased with our program and recommend it highly to those who are looking for a fine traffic safety program.

THE DEFENSIVE DRIVING COURSE IN AN INDUSTRIAL SAFETY PROGRAM

By R. C. BAKER
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Operated by Union Carbide Corp., Nuclear Division,
for the Atomic Energy Commission, Paducah, Ky.

The Defensive Driving Course was presented to approximately 1,150 employees of the Paducah Gaseous Diffusion Plant as a part of our plant safety program. Several questions arise over this presentation: Did the DDC belong in an industrial safety program? How was it implemented? What did it cost? Can the cost be justified? What effects did the DDC have on company (government in this case) vehicular accident rate; on employee personal driving accident rate; on the effectiveness of the plant safety program; on employee morale? Will DDC have lasting effects? To answer the first question about whether the DDC is appropriately a part of the plant safety program, we have to find answers for the other questions.

Although our on the job vehicular accident rate was not high and accident costs ran less than $1,000 per year, our off the job rate was high with resulting lost time injuries expensive in terms of employee benefit payments. Three men were killed in one accident in 1968. Plant management accepted "Defensive Driving" as the topic of our first plantwide safety program of 1969. I am sure that the superintendents did not realize when they approved the topic that it would lead to the large program that eventually evolved.

How was the program implemented? A committee representing each plant division obtained National Safety Council's material on the DDC. After becoming convinced that the NSC course was more effective than providing a film and safety meeting type discussions, the committee sold management on DDC despite the obvious high cost in employee hours. There being no local instructor trainer, our safety engineer was sent to the NSC Instructor Training School.

Our safety engineer came back from Chicago loaded with enthusiasm, instructional techniques, and a bag of flat jokes. He taught a course to our Health and Safety personnel and then tackled the superintendents. As letters and certificates flowed slowly between Paducah and Chicago indicating advancement from Candidate Instructor to Instructor, to Candidate Instructor Trainer, he taught and trained 10 additional instructors. A classroom was set up and used almost continuously from the middle of, February to the middle of April. Each instructor used the same edition of the instructor's manual, the same visual aids, the same set of film; but each class was different because of the unique personality of the instructor and the employee group. Automatic Data Processing equipment was used for scheduling and recording attendance.

What did it cost? Plenty! The materials for the course may seem a little high priced, but these costs (approximately $800) were small compared to job time. Over 9,000 employee hours were spent in classroom and travel time.

Can the cost be justified? If all on the job vehicular accidents are prevented by the DDC, it will take us 35 years to pay for the course through savings on repair costs. We do not expect all accidents to cease and they have not. However, if half our off the job accidents are prevented through the presentation of the DDC and through follow up campaigns using DDC techniques, the cost of the course will be recovered in a few years by a reduction in fringe benefit costs, and a life or two may be saved. Other justifications concern employee safety performance and labor relations. Many of the aproaches, techniques, and attitude adjustments taught in the DDC are adaptable to industrial safety. We are using some, particularly in training new employees to recognize hazards, understand the defense, and to act in time to prevent accidents. Almost all accidents are considered preventable and employees are expected to work safely in spite of adverse conditions or actions of others.

What are the results? What effect did the DDC have? Our on the job driving is

not extensive enough to be statistically significant. So far this year we have had three fender-benders with a total repair cost of $200, a little under half our usual rate. Off the job disabling injuries are generally lower this year and only three have been due to vehicular crashes. The effect on the plant safety program has been noticeably beneficial. Our safety engineer became better known in all areas of the plant. Employees stop him as he goes through the shops and process buildings to relate to him some incident of how Defensive Driving prevented an accident or, now that they know him better, to report some unsafe condition or practice they observed. I can say with no reservations that the DDC provided a shot-in-the-arm, a revitalization of plant safety awareness. To date, we have accumulated 425 days, 2½ million manhours, without a disabling injury.

The DDC improved employee morale. With inflation depressing buying power and other worries, employees were glad to receive this obviously costly and worthwhile benefit. It was a management initiated action taken clearly for the welfare of the employees. At their suggestion it was taught at night to family members in three classes, and additional classes are being organized.

Will the DDC have lasting effects? We shall try to make the effects lasting through follow up safety meetings, bulletins, posters, and articles in the plant newspaper relating favorable employee experiences.

DDC can justifiably be presented as a part of a plant safety program. Local conditions may very well be the determining factor. In any event, adequate planning is necessary for elimination of wasted time and the benefits of the presentation of the course should be fully exploited.

INDUSTRY, BE THE LEADER — FIGHT TRAFFIC BUGS WITH DDC

By DAVID H. MIKKELSON
Safety Dir., Consolidated Dairy Products Co., Seattle, Wash.

The merits of defensive driver training are being debated. No one can debate the merits of the Defensive Driving Course. American industry should be the leader in the fight to reduce the human and property losses due to traffic accidents.

The Defensive Driving Course has had a successful start, and in many segments of our society the acceptance has been phenomenal. However, industry has not done enough.

American industry represents millions of employees and is well organized on a local and national basis. American industry believes in and has worked hard at both "on" and "off" the job safety for many years. It seems natural that they should be a leader in promoting the DDC for their employees and their families. This is especially true of the transportation industry as represented by bus, motor truck and taxicab companies. After all, defensive driving comes from these companies, and they have so much to give and so much to gain. They are recognized as the leaders in safe and defensive driving. They should set the pace.

If this is so, why don't they? There are apparently many reasons. The main ones seem to be: our people don't need the training; we're too busy for an eight-hour course during or after working hours; it costs too much; union resistance unless employees are paid; no instructors or classroom facilities; classes difficult to conduct due to irregular work schedules, line haul drivers, etc. What about these and other reasons? I say they are only excuses.

In my twenty-five years in the transportation and safety field I have been exposed to most of the safety things and ideas that have come along. They've all been tried and many are good, necessary and useful. A few years ago, we felt we had run the gauntlet of the five minute talks, the award programs, the movie films, the 10-year

watch, the posters, etc. People tired of listening to the same old things. We needed a new approach. Then we heard of DDC. I was skeptical, as my responsibility was for professional drivers, and they said DDC was for the private drivers. I took a look and then enrolled in the instructor's course. I was convinced. Next was management.

Our company had a good traffic safety record so I couldn't sell it as a remedy for a bad situation, but as something to enable us to maintain a good record. Management asked these questions: eight hours is a long time—can the course be condensed? Is the course any good? Will the drivers attend voluntarily? Will the unions allow us to require attendance without pay? What will it cost? Who will teach the course? Will we give the course to all employees? How about their families? As Safety Director I had to answer these questions, and here is the story.

I told them the course *couldn't* be condensed and shouldn't be. To determine whether it was any good and whether people would attend without pay, we had a meeting with the union. With their concurrence we ran a pilot class with 25 men. Half were pro-drivers and half were supervisors or management people from three different companies. At the end an anonymous questionnaire said unanimously that everyone should take the course.

We decided to go ahead, and the union agreed we could run the course after hours without pay, but we could not require anyone to attend. It then became a selling job. Management gave us the go ahead, and our president wrote two letters—one for department heads, managers and supervisors, and one to all employees and their families—telling them about the course and inviting them to attend. We prepared other material for distribution to supervisors and employees. The selling program was underway.

We have 1,200 employees of whom 600 are professional drivers. These employees are located in three states and 20 plants. Our largest plant has over 200 employees and our smallest less than 20. We sent 18 selected employees to the instructor's course, and about half of them proved to be very competent teachers. These instructors taught our Seattle classes, while I handled the classes in other towns. First classes started in the fall of 1966 and we finished in June, 1967. The company paid the cost of the program. Here are the results: 92 per cent of our professional drivers took the course; 70 per cent of our other employees took the course; 70 per cent of the employees brought someone from their family. Since 1967 we have continued to run classes for new employees and at new branches acquired by mergers.

The acceptance of DDC by these people was beyond my highest hopes. Here are some examples:

1. One employee traveled, on his own, 200 miles to make up a session.

2. At one branch (20 employees) we held the classes on four consecutive nights—two employees traveled 100 miles round trip each night. We graduated 100 per cent.

3. One of our veteran professional drivers took the course at the Eagles Club prior to our conducting the course. He said he and his wife attended and paid $4 each for the training. He told me it was the best $8 he ever invested, and if we had a driver who was reluctant to take the course to let him know and he would help us "sell" the course.

4. One driver of 20 years experience and no accidents said, "I thought I knew all about driving but this is a real eye opener." Later he said "We should have a refresher course every six months."

5. Some employees have taken the course a second time and others are planning to this year.

6. The majority of our people went out of their way to praise the course for its contents as well as the way it is organized.

I know the DDC is a good program and the best thing that has come along in traffic safety in the last generation. I know this because I have been on the firing line for 40 classes and 1,200 people. I've had the feed back, and there is no question that all drivers in this country and in the world should take DDC—they will enjoy the course and benefit from its lessons. People who attend think it is great. I have never had a disinterested person in all my classes. It can and will be improved but it is a quality product now.

In our case there was an extra bonus received by conducting this course for our

employees and their families. This bonus was in the field of employer/employee relations. Our president received many letters from employees and members of their families expressing their gratitude to the company for making this training available. It brings the company closer to its employees.

Now, let's get back to industry! I suggest every industry take a good look at the DDC as a means of improving the traffic safety picture in this country, as a means of protecting the welfare of their employees, and as a means of improving relationships between industry and the employees. Let's start thinking of ways that this can be done and forget about all the excuses as to why it can't be done. Where do we start? Where else but at the top?

At this point I am going to leave industry and direct my comments to the entire American establishment. There are many people and many organizations responsible for traffic safety and many people and many organizations who claim they are working on the problem and taking credit for the improvements. Traffic safety in my judgment is a "driver problem." I have no quarrel with those who want to make highways and vehicles safer, but that is not getting at the root of the problem. Everyone believes in traffic safety for the other guy. It is my contention that people will not take driver training unless they are led into it by the recognized leaders in our total society.

What is the answer? The President of the United States and the members of his Cabinet should take the DDC, and the fact they take it should be publicized. All members of Congress and members of the state legislatures should take the course, and it should be publicized. The governors of every state should take the course. The President and Board of Trustees of the National Safety Council along with all local safety councils should take the course, and the fact they took the course should be publicized. The same thing is true of the chiefs of police, highway patrols, and other law enforcement officials. The same applies to mayors and city councilmen; newspaper editors and staffs; radio and TV station managements; chamber of commerce officials; officers of trade associations such as National Association of Manufacturers, American Trucking Association, and American Transit Association; American industry and labor union leaders; church leaders; PTA members; members of service organizations such as Kiwanis, Rotary, community clubs, granges and fraternal organizations such as Elks, Eagles, Masons; and last but not least, Insurance Company members.

All of these organizations and individuals claim they are for traffic safety. We believe the best way to improve our traffic safety picture is to teach everyone Defensive Driving. If all of these people took the course themselves and the American public knew it, it is my belief we would then only have one problem, that would be getting enough instructors and classrooms to handle those seeking the training.

Many people, when told about the DDC, say, "It sounds great, everyone should take it." When you say "How about you?" they say, "I don't need it," or "I haven't had an accident for 20 years," or "I'm too busy." I say people are hypocrites who claim they are for traffic safety or interested in the welfare of people, if they don't take the DDC course. None of us are as good a driver as we think we are, and we can always acquire more knowledge and skill. If we are good drivers our associates, our friends, and our families know it. We owe it to them to set an example by taking this training and thus lead people into doing the same thing.

People have a peculiar conceit about their driving ability. Everyone thinks they are a good driver. Have you ever heard anyone say "My driving is sloppy, and I need some more training"? Yet, driving is a skill that is improved by practice, training, experience, and by attitude. People with top skills continue to practice. For example, a professional bowler or a professional golfer will practice for hours, even though he is at the top of his game. Why don't drivers practice too?

I challenge American industry, the labor unions, and all others to perform a real service for their people: take the Defensive Driving Course. You and your organization will benefit along with the American people.

Defensive driving means driving like you do when you suddenly realize your license has expired; driving like everyone else on

the road is crazy; driving like you want your kids to; driving like you would if your name, address, and phone number were printed on all four sides of your car; driving all other cars on the street; driving like you do when there is a picture of a highway patrol car in your rear view mirror.

This is the age of everyone doing their thing. Our thing should be Defensive Driving. American industry, front and center!

DDC AS A SAFETY PROGRAM FOR INDUSTRY

By R. N. GRAY
Dir., Technical Services Education, National Cash Register Co., Dayton, Ohio

National Cash Register is a worldwide organization dealing in the manufacture, sales, and service of EDP equipment, accounting machines, cash registers, adding machines, and business forms and supplies. In more than twenty-four years with NCR, I have been exclusively associated with the service portion of the business. The last ten years have been devoted to the education and training of our technical representatives, who now number more than 10,000 in the U. S. and Canada.

In the U. S. and Canada NCR maintains over 500 points of service for its products. These points range from large operations such as in Chicago to the resident man living in his territory using his home, a truck, and a telephone answering service to conduct his servicing operation. Available to this large group of technical representatives is a fleet of 5,600 vehicles. In the main, it is comprised of station wagons and sedan delivery trucks, with a smaller number of heavy duty units mainly used in the larger cities.

Naturally, with a fleet of this magnitude, the accident rate becomes of prime interest both to our corporation and the company handling our vehicle insurance. In a typical year of NCR fleet operations, we have between 300 and 600 moving crashes, and hundreds more damaged company cars, including those hit while parked.

Nearly a hundred of our employees are injured in these crashes, many seriously. At least a hundred others—family members or friends, pedestrians, or people in the other car—are also hurt. Most tragic of all, some of our fellow employees lose their lives.

Each year, direct costs to the company exceed half-a-million dollars. These include claims settled, property damage to company cars, company cars totally destroyed, and driver-passenger injuries. In addition, indirect annual costs are estimated at substantially more than that amount. These indirect costs cannot all be gauged by mere computations. They include the expense of filling out claim reports, going to court, lost time by supervisors, loss of good will to the company, and many others. Following an accident, there are reports to the police traffic division to give more detailed account of the case and reports to the state as required by the financial responsibility law. Reports, analysis, and cost estimates have to be drawn up. In the meantime, the insurance adjuster arranges for repair of the car, tying it up for several days. And, because no other car is available for temporary assignment, employees are pinned down to the office, driven to and from work by friends, or the company pays for a rented car—more expense.

Prior to July of last year, although we were aware of the costs of accidents to our company, we hadn't really done very much about the accident situation except to review the claim data which was available from our insurance department. We found that during a three-year period, from January 1965 through February 1968, we had over 1,550 drivers involved in 1,700 accidents. This represented an insurance loss to us of over $745,000. More importantly, 161 of these drivers were involved in two or more accidents each. Of drivers involved in two or more accidents each, 141 drivers had two accidents each; or a total of 282 accidents that cost us nearly $200,000. Sev-

enteen drivers were involved in three accidents each during this period, and these 51 accidents had a loss to us of nearly $13,000. The situation worsened when we found that three of our drivers had four accidents each, costing our company $3,200. In other words, the 161 accident repeaters were involved in a total of 345 accident claims, having an incurred cost of $214,000.

From this, we had a good start as to who was involved in accidents. It was then a question as to how to attack the problem, and we looked further in our own claim records to find out what types of accidents were occurring. We found from among the more serious accidents involving our company vehicle drivers, the following typical examples.

One case involved a service man who was operating a station wagon in clear weather on dry pavement. As he neared an intersection within the speed limit (50 mph), the car in front of him (approximately 175 feet ahead) stopped. Our driver stated he skidded from 85 to 100 feet and struck the car in the rear. The car contained a passenger and the driver who, at the time, did not appear to be hurt. The passenger suffered slightly from nose bleed. The state patrolman who investigated issued a citation to our driver. Later on that nose bleed produced a claim in excess of $3,000 and, unfortunately, involved one of those accident repeaters we mentioned earlier.

Another employee was operating a passenger car at about 5:30 PM when he struck a car in the rear at an intersection. Again, the weather was clear. This time, the driver stated he didn't see this vehicle until he was about 20 feet away from it. The police issued him a traffic ticket. There was only one person in the other car. The claim on this one also ran into thousands of dollars.

Another service man thought the light had just changed "green" for him and proceeded on through the intersection. The next thing he recalled was striking the front end of another vehicle. Of course, the driver of the other vehicle thought the light had just changed for him. There were three people in the other car; one was injured. The accident occurred again during daylight at 5:10 PM and I won't even mention the cost of this catastrophe.

The reason for telling you about some of these serious accidents here is to point out that eventually, through our use of the Defensive Driving Course, we did find a method of instructing, training, and attacking such accident types as rear-end collisions and intersection collisions.

Believing that any situation can be improved, it was decided in 1968 that, working with the National Safety Council through our insuring agency, we would aggressively pursue the education of our technical representatives in Defensive Driving.

Twelve centers are involved. Nine of these are small three room regional centers where new hires are given basic training. Three are major centers located in Hartford, Connecticut; Denver, Colorado; and Dayton, Ohio. Dayton is our largest and newest center. It is a campus type complete with 100 classrooms, cafeteria, dormitories, etc. Denver involves forty classrooms and Hartford twenty-eight.

Our instruction staff numbers one-hundred and eighty-six. These are highly qualified, highly trained full-time instructors. The original cadre of instructors in each school chosen to teach DDC were trained by a cooperating agency of the National Safety Council. Since that time, a total of 58 instructors have been qualified.

The theme of our program was and is "A Defensive Driver Is a Safe Driver." Extensive use is made of all the National Safety Council training aids and materials. The entire program has been received with enthusiasm by the student body and instructors. Many favorable comments have been made by our staff in regard to the DDC manual and work book. These are so well prepared that the lack of a full-time instructor should be no drawback to starting the program.

Many of our instructors were worried prior to becoming involved in the course about their lack of knowledge of the driving laws in the many states. This turned out to be no problem, since DDC is mainly the practical application of common sense driving techniques presented in a simple manner. DDC borrows from the driving knowledge, skills, and experience of people who have spent years in motor fleet safety.

Our Regional Education Centers train approximately 900 new employees per year. Their basic course covers a twelve week span. During this time, they are given the Defensive Driving Course. The manner in which it is presented varies, but falls into two categories. In some centers it is given in a single eight-hour period—in others, one a day until covered. We have made no hard and fast rules, allowing each location to adapt in the best way for their needs.

We have, however, made some adaptations which are still part of the program:

1. Because of local driving situations in a particular school area, for example in Denver, we take special effort to discuss winter driving problems in the mountains with students from Southern and Southwestern areas.

2. We also established at the outset the "timed interval" concept of following distances and have found this application to be very useful in overcoming the rear-end accident. We were very happy to be one of the first large organizations to adopt this method into our program. We note with some interest that the timed interval system has become a part of the revised manual and course.

Our DDC training started in July 1968. Some 550 trainees from throughout the country who were taking courses in the Dayton School were the pilot group. Since that time, we have trained a total of 4,357 and are still training at the rate of 235 per month.

As has been previously stated, the accident costs to NCR, both direct and indirect, are very substantial. Even though the costs involved in presenting DDC to over 4,000 people are not inconsiderable, we would much rather budget the costs of the program as part of our on-going training and education expense than spend a much larger amount in claims payments. I would suggest that even without a fleet the prevention of lost time at work brought about by employees safely driving to and from work might still make it a good investment.

To measure the improvement in our fleet would be most difficult at this early date. Our statisticians say that three to four years must pass. However, using the year 1962 as a base, a sharp increase in losses paid by our insurer was noted and, as a matter of fact, the cost increased in 1968 to a high of 71 per cent over the 1962 base. It appears that the first seven months of 1969, projected to the end of the year, indicate our losses will have dropped to an amount of eight per cent over the 1962 base. During this same period there was a 30 per cent increase in the number of vehicular units. We believe that part of this loss improvement is directly caused by DDC.

The majority of the improvement, we know, is directly related to our management's interest in safe driving and strong backing of the DDC program. Without this backing no program can exist or be effective.

USES OF DDC AS A TRAINING PROGRAM FOR EMPLOYEES

By HAROLD B. WEEKS
Defensive Driving Consultant, Hartford Insurance Group, Hartford, Conn.

The Defensive Driving Program for the Hartford is mandatory for our 2,500 operators of company-owned vehicles and voluntary for our 13,000 employees. I say voluntary, but our regional managers are competing for 100 per cent participation by their employees. To date, five have obtained that, and fifteen have trained over 80 per cent of their licensed employees.

We recognize the value of this driver-training because we own and insure our own fleet. A recently completed survey did show that those who have completed the course have had better accident experiences. We hoped that by presenting this course to all employees we would cut down on absenteeism caused by automobile accidents. We do not have actual figures, but we believe that the program is doing this.

In building up our instructor staff, we found that there was an added advantage to this course. By becoming instructors, conducting classes, and using the prepared material, our people were becoming confident in their ability as public speakers. They were becoming more efficient in setting up this type of meeting and were better prepared to handle discussion groups on any subject. Department heads are now asking that we accept as instructors those people they are trying to advance in their departments.

We have a career development program where young men are trained in the home office and then sent out to regional offices to make a career in the insurance industry. We found that by training them as instructors they would perform an important function upon joining a regional office, and it is a quick method to get to know the personnel of a strange office and get to be known by them.

We have a manpower development program where each person, upon being hired, has a chance to compete with every other employee in the company. We are working to have the skill of being a Defensive Driving Course instructor added to our "Skills Inventory Record" which is fed into our data processing system. We have several excellent women instructors who are able to show that they are suited for better jobs than they are now doing.

All of our loss prevention men are eventually trained in conference leading. We use this type of instruction with them and with our insureds. What better training and practice is there than having them participate in the Defensive Driving Course Program? We feel so strongly about this that in our administrative advancement training program for engineering supervisors we have included the requirement that a person must have qualified as a Defensive Driving Instructor.

I am involved in training our people as conference leaders and as Defensive Driving instructors. These two things complement each other very well. A good conference leader can quickly become a qualified, certified Defensive Driving Instructor and, particularly with our crash program in 1968, a Defensive Driving Instructor gets plenty of practice to enable him to become a good conference leader. I am constantly amazed with the similarity between the methods used in the Defensive Driving Course Program and our own training program. That shows that they are both good solid programs.

We believe, with many experts, that the best method of instruction for adults in industry is the conference method. If presented properly, the Defensive Driving Course Program is just that. Some of our best sessions have been put on by good conference men who can get the class involved and, thru leading questions, get them to come out with the right answers. Conversely, we've had to retire some instructors who killed the sessions by asking the questions in the script and then giving the answers themselves, thus turning it into a deadly lecture series.

We start out by telling our men how to get ready to train. We first have to

have a training time table, telling the learner what he has to learn and do and by when. This is spelled out pretty thoroughly at the start of every one of the eight Defensive Driving Course sessions. We state that the instructor has to have a Training Breakdown listing all the important steps and the key points. This is done for them in the *Instructor's Manual.*

A good trainer has to have everything ready—have all of his essential materials and a place for everything. And, lastly, we have to arrange the work place—housekeeping, ash trays, just the way the trainer should keep it. This is pretty well spelled out if the instructor trainer has done a good job.

Let's see how our Defensive Driving Course Program agrees with the four recognized steps in training.

First, prepare the employee. Put him at ease: we have each participant stand up and introduce himself and the department he works in. This lets him know how his voice sounds in that particular room and he is more likely to join in the discussion later. We start with what he already knows (or at least what he should know) and we get him interested in learning by telling how the course will benefit him.

Second, present the task. We present the task by telling, showing, and illustrating, one step at a time. In the Defensive Driving Course Program the script and visual aids certainly do this. We stress each key point; that is why some points are repeated throughout the script. We give only what the learner can master or digest at one time. This is why it's desirable to spread the eight sessions out over a period of time.

The third step in a good training program is Try-Out. Let the learner try it out — tell him to practice the things that are brought out in class. Make sure he understands — have him present problems he encounters in trying out new techniques. Correct his errors and encourage him. This is what a good instructor must learn to do.

The fourth and last step is follow up. Put the learner on his own, tell him where to go for help, check up on him often at first and then taper off the extra coaching. Up to now, this step has been difficult with our Defensive Driving Course students, but our new program of follow up should show some results in the future.

These are the four steps in training. If the learner hasn't learned, the instructor hasn't trained. If we don't stick by established rules and stay with the Defensive Driving Course *Instructor's Manual,* we won't be doing the best job we can.

We believe that the Defensive Driving Course Program is a good program and can be used as a guide and asset to any kind of a training program.

DISCOVER YOUR MEMBERSHIP

Moderator: Richard F. Reimer, Mgr., Membership Dept., National Safety Council.

We had a session last year on value of membership and it was handled by Council staff personnel. This year we are fortunate in having volunteers from the ranks of our membership to assist us. "Nothing succeeds like success" and the actual users of services can best relate their own experiences.

The subjects to be covered this morning are divided into four sessions: Membership; Training; Awards & Contests; and Motor Fleet.

"Speak Up For Safety" is the theme of this year's Congress. You can be sure we are following this suggestion. There are no less than 14 people on the program today. First, let me introduce the staff participants:

Len Smith—Mgr. of Training Dept.
Mike Flaherty—Ass't Mgr. of Motor Transp. Dept.
Sidney Smith—Ass't Mgr. of Statistics Dept.

Introduction of the guest speakers will be made as we go along. Each speaker has utilized the Council services in his or her organization and can tell us about their operation.

Why National Safety Council Membership? Singly we can help you prevent accidents. You've heard statistics this week, but there is one that "says it like it is." In the 60's, over one million lives have been lost due to accidents. It's our job at the Council to gather information and prepare useful tools to aid in your accident reduction programs.

Can we really tell that membership in the Council helps? Yes! See comparison in *Accident Facts* showing frequency rates of N.S.C. members vs. non-members. Membership advantages could fill a session itself, but briefly, they help—

—Keep current on advances.
—Management appreciates reduction of accident costs. Accident costs to our Nation were over 2½ billion in 1968.
—Earn awards—help motivate safety attitudes.
—Compare records with others.
—Membership increases your staff—450 N.S.C. employees plus

Staff Representative to answer technical problems and assist in your programs.

Membership Consultant—your friend and aid at Council Headquarters. There is a consultant assigned to your account. If you have not already done so, meet and visit your contact at the Council Exhibit.

Now, I'd like to introduce our first speaker. Don Espinosa is Safety Director for Rheingold Breweries? Don left the midwest division of Pepsi Cola to take the directorship of safety for this large eastern company. He has served on Council committees (including membership) for some years. Don will explain briefly how he is putting N.S.C. membership to good use at Rheingold.

WHY NATIONAL SAFETY COUNCIL MEMBERSHIP?

By DONALD P. ESPINOSA
Director of Safety, Rheingold Breweries, Inc., Brooklyn, N.Y.

So who needs the Council? My insurance carrier provides me with posters and pamphlets and inspects my plants; besides, my company regards membership in the Council as a charitable contribution, and our charity budget for the year is exhausted.

This is a sampling of the kind of reasoning I was exposed to while serving as Membership Chairman for the Food & Beverage Section, from companies that I solicited for membership. In spite of my lengthy letters of explanation, along with the Council's membership propaganda I had sent them, these companies completely missed the point of Council membership.

I consider myself fortunate that I have been closely associated with the Council since the first day of my safety career. I was doubly fortunate in that my personal counselor during these early days, was the late Glen Griffin, who for 25 years was training director for the National Safety Council. In fact, my first official act as a safety director was to attend a National Safety Congress. Within a month of my appointment, I attended the fundamentals course at the Safety Training Institute. I have since attended nearly every course the institute offers and have found the knowledge I obtained through these courses essential to my performance. For these reasons, I am quite obviously prejudiced in favor of membership in the Council and I regard it as a "must" for the safety professional.

Once I had cut my teeth on industrial safety, I soon found myself with a new employer and responsible for a truck fleet of over 800 vehicles, an area to which until then I had never been exposed. Again, the Council came to the rescue, and with the help of their Commercial Vehicle Section, I was able to put together an effective fleet safety program. Their help has been continuous in both my industrial and fleet safety endeavors and they haven't let me down yet.

While a few insurance companies provide excellent safety services, I don't know of any insurance company, local safety council or ASSE chapter that has the wealth of safety information at its disposal as does the Council. A few months ago, to give you an example, I had inquired on the subject of automotive battery explosions after having had one in my present fleet. Not only did I receive a sizeable bundle of information in response to my first request, but there has been a steady flow of data from the Council ever since on that subject. Where else can you find a safety specialist in every field under one roof, who is at your disposal for the cost of a phone call?

I have attended many safety shows and expositions, and I have yet to find one that can equal the Congress. The only other type of meetings that I have found to be of value have been those that deal with specific safety subjects, such as the Annual ASSE Professional Conference, fleet seminars, and special subject industrial seminars.

If any one asks me how to get their company's Safety Program going and get their newly appointed safety man started in his professional career, my answer is always the same: join the National Safety Council, send your man to the Training Institute and take advantage of all that the Council has to offer. I found, while serving as Membership Chairman, that the biggest reason for companies dropping out of the Council was that they were not properly utilizing the Council's services.

I have saved the best for last: In addition to the advantages I have just described, the greatest benefit of Council membership, in my opinion, is that it serves as a vehicle to bring together safety professionals from all areas of safety so they can exchange ideas face to face. I have often come away from a Congress or other Council sponsored activity, having learned as much from informal discussions with fellow safety men, as I did from the formal sessions.

As far as I am concerned, the safety professional whose company does not belong to the Council and take advantage of all that it has to offer is simply "not with it."

SUPERVISORY TRAINING MATERIALS

By FRANKLIN G. PATER
Mgr., Safety and Loss Prevention, Trailmobile Div., Pullman, Inc., Chicago, Ill.

What is available from National Safety Council?

Five minute safety talks

The Industrial Supervisor

Data Sheets

Supervisors Safety Manual

How to make a safety speech

Film Series

Do your foremen know what is available?

How can you show your foremen management's interest?

Materials for self improvement

Five minute safety talks and talk topics: I keep a library and when I see an injury trend in a department, the foreman and I review these and select a few for his use.

The *Industrial Supervisor*.

As a change of pace this magazine is sometimes sent to the home; when appropriate it is sent to the wife.

Send them all to the plant manager for distribution.

Accompany them with a letter from me highlighting specific articles in an issue and asking for a reply.

Data Sheets: Used to supply technical information for specific department or processing problems. I use them for supervisory and engineering personnel.

"Supervisors Safety Manual":

Each foreman at all plants has a copy of this manual. It was presented to him as a text and the subjects were discussed in formal classroom sessions.

"How to Make a Safety Speech":

How many foremen know how to prepare for a speech—formal or informal? Keep a supply of these on hand, and if necessary, hold practice sessions with them.

Film Series: These films are never used by themselves but as *part* of a meeting. They are used to train new foremen, used as refreshers, and used in particular instances.

SAFETY TRAINING INSTITUTE COURSES

By EDWARD N. DECK
Consultant, Safety and Plant Protection, General Electric Co., New York, N.Y.

When we hire a safety professional, we attempt to engage an individual who has received some formal-safety training. When he reports to us, we allow him ample indocrination time to become familiar with our operations and procedures before we give him further training in safety. After he has been with us four to six months, we schedule him for the fundamentals course at the National Safety Council headquarters in Chicago, a one week course which gives him a good solid foundation in the basics of accident prevention. He not only learns from the formal instruction; he also learns how accident prevention is carried out in other industries from his contacts and associations with other students. Thus, he has a better grasp of the whole accident prevention picture and an appreciation of its importance in controlling losses. This particular curriculum is invaluable for training employees who are promoted from within.

When a man completes the fundamentals course, we try and schedule him for one of the condensed courses within the next twelve months. This will depend to some degree upon the person, his work, and the plant location. If the person is involved with training, directly or indirectly, we enroll him in the course "Safety Training Methods." Here he will learn sound train-

ing procedures for training supervisors and employees and how JSA and JIT fit into the accident prevention picture.

Following this course, and again within the next twelve months, if not earlier, we may send this same individual to the "Management Techniques" course, where he will learn about communications, conference leading, and other tools of management. Thus, we try within a period of about two to three years to train all of our safety professionals through courses offered by the Council. If additional training is required, particularly where we encounter processes where noise is a problem, we may additionally send them to the Council's course on noise. The same is true in the area of industrial hygiene, both for back-up and where the employee shows a desire for further education.

We have found training of this type a better situation than trying to develop our own safety training program within the company. It exposes our men to the latest trends in accident prevention and also helps them to develop sources of help over and beyond those the company offers.

HOME STUDY COURSES

By T. T. PINDER
Director of Safety, Utah Copper Div., Kennecott Copper Corp., Salt Lake City, Utah

Effective safety supervision can be learned quickly and inexpensively right in the comfort and quiet of a supervisor's own home. The method: National Safety Council's home study course. Advantages: (1) the supervisor studies on his own time; (2) the supervisor learns at his own rate; and (3) the supervisor receives personal attention from his instructor.

In 1962, after thorough review of many courses, Kennecott Copper Corporation's Utah Copper Division decided to enroll a number of supervisors in the supervisors' home study course, "Supervising for Safety," and 134 supervisors were enrolled, with 114 completing the course in the required time. After evaluation, it was felt this was a very excellent program to give the supervisor a new insight and a tool for safety improvement, so in 1963 an additional 295 supervisors were enrolled; from 1964 through 1967, 136 were enrolled; in 1968, 148 were enrolled; and this year to date we have enrolled 22.

Since the inception of the program, we have enrolled 735 supervisors, with 550 having completed. Of 46 supervisors who failed to complete the course within the required time, 35 had terminated their employment.

We have found that the safety performance of those supervisors completing the course has improved. This is attributed in part to the additional safety training obtained from the home study course.

The Utah Technical College is now making further use of this course for safety development of supervisors. Supervisors and other interested persons attend two sessions per week for twelve weeks.

Safety and the Foreman
Know Your Accident Problems
The Human Element
Maintaining Interest in Safety
Instructing for Safety
Health and Industrial Hygiene
Personal Protective Equipment
Departmental Housekeeping
Materials Handling and Storage
Guarding Machines and Equipment
Hand and Portable Power Tools
Fire Prevention and Control

Benefits to the company are: (1) information to management on supervisors' quality; (2) a supervisor's interest in safety is indicated by whether or not he completes the course; and (3) home study impresses his wife and family and helps with off-the-job safety.

It is suggested that the home study course could be made more effective by changing the sequence of the test questions each quarter so individuals in the same plant can not exchange test papers.

STATISTICS OVERVIEW

By SIDNEY D. SMITH
Assistant Manager, Statistics Department, National Safety Council

The Council can provide its members with valuable statistics services. Among these are the many daily requests for all types of accident statistics, and through member participation in the sectional industrial safety contests and in the Award Plan. We have several speakers with us who will tell you of their utilization of these services.

The Statistics staff handles an endless variety of accident statistics questions. Through its own files, Council library resources and outside sources, we can usually provide an answer to most questions. If no previous statistics have been compiled we can often provide a sound general estimate.

The industrial employee safety contests are among the oldest and most popular services of the Council. The Pulp and Paper Section started the first contest in 1926. Today more than 7,000 member units participate in 26 separate contests, ranging from the chemical and food industries through hospital employees, mining and marine transportation.

Each contest has its own rules, but the basic principles are the same. Contestants submit simple monthly reports on precoded punched cards, entering total employee manhours worked and disabling injuries. With increasingly sophisticated computers, the data is readily tabulated and monthly bulletins are produced showing competitive standings, based on injury frequency rates. Members compete against other units of similar operations and size. Award recognition is received by winners at the end of the contest year.

Another program is the Award Plan for Recognizing Good Industrial Safety Records. Unlike the contests, this plan is noncompetitive. Based on statistical techniques similar to those used in quality control, the injury frequency and severity rates of member records are evaluated against their own prior performance and that of their specific industry classification. Units meeting high standards qualify for one of four levels of award recognition. These awards are highly coveted.

Recognition is available annually and for certain interim no-disabling-injury records. More than 8,600 units were evaluated in the past year. Less than one out of twenty qualified for the Award of Honor, the highest level of Council recognition. The figure would be even less, but many units apply only if they believe their records may qualify.

Contests and awards are only one tool in the total safety program, but participation is a proven technique in stimulating and sustaining interest in accident prevention, as evidenced by the thousands of participants.

EVALUATING STATISTICS

By MARIE SCOTTI
Manager, Communication Services & Division Safety Coordinator,
Maxwell House Div., General Foods Corp., Hoboken, N.J.

We live in an age of numbers. The flashing lights and spinning discs of computers have provided a flood of statistical facts and fancy the extent of which is near the incomprehensible. Yet, to us as safety professionals and communicators, it has meant a wealth of material to buttress our task of interpretation and persuasion. The staggering profusion of data has also meant new demands on our skill in handling the evaluation and editorial aspects of the topic.

Let's examine the negative side first—the side of Disraeli, who said, "There are three kinds of lies: lies, damned lies, and statistics," and of Carlyle, who wrote, "You may prove anything with numbers."

Statistics are dangerous because they are so pliable. They are not living things; they

are only numbers that must be interpreted by living things. Consequently, the statistics may be correct, the conclusions quite false. Or the semantics may be biased. An explanation of a price increase to consumers, for example, sounds a little more palatable as three tenths of a cent a pound rather than six dollars a ton, even though both figures are correct.

All we can do in this fertile field for deception is to strive to the best of our ability to present statistical information as validly as possible. We must ask ourselves a number of questions about statistical data: Who says it is true? How do they know? Has the research been adequate? Are any important figures missing? Do the findings make sense? Are the results worthwhile and significant to the reader?

The primary source of statistics is one's own organization or one's own efforts, but there are a profusion of other sources: the National Safety Council, U.S. government agencies, trade associations, business and research organizations such as Dun & Bradstreet, the National Industrial Conference Board, the United Nations, and many others. Assuming then, that your data is as valid as it can be and bias has been reduced to an acceptable minimum and the information is worthwhile, you still face the problem of evaluation and presentation.

Statistics are facts that must be used to sell a safety program to top management. If they reveal efficiency, the selling point is that the safety program is needed to maintain that efficiency. If deficiencies are revealed, the need of a stimulated safety program to eliminate them is indicated.

We must keep top management informed with facts. Tangible information — ammunition — can be found in the intelligent use of statistics, for statistics reveal that accidents are inefficiencies. Top management people, having many reports to review and digest, welcome statistics that are concise and can be readily studied and understood. To be most palatable and easily digested, these statistics should reveal trends.

Accident Facts, an annual booklet published by the National Safety Council has proved to be an invaluable reference to me. In the 1968 issue of *Accident Facts* we read: "For those who have compiled this book, men do not exist as columns of numbers, neatly tabulated on a page, but as valuable individuals whose lives are worthy of intensive research efforts. This perception of man embodies a commitment to insure his safety — a commitment that must extend beyond the pages of a book. For *Accident Facts* depends upon the wisdom of men to interpret the numbers. As a product of man's ability and desire to communicate, *Accident Facts* would be a failure if it did not encourage more men to 'speak up for safety'."

This publication estimates the total cost of accidents for United States in 1968 at $22,700,000,000. The total is made up of about one-half direct or visible costs of accidents and about one-half of other or less visible costs of accidents.

Accidents are a direct drain on profits. The cost is wholly unnecessary to the production of any product, including coffee. Accidents are an evidence of inefficiency and failure on the part of someone or something, whether it was the injured employee, his fellow employee, his supervisors, the management, or the equipment manufacturer. Someone or something failed. Accidents are important to cost cutting and to profit development because, unlike many other costs of doing business, they can be reduced or at least prevented from climbing; and they are unique in this respect.

Take a look at your costs of doing business, costs of product, the costs of new equipment and machines, the costs of labor. How many of these show any promise of cost reduction except as you may be able to introduce labor-saving devices, resulting in decreased numbers of people? We know in our own company, and you know in yours, that through progressive safety programs and safety measures they can be reduced if not entirely eliminated.

The emphasis on costs and profits as related to safety is in no way intended to minimize the humanitarian aspects of accident prevention. This is still our most important consideration — the protection of life and limb, the elimination of pain and human suffering.

Although I use National Safety Council frequency figures as a measure of our accident experience and comparison with others in the food industry, we, in the field of safety engineering, know that this measure by itself can be misleading, even deceiving.

In our opinion, the important thing is not only to demonstrate a lot of frequency and severity figures to management, but to translate these into dollars — dollars for each year in total, and dollars per accident, using methods traditionally acceptable in the field with which we are familiar. Accidents are an important detail of any business. They cannot be ignored.

Of course, we at Maxwell House and in General Foods still compute frequency and severity rates, because they still are necessary for reporting to the National Safety Council, the Bureau of Labor Statistics and other governmental agencies. Frequency rates and severity rates do not reflect accident costs.

The Maxwell House safety record for the year 1968 was not very good. The Division experienced an increase in lost-time injuries as well as all-type injuries. There was a total of 24 lost-time injuries. This total is higher than that for the three years immediately preceding 1968. The Division had 14 disabling injuries in 1967; 20 in 1966; 18 in 1965. There were 1,898 all-type injuries for year 1968. For the three years preceding; 1,170 in 1967; 1,227 in 1966; 1,359 in 1965. On the negative side, too, for the first time in its history, the Division suffered two fatalities.

On the bright side, the record shows that even though the number of lost-time injuries is high for year 1968, the frequency rate of 2.81 for the Division is better than the GF corporate rate of 3.36. On the bright side, too, was the safety performance of the Maxwell House Jacksonville Plant: the plant worked from September 27, 1961 to August 11, 1969 without a lost-time injury. The National Safety Council has awarded the Jacksonville Plant an Award of Honor for working 7,057,390 man hours without a lost-time injury. It far exceeds any other record in the food industry. The National Safety Council plaque furnishes evidence that Jacksonville did indeed accumulate an outstanding safety record — a record that will stand nationwide and in GF for many years to come. We at Maxwell House found the National Safety Council most helpful in verifying this record. Needless to say, we would not have had a reference on hand of what our competition was in the food industry.

Eight million dollars of Maxwell House sales were needed to pay for sickness and accident and medical costs for fiscal year 1968. Days lost from work caused a loss of 640,000 pounds of production in 1968. You may find this helpful in developing for your company a similar statistical report.

I look for each monthly issue of National Safety Council publications which contain accident facts and figures for both on and off the job during the year. These figures can always be utilized when comparing statistics of your own company with those of other companies nationally. I have always found the staff members of the Statistics Department of the National Safety Council very helpful and have used them as consultants on further refinement of Maxwell House figures. This can prove invaluable in trying to discover new ways of presenting accident facts and figures. Very few, if any, safety professionals identify themselves as statisticians. The National Safety Council does make available qualified statisticians as part of your Council membership.

Remember — all we can do in this fertile field is to strive to the best of our ability to make this statistical information as valid as possible. Make sure information is true and we know it to be so — that the research is good and there is nothing important missing and the findings do make sense. The results must be worthwhile and should be significant.

VALUE OF NSC AWARDS

By RICHARD W. PASCOE
Safety and Security Facilities Coordinator, Automotive Assembly Div.,
Ford Motor Co., Allen Park, Mich.

Since the Ford Motor Company has been a long-time active participant in the Award Plan for recognizing good industrial safety records, we were asked to present our thoughts and experiences. One should not brag about one's good record — which reminds me of the whale who must come up to the surface to spout off . . . and promptly gets harpooned! But here goes with our Ford experience, anyway.

Since the inception of the National Safety Council's "Awards Program" in 1951 for recognizing outstanding safety performance through December, 1968, we have won 1,788 awards. The Ford Motor Company, per se, has won 12 Awards of Honor and 4 Merit Awards. Of the total of 1,788, there have been 23 National Safety Council *best records* given to the Ford Motor Company locations. Currently, our Kansas City Assembly Plant has over 14,000,000 manhours without a disabling injury.

Let's talk briefly about some ideas of presenting the Award of Honor. Last spring, the Dearborn Assembly Plant established a new Division safety record. The Division General Manager presented the plaque to the Plant Manager in the Staff Executive Dining Room.

Another plant holds the presentation of the plaque until they have Open House or the display of new model vehicles for employees and their families. At this time, the news media, government officials, local mayors, councilmen, etc., are cordially invited to the affair. The top ranking government official in attendance makes the presentation.

Should a plant win an award, the plant manager writes a letter of congratulations to the management team (foremen on up), thanking them for a job well done. This letter can be accompanied by a small gift such as road flares, vacation pack, first-aid kit, etc.

For the Award of Merit, usually the Division Industrial Relations manager writes a letter to the Plant Industrial Relations manager congratulating him on his effort and urging him to continue the fine safety performance. Safety in our organization is part of the Industrial Relations Department. Everyone welcomes letters of congratulation for a job well done from their boss.

Some plants carry it even further. On a designated day they have free coffee and doughnuts for all employees involved.

Ford Motor Company finds the Awards Program to be an excellent one in which we have derived many benefits and we hope to compete with others in our trade for many years to come.

HOME STUDY COURSE IN MOTOR FLEET SAFETY SUPERVISION

By ROBERT PURCELL
Director, Fleet Safety Training Division
Motor Transportation Department, National Safety Council

August 1 marked the second birthday of NSC's Home Study Course in Motor Fleet Safety Supervision. In its two years of operation, this highly successful course has enrolled more than 1,600 students.

Developed over a period of years, the course has filled a long-standing training need for motor fleet supervisors in such industries and agencies as trucking, schools, transit, insurance, construction, chemical, oil,

baking, milk, the armed forces, all levels of government, police, utilities and the post office department. In addition to all 50 of the United States, students are located in such far off lands as Australia, Canada, Israel, Saudi Arabia, Luxembourg, Viet Nam, Ghana, the Canal Zone and Germany.

The home study course provides supervisors with a wide range of accident prevention information essential for safe—and more profitable—fleet operation. The broad scope of the course is evident in some of its subjects, such as: elements of a fleet safety program, special considerations of a small or scattered fleet, organizing fleet accident data, driver selection, training and supervision, garage safety, on-and off-the-job safety, vehicle maintenance, safety meetings and incentive programs.

The authoritative *Motor Fleet Safety Manual* is the basic study text for this course, and the study assignments consist of 12 lessons. The student is allowed one year in which to complete the course, although the recommended completion time is six months, or an average of two lessons per month. Upon graduation, the student receives two diplomas: one wallet-size and the other suitable for framing. As a rule, the diplomas are sent to the supervisor of the student, with a request that they be presented by him to the student. This practice has met with a favorable response from supervisors and students, because it keeps the supervisor informed of the student's progress and also offers him an opportunity to commend the student for his achievement.

An enrolled student receives all materials necessary for completing the course. These materials consist of the *Motor Fleet Safety Manual,* study guide, all 12 lessons with review questions, mailing envelopes, student correspondence forms and an evaluation form to be completed by the student upon graduation. The price of the course is $50, less the usual NSC member discounts.

Stated in broad terms, the objective of the course is to *teach* and *train* the student in safety, rather than to test his knowledge of safety. That is why there are no true-false questions in the course. Instead, the student is usually asked to answer multiple choice questions, with the correct answer directly before him. If he is not sure of the right answer, he is encouraged to refer to the *Motor Fleet Safety Manual.* No numerical scores are given, but ratings are expressed in terms of outstanding, excellent or good. If a student should answer an item incorrectly, the correct answer is provided, together with the exact page in the manual on which the correct answer can be found.

The value of this training course is shown by the experience of Consolidated Freightways, one of the largest trucking companies in the United States. This company encourages its supervisory employes to enroll in the course and reimburses an employe upon successful completion of the course. William M. Foley, director of safety for Consolidated, has expressed his opinion of the course in these words:

"This home study course is especially suited for busy people who wish to increase their knowledge and skills. The really nice feature is that the school comes to them; students receive individual attention and can work at their own pace, learning what they really need to know. I feel that the Motor Fleet Safety Supervision Course is especially useful, and I anticipate that more of our employes will avail themselves of the opportunity to enroll in it."

It is evident that an informed supervisor can be a key man in assuring the adoption of safety practices that will reduce accidents and increase profits for the safety-minded company.

In view of the outstanding success already achieved, there is no doubt that the home study course will be celebrating many more happy birthdays in the years ahead.

State Safety Programs

GETTING A NEW STATE PROGRAM GOING

By DON E. HOOVER
Director, Bureau of Safety and Regulation,
Michigan Department of Labor, Lansing, Mich.

Michigan's first inspection law was enacted in 1883. Provisions were made for wage payments; coal mine inspection; regulation of private employment bureaus; hair picking machines; boilers; ventilation of workshops; foundries; protection of women by preventing their employment in saloons and providing them with seats for certain types of work. This first law was replaced in 1909; the out-dated 1909 legislation was in effect until August 1, 1967. During this time Michigan's economy underwent a major shift from agriculture, lumber, and mining to mass production industries. Manufacturing employment increased 608 per cent between 1900 and the present. Industry expanded in both employment and production capacity.

All these changes affected the type of industry as well as the type of establishment. They also brought on major social problems in connection with industrial health, safety, industrial relations, vocational training, employment of women, child labor, seasonality of employment, and social insurance. The labor laws of this period failed to keep pace with these problems because they were based on an outdated economy, plus the fact that labor legislation was scattered among a dozen or more boards, bureaus, and commissions. Industrial safety inspections were limited, because for many years the inspection team numbered less than ten. In recognition of the seriousness of the problem, Governor Romney in 1966 named an Occupational Safety Study Task Force to study and suggest new and all-encompassing approaches for the attainment of occupational safety and a reduction in injury rates.

Members of the Task Force included representatives of various manufacturing operations, officials of organized labor, representatives of safety councils, trade associations, and the insurance industry. They, together with Department of Labor assistants, made an intensive study of the problems outlined in the governor's charge. Here is a summary of their recommendations:

1. The establishment within the Department of Labor's Bureau of Safety and Regulation of an Occupational Safety Board charged with the responsibility of considering and acting on the need for developing occupational safety regulations, standards, and codes in areas of occupational activity not covered by the rules of other state departments or agencies.

2. Establishment within the Department of Labor of a staff for safety education and training, whose duties should include the development of training programs for state safety inspectors, safety seminars for management and union leadership, and the development of safety bulletins, occupational safety programs, and other safety media.

3. The creation within the Department of Labor of a Bureau of Compliance and Appeals with authority to effect compliance with the safety regulations, standards, codes, and orders of the Bureau of Safety and Regulations and the authority to grant modifications.

4. The adoption of a uniform reporting system requiring mandatory reporting of disabling injuries.

5. The upgrading of key personnel of the Department of Labor to a professional status qualified to counsel with and to sell management and labor on their responsibilities in achieving occupational safety and educating all those concerned in effective safety methods.

6. Recognition of the principle that the improvement of occupational safety is a responsibility of the state rather than the Federal government.

The Task Force recommended that appropriate legislation be written to accom-

plish its recommendations. Through the coordinated efforts of Task Force members and the staff of the Department of Labor, proposed legislation was written and introduced and became Act 282 of the Public Acts of 1967. This is an example of one piece of legislation in which labor and management agreed. During the two years that this new Occupational Safety Commission has been working in the interest of safety, labor and management have worked together as a team. There has been almost complete accord in the promulgation of safety rules by both management and labor.

Some of the major provisions of this new occupational safety act are: an Occupational Safety Standards Commission; Board of Safety Compliance and Appeals; Safety Education and Training Division; Method of financing.

1. The Occupational Safety Standards Commission, consists of nine members chosen from management of principle industries, one of whom represents a company hiring less than 200 employees; three represent labor, with no more than one from any international union; two represent insurance organizations doing business in Michigan; and one is a member at large. The Director of Labor is an ex-officio member and serves as secretary. The governor appoints the members for three-year terms.

The Commission meets monthly to consider adoption of safety standards developed by seven-member advisory committees who are specialists in their field. Public hearings are held on each proposed standard in order to give the Commission the reaction of the public before making a final decision about a proposed standard. So far, the commission has promulgated standards for: use, care and protection of abrasive wheels; definitions; female hours of employment; floor and wall openings; and guarding of power transmissions. Several others are in the final stages: logging safety; industrial lift trucks; head protection and respiratory protection; fire prevention and protection; power presses; ladders and scaffolds; and fire extinguishers.

2. We also have a Board of Safety Compliance and Appeals, consisting of five members appointed for four-year terms. Two members are representatives of organized labor, two represent employer interests, and one is a member of a Michigan chapter of the American Society of Safety Engineers. This board conducts hearings to determine compliance or noncompliance with safety orders. After the hearing the board may: (a) dismiss the order; (b) modify the order; (c) extend the compliance date; or (d) issue a final order sustaining the safety order and direct compliance by a specified date.

Once again, I would point out the cooperation which exists between labor and management. Of approximately 6,000 safety orders issued, 220 failed to comply. These 220 companies were referred to the Board of Safety Compliance and Appeals for disposition. They were sent notices giving them ten days to comply or be scheduled to appear before the board. In only one case was it necessary for the department to ask for a court injunction against the employer. This in itself is an indication that management is willing to cooperate and improve safety conditions in places of employment.

3. The creation of a Safety Education and Training Division within the Bureau of Safety and Regulation. This division is composed of four sections: Safety Services; Education Services; Injury Analysis; and Communications.

The Safety Services Section develops statewide safety education and training programs to acquaint employers, supervisors, employees, and union leaders with the most modern and effective techniques of accident investigation and prevention. This is accomplished through safety director programs, management safety seminars, safety council programs, supervisors safety workshops, and union safety seminars. During this past year we have conducted 108 safety seminars and workshops involving 1,775 management personnel. These people represented a total of 355,000 employees.

The Safety Education Section develops and promotes safety in public schools. Emphasis is placed on the junior and senior high school industrial or vocational education program and the development of safety courses in colleges and universities. We reason that the introduction of good safety attitudes in the minds of our young people will help them to prevent accidents when they assume full time jobs. During the past year we conducted eighteen workshops for school administrators to acquaint them

with their responsibility for school safety, fifteen one-day seminars for industrial vocational education teachers, and ten in-service teacher training programs. The supervisor of this activity is an experienced teacher with a master's degree in education. He fulfilled fourteen speaking engagements to college and university classes. He initiated development of four college courses relating to education and assisted Lansing Community College in establishing a two-year associate degree program in safety. This is among the first two-year programs in the nation.

The Injury Analysis Section has developed a method of measuring industrial injury experience, applying the principles of USASI Standard Z16-1. As an interim measure, four high-frequency industries were surveyed, yielding a generous sample to test the measurement system. This survey was designed to collect frequency rates on a voluntary basis and to incorporate an injury audit function. Preliminary results indicated that the system had been properly designed and operated correctly in developing accurate frequency rates. Later phases of the developing will incorporate modified measures of severity as well as frequency.

The fourth section, Communications, publishes safety literature and prepares informational and instructional material for release to the news media. More than 130,000 pieces of safety literature were distributed this past year.

4. You may think, "This sounds good, but how do you finance such a big project as this?" An annual levy, based on the previous year's total annual workmen's compensation losses, excluding medical payments, is paid by all employers. The levy is ¾ of one per cent. Income received from this levy so far is: 1966—$451,000; 1967—$574,000; 1968—$700,000.

One serious misconception of many legislators and some government officials is that they expect immediate results upon the passage of legislation such as our safety law.

Those of us in the safety profession realize that there is much more to be concerned about than just seeing that physical hazards are eliminated. A large part of our job as safety professionals is to be concerned with the attitude of workers. This requires a continuing education and training program.

We still have a few problems to iron out, but we have made great progress. Our experience with this new act convinces us we are on the right track.

GATHERING AND DISSEMINATING WORK INJURY STATISTICS

By HENRY J. GMEINDER
Administrator, Statistical Div., State of Wisconsin Department of Industry, Labor, and Human Relations, Madison, Wis.

The State of Wisconsin Department of Industry, Labor, and Human Relations firmly believes that nothing of consequence can be conceived, initiated, achieved, and maintained without good records and statistics. What are our principal ongoing work injury statistics programs?

Workmen's Compensation Statistics

The most significant source of work injury statistics has been for almost sixty years the employers' first reports of injury or disease under the Workmen's Compensation Act of Wisconsin, and the supplementary reports on such cases.

Employers covered under our Act must make a first report of injury or disease on a prescribed form directly to the Workmen's Compensation Division of our Department on the fourth day after the employee leaves work due to injury or disease (if disability still continues), or sooner in case of death, permanent disability, or where more than three days of disability is certain to result. The first reports are scrutinized by four of our department divisions. The Workmen's Compensation Division is interested in the legal and administrative aspects; the Industrial Safety and Buildings Division in safety violations; our Statistical Division

in generating statistics; and the Labor Standards Division in child labor law violations.

The information that our statistical division gleans and stores through data processing includes:

1. *Employer Data:* Name and address; account number (we use the unemployment compensation number where UC-covered, and fabricate a number where not covered); insurance status (if the employer is insured, we use a code assigned to his insurance company, if he is self-insured, we assign a special code; if he is neither insured nor self-insured, we assign another special code); SIC industry code; report lag (number of calendar days elapsed between last day worked due to injury or disease and date of receipt of first report); whether this is a state employee case or not.

2. *Injured Employee Data:* Name and address; accident date; last day worked (how do you keypunch "No loss of time, just end of finger"?); source of injury (in one case this was reported as "A cow pinched him"); accident type ("he was down in the back from lifting"); kind of disability (entered after "Did death result: 'Heavens, no'"); nature of injury (condition always improved on weekends); part of body affected ("ingenious hernia"); birthdate; age ("she says 29"); sex (would you believe "yes"?); place of occurrence of injury ("punctured sitter"); occupation ("semi-frozen driver").

3. *Other Data:* Month reported; claim number (year reported plus assigned number).

Our coding of source of injury, accident type, nature of injury, and part of body affected is based generally on the concepts of Z16.2 (USA standard method of recording basic facts relating to the nature and occurrence of work injuries). Statistical data from these first reports are summarized in a special quarterly report. (This was done monthly until budgetary limitations necessitated the change.) The report is distributed only to those who specifically request it and have a specific use for it. This is determined by biennial mailing list surveys. Running records and data banks of significant information not printed in the quarterly report are also maintained for answering quickly and efficiently the many and varied inquiries directed to our statistical division. In addition to the above, the information generated from the first reports of injuries are used for the following:

1. "Middle 80" Program. A monthly data processing report identifies the ten employers in each of eight safety regions with the highest ratio of work injury cases reported to the number of persons employed. This ratio is computed on a moving average basis. Each month, safety specialists (of the Division of Industrial Safety and Buildings) discuss safety problems with these employers and help them set up safety programs.

2. Our statistical division provides our Risk Management Council (formerly called Injury Frequency Council) quality control charts on the number of work injury cases reported in each of the eight safety regions set up by the Division of Industrial Safety and Buildings. We also provide charts showing trends and related tables and analyses. The risk management council, formed to give impetus to accident prevention work, is comprised of the commissioner, the administrators of our department's industrial safety and buildings, workmen's compensation, administration and statistical divisions, and their representatives. The council's primary goal is to achieve full cooperation between our various divisions for the benefit of everyone concerned so that we may focus on significant problems much more effectively.

3. Each month, we provide listings and tabulations on reported work injuries of state employees to the State Safety Coordinator; information on work injuries to minors in agriculture (only those covered under our Act) to the Bureau of Labor Standards of the U. S. Department of Labor, a listing of City of Madison employee work injuries to the Risk Manager of Madison's Bureau of Finance.

4. A confidential quarterly report on selected occupational disease cases reported is prepared for our department's staff and that of the Department of Health and Social Services.

5. Data generated from the first reports of injuries provide the Wisconsin Council of Safety with an important source of decision-making tools. About two months ago, for example, we handed out and discussed various tabulations of reported injury

cases at a training seminar sponsored by the Wisconsin Council of Safety for officers of local safety councils. The reports showed the number of cases reported in 1968 for industry or trade groups in counties and selected cities covered by the local safety councils represented. We also prepared a distribution according to accident type patterns for the various counties. As an aid in pinpointing trade groups experiencing the highest incidence of reportable injury cases, we selected the three largest industry or trade groups (per number of injury cases reported) in each given city and county. Other related tables were also presented.

One offshoot of the first reports of injury is our promptness of first payment of compensation program. Upon receipt of an employer's first report of injury or disease, an informative letter is mailed to the injured worker explaining his rights under the Act, together with a post card to be returned by the employee. He is asked to correct the spelling of his name, if necessary; to indicate the date on which his first payment of compensation was received (or if none received, why); last day worked due to injury or disease; date of return to work; amount of wages or salary paid.

Annual and semi-annual reports based on these cards contain the record of each insurance company and self-insurer. The report is sent to all insurance companies licensed to write workmen's compensation insurance in Wisconsin and to all self-insurers. Officers of the companies with the poorest records have been called into the office of our commissioners to inquire as to their procedures and reasons for delay, with the objective of improving their performances.

We get some rare comments on these cards, too. In one case, the card fell into the employer's hand. He wrote to us: "Dear Sir—I don't know what this all about. This drunk is not injured that I know of. He is working for another contractor. He asked me many times to have himself fired or layed off. He missed many days of work and when he came back, said he was in no condition to be on the job. Because I wouldn't fire him, he quit. So that's all I know."

A second offshoot of the first reports is our accident-injury costing program. At the request of private industry in Wisconsin, an Accident-Injury Costing Advisory Committee was formed, composed of members from industry, labor, the Wisconsin Council of Safety, and representatives of various state government agencies. This committee was formed about two years ago to help develop a program to assist in determining the virtually unknown total costs to private industry and government of work injuries and accidents. We use a random sampling scheme based on the first reports of injuries. Employers are requested to provide us with costs incurred from the nonproductive time of the injured employee and other workers—costs which are not covered under the Act—and with property and product damage costs resulting from the accident. Our primary goal in this program is to prove, in terms of dollars and cents, that accident prevention is cheaper than accidents. That sounds quite simple, but, of course, it isn't.

The three key reasons for involving the state at the macro (state) level are:

1. No single agency or group, other than the state, receives accident-injury information of the nature that we receive. The state can best provide overall direction and coordination of effort.

2. No single agency (private as well as public) could glean sufficient costing reports to establish statistics (summary figures) and parameters. A very wide range of industries, occupations, accident types, etc. are required for this task.

3. The important technique of determining accident and injury probabilities with respect to specific accident type, source of injury, body part affected, etc. can more effectively be undertaken only when large aggregates of data are gathered on a random basis. Cost probabilities can also be associated with accident and injury probabilities.

Our initial sampling phase is expected to be terminated at the end of this year. Our approach, thus far, has been to compile data for determining cost parameters for accidents and exposures causing injury or disease only because our ongoing workmen's compensation statistics program lends itself to our present costing system. An even more significant contribution to total loss control or risk management would be in

costing no-injury accidents and losses in accidents with no visible damage.

It is hoped that this costing program will spur businessmen to build accident cost categories into their cost accounting systems to assess management control.

Self-insured[b] employers and insurance companies (on behalf of their assured) must file various supplementary reports with our department's Workmen's Compensation Division on all injury and disease claims which require a first report. After the necessary reports are in and the cases are closed, our Statistical Division assigns codes for the following information (and makes necessary revisions of codes previously assigned when the case was first reported): (1) the specific kind of disability—fatal, permanent total, permanent partial (six categories) or temporary disability; (2) the number of days, counting six days to the week, for which indemnity (compensation) was due or payable; (3) the number of days, counting six days to the week, of actual time lost due to injury or disease (healing period); (4) dependency, in fatal cases; (5) month and year closed; (6) wage of injured employee; (7) disposition of case (compensable, compromise, noncompensable); (8) manner and basis of closing case; (9) in formal cases, time taken to close the case; (10) in certain permanent partial disability cases, per cent loss of use of body member or organ; (11) a special code in penalty cases—there are three main types of penalties: (a) 15 per cent increase or decrease in indemnity because of violation of safety rules or statutes; (b) double or treble indemnity for violation of the child labor law; (c) 10 per cent penalty for inexcusable delay in payment of compensation. We maintain an auxiliary 3x5 card file on all penalty cases due to limited computer capacity (ah, there, budget!); (12) in reopened cases, additional information is coded.

Annual reports are published on the above data, showing amount of indemnity and medical aid paid. The number of cross tabulations and classifications that can be prepared from these data are innumerable. Examples are: source and accident type; kind of disability; nature of injury; part of body; occupational disease; industry within county or safety region; penalty cases; formal hearings and insurance status. Special studies are prepared for industry and trade groups, on request. For instance, we have made a statistical report to the safety meetings of the Wisconsin Canners and Freezers Association every year since 1946.

Virtually the same users of our first report data ask for settled cast data. In addition, our department safety seminars use special studies on industry and trade groups. The University of Wisconsin uses several of our annual releases as part of their course work. An offshoot of settled case data is the compilation of data on payments made into and out of an additional death benefit fund for children and a second injuries indemnity fund. We have also made special studies such as amount of attorney's fees paid in permanent total disability cases, which required our digging a little deeper into the files of the Workmen's Compensation Division. None of the above would be possible without the close cooperation granted us by the Workmen's Compensation Division.

Work Injuries Cooperative Survey

Our second major work injury statistics program is carried out in cooperation with the Division of Industrial Safety, Bureau of Labor Statistics, United States Department of Labor. Under this cooperative program, information is collected to determine the frequency and severity of work injuries in Wisconsin on the basis of the USA Standard Z16.1. This is an annual cooperative survey; reporting is voluntary. The requested information furnishes both the State of Wisconsin and the U. S. Department of Labor with data needed for compiling state and national standard injury rate summaries. (Close to twenty states have similar cooperative programs with the U. S. Department of Labor.) Wisconsin employers are asked for the following information, for a given year: (1) average number of employees and total hours worked by the employees; (2) nature of business; and (3) number of disabling work injuries incurred (loss of one full calendar day or more, due to injury or disease) by classification, and the corresponding number of calendar days lost or charged.

The methods of classifying work injuries in accordance with the USA Standard method of recording work injury experience are independent of workmen's compensation

laws and rulings of workmen's compensation agencies. Injury rates compiled in accordance with this standard allow comparisons within identical industries; with other industries; with other employers; by size of employer; by location of establishment; between states; with national summaries; with the experience of employers affiliated with various safety councils, trade associations, etc. Incidentally, members of our Wisconsin Council of Safety generally have lower injury frequency rates than nonmembers; the 1969 edition of *Accident Facts* makes the same statement for members of the National Safety Council.

I am aware that Z16.1 has been under fire during the past few years. However, I know of no standard that can take its place for state and national summaries as yet. There is much demand for data that can be compared with other data. I repeat that, unfortunately, workmen's compensation data can not be used to offer comparisons with national data or data from other states. This was brought home to me forcefully in my works on the IAIABC Statistics Committee.

Our top ten program draws data both from our closed workmen's compensation statistics and from the work injury cooperative survey, as well as from other sources. Periodically, for the state as a whole or within selected industry groups, ten employers are asked to come to the Industrial Safety and Buildings Division's main office for consultation. This program was initiated as a management approach of having top safety management talk with the top managers of companies in Wisconsin that are having unusually high injury frequency rates and unusually high settled case incidence and cost ratios per employee. The primary goal of this program is to get a commitment from top management to institute a meaningful safety program. Our injury rate and workmen's compensation settled case statistics form the backbone for this Industrial Safety and Buildings Division's management tool.

Deputy Reports. To further sharpen the decision-making tools of that division, and also to improve activity feedback by its deputies for administrative purposes, a statistical compilation system of significant data (by means of a new deputy report log sheet) was launched as of the first of this year. In addition to serving as a daily log sheet for each safety deputy and as a vehicle for generating administrative statistics, the new form is intended to serve as an essential tool for feeding back information needed in planning safety programs, for setting up methods of study to allow objective conclusions, and for measuring the effectiveness of various safety programs. Some of the items on this daily log sheet are: location—where the activity or call took place; name of the deputy and section of the division for which he works; the day and week the given action took place; the owner, firm, or employer visited or whose facilities were inspected; type of call or meeting—inspection, reinspection, "Middle 80" call, accident investigation, conference, interview, hearing, complaint, safety seminar, educative, consultive, etc.; nature of business of employer; whether employer has regular safety program; number of violations found, if any; number of units inspected; Wisconsin administrative code involved; and fee, if any.

Each month, the Industrial Safety and Buildings Division reviews and analyzes a detailed data processing printout of the information generated during the most recent month. The information is broken down by district, region, etc. Dovetailing information generated from these deputy reports with data generated under the other work injury statistics programs described earlier will provide a way for determining the significance of various accident- reducing programs and a vehicle for preparing useful decision-making tools for optimal allocation of funds, resources, and activities.

Users of Our Work Injury Statistics. I have already mentioned many of the users in connection with our various programs. Many users request data encompassing all of them. Some make requests only for specialized data.

Our commissioners, division administrators, and their attorney and engineering staffs give many speeches and lectures and conduct safety seminars. Our statistics are used as a base for many of these.

We, ourselves, use our own data in many ways. For example, we examine the records of our self-insurers and those applying to self-insure to determine whether these data,

in conjunction with their financial statements, justify their being self-insured. Our first concern, of course, is for the employees of the self-insurer or would-be-self-insurer. It is our responsibility—and it is a heavy one—to determine whether a given employer will be able now and in the future to fulfill his obligations under the Workmen's Compensation Act of Wisconsin.

We answer requests from such diverse places as the governor's office, the legislature, University of Wisconsin, Department of Health and Social Services, various U. S. government agencies, Wisconsin Compensation Rating Bureau, safety councils, various advisory committees, trade associations, hospitals, individuals—almost every group conceivable. We answer as many requests as possible.

Not the least of the usage of our statistics is that for budget planning and presentation; for justifying requests for more personnel and equipment; for defending current programs; for curtailing or dropping programs that are no longer useful. Thus, our work injury statistics are often used administratively, as a measure of accomplishment, ineffectiveness, or failure.

In our experience, we have found a few in the safety movement who do not appreciate the dissemination of significant information, especially where the data reflect less than perfect performance. One would be less than objective, however, if only good news were published. "Managed" statistics are useless; only honest analysis of the good and bad—and in-between—can lead to desired action.

Summary

Our accident-injury costing objective of preserving labor and capital as basic resources really applies to the whole field of accident prevention. Human resources are by far the most important since capital formation and natural resource development are dependent upon people. Accidents and injuries weaken the capital structure not only of the individual firm but of the entire state as well.

Gathering and disseminating work injury statistics are as important to the safety movement as check stubs and cancelled check statements are to our checking accounts. We may not like to keep them straight or look at what they show but keep them and look at them, we must!

Because of limitations of staff and budget, our division must restrict and channel expenditure of time, personnel, and equipment to the collection and analysis of only those statistics which improve the service and advance the programs of the State of Wisconsin Department of Industry, Labor, and Human Relations. A committee of management and labor, formed to evaluate the programs of our Statistical Division toward a goal of collection and analysis of those statistics which could significantly add to the effectiveness of state service, pointed out to us that all reports must be evaluated within our division on the bases of purpose and effectiveness. It was their opinion that once purpose is clearly defined, effectiveness will follow. They said we must be prepared to question the purpose of current programs and requests for any additional programs, whether periodical or special, and suggested the following guidelines in such examination:

1. Is the purpose of the report to supply data to the Department of Industry, Labor, and Human Relations for *internal* use in enforcing statutory requirements, planning Department programs, determining trends in Department activities, or comparing with the work of federal agencies, private and professional associations, and similar commissions in other states?

2. Is the purpose of the report to supply data to the department for *external* use in educating the public and specific groups in department activities or stimulatng and guiding the activities of affected groups?

The committee said that the content of all reports must be designed to effectuate their specific purpose. I think these are good guidelines for all similar programs.

You will find similarities and differences in the way injury statistics are gathered and disseminated in Wisconsin as compared with other states and organizations; in the way decision-making tools are developed and used; in the types of analytical categories generated; in the sampling and nonsampling schemes used; in the goals and objectives set forth; in the structure and usage of advisory committees; in the distribution techniques employed. But underneath it all is our common purpose of triggering action which will result in reducing accidents, injuries, and disease.

The Changing Role of the Safety Professional

THE NEED FOR CERTIFICATION OF THE SAFETY PROFESSIONAL

By G. L. GORBELL
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The decade of the 60's, now drawing to a close, will long be remembered by those in the safety field as the period which marshalled in what could almost be called "the renaissance of professional safety." The bringing to fruition, through the diligence of many dedicated safety practitioners under the aegis of the American Society of Safety Engineers, the dreams and plans which have culminated in establishing the safety professional's place in the sun!

Although it was the subject of frequent discussions and considerable thinking for many years, it was 1963 before the ASSE conceived a logical approach to identifying the type of work safety personnel should be doing, and to establish a plan for their growth and development which would give them legitimate claim in the eyes of management and the public, as practitioners of professional standing. The plan was called the Professional Development Project. It was decided that the project be undertaken in three distinct phases, separate in subject but interrelated in purpose.

Phase I was directed to outlining the scope and functions of the professional safety position in an attempt to precipitate out of a mass of variable position titles and varying functions a common denominator which would best delineate the safety professional's job. This was no mean task and the committee assigned to it labored long and arduously to complete their objective. The conclusions of the committee were published in December 1966 by the ASSE in a four-page report entitled "Scope and Functions of the Professional Safety Position." Briefly, it identifies four major areas comprising the principal functions of the saftey professional and furnishes a comprehensive analysis of each area. The areas are:

1. Identification and appraisal of accident and loss producing conditions and practices and evaluation of the severity of the accident problem.

2. Development of accident prevention and loss control methods, procedures, and programs.

3. Communication of accident and loss control information to those directly involved.

4. Measurement and evaluation of the effectiveness of the accident and loss control system and the modifications needed to achieve optimum results.

Phase II of the Professional Development Project inyolved the study of current educational opportunities in safety and the development of a curriculum guide for a Bachelor of Science Degree in Occupational Safety. Although Phase II has not been completed, it is very close to the final wrap-up. The committee assigned to this phase conducted a survey which contacted 1,250 four-year colleges and universities in the United States and Canada, requesting information on degree programs and courses. It was found that 1,012 courses in Safety and related fields are offered by 280 institutions. Undergraduate (four year) degrees are offered by five institutions (two degrees in Industrial Safety, one in Safety Management, and two in Fire Protection Engineering). Graduate degrees are offered by 14 institutions, and 196 institutions have no courses in safety. The ASSE published this survey in July 1969 as a "Status Report—Educational Opportunities." It is a most interesting reference source for those who desire information on the institutions and available courses listed in the following categories: Industrial Safety/Industrial Accident Prevention, Safety Engineering,

Safety Management/Administration, Safety Education, General Safety, Accident Prevention, Driver Safety/Traffic Safety, Fire Protection, and Industrial Hygiene/Health & Environmental Health.

The growing list of institutions now offering or actually planning undergraduate degree opportunities not only reflects the institutional interest but also presents a challenge to every safety professional to continually advance his knowledge and capabilities. Further, it will raise the level of competence in the safety profession and enhance possibilities of the eventual adoption by the states of legal registration for the safety professional.

The Phase II committee has recently published a *Curriculum Guide for a Bachelor of Science Degree in Occupational Safety*, which presents recommendations concerning the development of an educational program to provide the unique and diversified knowledge which will be required if future safety professionals are to meet the challenges of tomorrow, so apparently Phase II is just about complete.

We now come to Phase III, which concerns registration or certification of the safety professional. Actually, preliminary research was done on this project in 1960, three years before the adoption of the Professional Development Project. A special study was initiated to secure and analyze requirements for registration in 50 states. It was found that most state laws require graduation from an accredited engineering curriculum, followed by approximately four years of responsible engineering experience, plus the successful completion of an oral and/or written examination. Most state laws, however, permit the substitution of practical experience for formal education.

It was the conclusion of the Phase III committee that legal registration was out of the question at this time since it would require specific legislation in each state for universal effectiveness. Also, in order to gain the recognition of the states, it would be necessary to have well-defined and accepted university curricula for individuals to become educated in this specialization. It was felt that the alternative, which could be a base from which to work for eventual legal registration, was the formation of a special corporation whose functions would be to determine the individual's qualifications by either written or oral examination, then issuing some identification that would indicate that requirements have been met.

In October 1968, the Executive Committee of the ASSE decided to go ahead with a certification program, so an initial Board of Directors of the Board of Certified Safety Professionals, comprising nine persons, was appointed to draft by-laws, secure a charter for incorporation, prepare requisites for certification, application forms, examinations, etc. Early in 1970 the Board will be ready to accept applications.

Let us examine the values associated with certification—its immediate and future effects on the safety profession, the practitioners, industry, and the public.

What will certification do for the safety profession, assuming that the certification system is accepted as a valid, reliable means for attesting the qualifications and competence of an individual to be designated a safety professional?

1. It should raise the general level of competence in the profession by encouraging those who may lack the necessary qualifications for certification to persevere in the improvement of their knowledge, skills, and capabilities to meet the requisites for certification.

2. The certified safety professional will be recognized as one who has demonstrated initiative, drive, and determination by his voluntary subjection to the examination of his knowledge and abilities as a safety practitioner. His opportunities to advance in the field will be enhanced because prospective employers will recognize his CSP as a stamp of approval; indicative of a high degree of competence. One does not have to be a seer to predict with confidence that the 70's and years beyond will open new and greater horizons for the qualified safety professional. The tremendous increase in scientific knowledge and technological advancement in all aspects of industry, government, and transportation introduce complexities in safety which will require the professional trained to utilize scientific principles and methods to achieve adequate results.

Imminent, and undoubtedly inevitable, Federal legislation in occupational safety and health, mining, transportation, the recently passed Construction Safety Act, the High-

way Safety Act, air and stream pollution acts and the increasing interest in product safety as evidenced by the formation by the government of a National Commission for Consumer Safety are bound to demand the services of thousands of safety and health professionals. Those with certifications in their professions will be barraged with offers from the Federal and state agencies which are woefully undermanned, and also industry, which will be required by law to improve its safety and health programs to meet government standards. The ASSE conducted a survey in 1968 of large industrial employers to determine the need for professional safety personnel in the coming years. The total needs were estimated as close to 1,000 safety professionals annually. It is estimated that the combined needs of the Federal and state governments will be about 12,000 professionals to cope with the inspection needs if all of the legislation now pending becomes law.

3. As the number of certified safety professionals grows and the educational institutions observe the expanding needs of government and industry for qualified professionals, they are certain to establish curricula in occupational safety. Eventually, the states will recognize the safety profession as one which merits legal registration based on the fact that accredited curricula will be available in our colleges and universities.

It may be of interest to know that planning, designing, and changing processes wherein the safeguarding of life, health, or property is concerned is presently designated as "Professional Engineering" by the laws in New York State and other states. "Safety Engineers" are presently licensed as such by 12 states.

4. Certification is a morale builder bringing justifiable pride to the individual who has proven his competence in the field of safety by his ability to meet the requirements for certification as a safety professional. His professional designation will identify him with his work and encourage him to assume full responsibility for the quality of his work.

5. Certification will promote high standards of professional conduct and ethical practices. It will foster top quality job performance and integrity.

6. If an individual has the drive and ambition which motivates him voluntarily to seek certification, is it not logical that management will furnish him an opportunity to demonstrate this quality of determination in the performance of responsible tasks?

Summary

Over the past 50 years, the safety profession has had a long, hard pull to attain its present tenuous status in the professional community. It is poised on the threshold of opportunity to take a significant step toward acceptance as a peer among professions. In the 60's, the safety profession has achieved objectives, through a planned approach by the American Society of Safety Engineers, designed to define the scope and functions of the professional safety position, developed courses and curricula for use by educational institutions in considering the establishment of a Bachelor of Science Degree in Occupational Safety and, as the last phase in its Professional Development Project, it was instrumental in creating a special corporation whose functions are to determine an individual's qualifications by education, experience, and examinations for designation as a certified safety professional.

The benefits of certification of the safety professional to the practitioner, the profession, the employer, and the public are obvious. The evidence of competency in safety furnished by certification will improve the individual, raise the general level of competency in the safety profession, promote high standards of professional conduct, assure management that it will receive top quality job performance, and last, but definitely not least, it will enhance the safety profession's chance to take its rightful place in the sun!

HAZARDS IN CONTEXT

By ERNEST LEVENS
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One element in the social revolution of the 1960's has been an accelerating public awareness of "spaceship earth" as a closed ecological system, coupled with a deep concern about the "quality of human existence." That awareness and concern are being expressed in a flood of legislation and regulations redefining the levels of risk deemed acceptable to society. The decision, then, as to the acceptability of risk is increasingly a social decision, based on our changing value system and imposed on the individual or a group. Meeting these risk limits, within the constraints further imposed by available technology and economic resources, is the challenge faced by the safety professional.

The big question is: Can we meet these more and more stringent risk levels using only the conventional tools of the past 50 years? I believe we can but only to the extent that the problem to be solved is a conventional problem. While I deeply regret that legislation has been felt necessary in certain areas to overcome failures to act voluntarily, I expect that conventional methods will bring a measurable, national improvement in safety performance because results will be audited against uniform standards.

But I also believe we will soon reach a new performance plateau because our conventional methods suffer from several serious limitations:

1. The first step in achieving a pre-determined acceptable level of risk (whatever that level may be) is to identify the hazards which, if not eliminated or controlled, could result in failure. In this sense, risk can be considered the probability that failure will occur.

Recognition of hazards is highly dependent on the experience and skill of the individual analyst. The information available to him, whether it is acquired personally or from the recorded experience of others, must provide him with enough insight into the accident potential of a given situation to be useful in predicting that there is some level of risk associated with that particular activity. At its best, hazard recognition based on experience is practiced as an intuitive art in the hands of the skilled safety professional, a skill of limited availability. This presents a problem to management, since the quality of the analyst's work and his frequently obscure thought process are not independently monitorable, short of having them checked in stepwise detail by someone of at least equal capability.

2. A graphic form for showing the thought process involved in a hazard analysis has not been available. Such a formalized visual aid would be valuable as a tool for understanding an operation, for communicating the results, and for deciding on trade-offs.

3. A seat-of-the-pants weighting or criticality scale is sometimes applied to the consequences of failure, so that we rate a risk as, perhaps, "high," "moderate," or "low." On this basis, we are apt confidently to talk about taking a calculated risk when it would be far more accurate to recognize that only a rough qualitative assessment has been made. The fact is that, in the absence of a mathematical model, the conventional hazard analysis cannot be quantified. If the analysis could be quantified, then we could evaluate the relative safety of alternative designs or procedures as a tool for management decision-making in accepting or rejecting a given risk.

4. The conventional analytical method is reasonably successful in identifying fairly simple, familiar, sequential combinations of hazardous events taken one or two at a time. But the method is not as effective as we might wish on new hazard combinations in state of the art situations for which no experience (i.e., hindsight) is yet available, or in dealing with complex or parallel events. The unfamiliar is likely to remain undiscovered, unevaluated, and uncorrected in the absence of a formal analytical technique for revealing its presence.

5. The lack of a unifying concept for hazard recognition requires the analyst to commit to memory, or search for, the pos-

sible outcomes of thousands of apparently unrelated combinations of situations. The very words we use in hazard analysis tend to constrict the ability of the analyst to see and integrate hazards. This limitation is especially hard on the novice analyst until he acquires the intuitive skills of the experienced safety professional.

6. We should not overlook the persistence in our culture of a folklore and mythology about hazards and accident causation. The word "hazard' is derived from an old game of chance played with dice. The same sense of chance, unexpectedness, or unforeseeability can still be seen in commonly held attitudes about accidents; safety professionals are by no means exempt from their cultural heritage. As a result of the influence of culture and language, there is a strong undercurrent (even if subconscious) of feeling that accident causation is somehow involved with uncontrollable, even malevolent, forces in nature, about which we can do very little. Thus, we commonly talk about acts of God, one's number being up, the breaks of the game. This fatalism may play a strong role in failure to take simple precautions to identify and neutralize hazards, as well as in hero-worship of the chance-takers, the defiers of fate.

The thought process involved in the conventional type of hazard identification exercise goes something like this (greatly simplified, of course): if the guard is left off this in-running nip point and if an employe is working on the machine and if he somehow gets his fingers in the nip, then he will be seriously injured; the nip point is labeled a "hazard" or, perhaps, a "potential hazard." Or we may think: if this alkali metal perchlorate is contaminated by a spill of lube oil and if sufficient energy is somehow applied to initiate a redox reaction, there will probably be an explosion; the strong oxidizer is labeled a "hazardous substance." In other words, of all the contributing events in a particular dynamic sequence which together generate a specified *outcome:*

$$\text{If } A \xrightarrow[\text{by}]{\text{followed}} B \xrightarrow[\text{by}]{\text{followed}} C \xrightarrow{\text{then}} D$$

the one perceived as the pivotal event (*A* or *B* or *C*) is tagged "hazard." Which event is seen as the pivotal one may become the subject of disagreement, although it is often the one immediately preceding the end result. What we usually do, then, as a convenient oversimplification, is mentally to compress a whole sequence of events (a process) into a single event, then name the single event as though it were an object or thing.

A mechanical analogy is the repeated folding of a long, narrow strip of paper until it is in the form of a small pellet; the original strip can be recovered undamaged (except for the creases) by unfolding. This type of mental condensation ordinarily poses no conceptual or practical problems when, for example, we consider a chair simply as an object, neglecting the unending processes of change within the wood, metal, and fabric of which the chair is made. But relying for support on an antique chair partly disemboweled by moths, termites, and dry rot can have unwanted consequences which a broader awareness at the event or process level might have prevented. In still other situations, the major events of immediate concern may not be found at the macroscopic level, but be occurring at the microscopic, molecular, atomic, or even subatomic levels.

The idea that a distinction must be made between dynamic "events" and static "things" is of such fundamental importance in hazard recognition as to justify further exploration of the concept. Scientists infer that what is going on in the universe consists only of electromagnetic events. At this level, there are no qualities and no things—no color, taste, shape, or sound. What we perceive directly by way of our senses represents a first order of abstraction from what is going on. From these limited sensory experiences, we construct conceptual models of atomic structure and act as though the universe has this structure; we project our sensations onto the outer world. Giving our perceptions labels (i.e., names) represents a still higher level of abstraction. As we move from the lowest verbal level of description, factual statement and naming, into successively higher levels of abstraction, we move further and further away from direct sensory experience. The patterns of linguistic usage tend to lead us to confuse these different levels of abstraction; we act as though inferences were facts or as if words were things.

The point is that categories, classes, laws of nature, and the like are higher-order abstractions invented — not discovered — by man; they do not exist out there. We can put an individual thing into as many categories as we please; none is more real than another. When we ask "What is it really?" we mean, "What do we call it?" The value in being able to invent new categories freely will be discussed later. A limitation on our freedom, of course, is that some agreement about the categories selected is necessary for communication; if my "dog" equals your "horse," we will have a problem unless we can both see and point to the same animal. The further we get from shared sensory experiences, the more difficult becomes the process of communication.

It will not do very much harm to continue the comfortable short-cut of thing-ifying, provided, in analyzing hazards, we keep constantly in mind that the things we attach names to are actually in a state of dynamic equilibrium rather than static. What we are concerned with are stresses which cause changes that exceed the expected limits of variability and thus upset an accustomed or controlled equilibrium. These are variables of frequency, duration, amplitude, sequence, and polarity, for example. Thus, we should be thinking of hazards in terms of events, states, or conditions, rather than as things or objects; and we should look for stresses generating non-tolerable changes that upset an equilibrium and result in some undesired consequences.

If we want to describe an event fully, we also have to locate it in both space and time. The Golden Gate Bridge in 1968 is not the same as the Golden Gate Bridge in 1958; nor is John Doe driving to work on Monday morning after a big weekend the same as the John Doe that left for home on Friday afternoon. When and where are as important as what. It is also necessary to recognize that every event has associated with it a certain probability that it will occur within some particular time span. The net probability of the individual probabilities in a sequence of hazardous events represents the risk of failure. We are undoubtedly in agreement that we cannot reasonably expect a zero probability of failure. The concept of absolute safety is thus not very useful, and we will do better to think of reducing risks to an acceptably low level.

Occasionally, we are able to visualize all the possible outcomes of some simple physical process (e.g., the toss of a coin or a die) and from this readily conclude that, if the process is unbiased and if we repeat it enough times, the probability of a specified outcome is 1 in 2, or 1 in 6. It is not necessary, of course, to toss a real coin to discover the possible outcomes of tossing one. We can itemize the possible outcomes (in relation to some specific question we have in mind) by simply imagining that a coin has been tossed. The experiment, then, is a purely conceptual one for which we have selected the sample space. We have analyzed a *model* of an event of interest; i.e., tossing a coin. In the real world, of course, coins are not weighted precisely the same on both sides, and the relative frequency with which heads appear may prove to be 0.476047 instead of 0.50000. It is vitally important that models and reality not be confused with one another.

The complexity of most events is so great that we cannot deduce any theoretical probabilities of occurrence simply by analysis of a conceptual model. We are forced to wait until a large enough sample has been studied, or enough collective experience accumulated before an after-the-fact empirical probability can be assigned. What is often not realized is that, even though the probability of any single occurrence of a given event may be very small, with enough repetition the chance that it may happen at least once within some given period of time approaches certainty. To illustrate this point, consider the probability that at least one head will turn up on repeated, fair tosses of an unbiased coin (or on one toss of a number of coins). We can show the possible outcomes by listing in order the outcome for the first toss (or coin), the outcome for the second toss (or coin) and so on.

There are two possible outcomes for a single toss of one coin: heads (H) or tails (T). For two tosses of the coin (or one toss of two coins), there are four possible outcomes: HH, HT, TH, TT; the probability of each permutation is $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$. There are three permutations containing at least one head, so the probability of turning

up at least one head in two tosses is ¾. For three tosses the probability of each permutation (i.e., HHH, HHT, HTH, etc.) is ½ x ½ x ½ = ⅛, and the probability of at at least one head turning up is ⅞, since at least one head occurs in seven of the eight possible outcomes. For eight tosses, the probability of turning up at least one head becomes .255/256 or 0.9961. The duration of the event of interest, or how often it is repeated, is thus of critical importance. In fact, this exercise in statistics constitutes a demonstration of Murphy's First Law: If anything can possibly go wrong, it will.

Usually, we do not deal with coins or dice, but are confronted by extremely complex situations with largely unknown outcomes as well as unknown probabilities of occurrence. About the best we can do is concentrate on the relatively few events that, from experience, we know we would most prefer not to have happen; it seems easier to look for failure than for success. For these key, undesired outcomes we can, through test or personal durability, gradually acquire data on the relative frequency of occurrence. The frequency and severity rates for disabling work injuries fall into this category. The significance of these relative frequencies depends on the size of the sample.

In recent years, a great deal of effort has gone into determining the reliability of hardware items from tests and from maintenance and repair data (i.e., relative frequency of failure, and the outcome or failure mode). This effort is now being extended to the problem of human error, but the very limited information available is not immediately applicable to the industrial work-place. More useful data should be developed in the next few years. This lack of failure rates is not serious in industry, where the primary need is for a more powerful tool for qualitative analysis. In the design of military weapon systems, failure rates have been used successfully as a measure of the relative safety of the system; they have also been misused by imputing disproportionate importance to data of minimal statistical significance.

Based on the discussion to this point, we can broadly consider hazards to be any events we happen to be interested in because, in combination, they have some probability of resulting in an undesired outcome within a time-period of concern to us. In other words, we are looking for patterns of events in the particular context of accident prevention at some acceptable level of risk. But we still need to select the events of concern and decide how concerned we should be about them, given the context.

First, we can narrow our search by directing it only to those events (or conditions) which might cause injury or harm to people, damage to or loss of equipment or property, or interruption of work. If we can prevent those end results at a low probability of occurrence, then we can consider the activity to be safe.

Next, we can reduce our search to even more manageable proportions by limiting its scope to some defined boundaries. If we select the boundaries so that the elements included have some significant relationship to one another, then we have bounded a "system."

By way of definition, then, we can consider a system to be an orderly arrangement of components of elements which are interrelated and which act and interact to perform some specified task or function in a particular environment and within some particular time period. We can also treat safety as a measurable attribute of a system, provided we use an integrated approach to evaluating all the possible hazard interactions of the included elements, either singly or in combination; that is, for our purposes, facilities, equipment, procedures, and people.

For convenience in analysis, we can subdivide a system into an assemblage of subsystems, and these in turn, into components. An example of a system is the one for waking you up in the morning at a specified time. The system components (or subsystems in this case) consist of an alarm clock, you, and the environment. The clock must be in good working condition, but you must perform the essential operations of winding, setting the time, and activating the alarm mechanism. Failure of the alarm system can occur if the clock is affected by abnormal environmental conditions: heat, moisture, dust, corrosion, etc.

However, we can't be completely arbitrary in setting the boundaries of a system. A system cannot be understood simply in

terms of its individual elements or component parts. Every system has assigned objectives, a mission. If the operation of the system is to be effective, if the system is to accomplish its mission, then all of the parts (subsystems and components) must interact in a predictable and measurable manner within specific performance limits and operational and design constraints. Nevertheless, the bounding of a system, subsystem, or component depends upon the analyst's point of view. An automobile carburetor is a system to the carburetor manufacturer; it's a subsystem to a designer of systems which include the accelerator, fuel pump, etc.; and a component part for the automobile manufacturer. In an analysis, the definition of a component may thus vary between systems and even within a given system, depending on what is of interest at the time. This is the value in being free to invent categories or classifications, as I mentioned before.

There is an important precaution that should be emphasized here. Since the setting of boundaries for a system, subsystem, or component is largely a matter of convenience, or jurisdiction, or contract, we must not overlook the fact that accidents do not respect such boundaries. We must, therefore, be certain to inspect thoroughly the interfaces between system and subsystem boundaries so that we do not neglect some possible hazardous interactions of people, places, and things to cause an undesired outcome. The safe operation of an electrical system, for example, is not of much use if turning it on generates a radio frequency signal which detonates some nearby explosives. The integration of the individual system analyses is thus an essential facet of the hazard recognition process.

In analyzing any system, three basic elements must be considered: (1) the equipment (or machines); (2) the operators; and (3) the environment in which both men and machines are performing their assigned functions. All of these are in continuous, dynamic interaction with one another within some predetermined limits of variability. If these limits of variability are exceeded, then the system may be incapable of operating or becoming damaged, it may deteriorate too fast, it may perform its mission poorly, or someone may get hurt.

As an interacting subsystem, man has certain general characteristics which must be taken into account: (a) physical dimensions, (b) capability for data sensing, (c) capability for data processing, (d) capability for motor activity, (e) capability for learning, (f) physical and psychological needs, (g) sensitivities to physical environment, (h) sensitivities to psycho-social environment, (i) capability for coordinated action, and (j) variability within and between individuals with respect to all these characteristics. Stress leading to human error can occur when man's physical, physiological, psychological, or biomechanical limitations are exceeded.

Man and machine interact through procedures, spelled out as functions. Functions are described in terms of tasks, and tasks in terms of elements. This convenient subdivision provides a basis for determining whether or not tasks are within human capabilities; what knowledge, skills, and numbers are required to perform them; what information is needed to carry them out; what hazards or risks are involved, and so on.

Those variables in the environment which may affect the system and its performance must also be taken into account: the weather, air turbulence, temperature, humidity, pressure, chemical composition, time of day, geography, and many more. The performance of both men and machines can be profoundly influenced by environmental variables which exceed their normal limits and thus place a stress on the system.

The effects of the interactions of man x machine x environment on the accomplishment of the system's mission are certainly related to system reliability. But, it is not always recognized that a mechanically reliable system is not necessarily a safe one. A hand grenade, for example, is a highly reliable device, but in a man x machine system it is not safe unless the human subsystem is well-trained in its use and does in fact use the grenade as he was trained.

Thus, analysis of human failure is as essential as analysis of hardware failure in the systems approach to accident prevention. Human errors which can degrade system reliability include: (a) failure to perform all or part of a task; (b) performance of the task or step incorrectly; (c) introduction

of some task/step which should not be performed; (d) performance of some task/step out of sequence; or (e) failure to perform the task/step within the allotted time period. Any of these human errors can degrade system safety. It should be emphasized here that the term "men" includes operators and maintenance men, as well as those who manage the system, those who design it, and those who establish the requirements.

Since the thrust of hazard analysis is to identify interacting combinations of events within a system, we will find useful the concept of "set." A set is any collection of items (events, objects, labels, people, time intervals, numbers, etc.) defined by specifying which items are elements of the set. This may be done by stating some rule by which the elements can be identified, or by actually putting the elements on display. For example, we can specify as a set: {the integers which appear on the six faces of a die}, or {1, 2, 3, 4, 5, 6}.

There still remains the question of just how concerned we ought to be about a set of events we have identified as hazardous. Obviously, we will be influenced by the probability that hazardous events will occur as discussed before. Since this type of information is generally not available in industry, for some time to come we will have to make educated guesses about the likelihood that hazardous events will occur.

Besides their probability of occurrence, we are also influenced by the consequences of hazardous events. Evidently, we will be somewhat more concerned about a one in 100 probability of an inadvertent nuclear event than about an equal probability of being rained out of a picnic next Sunday. A convenient qualitative scheme for applying a relative criticality index to undesired outcomes is the one used in weapon systems development:

"Conditions such that personnel error, environment, design characteristics, procedural deficiencies, or subsystem or component failure or malfunction:

Category I — Negligible: will not result in personnel injury or system damage.

Category II — Marginal: can be counteracted or controlled without injury to personnel or major system damage.

Category III — Critical: will cause personnel injury or major system damage, or will require immediate corrective action for personnel or system survival.

Category IV — Catastrophic: will cause death or severe injury to personnel, or system loss."

We are now in a position to define a hazard in terms of interacting events involving man x machine x environment, probability, undesired outcomes, systems, and sets:

Hazard: In a system defined in both space and time, a real or potential set of identifiable events which, on interaction of the elements of the set, have some likelihood of generating an undesired outcome.

Undesired Outcome: Injury or harm to persons, system functional damage, degradation of system performance, or contribution to an undesired outcome in another system.

When an accident has occurred, the hazard set has interacted, with an overall probability of 1.0, to generate the observed undesired outcomes.

In summary, we can visualize an undesired outcome as the end result of one or (usually) more sequential (sometimes parallel) malfunction events, each with its own probability of occurrence, initiated by some kind of stress on a specified system which has previously been in a state of dynamic equilibrium (i.e., under control). Event interaction occurs within some finite time, ranging from micro-seconds or less to many years. A stress on the system can be anything which tends to disturb normal (i.e., planned) functioning: excessive pressure, power failure, sudden change in pH, corrosion, release of toxic material, a hurricane, pushing the wrong button, etc.

If a possible system stress can be anticipated by analysis of a model of a system well in advance of operations, then adequate means of preventing either the stress itself or its undesired effects can be built into the system. Alternatively, although not as desirable as preventive design, the hazard sequence can be interrupted by taking some appropriate corrective or protective action, provided there are means both of monitoring

for the occurrence of an early malfunction and of detecting soon enough and reliably enough.

We can thus define a safe (or successful) system as one in which the likelihood of occurrence of all identifiable (i.e., recognizable within the state of the art) undesired outcomes is kept within acceptable limits. What limits are acceptable is a matter for management decision, guided by the best possible analysis that can be performed.

The success or failure of a real system is best demonstrated by actually operating it; unfortunately, this is time consuming, often impossible or excessively costly. Next best is to perform limited testing of all or parts of the system, under controlled conditions which simulate actual operations as closely as ingenuity can devise; this, too, can be expensive and time consuming. The next alternative is analysis of a model of the system confirmed by a few tests. The least desirable method is analysis alone, but it is the only recourse when no testing can be done; it has the advantage of least cost.

We can tie all of the concepts discussed here into a scheme for effective hazard analysis:

1. Define the system in space and time, including its objectives, the location of its interfaces with other systems of interest and the analytical limits of resolution within the system (may vary, depending on the analyst's interests).

2. Specify the identifiable undesired outcomes, states, or conditions within the defined system.

3. Select the key system-characteristic undesired outcomes that serve as the basis for decision by comparing them with some index of criticality (e.g., negligible, marginal, critical, catastrophic); record the results.

4. Determine the possible modes of occurrence of the selected undesired outcomes.

5. Evaluate the likelihood of occurrence of the possible modes of occurrence. This can be done with logic alone; failure rate data are not needed in most industrial systems. An estimate of mission success can even be made on the basis of events being likely or unlikely to occur.

6. From the foregoing, decide if the system design is adequate to prevent failure and, if not, what design changes are required to improve the relative safety of the system.

7. Analyze any system revision as above, and repeat as often as necessary until the optimum design is achieved.

The usual intuitive method of analysis, discussed at the beginning of the paper, should not be entirely discounted. It works very well in many situations, particularly when it is not pushed beyond its limitations. Intuitive analysis seems to be a subconscious mixture of two basic formal methods, inductive and deductive analysis, either or both of which can be used in the scheme outlined above.

The inductive method of analysis involves a "what happens if" approach, in which one reasons from the particular to the general. In terms of the previous discussion, the analyst identifies the possible state of existence of the system elements and, sequentially, tries to determine the possible effects of each on the overall system (undesired outcome). Job hazard analysis, gross hazard analysis, fault hazard analysis, failure mode and effect analysis, and failure mode, effect and criticality analysis are all inductive methods.

The deductive method of analysis involves a "how could this have happened" approach familiar to friends of Sherlock Holmes, reasoning from the general to the particular. The formal process, widely used in the aerospace industry, is called Fault Tree Analysis, since the resulting logic diagram somewhat resembles a multi-branched tree. FTA provides the only method known for the overall quantification of risk. In terms of the previous discussion, the analyst specifies a state of existence of the overall system (undesired outcome) and tries to identify the system elements that could contribute to its occurrence.

There is a growing literature about these formal analytical methods so they will not be discussed here. All have their place Each, to a greater or lesser extent, provides a means for overcoming the limitations of intitive analysis by formalizing our customary thinking process. Regardless of the method used, the systems concept of hazard

recognition and analysis makes available to the safety professional today a powerful tool of proven effectiveness as the basis for informed management decision-making about the acceptability of risks.

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ADDRESS

By GEORGE C. GUENTHER
Director, Bureau of Labor Standards, Washington, D.C.

Early in September, it was my honor to join the Nixon Administration as Director of the Bureau of Labor Standards. This Bureau develops and advances employment and safety standards and assists states and labor-management and civic organizations that are working to improve labor legislation and administration. The Bureau develops and enforces safety regulations for persons working under Federal supply contracts and in the shipyard and longshoring industries. Under the Fair Labor Standards Act, the Bureau also develops standards which prohibit the employment of children in potentially dangerous jobs and attempts to provide job opportunities which will not be hazardous to the health and well-being of children.

Prior to joining the Bureau, I served as Deputy Secretary of the Pennsylvania Department of Labor and Industry with primary program responsibilities in workmen's compensation and occupational safety, fields which are intimately related.

As a newcomer to Washington, I have been impressed with a number of things, perhaps the chief of which is the caliber of the people with whom I have become associated. In the Bureau of Labor Standards itself, I count myself extremely fortunate to be able to call on the services of a broad range of experts.

Secretary of Labor George P. Shultz has a distinguished background ranging from a teaching career on the campus in industrial relations across the broad gamut to the cold hard world of labor arbitration. Prior to becoming Secretary of Labor, he served as Senior Staff Economist for the President's Council of Economic Advisors. He has served three Presidents and three Secretaries of Labor in a variety of capacities.

From the Secretary on down, today's Department of Labor is committed to improving the working conditions of our nation's employees. You have all heard much about and have discussed previous safety and health legislation pending in Congress. Your managing director, Al Blackman, testified not only on the previous bills but also on the new one before the House Labor Subcommittee presently holding hearings on the Hill.

I am assuming there is no need to justify the need for more and better occupational safety programs. You know the statistics — you make 'em or compile 'em. You know as much or more than anyone else in the nation about how to prevent accidents and injury. You know the need and have long supported efforts to professionalize the work of accident prevention. Indeed, it has been one of your primary purposes. You know the present shortage of trained safety engineers and other technicians and the urgent need to train more. You are trying to do something about these needs and so are we — both in and independent of the bill.

You are certainly entitled to high commendation for sponsoring the creation of an independent Board of Certified Safety Professionals, which is about ready to accept applications. There is a need for some way to identify individuals from various special professions who meet an established set of criteria reflecting high standards of professional competence.

Not only do we need to certify professionals presently competent, we also need and have been thinking about improved training facilities for a growing variety of people associated with safety both in government and in the private sector — safety

engineers, fire prevention engineers, industrial hygienists, health physicists, the subprofessions of technical assistants, and the whole range of safety managers, supervisors, and foremen.

I should like to find a way to lead or lure more colleges and universities to enlarge and enhance safety and health education and training looking toward a degree. We are, in fact, now considering a proposal to set up an independent training institute.

In any event, the need for competent professionals to safeguard workers in our complex technology must be met by training. This the 1969 Occupational Safety and Health bill recognizes. In perhaps one of its most important sections, it charges the Secretary of Health, Education, and Welfare with responsibility to conduct or contract for this type of broad education and training in both the safety and health fields.

In Al Blackman's testimony in both 1968 and 1969 he alluded to your concern for more and better educational criteria and support for legislation which could build professional competence for today as well as tomorrow. The 1969 bill gives strong impetus both to safety professionalism and education. Its requirements give support, prestige, and importance to the safety profession as well as stimulus and challenge to safety professionals.

Last year Congressman Steiger discussed the minority objections to the Occupational Safety and Health bill as then reported out of the House Education and Labor Committee. Among other things, he protested that drafters of the bill originally proposed to the Congress last year had not consulted anyone about its provisions before its introduction. Before the present Administration bill was introduced, not only were previous safety and health bills examined, but the views of everyone who addressed the public hearings were carefully reviewed. Then other Federal agencies were consulted; so were national safety organizations like the National Safety Council, national standards-setting groups, doctors, insurance executives, union leaders, plant level safety engineers, state officials, members of Congress. Then the Secretary appointed his National Advisory Committee of 15 members under the chairmanship of Governor Howard Pyle, who gave dedicated and expert counsel. Consultation and coordination were not only there, they were endless. So we believe that Congressman Steiger can no longer fault us for failure to consult interested parties on the Administration's current bill.

The major objections of last year's minority have mainly been met in this bill. Instead of continuing the Secretary's power to be cop, judge, jury, and prosecutor, his former standards-setting powers are lodged in a National Occupational Safety and Health Board of five Presidentially appointed members, at least three of whom shall have technical qualifications in the field. They are directed to take advantage of existing expertise in the standard-setting field. They shall adopt national consensus standards where they exist and give their sponsors an opportunity to modify them and advise on the feasibility of developing new ones. Where adequate consensus standards are not thus available, the Board may initiate standards-setting through the holding of public hearings and obtaining the views of interested parties. The Secretary of Labor and the Secretary of HEW, should they object to any proposed standard, participate in the standards-setting process by such objection and the development of alternatives.

I'd like to pause here a moment and discuss standards-development under present laws. The Bureau of Labor Standards is deeply involved in administering standards under the Longshore and Harbor Workers Act and the Federal Supply Contract Acts. It is in a position to observe gaps and weaknesses as well as good standards. Inspection data highlight the need for changes, updating, and new standards. We issued a Status Report on Safety Standards last December which showed 60 per cent of the USASI — now ANSI — standards were five or more years old. The Bureau received many requests for this report and the next month ANSI called a special meeting to discuss the report's findings and undertake serious commitments. Quite a lot of action was generated and, hopefully, there will be more. ANSI is streamlining its procedures and reorganizing its staff. It is at work updating the oldest standards and has ordered a "speed-up" by those groups working on new standards. In fact, only four out of 69 standards five or more years old have had no action taken on them. All the rest

are in various stages of review, redraft, approval, or have been withdrawn. So the few groups making no progress will be dropped by the end of the year.

While I realize standards development and enforcement are not the whole story in accident prevention, they are in our view, pretty fundamental. I should like, therefore, to appeal to ASSE's Standards Committee representatives to take a more active role in the development of standards. I even would like to propose that ASSE chapters consider sponsoring standards within ANSI procedures. After all, your membership embraces much of the nation's expertise in the detection and control of work hazards. ANSI and the Government would like very much to call upon this expertise to produce better standards than can be produced any other way.

You have a selfish stake in helping to develop such standards. If you don't lend your expertise to devise effective safeguards for workers without impairing production, less effective ones may be devised by others which you may have to comply with. The Government has an obligation to enforce safety standards, an obligation it cannot ignore even if it must devise less effective ones all by itself. It doesn't want to develop standards unilaterally, since it prefers your help, but it can.

Enforcement considerations bring us back to the 1969 bill. The Secretary of Labor is responsible for administering the standards when adopted by the Board. Should he find cause to believe, through an inspection, that a standard has been violated, he may petition the Board to hold a public hearing and to issue an order enforceable through the courts to comply with the standard.

Another major objection of last year's minority report was the authority given Labor Department inspectors to shut down a plant whenever in their view danger of death or other imminent harm might come to employees from continued operation. The current bill authorizes the Secretary of Labor to seek a five-day temporary restraining order from a Federal court to stop work. Concurrently, he may then petition the Board to hold hearings and continue protection, if necessary, through obtaining an injunction from the court. In granting either temporary or permanent relief, the court shall set a sum which it deems proper to pay such costs, damages, and attorney's fees as may be incurred by any party found wrongfully restrained or enjoined.

While these new provisions meet the minority's objections, we believe, they have aroused some critics who fear that restraints on the Secretary's action are so cumbersome as to thwart enforcement. We believe that, first, most employers want to obey the law when violations are called to their attention and, second, they don't want to get tangled up in administrative hearings and litigation any more than the Government does. The penalty clauses in such laws are inserted to bring a reluctant minority along with the majority, to protect law-abiding employers who should not suffer unfairly from cornercutting competitors. On the other hand, penalties for determined violators are fairly stiff. But in any case, American jurisprudence historically has sought to assure due process to protect individual rights from arbitrary and capricious Government action. We have written a great deal of due process into this bill.

Otherwise, this bill contains many of the other provisions of last year's Committee Print, because our drafters found them good. The very important enlistment of state resources through Federal grants-in-aid is retained. You recall that states could receive up to 90 per cent of Federal funds for planning improvements in their safety and health programs, and up to 50 per cent for carrying them out.

This provision is consistent with President Nixon's new Federalism concept of enhancing and expanding the role of the states in the delivery of governmental services. We provide just about maximum incentive for the states to take over. Flexibility for state innovation is encouraged. We provide a three-year interval for a state to complete its plan development. Ours is a truly State oriented bill. As Jim Hodgson says, "Nothing would please us more than if three years from now every state had its own approved program administered by its own people."

In addition to meeting the objections outlined by Congressman Steiger last year, the 1969 bill also focuses on another lack strongly emphasized by ASSE in testimony before the Congressional committees, namely

lack of comparable national statistical information on work injuries and their causes. The bill requires employers to keep records and authorizes the Secretary of Labor to issue regulations for their collection and analysis.

The bill also recognizes the need for research into the many technical problems involved in advancing worker safety and health. Safety lends itself to finite and timely considerations, as Jim Hodgson says. It's easier to get hold of, so 95 per cent of the standards cover safety and only five per cent cover health. We want to redress the balance in research but that doesn't mean we shall neglect safety. Health problems tend to be elusive and long range. Perhaps the minor fraction they represent in standards, and in statistical data for that matter, arises from our failure to recognize them, our ignorance of their nature and scope. So the bill gives the Secretary of HEW responsibility again to conduct or contract for research in both areas. In addition to old work hazards we have known since the Bronze Age, modern technology's creation of a whole new kind of work environment has brought new health hazards little understood and imperfectly or completely uncontrolled. Such things as high energy sources, beryllium, mutagenic chemicals, pesticides, and many, many others.

In fact the bill recognizes our present state of ignorance and directs the Secretary of HEW to make a report to the President and Congress within two years on the nature and prevalence of modern occupational diseases, together with recommendations for their effective control.

The Administration's efforts in drafting a regulatory bill could be summarized somewhat as follows: first, it believed a set of affirmative provisions was needed; second, and of equal need were safeguards — safeguards to insure operation and administration without abuse or excess. We took care to build both into our bill. Extensive provision was made for participation by the parties of interest — formal participation in standards-setting and other features. Next, we gave careful attention to due process. Suitable provisions exist for hearings, reconsiderations and legal appeals.

So, the result of our efforts was a bill designed with three objectives. First, to have a positive impact on the improvement of safety and health in the American workplace; second, to be comprehensive in coverage and forward-looking in its scope; and finally, to insure against inequities and abuses in its application. We hope we have achieved these objectives. We believe we have.

With its introduction into Congress our bill has been launched into the marketplace to compete with many other bills both on and off the safety and health subject for public support and Congressional action. The prevailing climate is, I think, favorable.

It is sometimes hard to find direction or perspective in these times of massive unrest among people — unrest accompanied by high aspiration. But one thing seems certain — they are prompted in a large measure by a search, indeed a passion, for improvement in the quality of American life. This passion is largely manifest in terms of concern for human well-being.

Certainly, compelling human considerations exist to prompt our search for improved industrial safety and health conditions. As the nation goes forward in search of the better life we should not be surprised if new attention should turn to the health and safety of our 80 million work force.

It is said that each subject has its time. We sense a favorable and fair wind blowing for a new high level of safety and health in the American workplace. In achieving this goal, we advance another step up the ladder toward improvement in the quality of American life. In this historic year when Astronaut Armstrong has taken a giant step for mankind, lets hope we can take one modest step for the American worker. To this end I commend to you the Administration's Occupational Safety and Health Act of 1969.

Evaluating Company Safety Programs

PLANT PERFORMANCE — U.S. AND FOREIGN

By T. A. KRAKLOW
Director of Safety, Deere & Co., Moline, Ill.

Safety—sicherheit—securite—seguridad—no matter what it has been called in various countries, it generally has been the stepchild of the management family, never quite sure of its proper place. Yet safety, if it so desires, can demonstrate that it can make a most significant contribution to business and society by providing sound and inspiring leadership that is needed and wanted by those who have the responsibility for making our economy productive and satisfying.

In the past, we could use the old "milk bottle process," where you let the milk set, the cream comes to the top, and then you use it. Applying this to safety, some of us wait. Our programs are injury observation programs; we wait until a series of accidents happen to indicate a trend, then we do something. These days, we don't separate cream from the milk—we buy half and half or pure cream. We don't wait to use it. This should apply to safety or accident prevention. We have to arrange or plan. We don't have time to wait for results. The new process does a better job in much less time and gives better results.

In its modern interpretation, safety extends far beyond personal injury. It must include the broad spectrum of industrial loss prevention. There is a mistaken belief that too often a safety program is built around goggles, hard hats, safety shoes, posters, and prizes. They are important offshoots, but can never substitute for an accident prevention program. For example, if we talk more about the benefits of a preventive maintenance program, good work order system, equipment and cost records, and other helpful administrative controls, we'll find ourselves armed with facts that only a muddlehead would dare to dispute. You know what these facts are—much less downtime, buildings and equipment in better shape, higher quality production, less rework—all affecting the company. Accident prevention will pay big dividends in conserved material, manpower and money.

Accident prevention is anything that interferes with the intended efficient flow of production. It matters not whether the accident occurs to men, machines, or material. The safety director performs a service and must continually develop his talents. His knowledge must grow and keep pace with the progress of the world in which he works. He must draft the safety program, but the staff and line must see it is properly implemented. Yet the safety program must be workable, reasonable, practical, and adaptable to different sized plants within the organization. Its objective is to be understood as a responsibility assigned to various levels of management. Many engineers in staff positions have resisted safety engineering requirements as "going too far," "do good," "uneconomical," "unnecessary," and "impractical" road blocks for getting the real job done. They insist you can't make things foolproof, and this many times has influenced the thinking of others.

In addition, the safety director is expected to have a good understanding of safety theory and practices and make accident prevention evaluations, not inspections. Evaluation should mean how well supervision implements the factory accident prevention program in a department. That performance, in turn, must be evaluated by superiors.

Management must recognize they can get just as much accident prevention as they want, but they have to want it. In this sense, manager, works manager, division superintendent, or general foreman must set up a plan of action aimed at improved performance in areas such as reduced scrap, time on incentive, production, accident prevention, etc. The safety director must also furnish some measuring tools such as frequency, severity, cost of injuries, etc.

Accident prevention must emphasize results, not activities. Results should be judged by a reduction in frequency rates, severity rates, number of non-injury accidents, and costs. To accurately evaluate an accident

prevention program, all of these measuring tools must be used. In our operations in the United States, Canada, France, Germany, Spain, Argentina, Mexico, and South Africa, the Z16 method of measuring and recording lost-time injuries is used exclusively as a common denominator. In addition, non-injury accident costs are gathered and distributed as well as accident cost in per cent of payroll, accident cost per man-hour worked and, every once in awhile, accident cost in per cent of productive labor in order to pinpoint a division or department that appears to be out of control as far as accident rates are concerned.

While we have check sheets, manuals, and a host of other tools for use by the plant safety director, too often these are taken for granted. Because it is written down and available, everybody knows how it is to be done; but we have had management changes, new staff men, new supervision, new workmen; yes, even new safety men. Good practices are dropped or communications break down. Here is where audits can be used to inform management of their shortcomings or where improvement can be made. Audit procedures must be based on a safety program that is in use, understandable, reasonable, practical and adaptable to different sized plants.

This fourteen-page "Accident Prevention Program Survey" is sent to each plant for completion by the person in charge of safety and covers pertinent questions:

1. *Accident Prevention Responsibility and Participation*—process and tool engineering; new machinery and processes; employee safety; executive safety committee; accident investigation routing; manuals and forms; rates and costs compiled.

2. *Factory Inspections*—unsafe acts and conditions; who is responsible for correction; routing.

3. *Factory Safety Director's Activities*—per cent of time on safety activities (training, indoctrination, production and staff meetings, accident facts, protective equipment.)

4. *Physical Qualifications of Employee*—pre-employment tests; re-examination; job class and physical requirements.

5. *Accident Prevention Training*—production and staff training (who conducts subject); special training; supervisory training; induction of new employees; employee training by supervisor.

6. *Accident Investigation and Report*—accidents (injury, near miss, lost-time, property damage); corrective measures; reports; accounting (costs).

7. *Accident Prevention Records*—form used; routing; analysis.

8. *Joint Health, Safety and Sanitation Committee*—as specified in contract.

9. *Safety Equipment*—control over issuance; control over purchase; labeling hazardous material; required.

Someone may question, "Why have the safety director fill out the survey?" Why not? He is responsible and accountable for the program at that factory. Any wrong or erroneous answers will come to the surface when the survey is reviewed with top management and, likewise, foot dragging departments or staff functions will also be apparent. If the safety director has done his job well—furnished top management people figures reflecting frequency, severity, and costs (dollars and cents)—the safety audit will bring discrepancies to the top, where management men can review and improve upon things that require management decisions and action to control loss prevention as it relates to people, property and products.

Safety programs must be based on facts. There is no place in any safety program for opinions, hunches, or wishes that run counter to facts. The results of a safety program are humane, but optimum results are obtained only if a factual approach is taken. This approach requires sound procedures directed toward basic factors.

It's true management may raise questions or objections to the safety directors, but in most cases, if facts are presented, management is questioning the program or method, not the principle, and there is a big difference. It would be unjust to accuse them of lack of interest. A few years ago in my own community, the plant manager of a fairly large company was asked to give a talk to our local safety association on safety as it pertains to guarding of machinery. His opening remark was a classic and certainly did not speak well for the safety activities in his particular establishment. He said, "I have spent more time learning about safety and accidents since I accepted this speaking

assignment, than I have in the past. Maybe it's necessary that I make more safety speeches in order to arouse my interest." Analyse the remark carefully. Management must be kept informed if they are to carry out accident prevention programs. From his remarks, I drew the conclusion that he had not been kept informed in the benefits that could be derived from an active program.

It is fair to believe that the motivating force toward greater safety is management abhorrence of waste and its affect on profits. We make profit by eliminating or minimizing waste. It matters little if the waste is in equipment, materials, interference with human effort, or damage to human bodies. Of course, there are more than profits involved. People are involved, and there is a sense of public responsibility. When you get right down to it, only an informed top management can give safety all the attention it rates.

A SURVEY TEAM'S EVALUATION

By DONALD G. WINDSOR
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E. I. duPont de Nemours & Co., Inc., Wilmington, Del.

One method Du Pont uses to evaluate safety is the field group, which we call our Survey Unit, that conducts annual audits. To place the group in the Du Pont organization, we should know that E. I. du Pont de Nemours & Co., Inc., has its corporate headquarters in Wilmington, Delaware, where we started in 1802. We are about 108,000 strong in the U. S. with 92 plants and 42 laboratories scattered throughout 30 of the 50 states. The Du Pont Company is divided into 26 departments, 12 of which may be called industrial or production departments and the remainder staff or support departments.

The Safety and Fire Protection Division is a part of the Employee Relations Department. We feel that safety is, indeed, a facet of good employee relations. With our present organization, we are more able to take an objective viewpoint than if we were a part of a "doing" or line department. Our division, a relatively small group of about 30 people, is the corporate safety advisory body and is divided into four sections:

1. *Promotional.* This section provides information and furnishes ideas that will assist company units in their promotion of safety and fire protection. Our promotional engineer edits various bulletins and publications and guides selection of visual aids which are loaned to company units.

2. *Statistics and Reports.* This unit maintains records on injuries both on and off the job and prepares monthly statistical reports on safety performance. The group also confirms eligibility in our company no-injury award plan.

3. *Insurance.* Basically, the Du Pont Company is self-insured. The Insurance Section administers our self-insurance plans covering property damage and occupational disabilities. It advises generally on all matters of insurance in the casualty and property fields and negotiates for and places insurance with outside companies when necessary. The files and statistics for appropriate reporting to management on property damage and casualty loss experience are maintained here.

4. *Engineering.* This section, for which I am responsible, encompasses two groups—the consulting engineers and the survey unit. Our consultants, four in number, are assigned specific departments and work primarily with our Engineering Department advising on new construction and alterations to existing facilities. The second group, the Survey Unit, is the field group which conducts inspections, or surveys as we call them, at all units both in the U. S. and at our foreign subsidiaries. This group of engineers is one of the primary means we have to keep our fingers on the pulse of safety throughout the company.

The Survey Unit currently consists of a supervisor and ten engineers. Each engineer has at least a four-year technical degree. Degrees in physics, chemical engineering,

mechanical engineering, safety and fire protection engineering, industrial engineering, electrical engineering, and civil engineering are represented. Most of our engineers come from Du Pont plants or labs.

The major responsibilities of the Survey Unit in connection with their annual surveys are to recommend improvements in the safety and fire protection facilities and programs and to make the necessary followup to effect compliance for proper action on these recommendations. They are, in effect, providing an underwriting service for our assets, including employees and physical property. These men are safety and fire protection engineers. It's difficult to say exactly where fire protection leaves off and safety begins, or visa versa. The two are so closely interrelated that we prefer not to try to separate them.

The surveys performed by these men are of two types—one termed "regular" and the other "interim." These are performed alternately; that is, a regular survey one year, and an interim the next. A regular survey covers all facets of safety and fire protection while an interim survey concentrates on one or two specific problem areas. The average length of a survey varies with the size and complexity of the unit being visited. Generally speaking, a regular survey would take from two to four man-weeks, while an interim survey would take somewhat less than that. On the larger plants, we send two or three engineers, who divide the work.

First step in a typical regular survey is office preparation. In the case of a plant audit, the engineer notifies the plant manager by letter about two weeks prior to the survey of his intention to visit the plant. A copy of the letter is sent to the production manager in Wilmington, which gives him the opportunity to contact us prior to the visit. Our consultant assigned to the plant discusses new or planned changes and special problems or concerns which may have come to his attention. The plant file is reviewed, which includes correspondence our division has had with the plant since the last survey, the last several survey reports, descriptions of unusual incidents, and long-range plans of the site. The injury experience for the location is obtained from our Statistical Section and property damage experience from the Insurance Section.

Reviewing all of this information better equips the engineer to appraise the safety program and its accomplishments and shortcomings. If the engineer who conducted the previous survey is in the office, he is consulted concerning his evaluation of the plant's posture on safety and fire protection.

Throughout these preliminaries, the survey engineer is encouraged to avoid prejudging the unit. This may be difficult, but experience indicates that first-hand on the site observations are the most valuable toward obtaining a meaningful objective assessment of safety.

Our engineer is representing a staff organization functioning in an advisory capacity. He is a salesman with a rather subjective product to sell; that is, safety. He sells safety through his recommendations. The plant is not compelled to accept his recommendations, and he, therefore, must be as objective as possible in presenting them. The engineer can make a better survey if both he and the plant fully understand this relationship. The survey effectiveness and the acceptance of our recommendations hinge, to a large extent, on the attitude with which the survey engineer approaches plant personnel and plant problems.

Following our engineer to the plant, his first morning is taken up with planning. Early in the day, he meets with the manager and reviews tentative survey plans. He solicits comments from him regarding any special problems to which management may wish attention directed. Working with the plant safety and fire protection supervisor, or whoever has been assigned to coordinate the visit, plans are made for the survey. If the engineer is not familiar with the plant layout, a high spot tour is made.

Generally, an engineer will schedule testing of outside fire protection facilities early in his visit. If these activities are postponed until the last few days, it inevitably rains. We test and inspect fire pumps, sprinkler systems, fire alarm systems, fire hydrants and associated equipment, sectional control valves, underground fire mains, (including hydrostatic tests, water flow, and coefficient of roughness calculations), fire brigade response and training, and foam, "Freon,"

and other special protection systems. It is not the intent that the plants rely on our organization for periodic testing; we are sampling to insure good maintenance and adequacy of facilities and the ability of employees to use them.

Let's pick up our engineer, now about to visit a production area. He meets with those in charge and reviews the process, checking each step carefully and ascertaining the status of the plant's process hazards review. We feel this is very important and request that each plant have a committee which conducts annual process reviews in detail.

Accompanied by a member of operating supervision and generally a representative of the safety office, our engineer then tours all of the plant including tank farms, loading spots, warehouses, etc. When possible, the process flow is followed. We include such things as exits, floor loads, fire cut-offs, electrical facilities, pressure reliefs, ventilation, elevators, materials handling equipment, guarding, etc. Procedures such as emergency shutdown, operating practices and safety rules are reviewed with employees to determine their knowledge and whether good practices are being followed. Much attention is directed to the people facet—how are they going about their activities, are they wearing the proper protective equipment, are they following the prescribed procedures. Throughout the survey, the engineer keeps alert for some of the more subjective items such as management participation in safety, the safety organization, communications, publicity, supervisory acceptance of safety responsibility, and employee attitudes and work habits.

The engineer submits his recommendations daily. These are generally reproduced and passed to the staff in the various areas. At the conclusion of the survey, a meeting is arranged to summarize for the manager and his staff the results of the survey in a logical, concise and hopefully, convincing manner.

Upon returning to the Wilmington office, the engineer again reviews his findings with the production manager to whom the plant manager reports. Production management have requested these visits and it is another indication of the sincere interest top management in our company takes in safety.

Following each survey a report is issued which evaluates the current safety and fire protection conditions and advises of improvements deemed advisable. Specific recommendations are not included in the report as they are left at the plant. The report is not an outline of facilities or programs but conveys our opinions and the reasons for them. It is organized into 10 general topics:

1. *Safety organization and administration.* Here we evaluate the central safety organization, the subcommittees and special committees, area staff organizations, and the safety and fire protection group.

2. *Safety program and activities.* This describes and evaluates the overall program and the individual area programs. Here we evaluate such things as safety meetings, publicity, and special promotional activities.

3. *Environmental safety.* This includes our opinion of building arrangements, exit facilities, lighting, ventilation, machine guarding, housekeeping and orderliness, and general maintenance. This is the more physical side of safety.

4. *Rules and procedures.* How adequate are general and area rules and operating procedures? Are the personal protective equipment requirements satisfactory? Statements regarding the adequacy of the plant safety manual and employee safety knowledge are included here.

5. *Employee work practices.* This is a very important section and includes an evaluation of the degree of compilance with rules, procedures, and similar requirements. The application of good safety judgment and the effectiveness of supervision in controlling work practices.

6. *Process hazards.* A description of major process hazards and an evaluation of the adequacy of control and protection of the plant's hazards review program are included here.

7. *Equipment inspections and tests.* What have our field observations revealed about the programs, procedures, records, and execution of equipment inspections and tests? This involves a great array of equipment all the way from sprinkler systems to lift trucks, pressure relief valves, rupture discs, portable electrical equipment, and emergency apparatus such as breathing equipment and fire extinguishers.

8. *Fire and explosion control.* This is an evaluation of facilities and arrangements such as sprinklers, fire walls, separations, barricades. We include here unsafe practices and employee's knowledge with respect to fire and explosion safety.

9. *Fire protection facilities.* This outlines our opinion of the water supplies, fire protection water distribution system, fire brigades, mobile equipment, and major fire protection facilities common to all areas.

10. *Emergency preparedness.* We ask each site to have a disaster plan and a disaster control training program, including periodic drills. Here we comment on the adequacy of these preparations.

Under each of these topics, we include general comments on corrective measures if there is a need to correct basic weaknesses as revealed by our survey.

On the interim surveys the engineer has the prerogative of selecting one or perhaps two facets of safety or fire protection and delving into these in detail. The area to be investigated on the interim survey is generally based on his office preview. The survey procedure is very much the same as for a regular survey. Meetings are held with management for evaluation purposes but the report that is written following the engineer's return does not evaluate the total safety and fire protection picture.

Each engineer is assigned the responsibility of following up on his reports and recommendations. As we are not in line organization, we function in an advisory capacity and have no authority for enforcing recommendations. The engineer must sell his suggestions on their own merit. Even in this environment, the last check revealed over 99 per cent of the recommendations made were accepted and carried to completion.

In evaluating safety in the field, we are constantly looking for other ways to improve. We have established near-term goals for both on and off the job performance, and we're quite dissatisfied with current performance. While our experience is generally more favorable than the average in industry, our management has clearly let it be understood that until we are able to operate our company without serious injuries they will not be satisfied with our safety posture.

MAKING A PERFORMANCE AUDIT

By C. E. WILSON
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Before examining the mechanics of making a safety performance audit, and in order that you will have a better understanding of the logic for making such audits, let us take a look at the subject of responsibility. Every person in a company which is striving to reduce accidents has a responsibility to prevent accidents. This is true from the top official to the lowest paid employee. The measure of the accident experience is really a measure of how well a group accepts and carries out its responsibilities. A prerequisite to this, of course, is the identification of these responsibilities.

The activities of the various levels of management and workers must be established. Such activities must be based on the principle that each level does what it can best do in relation to the basic techniques of accident prevention. Once such activities are established, they become the responsibilities of the various levels. To audit means to examine closely and verify, and although it is best known from its use in accounting, any activity for which specific procedures have been established can be audited. Consequently, a safety program which assigns specific responsibilities to various levels of supervision and which includes known activities which supervision must perform in order to carry out their responsibilities can be audited. However, if a safety program does not assign responsibilities and specific activities, it is doubtful it can be audited. In fact, it is questionable if it is a safety program unless it does assign specific re-

sponsibilities and activities. My subject today is the safety program audit procedure of Bethlehem Steel Corporation.

One might first ask why audit a safety program; don't injury frequency and severity rates tell all we need to know about accident prevention progress? These rates are, however, often erratic in movement and, even if not erratic, do not tell us specifically what accident prevention tools are not being used as they were designed to be used. Auditing provides a method for a detailed examination of the way accident prevention tools are being used.

In order to provide a clearer understanding of our audit procedure operation and objectives, a short review of the accident prevention tools in Bethlehem's program is necessary. The principal tools are accident investigation, job safety analysis, job safety training, planned safety observations, corrective procedures and physical inspections.

Accident investigation has a dual purpose: first, to determine the causes of an accident (both man and environment) in order that action can be taken to eliminate the causes and thus avoid a repetition of that accident; and second, to provide cumulative data so that accident factors which are repetitive can be identified and eliminated. Cumulative data also identify the jobs or tasks (as differentiated from occupations or positions) which produce the largest number of injuries. This, in turn, identifies the priority areas for the rest of the accident prevention tools.

A job safety analysis sets out in writing the steps of a job, the hazards of each step and how to do the job so as to avoid these hazards. It describes the safe way to do the job. Job safety analyses, along with safety rules, are material for job safety training.

Job safety training is accomplished through both group meetings and planned personal contacts. We particularly emphasize training through planned personal contacts, that is, person-to-person instruction from supervisor to worker.

After men have been instructed in how to do their jobs, they are then periodically observed doing their various jobs to determine if they are doing them as they have been instructed. If they are, they are commended. If they are not, they are corrected, which is usually done through reinstruction on how to do the job safely.

Another accident prevention tool is inspection by supervisors of tools, equipment and the entire physical environment in which men work. This is essential because these things change. The need for repairs or replacements must be determined before the equipment or work environment becomes unsafe.

How effectively and adequately these are done will determine how successful the safety program is in eliminating accidents.

In summary, the accident prevention tools related to the worker side of the job result in four things, which are:

(1) a determination of the correct way to do jobs.

(2) education of employees on the correct way.

(3) observation of employees to determine if they are doing the jobs correctly.

(4) commendation or correction of employees.

The same four results are necessary for the supervisory jobs. Accident prevention responsibilities and the correct use of the accident prevention tools available to him must be determined for each level of supervision. Each supervisor must then be taught his responsibilities and correct use of the tools. He must be observed to determine if he is carrying out his responsibilities and using his tools correctly, and the observation should be followed by either commendation or correction.

Bethlehem, after determining what the responsibilities of each level of supervision would be and how the accident prevention tools were to be used, initiated a formal safety training course in the fall of 1962. This training was designed to provide uniform instruction on supervisory safety responsibilities and activities to all Bethlehem supervisors. During the two-year instruction period, and for some months thereafter, there was a marked and steady decline in Bethlehem's disabling injury frequency. Then, however, and surprisingly, the injury experience started to trend upward.

It was essential, of course, to find out why, and we decided that we needed to know whether and how the accident prevention tools were being used and to change their use where necessary. After a period of study a procedure was developed designed

to examine and determine the extent and method of application of the tools. In other words, it was the development of the observation step. The procedure was based on the use of check sheet forms, and it was decided to refer to the procedure as an audit. In November, 1965, the first audit was made and the audits have continued since then.

Our first objective for study was our large steel plants with many departments and large numbers of employees. We decided that auditing there would be on a departmental basis rather than plant-wide. The reason was that to audit an entire plant of the size involved would require an enormous amount of time and personnel and that a total plant audit was not necessary. Our judgment was that whatever we found in a department selected for audit would be representative of, and a guide to, the manner in which the safety program was being followed in other departments.

Departments are selected for audit after a review of the frequency rates of all departments in that plant. The department with the highest frequency is *it*. For this purpose we use our serious injury index frequency rather than disabling injury for the reason that serious injury index is more indicative of safety performance. As the program was extended to include all types of operations, it was determined that in smaller operations, the entire operation can be audited. However, since the audit team organization varies with the scope of the audit, I shall describe the one we follow at our steel plants on a departmental basis.

Each audit team includes two operating department heads or assistant department heads from two operations other than the operation at which the department to be audited is located, one safety engineer from each of the same two operations that supplied the operating personnel for the team, and one representative of the compensation and safety division, industrial and public relations department, from the home office. Wherever possible, the two department heads or assistants are from departments which have the same or similar production activity as that of the department to be audited. For example, if a Blast Furnace Department is to be audited, the operating personnel come from Blast Furnace Departments in the other plants.

The time required to audit a department varies from a few days to a full week, depending on the size of the department. The audit team convenes the evening before the audit is to start, at which time the representative from the home office orients the other members of the team on the purpose of the audit and the procedures which are to be followed.

On the morning of the first day the audit team meets first with the general manager of the operation and then with the superintendent of the department to be audited. At that time the purpose of the audit is explained, which is: to assist the plant and department to determine weaknesses that may exist in the safety program. It is not on a witch hunt. The procedures are also reviewed and any special arrangements required are also discussed.

Following the meetings with the manager and department superintendent, the audit team familiarizes itself with the departmental organization and reviews the departmental organization chart. Among other items of interest, the team learns which supervisors might have an unusually large number of men to supervise. The team at this time also familiarizes itself with the accident-problem areas in the department by analyzing a sufficient number of accident reports to determine which jobs or tasks are producing the highest number of injuries and to determine the most frequent accident types and accident causes for those jobs. The team also studies the length of experience of those injured on the positions to determine if the lack of training and orientation of employees is one of the problems.

Using the check sheets, the use of each of the accident prevention tools is then studied from both a quantitative and qualitative viewpoint, that is, to determine not only that the tools are being used as frequently as the program requires, but also that they are being used in the manner required. Four check sheets were developed for this purpose. Each deals with one of the accident prevention activities or tools and, of course, is designed for use with Bethlehem's safety program. Consequently, they are not shown here because they would not be applicable to others' programs.

To secure the information needed to complete the check sheets requires the audit team not only to study the safety activity

records of the department but also to interview hourly-rated employees and all levels of supervision of the department. When all check sheets are completed, the audit team has a good picture of how each tool is being used and whether correctly or incorrectly.

The check sheets for auditing accident investigation establish the information by which to determine whether *every* accident is being investigated, whether the investigation is complete in all required details, whether the accident description is clear and complete, whether all causes—both man and environmental—are being recognized and reported, and whether proper actions are being taken to eliminate the causes.

The check sheets on Job Safety Analysis permit the audit team to determine whether job safety analyses were in existence for the jobs on which employees were injured prior to the injury. If a high proportion of injuries occurred on jobs on which safe job procedures had not been developed through analysis, it indicates a weakness in the program in that an inadequate number of jobs have been analyzed. Using the check sheets, the team also determines the quality of the job safety analyses that have been prepared. By reviewing a representative sample of job safety analyses, the team determines whether these meet all the requirements for a good J.S.A. The team also determines how the analyses are used, that is, whether they are used for employee training and job planning as our program contemplates.

The check sheet for job safety training reveals the frequency of personal contacts and group meetings by studying the individual employee records maintained in the department. These records should show the dates of every employee's planned personal contacts as well as the subjects on which he was contacted. The quality of the job safety training is then checked by interviewing a number of employees selected at random to determine if they recall a recent personal contact, and, if they do, how much knowledge they have retained of the subject matter of the contact.

A fourth check sheet determines the adequacy of the planned safety observation program and the inspection program. From this check sheet the audit team determines whether supervisors are conducting planned safety observations, that is, the observation of men at work to determine if they are doing the job according to safe job procedures. They also determine from the record of planned safety observations whether supervisors are recognizing the need for reobservation where men are not working in accordance with safe procedures and, if they are recognizing the need, whether they are making reobservations promptly.

The audit team also makes their own job observations using selected job safety analyses, observing jobs being performed and determining if the jobs are being worked as prescribed by the job safety analyses. From discussions with employees, this also gives the team an opportunity to determine the general level of knowledge of how to avoid the hazards.

With respect to inspections of the work environment, each first-line supervisor should have and use an inspection checklist for his area of responsibility. The checklist should be specific to the environment. The audit team determines whether or not each supervisor has such an inspection checklist and, if he does, whether the lists are adequate, and whether an adequate procedure for correction of reported unsafe conditions is in effect. Where any of these are lacking, it is an item which requires correction.

The audit team makes a physical inspection of the department and notes any unsafe conditions, unsafe practices and poor housekeeping for inclusion in the final report of the audit.

Although most of the audit is concerned with the accident prevention activities of the first-line supervisors in the department, the audit procedure is designed to also determine whether higher departmental supervision, such as general foremen, assistant superintendents, and the superintendent, are carrying out their responsibilities in the accident prevention program. Since their responsibilities are also spelled out specifically, it is relatively easy to determine if they are being carried out. In general, the activities of higher supervision are in directing, guiding and controlling the accident prevention activities of the first-line supervisors.

After the audit team has collected all the available information concerning the functioning of the safety program in the department being audited, a written report is pre-

pared and completed before the group leaves the operation. This report, in sequence, lists the findings and recommendations of the audit team for each of the safety program tools and includes the unsafe acts and conditions observed by the audit team.

No attempt is made by the audit team to assign numerical grades to their evaluation of the department's program. It is simply a statement as to whether or not each tool is being used properly. When the audit team's report is completed, it is reviewed and discussed with the head of the department which was audited and any of his staff whom he may desire to have in attendance. Thereafter, the audit team and the department head meet with the manager of the operation, together with members of his staff, to discuss their findings and recommendations.

The audit team's job is then completed and action on their recommendations is for the decision of the manager and department head. The result of the audit is not reported to anyone other than plant personnel.

In addition to auditing by corporate audit teams, two other types of audits are in use. These we call internal audits. In one, the manager of an operation names an audit team consisting of operating and safety personnel from his operation to audit a department in the operation. In the other type, a department head selects an audit team from his supervisors to audit a section of his department.

The mechanics of auditing are the same for each type of audit. These types of audits can be used even by single operation companies.

When any new procedure or program is begun, there is always a question whether it is or will be effective. Auditing has been effective for Bethlehem. There is a very noticeable improvement in the proper use of accident prevention tools in departments audited today in comparison with departments audited at the beginning of the program.

There has also been a marked decrease in the frequency of disabling injuries. As I mentioned earlier, auditing was started as the result of an unexpected rise in disabling injury frequency. From the beginning of the audit program, however, there has been a consistent decline in disabling injury frequency. In fact, Bethlehem's corporate disabling injury frequency reached record lows during the years 1966, 1967 and 1969 to date. Any single activity cannot be given credit for this improvement, but certainly performance audits have been a major factor in the reductions.

An unexpected, but welcome, by-product of the program has been the education and motivation of the operating people on the audit teams. They have learned a great deal about the proper method of use of the tools. They have learned more about accident investigation, job safety analysis and employee training. The opportunity to spend one week on safety is in itself an education and an inspiration.

After a week of searching for weaknesses in other people's accident prevention efforts, they see how their own programs can be improved and return to their own plant with ideas for improvement.

Back Injuries

LOW BACK INJURIES IN INDUSTRY

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Injuries to the low back take their place among the problems of businessmen along with troubles in production, sales, maintenance, safety, labor relations, etc. I state it this way because all businessmen have had some experience with employees who develop low back pain which becomes a responsibility of the employer. This is true throughout the United States and Canada because workmen's compensation laws provide that an employee who gets an injury in the course of his employment must be provided with medical care and also with disability payments if he is unable to work because of the injury.

Low back injuries are not the only injuries causing problems. Hand and foot injuries and cuts and bruises are more common in those cases where the employer has a responsibility. But low back problems result in far more trouble for the employee and employer than any other injuries. It is the purpose of this discussion to examine and evaluate this fact — to review what we know and don't know about low backs — so that all involved in these cases can at least believe we are doing as well as possible in handling individual cases.

If low back injuries are so common, we should be able to calculate how frequently these occur. Figures from New York and Illinois a few years ago[1] indicate that about two per cent of all employees will have a compensable back injury every year. From these figures it could be speculated that over a twenty-year period nearly half of all employees will have a back injury at work. We know this is not usually true, and the explanation is that many of the cases are recurrent injuries in the same person. The word *recurrent* is a key word.

Rowe, an orthopedist, has reported[2] that at the Kodak Park Works in Rochester, New York, over a ten-year period, 35 per cent of sedentary workers and 47 per cent of employees doing heavy work came to the medical department because of low back pain. Many of these were not compensation cases, but it gives a clue to a fact known by many doctors, especially orthopedists and industrial physicians: that low back pain is a frequent complaint in all people. We also know that fundamentally this is because the back is "engineered" for four legged animals, and that man, when he assumes an upright posture on two legs, must extend the back about 90 degrees at the lumbosacral junction. This is where most of man's back problems occur. This knowledge is of little solace, however, since it is not likely that man will start walking on all fours again.

Low back pain in any employee is of concern to an employer, but it is a responsibility only if the circumstances cause it to be a compensation case. Back pain may begin at any time. In Rowe's study of 500 cases, only 15 per cent said their backache was caused by an injury, and an additional 20 per cent believed there might have been a relationship between their backache and some unaccustomed activity. But two-thirds of his cases could not relate the onset of their back pain to any activity.

Sometimes back pain will first occur in an individual following some week-end activity at home. After experiencing the pain, the patient will learn that if he is careful and not very active, the pain isn't too bad. When he comes to work, though, and attempts more active bending, lifting, and twisting, the back pain recurs and from this moment thereafter the back trouble is a responsibility of the employer. From a medical standpoint, this seems to be unjust, but perhaps it is not from a sociologic and legal viewpoint.

In a study conducted by Hirsch[3] in Sweden on women of ages 15 to 71 years there was an increasing number with increasing age who said they had had backache severe

enough to interfere with activities or require medical treatment. However, after the age of 54, there was no further increase in the per cent who had suffered backache. But 70 per cent of those at age 54 admitted to prior back trouble at some time in their life. At the time of the study, all women were carrying on normal activities.

As I interpret these various reports of other doctors, and in the light of my own experiences, low back pain is a very common complaint in persons from all walks of life. Also, it usually begins during ages 30-40, and recurs in episodes that last only one-two weeks. Episodes of back pain occur in these persons every few to several months and between episodes there are usually no symptoms at all. Probably half of the recurrent episodes are precipitated by some unaccustomed activity or accident and about half begin during simple acts such as tying a shoe, getting out of a car, bending over a sink, etc.

From the above it follows that most cases of low back pain are not serious and recovery will occur with almost any treatment or even none at all. During the painful period it is necessary to avoid strenuous activity. Here is a key to explaining many of our problem compensation cases which are the responsibility of the employer.

In an analysis of 12,000 compensation low back cases in Ontario,[4] more than 80 per cent were back at work in less than three weeks, and 90 per cent in less than six weeks. In a small study of 226 randomly selected compensation low back cases I made in Ohio several years ago, 90 per cent lost less than one week of work. Other reports of low back compensation cases are similar. But there are always a small per cent of cases who are off work for many months and a small per cent who never are able to return to work and are awarded compensation for total permanent disability. When these few who lose much time or never return to work are studied in detail, some interesting facts emerge.

The persons who sustain industrial low back injuries and have prolonged disability and prolonged medical treatment differ from a group of similarily injured persons who have good results with little or no loss of time from work. The "poor results" group are apt to be in their late 20's or early 30's, unskilled, with jobs that are physically heavy, they are poorly educated and often have IQ's below normal. In this group there are many who have evidence of poor adjustment to life circumstances — they have more than usual difficulty coping with family and other interpersonal problems, and with financial problems. A final, extremely important circumstance in this group is that light or modified work is usually not available to them during convalescence. In some instances these workers lack education and training that would permit temporary assignment to other jobs, but frequently the employer makes little effort to find suitable temporary work.

In contrast, those employees injured on the job but who have little or no lost time from work are more apt to be skilled or clerical workers, with better education and ability to cope with life's problems. Also, persons in this group are able to be given light or modified work of temporary or even permanent nature, or the nature of their work is such that it can be done without excessive stress on the back. It should be mentioned that of these two groups, evaluation by physicians do not reveal differences in the severity of the injuries when first examined, based on history, physical examination, and X-ray. It is just that the first group do not respond as well to the same treatment under the circumstances of on the job injuries.

The initial treatment for low back injuries includes a restriction of activity — the painful area is put to rest. This is a most important factor. Other measures are used to a variable extent, depending on the amount of pain and muscle spasm — medicine for pain, physiotherapy in the form of hot or cold packs, diathermy, ultrasound, or traction. Only those with severe persistent pain are put to bed; most are allowed up and about and most can perform light or sedentary work for at least part of the time.

The medical management just described is used whether the injury is thought to be to an intervertebral disc or a sprain of one or more of the small posterior joints or of ligaments, fascia, and muscle. Improvement usually is apparent in one or two days and often by one or two weeks all symptoms have disappeared. A few cases will have symptoms for a few to several weeks but

if improvement continues gradually, recovery will usually occur. Many persons fitting this description will have subsequent episodes of low back pain; some will have many episodes. Each one is apt to be about the same, with recovery taking place each time. A small per cent may develop evidence of nerve root pressure in the low back, with persistent pain down the sciatic nerve on one side, with numbness and weakness in the lower extremity on the same side. These signs and symptoms are often caused by a protruding intervertebral disc. Treatment is by bed rest, perhaps with traction, for two to four weeks. If improvement does not occur, surgery is undertaken to remove the protruding disc from pressure on the nerve roots. This is certainly major surgery but most such persons are improved and able to resume light to moderate activity a few weeks after surgery. The skilled craftsman or clerical worker can usually resume his regular work, even though he has occasional back pain. It is important in these cases that the individuals do accept their back trouble without panic, they tend to understand the nature of the problem and to restrict activities as necessary and do not see this as a threat to their jobs or their future life.

If we return to the group who have poor results in recovery from a low back injury, we see several contrasts. A description of a typical case will emphasize what I mean. A laborer whose work is heavy sustains a low back sprain and is taken to a physician. An examination is made, X-rays are taken, diathermy is given to the back, the patient is given some pills and told to report for diathermy daily and either to stay off work or do desk work only. No such light work is available for a man with no education or sophistication, so he is sent home. Little or no detailed explanation of the nature of the injury is given by the busy doctor, and the patient fears the worst. He fears he will lose his job (this is sometimes not an unrealistic fear). He fears also that he won't be able to get another job because of the back injury. He fears being an invalid. He is restless and concerned just from staying off work—he fears his family will think him weak and unable to provide for them. He realizes the payments under workmen's compensation will not cover his expenses and fears loss of car or furniture or home. After a week of diathermy treatments his back is better but still somewhat painful, and the doctor releases him from treatment with the advice to do light work for another two weeks. If no light work is provided, the man will be dismissed. If no light work is available, he may attempt his regular work and have a flare-up of his painful back. In either instance, he will seek out another doctor who will repeat all the examinations and X-rays and treatment. When no improvement is admitted after a week or two, the doctor becomes frustrated, calls the man a malingerer, and sends him to another doctor, probably an orthopedist or neurosurgeon. Hospitalization and myelogram follow, and now the patient is thoroughly scared. He now complains of pain all the time, so he is referred to a neurosurgeon by the orthopedist or to an orthopedist by the neurosurgeon. Probably no reason for surgery will be found and the patient will be given physiotherapy for a week or two. When released from treatment he still complains of pain, so compensation payments may be continued for a few more weeks while still more doctors, including a phychiatrist, examine him for evidence of permanent partial disability.

The future of our patient may take one of several paths from here, but often he will have recurrent back pain and eventually have surgery. The results of surgery may be fairly good from the surgeon's standpoint but the patient considers it a failure because his back is not strong. Disability is prolonged and the chances of a successful career as an employed laborer are gone.

It is fortunate that this typical case makes up only a small per cent of industrial injuries. But it is common enough that all doctors who do industrial work see quite a few. Hirschfeld has made a psychiatric study of industrial injuries that has become famous.[5] Hirschfeld studied hundreds of cases of persons injured on the job who did not make normal recoveries and return to work. He evaluated in depth what I have described simply as difficulty in coping with life's problems. In brief, he found that most of the cases who won't get well have deep seated personality problems and, prior to their injuries, were barely able to assume roles of husband, father, breadwinner, etc. When injuries occurred that took them out of their normal roles, their personalities col-

lapsed and they found it easier to play the role of a sick or injured person than to continue in a barely successful life situation. The provisions of compensation laws played into their hands and aggravated the situation. Many of these persons never achieved rehabilitation in spite of (or perhaps because of) several doctors, nurses, other medical personnel, lawyers, counsellors, vocational experts, etc.

The purpose of this discussion was said to be to review what is known about low back injuries in industry so that all of those involved could do their parts properly, thus minimizing the number of problem cases. We would, of course, much prefer to prevent these injuries in the first place. But since low back pain is so common in people, we know some of these will be called on the job injuries according to our compensation laws. The fine efforts of safety engineers have already reduced the frequency of injuries of all sorts. In the future I believe we will see much more improvement in making the job a safe place through studies of biomechanics — an effort to recognize human factors in job design. But these efforts will never eliminate the low back compensation case and its problems.

By applying the best knowledge available, we should reduce the problem cases even if not the total number. The first key person in handling employees with on the job injuries is the supervisor or foreman. A sympathetic but businesslike attitude in a supervisor can lay favorable groundwork for recovery when an employee says he has hurt his back. Unfortunately, the opposite attitude is so harmful and rather common. It is too common that when an employee tells his boss he hurt his back lifting, twisting, pushing, etc., the supervisor reacts in a negative way. He attempts a denial of injury by explaining the work was not hard, that it was usual and common activity, and further alienates his employee by suggesting he might have hurt his back at home or during recreation. This behavior by the supervisor instills and arouses fear and hostility in the employee and he must defend himself. He feels weak and something of a martyr pitted against the big company, but he knows the law protects him when injured on the job.

The supervisor will send or take the employee to a doctor, who is the second key person in our low back case. Too many doctors are not objective in handling compensation cases. One common attitude is to identify with the employer and look disparagingly on patients who come for treatment at the employer's expense. This attitude is rapidly communicated to the employee and it arouses fear and hostility. Any treatment is less effective in such an atmosphere. Paramedical personnel who assist the doctor have attitudes which influence the injured worker—most often the assistant's attitudes parallel those of the doctor. If the doctor's schedule is busy, neither he nor his office help appreciate an unscheduled patient, and this may lead to a rapid and less than thorough examination and explanation to the patient.

Another attitude frequently seen in doctors is the opposite of that just described—in this instance, the doctor identifies with the patient. This is more apt to be the case in those states that permit the injured employee to choose his doctor. In this situation, the employee who has received a punitive reception from his boss will find a sympathetic ear in the doctor, who will then align himself with his patient against the employer. This drives the adversary nail deeper between the employee and employer and will have repercussions throughout the career of this employee. This kind of doctor sees his role as protecting his patient against an unsympathetic boss. The treatment he prescribes is apt to be somewhat dramatic and long lasting, with much time off work. He may over-diagnose and caution the patient that his injury is severe and paint a gloomy picture of discs and spinal fusions and prolonged treatment. He may point out that backache will recur the rest of his life, all due to this one on the job experience. This behavior is not popular with the employer, and the boss then takes the position he will get even with the employee when he does return to work.

This story could go on and on with mistakes that lead employees to become chronic low back cripples. But I am trying to emphasize where we should use *prevention*. In the past our efforts have been directed toward preventing the low back on the job injury under workmen's compensation law by teaching safe and efficient methods of work. Certainly, this is helpful. Also helpful are pre-employment medical examina-

tions. But these are not helpful unless the physician does the history of past health and the examination with great care and thoroughness. This is often not the case unless the doctor is truly interested in industrial medicine. X-rays of the low back have been and are used by some doctors in an attempt to predict those whose back will become painful, especially under hard work. I am not impressed with X-rays as a screening device used routinely. But I have pointed out that low back pain is common in all types of persons and that most low back pain is not from accident. Our laws state simply that injuries or conditions that arise out of or in the course of work are compensable. Under this definition, we simply are going to continue to have a lot of industrial low back injuries. *Prevention* should also be directed toward the employee who has already been hurt—we should try to prevent poor results. I have said most low back injuries are mild and permit recovery and resumption of all activities. Only a few involve long disability and treatment. Many of these poor results could probably have been prevented. This is where prevention should now be directed.

Supervisors should be trained in compensation law. When an employee alleges he has hurt himself in a manner that would constitute an injury under the law, the supervisor should tentatively accept this—tentatively only in that subsequent information might indicate an injury did not occur in the manner and at the time employee stated. He should show concern for the employee, not disdain. If employee carelessness is partly responsible for the injury, it still will be the employer's responsibility to care for him; this care should be given first and reprimands later, when the job is resumed. Medical care should be provided promptly. This will depend on several circumstances. Employers should have arrangements with or knowledge of doctors who will accept compensation cases and will provide first rate care. If the employer is permitted to choose the doctor for injuries, this is much easier. Employers with large work forces will usually have a medical department at the work site, which is ideal. Physicians should be chosen who will provide proper care in an unbiased manner; we have described some of the problems if this is not so. A doctor should make a thorough evaluation of a back case; this starts with a good history, followed by detailed examination and X-rays. Then the condition should be explained to the patient in terms he can understand. Specialists in the fields of orthopedics or neurosurgery should be consulted in appropriate cases. The doctor should be alert to failure of the patient to improve gradually but promptly. Restricted activity is necessary for low back pain and this is where our first key man, the supervisor, comes back into another important role. Light work should be provided and the doctor should know this is available. Nearly all back cases can do useful work during convalescence.

I have said that certain persons tend to have recurrent low back pain over many years. When such an individual is identified he should be provided with a permanent job that is not stressful to his back and retraining given if necessary. This may protect an individual with a weak back from serious trouble involving disc surgery and fusions with the possibly serious complications that can occur with this type of surgery.

Summary

Low back pain is common in man in all walks of life. State and Federal laws provide that employers are responsible for injuries at work. Therefore, we are not going to prevent all low back injuries that become a part of the cost of doing business. Traditional safety efforts are important and should be supported by top management. But equally important is the prevention that can start after the back injury has occurred. This is prevention of poor results. The key persons in this prevention are the supervisor and the doctor. The role of safety personnel is to see that these key persons play their roles properly.

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PSYCHOLOGICAL ASPECTS OF LOW BACK DISABILITY IN INDUSTRY

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I start my presentation with two specific advantages. First, I've had the opportunity of reviewing Dr. Bond's comprehensive review of low back problems as seen from the industrial point of view. Whatever I have to say will be an extension of a selected number of topics all of which he has already touched on. My second advantage is to have read and to be able to refer to, as has Dr. Bond, a paper which appeared in the April 1969 *Journal of Occupational Medicine* by M. L. Rowe, M.D., entitled "Low Back Pain In Industry."

One of Dr. Rowe's striking finds is that 70 per cent of low back disability is primarily and causally related to intervertebral disk degeneration, which appears to be part of the aging process in a large segment of the population. Moreover, to quote from Dr. Rowe's paper, "The kind of work done does not seem to be a significant factor in the production of low back disability although it is reasonable to assume that a man with a backache would have more difficulty performing a heavy job than a light one."

What emerges apparently is that the incidence of low back disability is not related to what a man does at his job (whether he is white collar or blue collar, whether he does heavy work or light work, etc.). What *is* significant in determining what will happen to the individual when low back pain arises after the attack occurs; this depends on who he is; what kind of individual he is psychologically and socially; what his work status is; and what his overall level of psychological security happens to be.

Dr. Bond has pointed out that in those relatively few (but *absolutely* many) individuals with severe disability, the worker strongly tends to be unskilled, to have limited education, and to have low intelligence. I agree with this and should like to give you my impressionistic view of the profile of these severely disabled workers.

It is estimated that 3 per cent (or 6,000,000) individuals in the United States can be considered mentally retarded. However, the vast majority of the mentally retarded, perhaps over 90 per cent, fall into the category of mild retardation and within this group of several millions, a very great number are what we call "borderline retardates." In recent years we have begun to realize that a great many of the mildly retarded are so because they have been deprived in a variety of ways, including poor nutrition (before and after birth) and poor or pathological nurture in the early years of life.

Many such individuals grow up essentially without saleable skills. These individuals often have a good deal in common. They are not bored by simple and repetitive work, they are willing and want to please, and they are not trouble-makers — they wouldn't know how. Occasionally (and it has probably happened at least once to everyone in heavy industry) one sees a slow individual who is a magnificent physical specimen, which incidentally at least suggests that the retardation or slowness is a product not of the individual's basic inherited constitution but of a deficient environment. Thus comes the cruel but not entirely inappropriate old army saying, "A strong back and a weak mind."

Now comes the problem. We have solid hard data such as in the Rowe Study that there is no such thing as a guaranteed permanently strong back. Indeed it would appear that the back-pain-free-life is close to the exception rather than the rule. However, we find that most individuals, blue collar and white collar, can and do return to work after recovering from episodes of low back pain, and most can manage to avoid surgery. (It should be added that studies comparing private and compensation cases have shown that the latter are off work for comparable conditions for much longer periods of time.)

The individuals who return in good time, and these are the majority, are those in general who have considerable personality

strengths. Technical phrases for this are "ego-strengths" and "coping-ability." These also tend to be the people who gain support from their environment, both the family environment and the work environment.

However, the unskilled, uneducated, intellectually deprived individual is not only unable to cope with the pain and other symptoms, in addition he does not get support from his environment. His marginal psycho-social integration now becomes *disintegration*. He becomes fearful. He cannot communicate verbally and so regressively he falls back to communicating with his symptoms. This mode of communication does not, needless to say, endear him to medical or supervisory personnel. Indeed, it is not even understood as a mode of communication, a call for help. It is clear, I believe, that the picture here drawn is a psychological and sociological problem. It is not basically a back problem; it has just surfaced as a back problem.

The human body, the mind, and indeed the family and social, including industrial systems are all to a great extent what we would call self-regulatory, that is, these systems all tend to minimize deviations from the usual or from the norm. However, some problems seem to be by their nature deviation-amplifying; this is the "vicious circle" type of problem. It can be characterized by the statement: The worse it gets, the worse it gets. Very often the marginal individual with low back disability has this type of deviation-amplifying problem. What is to be done?

There are no simple solutions obviously, but in general it would be helpful if all concerned parties did have a better notion of some general principles of human psychological needs. Professor Maslow, an eminent psychologist, has listed five types of needs, the so called Hierarchy of Needs common to every human being. These are (1) physical needs (2) safety needs, (3) need to belong, (4) need for self-esteem, and (5) need for self-actualization.

We can emphasize here the third and fourth sets of needs, those for belonging and self-esteem. If we can help the individual with low back pain to feel that he is not alone, and that he can maintain a useful identity with various groups, especially the work group which provides his and his family's subsistence, we will have gone a long way to improving the chance for eventual recovery. If we can in any way maintain the individual's self-esteem we will have provided motivation which again may lead to successful rehabilitation. The individual with diminished self-esteem is prey to all the negative emotions of guilt, feelings of worthlessness, despair, and actual clinical depression.

Psychological problems do not, of course, reside only in the most serious cases. Low back pain, with or without symptoms of nerve root irritation, can evoke considerable amounts of anxiety and fear in any one, no matter how well integrated or psychologically healthy. This is largely fear of the unknown. It is natural, for example, for the individual to wonder whether the pain will persist or indeed not only persist but get worse.

Here I believe is where the physician has the golden opportunity to practice preventive psychiatry by doing a good clinical workup, which includes careful history, physical evaluation, and other appropriate diagnostic procedures. The two important steps which then follow are (1) giving clear information to the patient as to what ails him (including the use of visual aids, demonstrations, and pencil diagrams) and (2) laying out a comprehensive treatment plan. In all of this the physican should be supportive and encouraging, and emphasize the improvement that is likely to take place if recommendations are followed.

Being in a hurry and abrupt with the patient in the acute and sub-acute stages of the disability will likely be paid for in subsequent chronicity. Need I add that supervision, personnel, and safety personnel as well as medical personnel can contribute much in giving appropriate support and encouragement to the patient.

To sum up, only the occasional patient presenting a low back problem presents a purely psychological condition which has no physical concomitant. *Everyone* with a physical low back problem also has something of a psychological problem, the type and degree bearing a relationship to the level of mental health of the individual. And lastly, there are those that tend to be the most

serious and the most costly whose problems are not only physical and psychological but are further complicated by social and cultural factors usually reflecting various kinds of deprivation in infancy, childhood, and adolescence. Our failure more often than not reflects our blindness in not seeing and treating the whole man.

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Measurement of Industrial Safety Performance

TWO APPROACHES TO A NON-ACCIDENT MEASURE FOR CONTINUOUS ASSESSMENT OF SAFETY PERFORMANCE

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For those close to the accident prevention problem, the difficulties in measuring safety performance are well known and need not be elaborated in this paper.[1] It is sufficient to point out that the present measures are neither stable nor sensitive to changes in system inputs and have dubious reliability. Moreover, and most importantly, safety measures depend on accidents to occur before they can be calculated. Such a post-mortem approach means a long lead time between action and subsequent effects, both when action is viewed as negative forces (the introduction of unsafe practices) and as positive forces (such as the introduction of accident prevention programs). It is analogous to a man taking a shower with fifty feet of pipe from controls to the shower head. It is little wonder that safety directors are unable to predict performance and are usually unable to explain either upturns or downturns in accident experience.

The purpose of this paper is to take an abstract view of the safety measurement problem, indicating several useful research tools of the past to arrive at a non-accident measure for continuous assessment of safety performance. The authors have attempted to move from an academic posture to a quasi-practical approach for individual application. Two approaches based on the same premise are outlined: a passive one, in which workers need not cooperate in the elements of the measure; and an active one, which depends upon employee cooperation and participation. Both approaches are based upon the past research experiments and, thus, it must be admitted that both represent experimental proposals rather than de facto safety performance measurement techniques.

The theory of accident causation has remained elusive even with the advances of physical and behavioral sciences. We are forced to live with a causal model of accidents which in essence insists that the causes of accidents can be identified and their subsequent removal will diminish the likelihood of similar occurrence. The causal model rests minimally on the following basic assumptions:

1. Causes can be dichotomized into unsafe acts and unsafe conditions.
2. Every accident has one or more causes which can be identified.
3. Elimination of past accident causes will eliminate similar and related future accidents.
4. Contributory sub-causes for the proximate causes can be determined for most accidents. Common causes which have no objective measure or easy counter-measure lie behind the occurrence of many types of accidents, while unique causes with efficient counter-measures account for only a small percentage of total accidents.

The drawback of the causal model is that it is deterministic, and frequently it is found that accidents do not occur even in the presence of unsafe acts and unsafe environments. Moreover, accidents can occur when either known unsafe acts or unsafe conditions are absent.

At present there are two approaches to safety performance measurement being used in industry in order to determine the level of plant safety. The first approach involves the use of available historical data, i.e., accident cost, accident frequency rates, severity rates, etc. The other approach involves

indirect indices based on the occurrences of events which are believed to be related to accident causation and are statistically much more frequent in their occurrence. Measuring unsafe acts and unsafe conditions are important in evaluating accident prevention methods, training programs, safety procedures, and inspections without waiting for accidents to occur.

It is this latter approach which will be treated in this paper with emphasis on methodology for determining existing hazards, weighing the relative critically of such hazards, and operational procedures for their measurement and analysis.

The General Plan

Both the active and the passive procedures developed in this paper are basically similar in structure. Each procedure involves eight major steps and the corresponding steps in each of the procedures are functionally similar and have identical precedence relationships.

The first step involves identification of major unsafe acts and the unsafe conditions that can occur in the work area under consideration for the assessment of safety. The person or persons involved in this task should be very familiar with the operations performed in this department, the type of workers involved, their habits, the unsafe conditions that can take place, and accident reports from the work area. Since high accuracy in identifying the unsafe acts and unsafe conditions is necessary for successful applications of both the active and the passive procedures, the authors propose to use the critical incident technique for the former and detail analysis of the previous accident statistics (reported according to ASA specifications) for the latter. The approaches are discussed in the later part of the paper in detail.

The second step in the procedure is to scale all the identified unsafe acts, unsafe conditions, and their combinations (sometimes called interactions) with due consideration given to the process, equipment, working conditions, and the potential injury severity and loss that can occur in case of accidents. Each item (unsafe act or unsafe condition or their possible combination) will be given a hazard index and variance associated with such an index will be computed.

After the scaling, all the items are screened on the basis of expected frequency (step three). The methods used for obtaining the estimates of frequencies in both procedures are different. For the active procedure the method is based on subjective judgments of persons familiar with the work area, while in the passive procedure the method used is analytical in nature (to be discussed later).

The fourth step is to design a scheme for measuring (sampling) frequency of unsafe acts, unsafe conditions, and their combinations. For active procedure this scheme consists of designing check-lists, which will be distributed to plant employees and for passive procedure the scheme involves designing of a behavior and environment sampling study.

Step five is to develop a scheme (method) for obtaining scores for safety performance based on measured frequencies of occurrences of unsafe acts and unsafe conditions and the hazard indices associated with each of the unsafe acts, unsafe conditions, and their combinations. The scheme to be developed yields three scores for each of the procedures. The scores are denoted by the letters, A, B, and C in the active procedure and $\overline{A}$, $\overline{B}$, and $\overline{C}$ are used in passive procedure. The scores A and $\overline{A}$ are associated with the occurrences of unsafe acts only, and the scores B and $\overline{B}$ are associated with the occurrences of unsafe conditions only. The scores due to combinations of unsafe acts and unsafe conditions are denoted by C and $\overline{C}$. A score in active procedure represents the sum of weighted hazard indices (expected loss) for all employees in the department per period and a score in passive procedure corresponds to sum of weighted hazard indices for all employees in the department per observation.

The sixth step consists of collecting the data according to scheme developed in step four, and step seven involves evaluation of the three scores from the collected information about the occurrences of unsafe acts, unsafe conditions, and the joint occurrences of both. Control charts can then be constructed similar to statistical quality control procedures to assess the safety of the system. Inferences about plant safety can

then be drawn from these control charts and necessary corrective actions can be generated to keep the safety performance under control.

In the following part of this paper two procedures: (1) active; and (2) passive are developed and discussed for assessing safety performance in any industrial situation. Both the active and passive procedures are based on the same fundamental concepts as discussed in the preceding part of this paper. The active system evaluates the safety performance based on information obtained through the cooperation of people on shop-floors whereas the passive procedure evaluates the safety performance on the basis of the behavior and environment sampling studies developed from an analysis of historical data.

Active Procedure

The active procedure is divided into eight main steps as discussed in the general plan. The first involves the use of the critical incident technique to identify unsafe acts and unsafe conditions. This technique has been successfully employed in pilot error studies[5] and in industrial applications.[6]

The interviewer in this case will interview workers, leadmen, and foremen from the area selected for evaluation of safety performance to get details about all unsafe acts observed during working hours and the different possible unsafe conditions that have or could have existed in that work area.

For obtaining the relevant information from the critical incident technique, it is necessary to make the following assumptions.

1. The full cooperation of all individuals is obtained when they are interviewed by the interviewer conducting C. I. T. Stated differently, positive motivation exists.

2. The interviewer is familiar with the detail operations of the department under study and also the various associated unsafe acts, unsafe conditions, and the department's accident-injury history.

3. The workers are knowledgeable enough to point out their errors and can recall if asked by an interviewer.

4. The workers are fully aware of the objective of this safety assessment program and thus are not inhibited in disclosing unsafe acts and the unsafe conditions.

The second step is to scale the relative danger of each unsafe act, unsafe condition, and their combinations. Several psychometric approaches are possible. Thurstone's method of successive intervals is a scaling method that appears to be well suited to use in this case. Selected persons (perhaps all workers) who, as expert judges, are familiar with the work area can be asked to rate each of the unsafe acts and unsafe conditions and their combinations. This method also can be easily adopted to handle large numbers of experts. The assumptions made in scaling are as follows:

1. The total number of hazard levels used for scaling are small enough so that a worker has no difficulty in discriminating between various levels. (Anchor effects suggest seven levels.)

2. Workers are consistent in their scaling ability. (This has been verified in past studies.[3]

3. A worker has enough knowledge about his work so that he understands the unsafe acts, the unsafe conditions, their consequences, and the nature and severity of the hazards associated with each of these and their combinations.

4. The Thurstone's method assumes that the individual scalings are independent and normally distributed.

One of the outputs of this scaling technique is a measure of agreement called the discrimination index (DI). Large values of DI suggest that the description is either too vague and must be restated or that the item simply receives widely different views as to its seriousness. In the latter case, this is a reason to discard the item for future use in a check list. In order to come up with reasonably stable hazard indices, this scaling procedure shall be tested and retested until the hazard indices and their associated DI values are found satisfactory.

The third step is to rate each of the unsafe acts, unsafe conditions, and their combinations according to frequency. Individuals experienced in the work area are requested to scale each of the unsafe acts, unsafe conditions, and their combinations according to their relative frequencies of occurrence. This frequency analysis is necessary in designing a useful check list.

The fourth step involves designing a check list. The check list should include unsafe acts and conditions which have high probability of occurrence, a wide range of hazard indices and low discrimination indices. These check lists would be periodically distributed in the department and the workers would be asked to participate in completing the check lists. The following assumptions are made in connection with filling out the check lists:

1. Worker is interested in participating in the safety activities and is willing to cooperate in filling out the check lists.

2. Worker understands what the check list means and the purpose of the check list in connection with the study.

3. The worker can read and interpret the check list with no difficulty and has no hesitation in giving correct information.

4. The worker does not forget the unsafe acts that he and others in the department performed and the various different unsafe conditions that existed during the period for which he is asked to fill out the check list.

5. The check lists are filled out according to instructions and contain correct information.

The instructions given to the workers for filling the check lists would be as follows:

1. Before completing this check list familiarize yourself with the unsafe acts listed in the rows of the check list and the unsafe conditions that are listed in the columns.

2. Place checkmarks in the first row under the appropriate unsafe condition which you have observed during this period in your department if no unsafe acts were performed by either you or anyone else in conjunction with these unsafe conditions.

3. In each of the other rows, indicate the number (1, 2, 3, etc.) of incidences which you recall where the specified unsafe acts (rows) were performed by either yourself or someone else in the department under the specified unsafe conditions (columns) during this period.

The fifth step is to develop a scheme (method) for obtaining safety performance scores. The method suggested in this paper gives three separate scores *A*, *B*, *C* for unsafe acts, unsafe conditions, and joint occurrence of unsafe acts and unsafe conditions, respectively. The scheme for scoring involves obtaining mathematical expressions for calculating each of the scores. The mathematical expressions are derived by using the hazard indices obtained in step two and the information obtained from the check lists.

Let us assume that there are N number of employees working in the department and, at the end of a period, the total number of check lists collected is equal to n. The values in the corresponding cells (except in the first row) of each of the check lists are then added to obtain the total frequency for each of the unsafe acts and the joint occurrences of unsafe acts and unsafe conditions. Since the workers are instructed to put checkmarks in the first row, which corresponds to no unsafe act, to obtain frequency of only the unsafe conditions we add up the checkmarks for each unsafe condition.

The scores are then evaluated by the following formulae:

$$A = \frac{N}{n} \sum_{j \in I} PIUA(i) \cdot fUA(i)$$

$$B = \frac{N}{n} \sum_{j \in J} PIUC(j) \cdot fUC(j)$$

$$C = \frac{N}{n} \sum_{\substack{i \in I \\ j \in J}} PIUAUC(ij) \cdot fUAUC(ij)$$

where:

A = safety performance score for the occurrence of unsafe acts;

B = safety performance score for the occurrence of unsafe conditions;

C = safety performance score for the occurrence of combination of unsafe acts and unsafe conditions;

I = set of unsafe acts;

J = set of unsafe conditions;

$PIUA(i)$ = hazard index for i^{th} unsafe act;

$PIUC(j)$ = hazard index for j^{th} unsafe condition;

$PIUAUC(ij)$ = hazard index for the joint occurrence of ith unsafe act and j^{th} unsafe condition;

$fUA(i)$ = total number of incidences involving i^{th} unsafe act obtained from the n number of check lists collected;

$fUC(j)$ = total number of checkmarks counted for the jth unsafe condition from the n number of check lists collected;

$fUAUC(ij)$ = total number of incidences involving the joint occurrence of ith unsafe act and j^{th} unsafe condition obtained from the n number of check lists collected.

Note that A/N, B/N, and C/N correspond to average weighted hazard index (loss) per worker per period of collection of check lists due to unsafe acts, unsafe conditions, and the joint occurrences of unsafe acts and unsafe conditions, respectively. Thus, by using the scoring scheme and the information obtained from the check lists the scores A, B, and C can be evaluated.

After evaluating the scores A, B, and C they should be tested for significant correlations with: (1) first-aid frequency, (2) lost-time accidents, and (3) production efficiency, and these should be found satisfactory before proceeding further with the procedure.

Since the estimates of the variances of A, B, and C can be statistically determined from the collected data, separate control charts for A, B, and C can be drawn. The new estimates of A, B, C should be plotted periodically to assess the safety performance of the department. The procedure can be called "continuous" in the sense that the workers will be asked to complete the check lists and the information about unsafe acts and conditions is essentially fed to the safety controller regularly and compared over time. The success of the procedure entirely lies in the cooperation of the workers with the plant safety agency and, therefore, it is essential that the workers understand the importance of this procedure. This procedure is not likely to succeed if proper cooperation from men on the shop floors is not obtained.

The Passive Procedure

Information required for this procedure can be obtained by using the various accident reporting procedures, e.g., ASA Z16.2, and also the information available in the safety office from safety inspection. The Bureau of Labor Statistics has published several reports (for example, BLS Report Number 341 prepared at The Ohio State University) presenting an analysis of accident causal information, which can be used for developing the passive procedure. This procedure, therefore, assumes the availability of such information in detail according to different accident criteria and it further assumes that categorization of the unsafe acts and the unsafe conditions according to different hazard and accident criteria is possible.

This procedure also involves eight steps. Step one consists of identifying the categories of unsafe acts and unsafe conditions. The data in each of the categories will be presented in format similar to ASA specifications. The second step is to assign weights or to scale the different categories of unsafe acts and unsafe conditions and their possible combinations based on criteria such as number of days lost due to accidents identified with particular unsafe acts or unsafe conditions or the joint occurrence of both of these. Assume that each accident is reported giving the following details: unsafe acts responsible for accident; unsafe conditions present at the time of the accident; number of days lost due to the accident; and severity of injury according to ASA specifications.

The next step is to assign weights or hazard indices for each category of unsafe acts, unsafe conditions, and their combinations. To determine the hazard index for unsafe acts of ith category we obtain a frequency distribution for the number of days lost by considering only those accidents which were reported to have been associated with the presence of unsafe acts of ith category. The hazard index then can be derived from the parameters of the distribution. It appears that either the median of the distribution or the second moment about the axis passing through zero number of days lost may be used to define hazard index. No significant research has been done in this area so far, and therefore, no general method can be suggested at this moment for defining

hazard indices from the frequency distribution without further research.

After the distribution curves of accidents with the criterion of days lost due to accidents are obtained for each of the ith unsafe acts, j^{th} unsafe conditions, and for each of their possible combinations, then a suitable method can be arrived at to obtain the corresponding hazard indices.

The third step involves a frequency analysis for an unsafe act and unsafe condition. In BLS accident causal reports such analysis is already available.

Step four involves designing an activity sampling study to determine what percentage of time a worker is engaged in unsafe acts and unsafe conditions. This technique has been used successfully in the past.[2,6] A study very similar to behavior sampling can be conducted, but since we are also recording unsafe conditions (hazardous environment) and the joint occurrences of unsafe acts and unsafe conditions, it seems more appropriate to view this technique as behavior and environment sampling.

The following assumptions are made in designing and conducting a behavior and environment sampling study:

1. The observations are independent.

2. The observer has the ability to dichotomize between safe and unsafe and is familiar with the operations of the study area and can recognize and categorize the observed unsafe acts and unsafe conditions.

3. Person designing behavior and environment sampling study has knowledge of statistical sampling theory and can determine: (a) type of sampling plan (simple random or stratified random); (b) precision and confidence level desired; (c) number of observations required; (d) economic considerations; (e) scheme for randomization of observations over working period according to type of sampling plan; (f) scheme for taking observations.

4. Workers do not change their behavior when an observation is made. This can be assured by either of the following two methods: workers are unaware that they are observed; or workers are informed and are convinced about the objective of the study and are interested in safety.

The most important part of designing the behavior sampling and environment study is to design the observation sheet. Since the sampling study consists of actually observing the workers and the work area at random points in time, it is often a difficult task to observe all the workers. In such cases only a few workers can be selected for observation. The workers can be stratified according to their job description and a proportional sampling plan can be used for stratas so that the sample consisting of selected workers would represent the population of workers in the department under study.

The observer observes selected workers and completes an observation sheet for each observation. The number of observations, the time of observation and the total period over which the observations are taken are decided before the study. After conducting the study the observations can be summarized and recorded on a "Summary Record Sheet."

The fifth step is an important one, which deals with the development of a scheme (method) for scoring. The scores obtained from this scheme are denoted by $\overline{A}$, $\overline{B}$, and $\overline{C}$, which correspond to the unsafe acts, the unsafe conditions, and joint occurrence of unsafe acts and unsafe conditions, respectively. The method for scoring is similar to that used in active procedure except that percentage of time in which employees are engaged in unsafe acts and unsafe conditions exist is used instead of using actual frequencies. Note that the values of $\overline{A}/N$, $\overline{B}/N$, and $\overline{C}/N$ obtained by using this scoring scheme correspond to average weighted hazard index (loss) per worker per observation made in the behavior and the environment sampling study due to unsafe acts, unsafe conditions, and their joint occurrences respectively.

The next step therefore involves the evaluation of the safety performance score, which is done by using the "Scheme for Scoring" and the data recorded on the "Summary Record Sheet." The three safety performance scores $\overline{A}$, $\overline{B}$, and $\overline{C}$ are then checked for significant correlations with existing safety performance measures, e.g., first-aid frequency, lost-time accidents, and production efficiency, and if found satisfactory are then plotted on the three different

control charts. From these control charts inferences are drawn and the necessary corrective actions are made to accident prevention programs.

Discussion on the Proposed Scheme:

The important aspect of developing this type of dual procedure approach is the advantage that one gets in obtaining more reliable information about the safety performance. The scores obtained from each procedure serve as checks for each other. Since the active procedure relies on current rather than historical data for developing a scoring scheme it should be favored for decision making, and passive procedure should be used as a check. The frequency of such checks depends upon the support and accuracy of the active procedure. Thus, to insure that active procedure yields scores which reflect true safety performance, cross-correlation of the three sets of scores—A and $\overline{A}$; B and $\overline{B}$; and C and $\overline{C}$—should be done to serve as a check. Another important factor is that since a behavior and environment sampling study will require a very large number of observations to get sufficiently high precision for small percentages of time in unsafe acts and unsafe conditions, it should be used as little as possible as compared to the active system which is comparatively inexpensive.

As discussed in the previous section, the active procedure will be more practicable in assessing the safety performance and, therefore, it is important to make a few comments on deriving inferences from the scores A, B, C. The main idea in having three separate scores is to give a better indication of safety performance to the evaluator. The score A, being evaluated by measuring only the unsafe acts, mainly reflects the unsafe working habits of the workers in the individual jobs and the effectiveness of safety programs. If it is found that the score A remains out of control limits even after introducing new safety programs, one should investigate the methods, equipment, and the design of the work place, as the causes of unsafe acts may be related to the design of the work place and the work method where safety was possibly overlooked. A problem of this type can be traced by observing the score C, which would be sensitive to effects of safety programs, workers, and engineering, maintenance, and housekeeping. Score B would be more sensitive to changes in the plant-wide general safety precautions and safety rules.

The safety engineers should take care in drawing inferences and initiating control actions on the basis of the scores A, B, and C on the control charts. The interpretation should be based on detail investigation. Perhaps the simplest way to investigate would be to review the check lists individually and then track down the occurrences of unsafe acts and unsafe conditions, which contribute the most in pushing the safety score outside the control limits.

The safety engineer should also be on the lookout for changes in worker behavior towards safety after introducing the active procedure. Since the workers are asked to fill out the check lists, they are made aware of what is unsafe everytime they fill out the list. It may be found that just providing this check-list will improve the safety of the department. Therefore, it may not be surprising to find that after some time, the check-lists and the whole active procedure are not effective. It is, therefore, advisable to be always on the lookout for this effect and to make changes in the check-lists from time to time to see that the check-list does provide useful information and is current with unsafe practices in the work area.

Conclusions

This procedure of continuous assessment of safety performance without waiting for accidents has several advantages. The active procedure provides for worker participation and awareness. Its use may be limited to special hazardous operations, although it may be time to test the myth that workers have little interest in safety. The idea of evaluating three separate scores will help in locating specific weaknesses in the safety effort. The effectiveness of the active procedure as mentioned earlier was demonstrated from the study conducted by the author with the cooperation of the 166th Tactical Fighter Squadron of the Ohio Air National Guard and the results were encouraging. It would appear that an active procedure coupled with occasional cross checking with the passive procedure will prove to be an effective tool assessing and controlling industrial safety.

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ISSUES IN SAFETY MEASUREMENT

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Problems of observation, measurement, evaluation, and inference are probably more acute in that strange area of science engineering management which deals with accidental human trauma than in almost any other field of investigation. The basic reasons for this are inherent in the common properties of those otherwise diverse events which are classified as accidents.

To begin with, accidents are inadvertencies or errors—uncontrolled and unplanned happenings. This is simply another way of describing chance-caused events. On top of this, it is in the nature of things that man will control his environment and his exposure to hazard in such a way that the risk of accidental trauma will always be extremely small. Taken together, these properties of chance and improbability characterize a class of incidents known to statisticians as "rare events."

Since accidental happenings cannot be controlled or predicted, they cannot generally be produced or reproduced under laboratory conditions. Furthermore, because of extremely infrequent and unpredictable times of occurrence, they are not generally susceptible to direct observation.

For these reasons, most techniques for investigating the causal or preventive aspects of accidental trauma are based on post-mortem inquiry and retrospective analysis. In general, conventional procedures for evaluating the degree of hazard or the level of safety performance associated with a given behavioral situation or physical environment are based on measuring and comparing the number or frequency of accidental occurrences. As most workers in this field have come to learn, such comparisons are difficult to interpret first, because of the statistical "flukiness" which governs the occurrence of rare events; next, because each occurrence is different in its nature and its consequences; and, finally, because the expected frequency of occurrence is the product of the risk or probability of occurrence and the magnitude or amount of human exposure. The last of these elements, exposure, represents a variable which generally receives little attention even though it is accounted for on a purely arbitrary basis.

What all of this means is that the field of accident control (better thought of, perhaps, as safety management) has found itself constantly beleaguered by the difficulty of measuring, comparing, interpreting, evaluating, and hence controlling the physical and human situation of interest. In reviewing this problem, let us consider some of the requirements of a measurement system for evaluating safety management performance.

The first need is to remind ourselves that the ultimate subject of measurement is not "accidents." Rather, it is some intrinsic property which might be thought of as "safety expectation." This is a property which, depending upon the generally strong role of chance, governs the probability of occurrence of any given number and severity of human accidents during some specific future time interval or some particular amount of human exposure. This property is, of course, not directly measureable, but must be inferred from the measurement of other attributes or events which are observable—including, but not necessarily limited to, current accident rates.

Second, it would appear that it is important to measure those attributes of an operating system which relate to the specific occurrences which we are attempting to control. A useful and efficient measurement scheme need not cover all occurrences, but it should at least cover those occurrences which are the subject of particular control interest. Also, we need not confine ourselves to the observation or measurement of the events of ultimate control interest; it may be preferable to focus measurement attention on precursor events or other attributes of the system which bear some appropriate relationship. The nature of this relationship should be such that effective control of the measured properties would result in comparable degree of control of the ultimate events of interest. The important thought here is that an effective measurement system aimed at the control of accidental injuries need not be concerned with the direct measurement of injury rates, but should at least be responsive to controllable forms of unsafe activity. Also, since most control activities or interests tend to be focused on specific types and kinds of accidents, an efficient measurement system ought to have a similar sharpness of focus.

Third, it would appear that for most purposes at least, relative measurement is more important than absolute measurement. We are much more interested in evaluating the magnitude of change over time or in the comparative evaluation of two similar situations than we are in establishing the absolute level of accident risk in a given situation. This implies that any measurement concepts and techniques adopted must be capable of a reasonable degree of standardization over time and across the full range of situations, unit sizes, safety management personnel quality, etc., likely to be of comparative interest. Standardization is important in that it provides a constancy of meaning or interpretation of measures to be compared and that it ensures that observations of performances reflect only on the observed, not on the observer.

Fourth, we require measurement systems which are capable of sensing those changes or differences which represent a proper reflection of safety management effectiveness. This means that we want, if possible, to avoid measuring the effect of uncontrollable or exogenous variables (outside influences). We also want to avoid the confusion which would result from using measures of effectiveness which respond merely to differences in the quality or quantity of human exposure. This requirement represents the rationale for attention to the variable of exposure which, it should be noted, possesses both qualitative and quantitative aspects.

Finally, we require measurement systems which are capable of achieving a known and acceptable degree of precision with regard to inferences to be drawn about relative levels of safety expection. This means that the random error or chance residual associated with statistics derived from those attributes observed must be capable of statistical estimation and must fall within an acceptably narrow range. This degree of precision will in turn be a compromise between three kinds of factors: the allowable degree of uncertainty; all other elements of purpose such as specificity, timeliness, etc.; and the cost of measurement.

It is of interest to review some of the more conventional measurement concepts and practices against this background of implied measurement needs.

Conventional Measurement Concepts and Practices

Most of the measurement questions which have arisen in this field have been concentrated on the appropriate statistical treatment of accident reports. By and large, these issues are the result of a conflict between wanting to pack as much information as possible into a few simple statistics while desiring that these statistics possess similar descriptive qualities and sufficient reliability so that they can be meaningfully compared.

The following questions reflect the kind of issues which U. S. Standard Z16.1 was partially designed to resolve.[1]

1. How do we combine injuries resulting from a wide range of non-homogeneous accident situations?

2. How do we count and combine accidents which range in severity from paper cuts to fatal injuries?

3. How severe must an accident be to count at all?

4. How do we aggregate accidents which involve only property damage with those which involve human damage?

5. How do we count and combine accidents which involve the simultaneous injury of more than one person?

6. How do we allow for the fact that during different periods of time and in different situations, the quantity and quality of human exposure to risk varies?

7. What statistical treatment is required for inferring real differences and interpreting and acting upon observed changes in accident counts?

Although it would be difficult to describe the full range of conventional practice or thought regarding these problems, it is possible to take up each of them in turn for brief review and appraisal.[2]

1. How do we combine accidents which differ in nature and circumstance? Typically, accidents are combined for measurement purposes if they involve human injury or death, regardless of similarity. For example, simple lifting accidents would, ordinarily, be combined with electrocutions. While this procedure has value for gross measurement purposes, it forecloses the possibilities of more detailed examination of accident situations, circumstances, or causal factors. The principal rationale for this form of aggregation is to obtain the largest possible sample size for statistical purposes and thus to facilitate the detection of real changes or differences in the gross environment. In effect, in the absence of standard reporting categories, established procedure tends to discard important specificity and detail for the sake of statistical power and gross description.

2. How do we combine accidents which differ in severity of human injury? Three conventions apply in the customary treatment of accident data.[3] One is to ignore severity aspects entirely and to aggregate all events regardless of severity into an overall frequency count. The other is to introduce some measure of severity such as the number of man-days lost, and then to cumulate these as a measure of accident experience. The third is to separate out and report fatal accidents only. The first of these procedures has the disadvantage of being oversensitive to minor incidents, since these are always in the preponderance, but greatly amplifies sample size and statistical power. The second measure, which includes severity information, is obviously more sensitive to severe and fatal injury accidents, but at the cost of effective sample size and statistical power. The third, cumulating fatal accidents only, is a still further step in this direction, focusing entirely on the most important class of events, but with very severe statistical limitations because of the small number of events included in most samples.

To the extent that it can be argued that all injury-producing events are the consequence of the same causal structure and that the degree of injury is merely a matter of chance, there are clear advantages in a measure which includes all events in the sample. On the other hand, and more typically, perhaps, the situation is quite the opposite. Not only would a paper cut and a fatal electrocution not be of equal importance, but it is hard to imagine that they are equivalent events insofar as reflecting safety attitude, supervisory effectiveness, education, environment, or most other aspects of safety management are concerned.

3. How severe must an injury accident be to count at all? The customary answer to this question is to count an accident as an injury producing accident if it is disabling (costs a human workday). This is, it seems, an arbitrary standard of inclusion and can only be defended on grounds of reporting uniformity and convenience — which, of course, is the argument for standardization. Clearly, the lower the criterion of severity the larger will be the sample size, but the more sensitive will any measure be to the more trivial class of accidents and the more difficult will it be to establish a standard reporting basis. Recently proposed modifications to the established reporting standards have tended in the direction of lowering the severity threshold in order to augment the number of reportable events.

4. How can non-injury-producing accidents be combined with those which result in human injury? In most safety management practice these two classes of accidents are not combined since safety management by its nature is concerned only with human damage. There are, however, some who argue that non-injury accidents do indeed reflect the same type of failure experience as injury accidents and, since they are closely related events, should be included in any measurement system for the purpose of boosting sample size. There are circumstances where this argument might be shown to be valid (e.g., vehicular roll-overs), but for most applications it is likely to produce serious distortions of interpretation. For example, it would be equivalent to combining parking lot fender dents with high speed turnpike collisions. The implications of this issue are similar to those discussed above.

5. How should accidents which produce multiple-person injuries be counted? The usual treatment of multiple-person injuries is to allow the measure of severity to reflect the aggregate loss. The effect on severity rates is to decrease effective sample size by weighting most heavily those events which produce multiple damage. For example, a single automobile accident resulting in fatal injury to two passengers and a driver would be weighted three times as heavily as it would have been in the absence of passengers. This issue would tend to have greatest interest for those activities where multiple-person accidents are not uncommon (mine cave-ins, maritime collisions, bus accidents, airplane crashes, etc.).

6. How do we allow for variation in the quantity and quality of human exposure to accident risk? The problem of exposure measurement is one of the most difficult aspects of accident measurement to deal with and, consequently, has received little attention. The standard and most common technique is to adopt an arbitrary but common sense measure of exposure: man-days worked, vehicle-miles driven. To the extent that this measure does not reflect uniform quality or degree of exposure over time or between situations, then it will not respond proportionately to real changes in the hazard situation. Beyond this, it is commonly assumed that there is a linear relationship between exposure and safety expectation. There is at least one area, that of traffic safety, where it is more plausible to assume non-linearity (accident expectation is proportional to the square of traffic density as measured by vehicle-miles).

Consideration of some of the questions posed by the exposure issue will help to illuminate the problem. Is it reasonable, for example, to compare accidents per mile driven for city drivers and rural drivers? Is it reasonable to use man-hours as an exposure base for comparing the accident experience of plants or industries without regard to work force composition, tasks, equipment, working environment, etc.? Is there meaning in following changes in accident frequency rates from year to year even though job structure and content are constantly changing? There are many questions of this kind which are much easier to ask than to answer. Fortunately, this component of the measurement problem is well subordinated in most situations by the problems associated with the imprecision or variance of the accident statistic.

7. What statistical treatment is required for inferring real differences? Standard procedure ignores entirely the question of statistical inference. Performance statistics are almost always reported without estimates of an appropriate confidence interval. Furthermore, it is generally impossible to impute such a confidence interval retrospectively to a ratio statistic. It is equally impossible, of course, to make confidence statements regarding the difference between two or more of these ratio statistics.

In summary, then, and reviewing together all of the foregoing questions, one issue appears repeatedly. This is the need to consider aggregating or combining as many events as possible—regardless of similarity of cause or importance—in an effort to enlarge the sample size as much as possible by extending the range of incidents included.

It is apparent that the heart of the uncertainty problem is the small number of occurrences being compared. For example, at typical industrial accident fatality rates (.10 deaths per million man-hours), twenty fatalities per year would correspond to 200 million man-hours of exposure or to the exposure of 200,000 men over one year. Chance variation alone could cause the number of fatalities for this rate of exposure to range between 13 and 29—even if the situation were constant.

It is reasonably clear that except for the crudest kinds of comparison—such as com-

paring the safety experience of entire industries or cities over relatively long periods of time—fatality measurement as a yardstick of safety management is an exercise in futility. If measurement is extended to include all disabling-injury producing accidents, a somewhat more reliable statistic is generated, even though it may be a less valid measure of safety performance.

Consider first the improvement in reliability which would result from this extension. In 1967, the National Safety Council estimated the national work injury rate at 14.7 injuries per million man-hours of exposure, which is equivalent to 29 injury accidents per 1,000 men per year. Although the expected number of injury accidents then would be much higher than that for fatalities (147 times higher by estimate), it is still too low to serve as a reliable statistical index for most purposes—that is, for all but the largest operating units. Blind chance would cause the number of injury accidents for a work force of 1,000 men with a (nationally) average safety level to fluctuate between 18 and 40, 95 per cent of the time. It has been reported that two-thirds of all industrial injuries occur in operations with fewer than one hundred workers. The consequence of this fact is that for most units or operations the expected number of disabling-injury accidents during one year of exposure is so low that even minimally precise statistical inference regarding the level of safety performance is out of the question.

The issue of statistical reliability, arising as it does out of the limited sample sizes associated with a rare-event process, has proven deeply frustrating. It is clearly evident that it must continue to serve as the major impediment to the achievement of suitable levels of precision for any measure based on injury-producing accidents. Concern over this problem has resulted in a number of proposals for new measurement techniques, ranging from minor modifications in existing standards to radical innovations in concept.

Recently Proposed Modifications of Standard Measurement Practice

Experience with the current standards for reporting and measuring accident experience has led to widespread dissatisfaction on the part of many officials responsible for safety management activities and performance because of the statistical limitations just described. One of the consequences of this has been the development and application of various reporting modifications, generally proposed for application concurrently with standard reporting. Some of the modifications which have been put forth in recent years are described on the following pages.

1. *The Serious Injury Index.*[4,5,6,7] The Serious Injury Index represents an attempt to enlarge the sample of occurrences beyond those which are defined as disabling injury accidents. In effect, it includes certain types of non-disabling injuries along with those disabling injuries which meet the lost time criterion. These include specified kinds of non-disabling eye injuries, fractures, lacerations, and other injuries for which work restrictions are prescribed.

The proponents of this modification (which has apparently found substantial useful application), argue that it results in a more meaningful as well as a more sensitive measure of safety performance.

Other advantages claimed for the Serious Injury Index include the greater degree of specificity and detail which can be developed regarding type of accident, place of occurrence, etc., because of the substantially greater numbers involved.

It should be noted, however, that while the higher frequency of occurrence of these less severe injuries would surely tend to produce a more sensitive measure, it would also be a measure which would probably tend to reflect a different class of events and which would be extremely sensitive to such situational factors as propensity to report minor injuries and consistency of medical treatment standards. These issues ought to be susceptible to some kind of objective evaluation and clearly deserve further study.

2. *The High Potential Accident Index*[8] The High Potential Accident Index represents an attempt both to enlarge the universe of events beyond disabling injury accidents alone while at the same time generating a safety performance measure which remains sensitive to serious rather than minor hazards. In practice, a reporting system was established to encourage the reporting of all injury-producing accidents whether disabling or not. These events are then studied for the purpose of identifying

those few which, in the judgment of investigators, had the potential for serious human or property damage (estimated at 4/10 of one per cent of all accidents vs. 7/1000 of one per cent for lost time accidents). These high potential accidents represent the measurement base of interest. In support of this proposal it has been argued that indexes based merely on raw minor injury data tend to reflect reporting rather than incidence, result in pressure on reporting and minor injury reduction, and do not reflect the overall level of accident cost performance.

On the other side of this case, however, is the issue of whether the HIPO index tends to reflect changes in the level of safety or changes in the standards by which minor accidents are judged to have been potentially serious. Although there is no logical reason for excluding the role of human judgment in any measurement process, it is important to develop rules for applying judgment which can result in verifiably consistent performance. There is much intuitive appeal in this proposal and it clearly warrants intensive development, refinement, and evaluation.

3. *Property Damage Accident Index*[9] The proponents of a measurement system which includes property damage accidents point out that the ratio of property to disabling injury accidents is at least 500:1. The measurement index most commonly mentioned is that of total realized dollar cost for replacement, repair, lost production time, etc. The plan as it has been applied in practice requires a workable scheme for enforced reporting of all property damage accidents.

Although this proposal has the least surface appeal—it is not clear that property damage costs should bear any relationship to human safety—it too should be susceptible to some kind of objective evaluation.

Other Potential Measurement Approaches

In an effort to circumvent the troublesome problem of statistical reliability in accident measurement, attempts have been made to introduce other measurement techniques for characterizing the relative safety or relative danger inherent in a given situation.[10] Whereas most of the more traditional measures deal with retrospective accident experience as a basis for estimating actual accident expectation — or for gauging prospective accident experience — it is appropriate to consider possible means for estimating prospective accident experience through some direct measure of accident propensity. To be useful for this purpose it is desirable, but not necessary, to be able to transform measures of propensity directly into estimates of future accident experience, or at least insofar as the objective is to make relative rather than absolute assessments.

Near Misses as a Measure of Accident Propensity

One possibility for such application would be the so-called "critical-incident" technique. Basically, this technique attempts to obtain reports of near-misses or accidents which, in the opinion of those reporting, almost happened. It is intuitively apparent that much of the accident-avoiding behavior of individuals is based on near-miss experiences, and it is surely sound in principle to expect that operating groups and organizations can similarly profit from the study of near-miss occurrences.

The critical-incident or near-miss techniques has many values and much promise in particular for investigating causal aspects of accidents, but until now it has found only limited application as a measure of accident propensity.[11] The major reason for this is that near-miss data are totally dependent on reports from those who are part of the situation and, in fact, close to the scene. This is a requirement which is likely to result in intrinsic deficiencies from the standpoint of reliability. As a measurement technique, critical-incident recording may be less a reflection of accident propensity than of propensity to report. Beyond this, near-miss measurement is not independent of the quality or quantity of human exposure and contains the same exposure measurement problems as actual accident data.

Nonetheless, although it is far from certain that the various problems of definition (what events are to qualify as near-miss?), of reliable reporting, and of exposure measurement could be solved well enough to develop a continuing and wisely applicable measurement system, there appears to be enough promise to justify serious developmental effort. Of all of the proposed measurement techniques which do not depend upon actual injury or fatality data, this one possesses the strongest face validity as an index of accident propensity. The issue of

statistical reliability will surely be less acute since near-misses probably range anywhere from tens to hundreds of times more frequent than actuals. This greater frequency should make it possible to categorize more finely the types of occurrence and to avoid intermixing potentially trivial with potentially serious incidents.

A recent contribution to the potential applicability of the critical-incident technique has been the development of a data collection procedure which employs a stratified random sample of participant-observers who are asked to recall and describe unsafe errors or conditions which have come to their attention.[12] Employing periodic samplings of this kind might enable the development of a useful index of safety performance. Clearly, much work remains to be done to establish that this measure is not only one which is statistically reliable but also constitutes a valid reflection of safety expectation.

Without attempting to spell out the details of the work that might be undertaken along these lines, it should be possible to establish a number of experiments in various installations to study various forms of near-miss data collection procedures. The key procedural stumbling block will be the development of a stable operating method for collecting data so that any near-accident which falls within a specified description and a specified closeness will be equally likely to be reported.

In essence, what is proposed is the initiation of experiments to establish whether or not the critical incident technique has potential application, not simply as a means for studying accident causation, but as a measure of accident propensity oriented towards the larger purpose of safety management. The question is not whether this technique has potential but rather for what situations its potential is greatest. There are some applications—near-collisions to commercial airliners, for example—where the combination of professional reporting and self-interest would surely favor successful application if effective procedures can be developed.

Unsafe-Behavior Frequency as a Measure of Accident Propensity

There exists another, little known, proposal for measuring accident propensity which deserves further testing and development. As originated and tested by Schreiber, it includes three basic properties.[13] First, it is based on the direct sampling of specified types of deficiency or discrepancy with regard to human action or behavior. Second, the sample size is directly controllable through the number of observations or opportunities selected. Third, it allows for the identification of change in the level of accident propensity through a form of statistical control chart technique which is analogous to that employed for statistical quality control.

In practice, this technique consists of using trained observers to examine or inspect operations under safety surveillance on a carefully scheduled basis (with respect to time, locale, etc.). Each observer is required to note the behavior of a given sample of operatives and to record each instance in which a specific breach of safe practice is seen to occur. From these observations a discrepancy fraction statistic can be developed on a daily or weekly basis as the roof measure of accident propensity. Schreiber has shown how appropriate statistical confidence intervals can be calculated and statistical control charts developed. He has demonstrated the actual application of this basic procedure to a variety of hazardous operating situations over time periods lasting as long as several months and has indicated the utility of this type of measurement system for identifying changes in the level of accident propensity and for correlating these with known or suspected changes in the social and physical environment.

There would appear to be promise in extending this basic measurement idea to a wider range of applications and in exploring a variety of observational and statistical techniques. For example, it should be possible to develop sample measures of accident propensity for purposes of comparing two or more situations of similar nature. To illustrate, the frequency with which established safety rules (such as not wearing safety glasses, standing under operating hoists, smoking in unauthorized places, etc.) are violated could readily and meaningfully be compared between divisions of an organization or between shipyards. Sample measurements of safety knowledge or skill could be compared between drivers or operators from various installations. Proper condition and functioning of equipment can be sam-

pled in exactly the same way and used as a basis of accident propensity measurement. In fact, it should even be possible to develop composite indexes which combine sample observations of many aspects of operator behavior, equipment condition, safety knowledge, etc. These indexes would have known statistical propensities, would not be of limited reliability because of sample size restrictions, and most importantly, could be constructed to reflect the controllable aspects of safety management.

Summary of Progress to Date

In summary, then, it is seen that the conventional standard measures of safety effectiveness have serious, perhaps insuperable problems, insofar as the principal purposes of measurement are concerned. Foremost among these is the problem of statistical unreliability due to the variability of a rare-event process in combination with small to very small sample sizes. This problem is basic and cannot be bypassed by refinement of interpretive procedure.

Attempts to circumvent this obstacle by such means as aggregating non-similar events, extending base measurement periods, lowering the severity threshold to include non-disabling injuries and even non-injury accidents have been proposed. While modifications of this kind tend to relieve some of the problems posed by statistical unreliability, they necessarily tend to cast doubt on the validity and significance of the results reported and to reduce the meaningfulness of the entire measurement process. Despite these problems there are reports of satisfactory experiences with some of these modifications.

In addition to questions on accident classification and reporting, there are complicated problems of exposure measurement which differ from situation to situation and which importantly detract from useful interpretation. There has been relatively little discussion on this issue, yet anyone with experience in this field appreciates its contribution to the confusion produced by the "accident numbers game."

The major alternative route to a concept of measurement based on the recording of actual injuries is one which deals instead with the concept of accident propensity. Accident propensity is, of course, only a concept and as such cannot be measured directly. But it can be considered to have many components or ingredients, which are measurable. Some, perhaps many, of these ingredients are measurable with considerable precision, and it may well be that these can be combined to form some kind of an acceptable index of accident propensity.

One type of accident propensity measure is the frequency of occurrence of various kinds of near-misses. These can be sampled within specific categories or classes of occurrence or can be combined into aggregate indexes. This measure, of course, still requires consideration of the exposure factor and is still not entirely free of reliability and sample size limitations. Some work has been done in attempting to apply this idea although it is not yet possible to establish its merit.

Another type of accident propensity measure is that of unsafe-behavior frequency. This can be applied to any specified type or form of unsafe behavior, unsafe condition, or unsafe equipment. It is independent of exposure variation, possesses controllable precision, and is directly related to the effectiveness of both general and specific safety management programs. This, too, has had some intermittent application — enough at least to establish feasibility if not value.

It should be pointed out that neither of these latter measurement concepts has been developed much beyond the proposal stage. Both require considerable conceptual and practical refinement as well as extensive practical testing and evaluation. In view of the increasing dissatisfaction which conventional methods have encountered, further exploration of these possibilities seems warranted. And of course, there will be other schemes put forward from time to time which may offer superior promise and which will require careful test and evaluation.

Further Development of Safety Measurement Concepts and Techniques

Any reasonably objective outsider reviewing the development in this field can't help but feel a certain sympathy with the dissatisfaction and frustration which conscientious practitioners of safety management must be experiencing. In most small and medium size operating units (which account for the preponderance of all accidents), it is virtually impossible to apply standard safety measurement codes and come up with reliable esti-

mates of safety effectiveness. In larger units, it may be possible to develop gross comparisons with some precision, but it is difficult to do this with enough detail and specificity to provide strong guidelines for action.

At the same time there are a number of proposals for modifications of standard practice and even for entirely different measurement concepts—still oriented towards the basic measurement purpose of safety management—which hold some promise for fruitful application. Unfortunately, there exists no reasonable scientific evidence which would make it possible to assess the validity of claims and counter claims for these. In addition, what practical support there is tends to consist of unsupported statements by the authors of these proposals asserting that successful application has been made. Beyond this, of course, some of these proposed measurement schemes are still extremely crude and primitive with much refinement and further development required before any useful application is likely to result.

Where do things go from here? How are these refinements to be accomplished and tested? How are these and possibly other conceptual innovations for safety measurement to be tested and evaluated in such a way as to replace innovators' claims with the much more convincing weight of objective and technically sound evaluation? Consideration of these questions suggests that the fundamental research challenge in this field is not that of developing more sophisticated statistical procedures or more imaginative measurement system proposals. It is the need for some plan to develop, refine, and definitively to assess the abundance of existing procedures, proposals, and possibilities.

For example, consider just one of the more promising of the recent proposals, the High Potential Accident Index (HIPO). How are standard procedures for judging the potential seriousness of recorded accidents to be established? How can the reliability of these investigative judgments be evaluated? How can the relationship between the HIPO index and other known measures of safety expectation or accident propensity be determined? How can the areas for possible useful application be established? How can needed validation data for management purposes be generated?

Ordinarily it might be assumed that this problem, like most of those of an applied nature, would be solved in time. Decades of trial and error experience, gradual accumulation of successful case studies, occasional student dissertations, evaluation of successively more powerful procedures and refinements probably would, within a half century or so, begin to weed out ineffective proposals and bring the stronger measurement system possibilities to the surface.

Can this tedious, drawn-out, costly route of improvement be accelerated? Perhaps, although at this time there does not exist any effective means for doing so. Yet, if this is in fact an area which has room for scientific investigation, then what better place to apply disciplined experimental research and development than to the fundamental measurement process.

One possible scheme for doing this would be to establish a national industrial safety research "laboratory"—under either federal or private auspices. The laboratory could readily be assembled since it need not consist of $200 million linear accelerators or $90 million radio telescopes. The basic laboratory requirement is simply met: real people functioning normally in existing work situations. It could, for example, be organized to consist of cooperating plants, factories, facilities, and installations belonging to the federal government or to other cooperating agencies or private corporations. The laboratory staff might be organized to include experienced safety engineers as well as representatives of appropriate disciplines such as psychology, statistics, medicine, etc., all combined into an integrated central research group. Possible facilities could include shipyards, ammunition plants, defense plants, overhaul shops, motor fleets, naval ships, manufacturing plants, etc.

The mission of this laboratory would be to conceive, develop, refine, test, apply, and evaluate alternative measurement schemes and proposals to form the basis for future safety management application. Since many of these proposals could and in fact should be tested concurrently it would be possible to study them in side-by-side application. These studies could be continued over many years if necessary so that longer-term deficiences and problems would have an opportunity to reveal themselves. In time, perhaps, the scope of interest might be

broadened to include the investigation of countermeasure effectiveness as well.

Some of the specific areas of measurement study and research might include the following:

1. *Refinement of Technique for Various Measurement Concepts*—exposure measurement concepts and techniques; sampling and interview schemes for near-miss recording; techniques of surveillance for unsafe behavior sampling; standard judgmental methods for high potential accident analysis.

2. *Research to Validate Measurement Concepts*—statistical relationship between disabling and non-disabling injury rates; statistical relationship of near-miss frequency rates, unsafe behavior frequencies, and disabling injuries; correlation of ratings between investigators judging high potential accidents.

3. *Research on Interpretation Techniques*—evaluation of statistical control chart techniques for identifying assignable causes; evaluation of statistical problems as a function of unit size; appraisal of techniques of classification of occurrences to provide homogenous categories.

This list of possible fields and areas of inquiry could of course be extended at length in order to facilitate both development and evaluation of all of the aspects of both new and established measurement ideas. Open publication of all results would help to communicate data of interest both to the safety engineering profession and to the research community.

Finally, if competent scientists and engineers sponsor and conduct these studies, it should be possible to establish a technically authoritative publication. This would have convincing impact on the professional safety management community at large with the result that useful findings might win much faster acceptance and might find their way into successively more valuable standard measurement and reporting systems.

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THE MEASUREMENT OF SAFETY ENGINEERING PERFORMANCE

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For centuries puzzling problems have been yielding to the power of facts scientifically marshalled, but among the many enigmas which remain some, though important, will not be solved unless their merits are realized more widely.

How to implement safety most effectively is one puzzle whose virtues have not yet commanded enough interest to enable its mastering. And the absence of a reliable safety performance measure may be as responsible for the lack of interest in a solution as it is the result of our inability to answer the question satisfactorily.

Characteristics of the Problem

Although there is reason to believe that society has been seriously concerned about safety since at least the beginning of recorded history, there does not seem to have been much realistic effort to achieve it. At most, safety has known sporadic popular attention and then only with respect to incidental issues which surfaced out of the mass of inadequacies and inconsistencies which create the hazard control problem.

Safety Is a Function of Emergencies

Practically without exception a dreadful event (for example, the 1968 Mannington coal mine catastrophe) or an increasingly intolerable injury and property damage experience (such as the familiar automobile accident totals which seem to grow annually) has been the initiator of every new safety consideration. Each is dealt with as if it were a distinctive disorder to be corrected, when in fact most likely these unwanted events are symptomatic of a larger systemic deficiency which must be corrected *in toto* or the incidental failures will persist — as indeed they have.

In the absence of practically any understanding that the complex safety problem cannot be solved by the simplistic approaches consistently used to attack it and because the inciting events demand quick attention, hasty antidotes usually are proposed. But when time has pushed the initiating event into the past, the improbability of an immediate recurrence encourages acceptance of the expediency as "good enough." It is permitted to stand, usually without challenge, until a new intolerable experience occurs. Then another expeditious remedy is likely to follow. Thus, safety has developed relatively haphazardly. Surely, reacting to emergencies generally does not allow the time to be taken that normally is needed for studying a problem. A solution, under such circumstances, is likely to be inadequate. Often, it is little more than a fixing of the obvious or assumed failure points. Indeed, the practice of safety seems to be essentially a patchwork of expediencies.

Prescriptive Correctives Dominate

As one safety step after another developed, the substantive as well as the expedient accumulated, until now there is a massive store of regulations, codes, rules, standard operating procedures, and safety program techniques. An observer can easily conclude that the answers to accident problems must be given either in the existing safety recipes or in some which eventually will be devised. Under the circumstances, continued reliance on established corrective prescriptions is not surprising. Their acceptance is so strongly fixed and their application is so widespread that it seems almost impossible to deemphasize reliance on them.

In the presence of almost endless lists of patent hazard correctives, most accidents, it would appear, should be preventable. That they are not has been frequently evident. The resulting frustrations probably account substantially for the popular emphasis on safety awareness programs, since errant behavior may be the most visible explanation for accident prevention failures. The rationale seems to be plain: given a resource for countering established accident causes, only ignorance of its applicability or benefits will limit its use. This uncomplicated notion suggests the need for safety observance promotions where

it is seen that established accident prevention procedures are not employed diligently. And the implication seems clear that when the promotional programs are implemented fully, accidents can be stopped. However, such simplism, which familiar safety efforts frequently exemplify, overlooks the complex nature of the hazard control problem and thereby disables the development of reliable safety performance measures. Safety achievement also is handicapped.

Indeed, safety awareness may not be a significant day-to-day deficiency at all. At least not in the United States, where safety education often begins in the grade school, if not at mother's knee. And safety reminders abound all around. The benefits of safety and the substance of its common recipes surely are known. But what is unknown—or perhaps, more accurately, what is difficult to relate—are the advantages and the disadvantages of the safety option in an inherently hazardous situation where some attraction exists and where the likelihood of immediate or significant harm does not seem too great. Rewards often require some exposure to risk. But how much? What are the tolerances for the harm to be expected from an unwanted reaction, if it occurs? Can an event be controlled to an acceptable level? These are some of the questions which knowingly or intuitively in some degree seem to occur in decisions involving the application of safety precepts. Therefore, it would appear that safety achievement is best not measured simply in terms of the occurrence of unqualified events, with an absolute null point as the performance objective. Reality seems to deny such a premise.

The Safety-Risk Paradox

There is a normal predilection, it seems, for taking risks if the possible consequences appear more attractive than the apparent probability and degree of harm that exposure to them may present. When the choice goes awry, plainly a bad judgment was made. But the ambivalent attraction between safety and risk apparently is a deeply ingrained human bent, which often disables wise decisions. And it does not seem to be alterable easily, even though current and historical disasters clearly teach the need for cautious risk selection and control. Caution therefore remains more an admonition than a precept. Yet this may not be altogether unfavorable, although in the view of conventional safety objectives it may be anathema to think so.

Daring and impatience may have enabled man's progress as much as they have occasioned countless costly interruptions in his pursuits. It seems that there is in general an intuitive recognition of the need for venturesomeness which opposes the obvious desirability of safety. Society, like the individual, apparently responds to day to day perils—in accordance with the dictates of the most influential culture and needs at the moment—by accepting a level of safety that it finds tolerable. Thus, a zero accident incidence, although ideally desirable, is not the universal standard for safety effectiveness. And administrators, on whom safety achievement depends, probably cannot be convinced that they should be held accountable for such ideal effectiveness.

The safety risk paradox may seem incidental among significant puzzles, but for the manager and scientist who will bother to be interested in its implications a fascinating consideration appears—one that should be worthy of the best and most intensive effort that can be marshalled to weigh it, since it seems basic to the whole problem of achieving desired goals through organized effort.

The inclination (and sometime need) for chance-taking appears to be fundamental in daily living. Venturesomeness indeed may be as responsible for human progress as the quality of the intelligence that has employed it. Its importance to society seems to be understood implicitly as evidenced by the familiar toleration of ventures which end adversely. Usually it is only when undertakings involve perils which are thought to be harmful almost immediately and in an intolerable degree that the prospects are considered unacceptable. Frequently it appears that the level of objectionable consequences is largely and exclusively a function of the expected gain from the venture. Risk vs gain trade-offs seem to be assessed instinctively (but sometimes analytically) according to such criteria as the threat to the mission, the probability of a harmful consequence, the degree of physical loss and suffering which could occur, as well as the sensitivity of legal and ethical relationships inherent to the venture and which are balanced more or less against the rewards expected from taking the risk.

Safety Performance Measurement Considerations

It seems that the determination of what is safe (or, from a risk-taking point of view, appropriate) is based on a fluid set of values. People appear to want protection principally from the kinds of harm they cannot tolerate, but the tolerances are not uniform. They seem to vary from individual to individual and within the individual according to the several discretionary factors he sees.

Safety Decision Variables

There are four judgement factors which, although not usually calculated rigorously, may intuitively govern safety decisions:

1. The likelihood (probability) of an unwanted consequence occurring.
2. The maximum degree of harm that could result from the consequence.
3. The social-sensitivity of the issues associated with the possible consequence (i.e., their legality, morality, or ethicalness).
4. The magnitude of the gain expected from the action taken.

Possibly each factor is related instinctively in some degree when a decision is required.

The immediacy, harmfulness, and visibility of a possible consequence ordinarily would govern the thoroughness with which a safety decision is reached. And motivational factors, which derive from the individual's heredity and culture, probably influence any interpretation of the results and the action taken. Thus, while it may be possible to regularize the process whereby a safety decision is made, it may be unlikely that any result would be weighed identically very often. And so disparate actions, with preventable accidental events following, probably are to be expected. It appears that a performance measure which uses accidental events in some scalar fashion to quantify safety effectiveness can not reliably and validly reflect the quality of the safety process. But when it is considered that perhaps the more common safety decision necessarily is not always to avoid hazardous situations, but rather to enter them when it is believed an unwanted consequence (if it should occur) is limited to an acceptable level, then safety performance is seen to be at least as much a function of the success in limiting consequences as in preventing them. A meaningful safety performance measure necessarily, therefore, would seem to be concerned with appraising the effectiveness with which events are controlled to levels which cause no greater harm than the individual (or the system) is prepared to tolerate. The variances in objectives, which influence safety decisions and consequences, are seen frequently in conflicting intentions at the administrator-operator interface and consequently they deplete conventional admonitory safety programs.

Safety Performance Measures Are Important to Achievement

When striving for accomplishment it appears that objectives — and the variations which occur in their interpretation — are not the only obstacle to achievement. Drucker[1] points out that "The real difficulty lies indeed not in determining what objectives we need, but in deciding how to set them. There is only one fruitful way to make this decision: by determining what shall be measured in each area and what the yardstick of measurement should be. For the measurement used determines what one pays attention to."

Safety achievement relies heavily on management effectiveness. In our society, we organize the efforts of individuals to achieve common goals. This requires leadership at each level of the hierarchy. A manager cannot prevail however unless his objectives are clear, and attainable, and measurable. Then he is able to plan to meet them, assign appropriate responsibilities to his subordinates and determine accountability for their performance. Otherwise, direction becomes intuitive, as so often seems to be the case in safety.

When the performance measure is relevant and reliable — at least to the point where its margin of error is acknowledged — it can feed back information that is useful for correcting systemic deviations. This is the expected purpose of gaging devices generally. It is a value that is sought particularly in measurement applications for management systems. It should have critical importance therefore for optimizing safety since, as in the case of many functions which may not be reliably carried out unless there is management* of the performance effort, industrial safety achieve-

*The work of managing is considered here to be persuading others to work — usually with respect to standards that are established for individual jobs.

ment relies to a large extent on such directorial influences according to how they are expressed downwards through the organization's echelons. Indeed, the industrial hierarchy is an outcome of the need for distributing and channeling the responsibility, authority, and accountability for fulfilling the corporate objectives. Safety is no more likely to be accomplished than any of industry's responsibilities if the hierarchical chain does not activate it as well. For this reason it appears especially important for the safety performance measure to be responsive to managerial measurement requirements. This suggests that the measurement device should assist, in its area of application, the fulfillment of the steps which generally comprise the work of managing. The manager plans the accomplishment of his objectives, organizes to achieve his plans, coordinates the workings of his organization, and then measures its progress, providing thereby a loop which enables optimization according to the sensitivity, clarity, reliability and validity of the measure's feedback. It is "the means of self control"[2] and its implications for safety achievement seem clear.

In its design or selection, there is the artful influence on achievement which a performance measure exerts that must be considered or it may in fact misdirect the effort. Drucker reminds that "The measurement used determines what one pays attention to."[3] And so it appears that the measure should deal clearly with what it is that is essential to the performance objective. If not, something other than the wanted results may obtain. Perhaps to a significant extent this likelihood has inhibited safety achievement.

Measures of safety performance customarily have been "accident rate" yardsticks probably on the supposition that numerical differences in accident tabulations, over periods of time, mirror the relative intensity of safety's programs. However the types of events that are measured, semantic differences in definitions, as well as frequently dubious relationships between a zero (or even changing) incidence rate and the quality of the safety effort are inclined to disqualify accident rates as meaningful indicators of safety performance. Common experience indicates that when given goals which are unrealistic, people generally choose performance levels that suit their convenience, knowing that they cannot be held accountable for failing to reach an ideal. Moreover, accident indices, by focusing on the zero rate as the implicit objective, tend to direct the safety effort toward risk avoidance (i.e., accident prevention) when the common inclination (or capability) may not generally permit the achievement of absolute safety perfection. The interest instead seems to be concerned with taking on risks, when they hold some attraction, and when the consequences will not be intolerably harmful. In such a circumstance the accident prevention ideal—as a constant objective—may be unrealistic and is likely to be qualified by performers according to what they consider to be their practical needs. Safety in practice, therefore, often becomes a complex problem involving establishing the merits of a risk as a function of its inherent hazards as well as determining the acceptability of available safety measures to control it. Indeed, safety is not a simple matter of avoiding inherently threatening activities or devoting one's self to proper but restrictive precepts. Consequently, irrelevancies are apt to occur between accident rate expressions and real day to day hazard situations which may falsify the usefulness of accident data for feedback on the course of safety performance.

Course of Action Determined By What Is Measured

In order for a measure to be reliable it is of paramount importance that its units be employable with reasonably duplicable accuracy by all who are trained to apply it. Then the information obtained can be interpreted reliably among analysts and intelligent inferential dialogue becomes possible. The accident unit of popular safety measures, however, does not permit such transference of interpretations. It may not even allow intelligent explanations of their observations by individual measurers.

This limitation is due partly to the absence of a standard definition for "accident." Dictionaires, for example, indicate the vagueness of the term by giving the differences in its usage. But even the most complete reference apparently cannot cope with the variety of shadings that apply. A rose may be "a rose is a rose," as Gertrude Stein says, but an accident is not always "an accident," speaking either colloquially or technically. Popularly, it may be an "injury,"

although there does not appear to be any lexicographic support for this synonymity. On the other hand, "accident" rarely is used as a synonym for "fire" or "infection," even though either may be harmful and sudden and, like injuries, may be reduced by studiously applying established diagnostic techniques and safeguarding principles. Furthermore, an unexpected, unwanted event which happily produces no injurious consequence rarely is classified as "accidental," although the dictionary would seem to permit that label. But a most distracting variant is the practice of identifying as "accidents" the injurious events which were predictable and whose consequences could have been controlled satisfactorily. In the writer's experience, the larger proportion by far of the industrial cases seen are so identified. Such events do not completely satisfy the condition of unexpectedness which the word "accident" connotes but, by implying uncontrollability and unpredictability, the accident label in these cases falsely suggests the cause is at least in part attributable to circumstances beyond the influence of those responsible for its elimination or control. The insidiously destructive effects of a partial excuse for the occurrences (i.e., "It could not be helped. It was an accident") and the resultant stricture imposed on the application of accountability in managed systems ("A man cannot be answerable for what he cannot help") erodes the base of the safety performance effort. Besides, the differences, though they seem small, can affect significantly the interpreting of measures which are based on such data.

But making the accident label more understandable without clarifying what is wanted or meant by safety performance would not settle the issues of the safety performance measurement problem. As Drucker pointed out, the measure determines what is attended to. Presently, the safety experience indicators focus attention on classes of events — principally fatalities and disabling injuries, but implicitly on all injuries as well. The thrust of the interest in safety therefore is in the direction of reducing injuries (or synonymously, "accidents") to the zero point. And the approaches followed, perhaps logically and appropriately under the circumstances, employ guarding and safe practice steps which hope to neutralize injury producing exposures. However, it is the opinion here that the control of such events involves concepts and methods which are far more complicated and encompassing than those conventionally concerned with reducing injury totals; and that devotion to injury reduction distracts from the central need for developing a body of effective hazard control knowledge. This necessity may be seen most clearly perhaps when the nature of safety engineering work is considered.

Safety engineering presently appears to be without definition. Almost any form of accident reduction program may be graced by the title. Semantically, however, it would seem that safety engineering should be concerned primarily — if not wholly — with the application of science to the properties of matter and sources of energy in the pursuit of man's safety. If this were its practice, it would approximate engineering work generally. But it would be differentiable, nevertheless, by virtue of its special engagement in the identification and practical control of failure points in operating systems. It would be separable as well from safety management, safety education, and other functional safety titles which might seem to have special roles to play but are involved usually in similar accident reduction objectives, often without any remarkable difference between their approaches. However, there is a question as to whether an engineering specialty in safety has a role to play. It is of interest here since the measurement of safety engineering performance, which is the concern of this paper, would be only an academic proposition if the work to be evaluated had little or no substance.

Engineers generally, in their professional practice are well aware of the importance of safety, and are attentive to it. Therefore, unless the safety engineering function truly has a special purpose it can be a hollow occupation and may be filled easily by almost any type of safety approach. But when the complexities of the requirements for controlling unwanted events are considered, safety engineering*, it seems, may have sig-

*In this discussion, safety engineering is considered to be essentially the scientific application of engineering and related knowledge to the problem of identifying systemic failure points and evaluating their risk with respect to the effect of possible countermeasures. The overall objective, then, is to develop information which will enable the designing of systems so that their inherent hazards will be known, assessed, and eliminated or controlled practically to an acceptable level of risk.

nificant value. The implications of its practice suggest it may provide the key to solving the troublesome day to day problem of controlling hazards**, practically, in operating systems.

The need, and the capability for satisfying it, to which a properly constituted engineering specialism in safety could respond may be evident when it is considered that engineers generally often treat trouble spots — which seem to have a small possibility for causing harm — as if they had no probability of occurring. The major determinant usually is the degree of consequence that is thought to be possible if a failure should occur. The greater the expected severity, the more the show of concern. This is a necessary and often proper posture if designs are to be developed practically. However, when the information upon which such judgments are based is deficient, an incorrect decision will follow. In this view, there are no bad safety decisions, just bad information.

Inasmuch as an implicit objective, if not the specific duty, of responsible leadership is to safeguard against serious deterrents to its mission and particularly to limit the risks which may be inherent in its ventures, definitive information on the presence of perils, their criticality, and means of control may be said to be imperative. Such intelligence, however, is not usually readily at hand. Its development generally requires aggressive inquiry that is conducted systematically from an informed vantage point. It is believed here that this requirement is not met normally and that it demands a special occupation if the complex information that often is needed is to be provided. This specialty, it seems, occurs in the practice of safety engineering as it is regarded in this paper. And when the performance of safety engineering is considered, its effectiveness would appear to be a function of how well *management* is enabled to reduce to the lowest practical level the risks which occur in its operations. Although safety ordinarily is concerned principally with injury-accident reductions, this interest may not be deemphasized but in fact implemented more practically by the characteristics of a performance measure as implied in the above consideration.

Engineers (and managers) are concerned with completing assignments according to certain goals, usually function, performance, schedules, and cost. And influence on each are attended to normally according to the magnitude of the affect that is experienced or sensed. The severity of a possible consequence, particularly when recognized before an event has occurred, therefore is a powerful inciter to action. It is a sensitive subject to which alert administrators respond and which may provide a base for measuring safety engineering performance, since it is meaningful, relates to a critical area of managerial interest and, therefore, has some good expectation of being attended. It will be seen later in this paper that an investigation has indicated there may be a substantial relationship between administrative effectiveness, represented by the ability to limit the unwanted increases in cost that are caused by unexpected contingencies, and the organization's ability to limit severe injury occurrences. The price of progress is risk. But when it is considered that there are implicit (and often explicit) delta limits for the severity of a consequence if a risk is taken, as well as for the practicality of its controls, the engineer (and other decision makers) must have knowledge which will enable the best balanced decision within the necessary tolerances. A frequent complication in the implementation of safety is the fiscal relationship between prevention and the possible cost of unwanted events. While it may be argued that accident prevention reduces expense, this may not always be so. Many times the cost of control may be considered to exceed the estimated damage. Certainly, with an increased investment in control functions, damages can be expected to reduce. But at some point a practical fiscal optimum occurs. Usually this is not calculated. The relationship between damage and control costs is evident.

Often the information required for a judicious safety decision is not immediately at hand, particularly when the risk-cost-gain consideration involves a number of variables, as well it might in many operations.

**Here hazard is differentiated arbitrarily from risk. A hazard in this context is considered to be any threat, peril or possible cause of harm, while a risk is viewed as a hazard whose potential for producing harm (and rewards) has been evaluated and is known. Thus a risk, *as conceptualized in this paper*, is a hazard whose degree of harmfulness, probability of causing harm, social sensitivity, and merits, if any, have been determined as reliably as may be possible or necessary.

There is a distinct need therefore for a specialized function to systematically assemble, analyze, and distill data which can persuade correct decisions. Such work appears to be uniquely that of safety engineering (even though it may seem to be intrinsic to the responsibilities of engineers generally) since experience indicates that engineering designers are inclined to view their projects broadly with respect to their missions, frequently missing thereby incidental failure points in the system. Unidentified hazards and others which though recognized were not pressed, on the assumption that they were insignificant, often have triggered unwanted consequences which have severely affected the public as well as employees. Safety engineering performance therefore is seen to be unmeasurable by standard means inasmuch as they reflect simply the rate of disabling work injury occurrence.

Accident-Injury Data Base Measures

The most common methods of quantifying safety performance are ratios of unwanted events (generally a specific classification of injury), and the exposure usually stated as a function of time, e.g., man-hours in measures of work injury experience.

Frequency and severity ratios are the accepted standard[4] measures by which a company appraises its work safety effort. Generally, these terms express the incidence of major injuries and the severeness of the major injury experience, each with relation to the man-hours of work exposure during the period that is measured.

The ANSI standard Z16.1 defines work injury as "any injury suffered by a person which arises out of and in the course of employment." Injury is construed to "include also occupational disease and work-connected disability."

Only disabling work injuries are used in determining the frequency and severity rates. However, since time-loss is the value factor to which the standard measures relate, the injuries tabulated are described frequently by the sometimes misleading term "lost-time cases." The standard describes four types of disabling (or lost-time) injuries which are summarized here:

1. *Fatality:* Tabulated irrespective of how long after the work injury occurred if death is attributable to it.

2. *Permanent Total Disability:* Any injury which (by the standard's definition) irreversibly incapacitates the individual for employment in a gainful occupation.

3. *Permanent Partial Disability:* An injury where irreversible loss of use of a body member occurs, as defined in the standard. (A combination of complete loss of use of two or more body members is considered permanently totally disabling).

4. *Temporary Total Disability:* Injuries which do not result in death or permanent impairment but which render the injured person unable for one or more days to perform effectively throughout a full shift the essential functions of a regularly established job which is open and available to him. Decisions as to whether an injured worker is capable of performing a regularly scheduled job are made by the company's physician. The majority of the injuries which count in the standard measure are qualified by this fourth classification.

It may be observed that interpretive variations can occur readily in the application of the "temporary total disability" classification. Also it is seen that the four classifications are highly selective, since the injuries and their classifications necessarily are arbitrarily defined. For example, inguinal hernia work injuries, until their repair, are considered by the standard to be partial disabilities; after repair, they are expected to be reclassified and counted according to the rule for temporary total cases. Physician treatment cases and first aid cases are not counted. And obviously neither are non-injury producing unwanted events which are of interest to safety effectiveness determinations. Furthermore, cases which are considered indemnifiable by the workmens compensation laws of the states may not be included in the standard rates since the laws of the states varyingly define compensable occupational injuries, and the states' definitions therefore often are not compatible with the standard's disabling injury qualification.

There are sound reasons generally for the limitations and the disparities which mark the use of the standard measure. It is difficult to explain, however, the confidence given to frequency rates as a meaningful indicator of the hazard control effort. The standard measure, clearly, by title and design

is concerned with "recording and measuring (disabling) work injury experience". It may appear logical to conclude that the rate of work injury occurrence is a direct function of the safety effort, but anyone who has noticed that disabling injuries do not necessarily follow risk taking ventures, (even when hazardous acts almost certainly could be expected to produce harm) will realize that zero and low frequency rates may occur in spite of a poor safety approach. The converse also can be observed. Probably there is a relationship between accident incidence and safety effort, but the appropriateness of appraising safety performance solely by the incidence of a single class of events may be as questionable as evaluating the strength of a bank by its rate of withdrawals. There are external factors, in either case, which should be known before a performance estimate is formulated.

The Standard describes three "measures of injury experience":

1. *Disabling Injury Frequency Rate* (the most popular expression of industrial safety performance). Its formula:

$$F = \frac{\text{No. of Disabling Injuries} \times 10^6}{\text{Employee Hours of Exposure}}$$

Example: Assuming an establishment experiencing 12 employee disabling injuries, during a one month measurement period, and a total employee hours of exposure amounting to 2,189,243, then substituting in the frequency formula:

$$F = \frac{12 \times 10^6}{2{,}189{,}243} = 5.48 \text{ disabling injuries/million hours of exposure}$$

2. *Disabling Injury Severity Rate* (essentially a weighted frequency rate) this measure expresses the days actually lost due to temporary total disabilities and the days charged arbitrarily by a schedule for the fatal and permanently disabling cases. The formula is:

$$S = \frac{\text{Total Days Charged}^* \times 10^6}{\text{Employee Hours of Exposure}}$$

Example: Assuming for the above example that the establishment experienced 10 temporary total cases which collectively totalled the days lost due to disability and one death for which the schedule charge is 6,000 days, plus one loss of an eye for which the schedule charge is 1,800 days, the combined total days lost and charged would be 7,872 days. Substituting in the equation:

$$S = \frac{7{,}872 \times 10^6}{2{,}189{,}243} = 3{,}596 \text{ days lost and charged per million hours of exposure}$$

3. *Average Days Charged Per Disabling Injury.* This measure is the ratio of severity to frequency rates. It may also be calculated as the ratio of the total days lost and charged to the total of disabling injuries.

Example: Using the data for the assumed establishment in the above examples and employing the given ratios:

$$\text{Av. Days Chgd. per Dis. Inj.} = \frac{3{,}596}{5.48} \text{ or } \frac{7{,}872}{12} = 656$$

The Z16.1 Standard refers also to two "Non-Standard Measures" which it offers as supplements to the standard frequency and severity rates. One is the serious injury frequency rate. It includes all the disabling injury cases counted in the standard ratios and adds several categories of non-disabling injuries as well. A ratio is computed then. Like the standard frequency rate, the serious injury frequency is an expression of the total injuries for its classification as a function of one million hours of employee exposure.

The other non-standard measure is the disabling injury index which multiplies the standard frequency rate by the severity rate (then divides by 1,000 to obtain a more manageable number) and is included in the standard "as an aid to those companies which want a measure of their combined frequency and severity experience." It is intended "primarily for ranking different establishments, organizations, or industries," but one can question the need inasmuch as comparisons between the index's computed values may be essentially the same as those for the severity rate multipliers. The examples of the frequency and severity rate calculations given above illustrate this. The frequency rate ordinarily is small numerically (in the order of 10) while the severity rate generally may be significantly larger (in the order of 1,000). Comparisons between the products of the severity frequency multiplicands therefore will tend to have differentials which proportionally approximate those between the severity rates.

*Temporary total days lost plus schedule charges for permanent disabilities.

An inclination to employ the severity rate when appraising occupational safety performance is of some interest. As noted earlier, the frequency rate popularly is the indicator of relative safety effectiveness. The standard, for example, makes the point with respect to its introduction of the non-standard serious injury frequency rate that for internal purposes such a rate may measure safety program effectiveness more adequately than the disabling injury frequency rate and contributes thereby its authoritative approval of frequency rates for the measurement of safety performance. Similar recognition is not given severity ratios, however, but the deference shown them by accommodating the "companies which want a measure of their combined frequency and severity experience" is noteworthy. It indicates some practitioners see (or sense) the value of appraising safety effectiveness as a function of the ability to control serious consequences rather than simply with respect to the rise or fall of injury rates.

The safety literature has reported criticisms[5, 6] of the Z16.1 frequency rate. The point of contention is the temporary total disability classification which often impairs cross-operations frequency comparisons, since identical injury cases are not necessarily classified by definition. A distinction occurs with respect to whether the injured person returns to work without loss of time.*

*The Z16.1 standard qualifies temporary total disability according to whether the injured employee (if not totally or permanently disabled) is able to perform effectively throughout a full shift a regularly established job that is open and available to him, without loss of one or more days of work due to the injury. The decision as to whether he is fit enough to do the assigned work is up to the employer's physician. This provision often encourages continuity of employment and is beneficial to the workman since it enables him to maintain his earnings. It may also have certain therapeutic values. But the employer with numerous and varied jobs is more likely to have open regularly established occupations than a small business operator. Also the physician engaged by the employer probably specializes in occupational medicine and may be more informed on desirability and opportunities for maintaining injured employees' work continuity. Consequently the number of temporary total cases (which are the substantial component of occupational injury totals) will vary between employers and often even among their locations. Such differences, as they affect the frequency ratio, distort the rate's reflection of the safety effort. They seem more descriptive of an operation's ability to control the work-day losses associated with injuries.

Because the Z16.1 standard selects one class of work injury (i.e., disabling) and because of the classification differences permitted by the temporary total disability definitions, some practitioners have turned to incidence rates using a wider spectrum of work injuries for frequency rates performance comparisons. De Reamer[7] for example, has suggested total-injury frequency rates as a means of indicating average safety preformance. The proposal is that frequency ratios be computed for all the work injuries reported to the plant dispensary. It is alleged that this rate "provides a sensitive barometer of accident-prevention performance" and that "such a measurement is needed if supervisors are to be held accountable for safety." However, total injury frequency rates, or the somewhat similar in purpose "serious injury frequency rate" referred to as a non-standard measure in *Z16.1*—1967, do not appear to enjoy wide popularity, possibly because practitioners are doubtful that injury data accurately reflect the quality of an operation's safety effort. The attitude of the medical treatment staff, for example, can be a significant but unquantifiable influence on the number of cases reporting to the dispensary.

Inasmuch as injury incidence ratios alone have not been satisfactory indicators of safety performance, several investigators have considered other evaluative methods. Simonds[8], for example, proposes "a means of ascertaining accident cost figures with sufficent validity and reliability . . . to warrant an executive's using the data in formulating safety policy as well as in evaluating departmental efficiency with respect to safety performance." A feature of this method is the use of dollars, rather than injury totals, for the measurement computations. (Numbers preceded by dollar signs are considered to have special significance for administrators). The measure computes the direct and indirect expenses of work injuries plus the costs of no-injury incidents. Thus the characteristic problem of frequency ratios, which when zero often incorrectly imply a perfect performance, would seem to be circumvented. Adoptions of this method, however, appear to be few. The reasons are not entirely due to any limitation inherent in the technique. There is, for example, the always considerable problem of gaining for a new measure the universality that is required if

its effect is to have significance. When, as in the case of the Z16.1 Standard, an authorized indicator of safety performance already exists it is unlikely that a new method will have wide, conscientious adoption — unless of course it clearly satisfies better than the incumbent measure all of the measurement needs of practitioners. Such a development does not seem to be in the offing, however. With respect to the limitations of Simond's method in particular, the necessary cost data often are not easily obtained. In many instances, considerable time must elapse before medical bills, loss appraisals, as well as claim settlements can be finalized. These data usually would not be available until the events they represented had faded many months into the past. In order to keep the measurement computations timely, the method therefore gives a means of estimating expenses, but the uncertainties of estimations seem to dampen a prospective user's confidence in the dimensions they provide. Even when estimates can be held to close delta levels there probably are many practitioners who are inclined to discount the measure, considering it to be only another rough depiction of performance.

A relatively unused but nevertheless apparently useful expression of performance, is the three-dimensional appraisal[9] of a company's experience using frequency, severity, and average severity data. It circumvents the disadvantage of employing only an incidence rate, while continuing the use of the standard measures which, in the author's view, is a practical consideration.

Fig. 1 plots eleven years of a company's frequency, severity and average severity record. It will be seen that the calculated trend (i.e., least squares line*) for the frequency rate indicates notable improvement, and for the severity rate there is improvement as well, making it seem that a safety

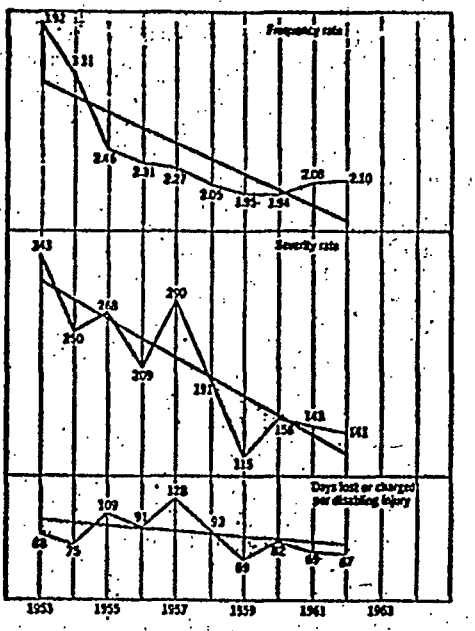


Fig. 1
Disabling Injury Trends 1947-57

advance has occurred when in fact the third trend indicates it is more likely that an injury control rather than hazard control effect took place. (The frequency rate, it will be recalled, is unprovable by controlling the temporary total cases, a variable which often is a function of management policy, availability of jobs for temporary reassignments, or the character of the medical treatment, rather than strictly safety). Qualitative judgments of safety performance reached exclusively in terms of the frequency, therefore, are apt to be grossly incorrect.

It is seen that the severity rate* when considered simultaneously with frequency may reveal the nature of the safety performance more definitively, thus seemingly deemphasizing the belief that "frequency is a much more valuable indicator of safety performance than severity . . ."[10]. Moreover, the average severity trend seems to provide a third and complementing gauge of the effectiveness of the severity control effort which, from a safety engineering point of view, would appear to be important. For

*One of the attributes of the mean of a group of measurements is that it is the value about which the sum of squares deviations of the individual measurements is a minimum. Similarly, with data that can be correlated by a straight line, there is one straight line from which the sum of squares of deviations of one of the variables is a minimum. This is the *least squares line* and is expressed with data as:

$y = a + bx$, where: y = estimated value of y for observed value of x

a = intercept, giving estimated value of y at $x = 0$

b = slope of line (identical with regression coefficient)

*The severity rate may in fact climb while the frequency is reducing, inasmuch as the schedule charges for permanently disabling

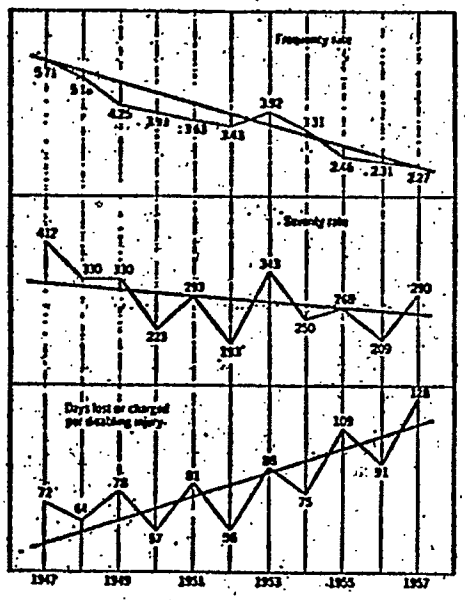


Fig. 2
Disabling Injury Trends 1953-63

the company exemplified in Fig. 1, severity control was a prime objective after the year 1957. The effect is indicated in Fig. 2* to the extent that: frequency tends to improve (i.e., reduce) year to year; severity tends to improve (i.e., reduce) year to year; average severity tends to remain flat (where F and S have been small and essentially are 1:1) but reducing where S has been generally higher. The plot reflects the disabling injury control experience with more definition than is obtained from frequency rates along or in combination with the severity rate, and seems particularly relative to appraising the wanted progress in controlling very severe injuries**. This appraisal method is troubled, however, for among other reasons by its reliance on accident data to indicate safety performance.

Because safety effectiveness measurement scales whose limits are injury (or accident) related do not seem to express competently the quality of the performance effort, measuring means which do not employ accident data have been proposed. These generally attempt to evaluate the state of the safety climate on the assumption that where there is evident attentiveness to the safety precepts which are recognized as essential to prevention, progress in injury reductions will follow. Such a "pre-accident" safety performance measure is expected to persuade preventive action before unwanted events have occurred. One approach[21,22] employs work sampling* techniques to secure data about the number and classes of unsafe acts and conditions observed in the shop. Clearly this procedure, which provides meaningful results inasmuch as the measurements may be made with a preassigned degree of reliability, is advantageous.

An analogue approach[18] appraised the performance of educational methods in accident prevention. It is of interest when considering the development of a safety engineering effectiveness measure since the familiar industrial safety programs are notably concerned with improving worker attitudes towards safety, through education. The investigator used a sampling procedure to observe types of unsafe behavior associated with industrial injuries at three shops of the Brooklyn Navy Yard and selected aspects of motor vehicle driver behavior at Mitchell Air Force Base and at Fort Dix. The observations were plotted

*The data reflected in Figs. 1 and 2 are actual and represent approximately 1,000 disabling injury (Z16.1) cases annually. The substantially large samples involved here are not replicated ordinarily. However, similarly revealing plots may be obtained for smaller numbers of events by using logarithmic plots or a "rolling average" to dampen the possible affect of large differences between the rates, year to year.

**The *Z16.1* scale of time charges, applied to permanent disabilities and fatalities, weights the severity rate heavily. Usually in practice the severity rate, therefore, reflects predominantly the time charges for permanently disabling injuries (and fatalities) where they occur.

*Work sampling was used first in the British textile industry by L. H. C. Tippett (L. H. C. Tippett, "Statistical Methods in Textile Research. Uses of the Binomial and Poisson Distributions. A Snap-Reading Method of Making Time Studies of Machines and Operatives in Factory Surveys." *Shirley Institute Memoirs*, Vol. 13, November 1934, pp. 35-93), and was introduced in the United States under the name "ratio delay" in 1940. The technique is based on the laws of probability, i.e., a sample taken at random from a large group tends to have the same pattern of distribution as the large group. In its simplest form the procedure consists of making random observations at random intervals of operators or machines and noting their activity. At the outset the statistical probability (confidence level) is decided so as to establish the likelihood that the random observations are factually representative of the normal population.

in the manner for statistical quality control, and the study evaluated the merits of behavior sampling and statistical control techniques for measuring the influence of safety educational programs on behavior. It was concluded that the techniques were suited to the purpose.

Although not concerned specifically with the development of a safety performance measure, but responsive nevertheless to the need for establishing effectiveness in controlling accidental occurrences, Tarrants[14] also employed work sampling methods. His interest, however, was an application of the *critical incident technique.** The systematic determination and quantification of critical causal factors, if accomplishable economically and reliably, could enable substantially the achievement of the accident prevention ideal and provide in fact a valid measure of performance. Furthermore, the employment of observer interviewers, in the pursuit of the critical incident (as well as some other sampling approaches) has the advantage of reviewing periodically with employees certain accident producing mechanisms which the refresher may assist in correcting.

The disadvantages of observer-sampling methods are many, however.

1. Ordinarily work sampling methods are not economical for studying operators or machines located over wide areas.

2. Assuming uniform perceptiveness, ability, and diligence among observers (which of course is improbable) it is nevertheless unlikely that every operator will be a wholly reliable source of information for the observer and that uniformity of inter-establishment data will obtain.

3. Sampling studies obviously present average results. There is no information as to the magnitude of the individual differences.

4. It is doubtful that an observer-sampling method for performance measurement can secure the universal acceptance and widely uniform application which are necessary if a new standard measure is to be established.

The Meaning of the Meaning?

It will have been evident from the number and variety of considerations afforded safety performance measurement, which are noted in the foregoing pages, that the subject is unsettled but not ignored. The approaches appear to be characterized by their concern with quantifying some aspect of accidental occurrences or the potential for accidental events.

While it may seem reasonable to measure effectiveness in terms of quanta of those elements which are the target of the effort, in the case of safety performance it seems as difficult to do this so simplistically as it is to measure productivity simply in terms of units produced. There are subtleties to be considered such as:

1. The meaning of the term "accident," which, unless understood uniformly, does not enable a constantly clear focus for an achievement effort.

2. The meaning (or objective) of safety for which one can realistically strive.

3. The implementation influences (such as management persuasiveness) which directly and indirectly must be harnessed to optimize the performance effort and to which the performance measure must be responsive since it provides the feedback which maximizes such influences.

The efforts up to now at developing an acceptable measure of safety performance have reflected their designers' views of what could or should be measured. Without general understanding and agreement on the safety needs to be fulfilled, however, the various proposals, though worthy, may be unrealistic and meaningful only to their creators. The posture of the proposers often seems reminiscent of Humpty Dumpty when he said about the use of words: "It's just a question of who is going to be master!"—the words or their meanings. Alice might have answered: "You can be the master of the meaning of your words if you like, but who will understand you? If you want to be understood you have to use the meanings that are generally agreed to." Lewis Carroll doubtless could have written a squelching reply for Humpty Dumpty, but he might

*The critical incident technique originated in World War II as a result of studies to determine the likely causes of military aircraft accidents. In the method, an observer interviews a stratified sampling of persons, eliciting their recall of unsafe acts and conditions occurring in their work. The stratifications are selected according to degree of hazard, type of exposure, degree of exposure, and other factors considered significant to the investigation. The purpose is to identify the critically unsafe acts and conditions in the operation and correct them before they occasion accidents.

have criticized, nevertheless, tendencies to develop expressions which may be meaningful only to their originators. Numbers, for example, communicate information when what they represent has real meaning. One may do as he wishes with numbers and words, but to enable the communication which measurements should provide, one is permitted to do only what reality allows.

Evidently safety is influenced by several interpretive factors. In fact, safety accomplishment seems to depend so strongly on personal values which interplay and tend to affect one another according to given circumstances that it may be impossible to establish a generally acceptable level of safety perfection. This seems to be the issue which entangles familiar safety performance measures, and to which the Z6.1 standard perhaps intuitively reacts but in doing so fails to measure reliably the extent to which a safety performance approaches perfection.

Z16.1 opts a particular class of unwanted events, the disabling injury, for surveillance. It may be assumed that its originators in choosing the disabling injury had recognized that this was the type of event which held the greatest potential for receiving general interest in its prevention. Possibly the rationale was that work injuries of less consequence were commonplace and, therefore, were likely to be regarded more tolerably. Attempting to develop concern about them therefore, might have been considered unrealistic.

Some observers, notably Heinrich,[15] judged as significant small events which by the grace of good fortune were not severe but could have been. Among the safety fraternity there then occurred a great concern for tabulating and evaluating minor injury and no-injury cases, with the intention of uncovering correctable causal factors and thereby shutting off the occurrence of more serious cases. But his objective often proved more hopeful than realistic. For one reason, there could be no severely harmful event if the system which produced a minor case did not have inherently a potential for a severe consequence. Unless the expanded effort involving lesser incidents was discriminating, with respect to the degree of hazard existing in the system, it was not likely to have the significant influence expected. And as a consequence, a general regard for such approaches and any performance measure related to them probably would not be high, as indeed seems to be the case.

It is the influence of judgment factors that a safety performance measure apparently must be able to deal with if it is to win universal acceptance. Obviously, several considerations affect the quality of safety performance, therefore it cannot be evaluated simply on the basis of unwanted occurrences. Such underlying considerations with respect to accepting hazards exposures as the degree of tolerableness which the hazards present and the consequences that may derive from them are not regarded in the measures suggested so far. Yet, decisions are made under the influence of such variables. Therefore, what may be thought to be relatively safe by one individual may not be similarly considered or attainable by another. Safety performance in the absence of common understanding of what the level of achievement should be realistically is practically without meaning.

But there is another major consideration which affects the meaning of proposed safety performance measures. It may be a key to the cool reception of measurement methods which have been suggested as substitutes for or supplements to Z16.1. This simply is the fact that Z16.1 has the distinction of being a national standard. In the absence of agreed on standards, measurements have little meaning. Measurement usually involves ascertaining quality, dimensions, or quantity by comparison with a standard. The use of an agreed on standard as the basis of comparison distinguishes measurement from judgment. Measurements are definite and satisfactory because all agree with the same thing, the standard. Therefore, whether Z16.1 is appropriate as a measuring instrument or not, it persists primarily because it has the superiority given it by virtue of being a national standard measurement method. A successor will have to achieve first, similar national acknowledgement, but this probably will not occur until there is common understanding of the safety effectiveness problem and the values to be weighed when considering its characteristics and solution.

Apparent Criteria

From the foregoing discussion it seems that a number of qualifications need to be

satisfied if a safety engineering performance measure is to develop. Some of the more important considerations appear to be:

1. The measurement data probably should not be drawn exclusively from injury-accident situations, inasmuch as safety engineering performance may not relate significantly to the occurrence of injuries — particularly over short time spans.

2. The measure probably should relate to the operation's effectiveness in fulfilling its mission generally and particularly with respect to its ability to limit severe consequences from any threatening deficiency in its systems.

3. The quantified values obtained from the measuring method should be replicable by anyone instructed in the use of its technique.

4. If possible, the measurement should enable valid comparisons of hazard control effectiveness between the operating components of an establishment as well as between classes of establishments.

5. The variable quantified should be realistic and, if possible, familiar and uncomplicated so that a minimum of instruction will be required to introduce the measure and obtain its acceptance.

6. The measure should be able to obtain of American National Standards Institute consensus approval so that it can meet the need for a standard measure of safety performance effectiveness.

Obviously, the construction of such a measure cannot be done routinely. The issues appear too complex for a simplistic resolution. Moreover the suggested desirability of measuring hazard control effectiveness rather than injury reductions to determine the quality of safety performance probably requires the development of unusual measurement designs.

It may have been noticed, in the review given earlier of the standard and heretofore explored evaluative methods, that recent investigators indeed have been attacking the safety problem unconventionally, but no approach seems to have enjoyed wide acceptance as yet. This may be attributable in part to the obscureness of any relationship between effectiveness in controlling threats to an operation's mission and the dimensions of present and investigated methods of measuring safety performance.

Yet it is competence in controlling the failure possibilities, which imperil the operation and its contributor claimants, that is basic to safety effectiveness. The quality of a system's control capability would seem to be a major concern when undertaking the advancement of safety achievement, inasmuch as when the control climate is unfavorable the strongest safety techniques, devices, and personnel are not fully attended and they become relatively powerless. The meaningful measurement of safety performance, therefore, may be essentially an appraisal of the control (i.e., managerial effectiveness) current for the operation generally, even though the measure's specific function is to assist the prevention of unwanted occurrences.

Feasibility of Inter-Modular Measurement

The writer for a number of years examined a variety of corporate performance data (drawn from annual reports to shareholders) to determine if there might be a relationship with common safety performance measures.

For the initial company studied, a relatively regular distribution of year to year changes in sales, earnings, and the severity rate was noted. Per cent differences in annual sales tended to be inversely related to per cent differences in annual earnings and severity rates. No other accepted safety performance measure appeared to develop a meaningful pattern relative to the corporate business data.

Later, 38 companies representing a variety of industrial classifications were similarly reviewed. The corporate performance data were expressed in this review as "total costs and expenses applicable to sales as a per cent of sales." These data were matched, year to year, with the corporate severity rate and it was observed that there was a somewhat better than chance distribution of matching changes between the severity rates and the computed cost figures. Again, no other accepted safety performance measure appeared to have a meaningful association with the cost data. The strongest relationships were noted in the case of those industries where severely hazardous exposures generally are inherent, e.g., petroleum and chemicals. These observations were reported in 1961.[16]

It may be assumed that increases in costs with respect to sales ordinarily are unwanted, unexpected and, therefore, are a kind of "accident." Rising costs, of course, can be a severe threat to the corporate mission. A management failure to control costs relative to income may be but another instance of deteriorating effectiveness in identifying and limiting the hazards which threaten the enterprise and its contributor claimants. The converse also may apply. Cost data therefore may be highly sensitive to changes in an establishment's control effectiveness and when correctly analyzed could signal the need for more effective action. To some extent this is the purpose of cost accounting departments, but their intelligence is applied parochially, usually with respect to the experience for individual cost categories. Certainly it can be expected that alert managers will be concerned with limiting threats to their systems' budgets, and failure to do so when income is declining will be viewed seriously. Any deficiency in maintaining such control may reflect on the control effectiveness in the establishment generally, and so a concomitant rise in the disabling injury severity rate may be explained.

If significant cost variables were identified and their relationships quantified, it seemed reasonable that an index reflecting the levels of change in effectiveness in an establishment could be computed. And it would enable the measurement of the establishment's effectiveness in controlling unwanted change. This is an important consideration, it was believed, since—for the company initially investigated—the changes in severity rates occurred while its safety organization performed relatively uniformly. Whatever the influences on the safety severity experience, they seemed to be external to the safety function. Safety achievement appeared dependent, consequently, on the establishment's general performance in controlling the many common factors affecting its welfare.

A study[17] was designed, therefore, to investigate the possibility of a relationship between work injuries and operating variables whose control ordinarily would occupy managers as much or perhaps even more than safety. It was hypothesized that injuries are only one type of contingency which concerns administrators. There may be others, such as increased scrap, shop costs and customer complaints, which when they occur are unwanted, unexpected, and therefore accidental—and which may arise from deficiences that affect as well the controls in safety's domain. If a statistical intercorrelation were found to exist, a measure of effectiveness in controlling unwanted events with implications for safety performance would seem possible.

In order to enhance objectivity and to secure expert factorial analysis the investigation was given under contract to Dr. Max Woodbury (then Professor of Research Mathematics at the School of Engineering and Science, New York University). The data were processed with the aid of the university's computer. The following observations were drawn from the results:

1. Comparative differences in the safety performance profiles of the seventeen diverse businesses studied appear to be explained by the variations in their severity rates and to some extent by the severity-frequency ratio (i.e., average severity) rather than the generally accepted measure: frequency rate.

2. The results broadly indicated that in an operating component where there is fairly good control of costs a generally good safety profile will prevail. The better businesses, from a severity control point of view, kept rework costs, direct labor costs, building and equipment maintenance costs, complaint, and shop costs on a relatively low level while scrap costs may be tolerably high.

3. The inverse relationship of scrap costs to other costs suggests that an effort to achieve wanted results in an emphasized performance area such as scrap cost reduction usually is may be at the expense of other less prominent goals. For example, scrap costs may be reduced by reworking the unacceptable products with a consequent increase in rework costs. Or quality standards may be lowered which then could affect complaint costs adversely. The implication seems clear that the measurement of interrelated performance areas may not be satisfactorily accomplished individually but some method that weights the factors and combines their effects into a single value must be used.

4. The tendency for building and equipment maintenance costs to be low where a good safety experience occurs appears to be contrary to the theory of the case. Usually it is expected that a generous posture

towards maintenance exists in locations where good safety records will develop. Further consideration suggests, however, that the well managed operation (also the safer one) receives regular preventive maintenance (under a controlled budget) and thus keeps unusual expenditures for repairs and replacements to a minimum.

5. The findings indicated that sales tended to fall off in those businesses where a better safety (severity) record occurs. This would be expected if the injury and sales data had been expressed only as totals. However, the data were examined on an equivalent man hour basis. Besides, the safety factor was dominated by the severity variable (severity rate) which is influenced heavily by the penalty charges (and days lost) for each injury. The comparison, therefore, is considered significant. It may be concluded that when sales decline managers are prompted to exert the strongest efforts to control their operations by obtaining optimum performances from subordinates. The implication seems clear that when managers control their operations most tautly, safety success, as indicated by the reduced occurrence of severe injuries, is likely.

6. Cost accounting data, statistically analyzed, apparently reflects the operation's control effectiveness and indications of better (or less) control seem to predict the occurrence of improved (or poorer) severity rates with a lead time of approximately nine months. The trend of the 1958 safety and fire loss experience for 15 businesses was foretold with greater accuracy than would be expected through chance. The severity experience seems to have been predicted accurately in ten instances; fire losses in eleven. Fire losses were not available at the outset of the study and so were not included with the safety variables studied. However, if the assumption is valid that the efficient control of costs is the result of effective managing (i.e., maximizing the performance of people) then the statistical analysis of an operation's cost data may predict progress in controlling contingencies other than those studied; for example, fire losses in this instance. The fire loss experience noted tends to give further credence to the hypothesis.

Whether data outside of safety's realm can be employed to construct a reliable and valid performance measure that will advance safety effectiveness is a question that must wait upon further studies. But the possibility seems feasible and the suggestion appears practical inasmuch as the events which safety traditionally measures apparently do not provide the necessary measurement information.

Cross-functional measuring, such as was explored by this feasibility study, may be theoretical but it is not unfamiliar. Cross-modality matching, whereby the elements of one domain are matched to those of another domain, has been developed in sensory measurement and the practicality—even the necessity—of inter-modular measurement techniques appears to have been suggested recently:

"Back in the days when measurement meant mainly counting, and statistics meant mainly the inventory of the state, and simple descriptive procedures of enumeration and averaging occasioned minimum conflict between measurement and statistics. But as measurement pushed on into novel behavioral domains and statistics turned to the formalizing of stochastic models, the one-time intimate relation between the two activities dissolved into occasional misunderstanding. Measurement and statistics must live in peace, however, for both must participate in the schemapiric enterprise by which the schematic model is made to map the empirical observation.

"Measurement provides the numbers that enter the statistical table. But the numbers that issue from measurements have strings attached, for they carry the imprint of the operations by which they were obtained. Some transformations on the numbers will leave intact the information gained by the measurement; other transformations will destroy the desired isomorphism between the measurement scale and the property assessed.

"Since the transformations allowed by a given scale type will alter the numbers that enter into a statistical procedure, the procedure ought properly to be one that can withstand that particular kind of alteration.

"The view is proposed that measurement can be most liberally construed as the process of matching elements of one domain to those of another domain. In most kinds of measurement we match numbers to objects or events, but other matchings have been found to serve a useful purpose. The cross-

modality matching of one sensory continuum to another . . . supports a psychophysical law expressible as a simple invariance: equal stimulus ratios produce equal sensation ratios."[18]

A measurement method was devised according to the findings of the feasibility study, but it remains to be tested. However by employing a modification of the study's cost accounting categories, inter-functional measurement of the control climate was continued as an experiment at the General Electric Company.

Data obtained from the company's annual report to share-holders was used to compute the ratios of costs to sales* for the period 1956-66. These were plotted with the severity rate and fire losses for matching years. Although the sample is small, the relative regularity with which the severity and fire loss curves track the cost-sales ratio seems impressive and tends to confirm the hypothesis that safety achievement is a function of the general control climate. The severity and fire loss varied, it would seem, under the influence of factors outside of the safety functions.

An observation which may have significance is the apparent relevance of the severity rate to the models of general corporate control effectiveness.

The knowing administrator may be expected to be vigilant for conditions in his operations which, in the event of a control failure, could threaten the mission. It may be for this reason that in business organizations operations such as marketing, production, and finance are attended closely by management. Their high correlation with mission accomplishment is easily recognized. But for safety the relationship to managerial achievement may be seen only when it is clear that hazards exist in the system and that they are so severe the mission may be jeopardized. Lesser injurious events in general rarely stimulate a strong administrative response unless their number reaches an intolerable level. This is infrequent in our relatively well informed society. And so the severe consequence is both the stimulus and the target for administrative control efforts with the result that where the managerial control is strong the severe event occurs less often, and vice versa.

The emphasis on the severe occurrence with respect to safety performance may seem improper in the light of currently popular views, even though some thoughtful study has occasioned it. Generally, the safety objective seems to be to prevent all accidents, i.e., reduce the frequency rate to zero. But familiarity with a number of industries indicates that as frequency approaches zero, severity does not necessarily follow proportionately. The very severe occurrences may continue at an unabated rate or may, in fact, increase.

It would seem that the identification of hazards and their evaluation with respect to their relation to the mission, the consequences of an event, and the applicable methods of control must precede the preparation of means to either design the hazards out of the system or, if this is not possible, to engineer limitations of their effects. And it appears also that such a practice is most needed where individual hazards have a potential for a severe consequence or for causing multiple events of a relatively less severe order. This, it is believed, is the principal function of safety engineering and therefore is a proper focus for the measurement of its performance.

In the writer's experience, with a variety of enterprises, only relatively few injury cases usually are responsible for the major effect of the accident experience — whether this be calculated in medical and indemnification costs, down-time, or degree of harm to the corporate image. And usually the causes are familiar hazards or agents which are not too difficult to identify with the aid of appropriate analyses. Normally, an approximate 10 per cent of the disabling injury cases seem to have occasioned roughly 90 per cent of the losses observed due to work accidents.

It would appear therefore that for practical as well as humanitarian reasons, the safety engineering function should cut-off the scope of its effort to some determinable level of severity and concentrate on the more severe exposures. This seems to be where the need is and it is a level of activity which management understands and is apt to be highly responsive to, with implications that seem to be clearly advantageous.

*The method of calculating used resulted in a cost-sales ratio larger than unity. The company, of course, was making a profit during the period.

After the severe hazards are controlled with good evidence of certainty, a considered widening of the safety engineering effort to attempt to control lesser (and often the more elusive) harmful agents would seem to be appropriate.

Whether these notions on the practice of safety engineering will have general approval is uncertain, but there seems to be some reason to believe that the measurement of safety engineering performance may be a function of the success with which severe consequences are limited. It appears that this may be measured by employing cross-modality techniques, which may have the additional advantage of detecting a faltering in the control climate with sufficient lead time to correct it and enable limitation of the otherwise prospective severe event.

Summary

Generally, it seems that the value and greater challenge of safety engineering occurs in its potential for eliminating the causes of severe events or limiting their possible consequences. Its practice in such a light is seen to be concerned with making reliable analyses of operations to identify failure points, evaluate their significance in the system as well as their likely effects and, within the limits of practicality, employ creativity in the application of a number of disciplines, including engineering, to devise control methods. However, the effectiveness with which the practice is engaged appears to be a function of the general administrative control climate in which the work is performed. This is a troubling consideration when the measure's expected use as a performance stimulator is weighed. One must question whether specialist performance can be measured except as a function of the climate in which it is offered. Also, it appears that injury ratios, the traditional units of safety effectiveness measures, may not describe performance reliably. Other data seem necessary. These measurement complexities may be resolved by constructing a measurement model of administrative control effectiveness which couples concretely with safety engineering performance. Such intermodular measurement has been explored, seems feasible, and appears to merit further investigation.

But in the final analysis the measurement method that will be used is the one which is acknowledged to be "standard." It would seem advisable therefore to make the most of the Z16.1 standard until a new measurement technique is designed and becomes generally accepted. To do this, it appears that the severity rate should be brought to prominence as the indicator currently provided by the national standard which most closely relates to the safety engineering objective of identifying and controlling the severe hazards in the systems served.

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Standards Development

SHOULD THE FEDERAL GOVERNMENT DEVELOP SAFETY STANDARDS?

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The question of whether the Federal government should develop safety standards is quite complex and involved. On the surface, it appears to be unencumbered, but the answer being sought really revolves around the question as to whether we should "chuck" voluntary safety standards, or diminish their role and go the Federal route. Any answer, mine as well, must be influenced by one's own experience, exposure, and degree of involvement in the utilization of safety standards. It is becoming quite difficult to maintain a cool and objective position with all that's going on.

Many are prone to overlook the contributions, the capability, and the important role played by voluntary standards over the past 50 years. The theme today seems to be, "What have you done for me lately? What can you do for me now?"

For the past three years, voluntary standards have received unparalleled exposure and publicity—some good, some not too good. The press, the Congress, the trade publications, the wage earner, and the consumer are all pushing for greater safeguards. The standards syndrome no doubt originated with the demand for auto safety, meat safety, product safety, mine safety, pipeline safety, radiation safety, and others. Over 1,000 safety bills were introduced in the first session of the 91st Congress (150 Senate—886 H. R.)— some major, but most having some peripheral safety involvement. All of this, coupled with legislative hearings and plenty of press exposure, has truly made this an era of standards.

This is not an attempt to evade the original issue or question. But, why should the question have been raised at all? The private sector maintains that it has the know-how and the capability to do the job—voluntarily. Others say they can't do it and that the job can best be done by the Federal government.

The statements made and the questions asked at the recent hearings on H. R. 13373 are indicative of the fact that there is some degree of disenchantment with the consensus or voluntary standards. The reasons why as well as the total answer is hard to come by. Perhaps the Department's involvement and experience in the use and application of voluntary standards may shed some light on the problem.

The U. S. Department of Labor is very much involved in this area. In eight laws and one Executive Order, the Secretary of Labor is charged with the responsibility of safeguarding some 35 million workers. Recently added to this list was responsibility for the safety of another 2.5 million workers involved in Federally financed construction.

Chief among the Department's legal tools are the Walsh-Healey Public Contracts Act, McNamara-O'Hara Service Contract Act, the Longshoreman's and Harbor Workers' Compensation Act. The Department seeks to meet its responsibility by, among other things, promulgating and administering effective safety and health standards. Such standards then constitute a master link between expression of public policy and Congress and, in their realization, to the workplace. With this as a backstop, perhaps the next question to be answered is, "Why is the Department so interested in the use of voluntary safety standards?" Or better, "How has the Department become so involved in the use of safety standards produced under the consensus principle by voluntary groups?"

Many are familiar with the historical PCA (Walsh-Healey) hearings held in 1964 to promulgate or modify the PCA Safety

and Health Standards. Those hearings, five years ago, served as a catalyst to bring on the standards syndrome. Briefly, the 1964 hearings resulted in two major conclusions: (1) nearly all, including management and labor, recommended that the Secretary of Labor get away from writing his own specification type standards and move toward adoption of consensus type standards; (2) the other recommendation, supported quite strenuously by the National Safety Council, National Association of Manufacturers, American Society of Safety Engineers, and others, was for the Secretary of Labor to establish a safety advisory committee. Late in 1965, the Secretary of Labor appointed a 12-man ad hoc advisory committee. This advisory committee met in March 1966, and its recommendations were essentially the same as those that emerged from the hearings. Consequently, the Secretary of Labor established a policy of adopting safety standards developed by voluntary groups wherever applicable standards existed. Subsequently, the Secretary formed the National Safety Advisory Committee. In December 1967, safety and health regulations were promulgated under the McNamara-O'Hara Service Contract Act by adopting standards developed by nationally recognized professional organizations and those published by the Federal government. This concept, that is the mix, of utilizing voluntary standards where they existed and Federal standards to fill the gaps was very favorably received. There was little or no opposition to this approach.

In September 1968, using the SCA approach, the Department proppsed a revision of the Walsh-Healey Safety and Health Standards, again adopting consensus standards wherever they existed and Federal government standards to fill the gaps. Hearings were held, wrinkles ironed out, and standards were promulgated, to become effective in January 1969. With a change of administration, the new Secretary of Labor delayed the effective date of the new PCA standards. This afforded the Secretary and his safety advisory committee an opportunity to fully review the new standards, the testimony of the hearings, and other appeals and considerations brought to his attention. After they were very carefully reviewed, with a high degree of involvement by the Advisory Committee and some very significant changes, the new PCA regulations, permitting adoption of consensus standards, were promulgated and became effective May 1969.

It was obvious early in 1968 that voluntary standards were going to be adopted, where possible, for the bulk of the Secretary's safety responsibilities. Consequently, it became imperative to take a very close look at the safety standards resources available to the Department in the voluntary private sector. A study was started. The first phase of this study was to determine the "state of the art." This effort was directed toward determining what was available, reviewing the age or vintage of the standards, relationship of their age to current applicability, the frequency with which standards were being revised or reaffirmed; determining the cause or causes for the delay in updating the older standards; and identifying the need for new standards (that is, with respect to the program needs of the Department). The 1969 phase of our evaluations was to be directed toward a qualitative evaluation of the standards and the quality of their safeguards.

In September 1968, we completed the first phase of the study and were requested to publish a report of our findings. The report was entitled, "Status of Safety Standards—A Review of Occupational Safety and Health Standards, 1968." With 234 ANSI standards as a base, very briefly, the results of this study revealed that: nearly 60 per cent of these consensus standards were five years old or more; of them 32 per cent were 10 years old or more; some 28 per cent were more than five years old, but less than 10 years old; some 40 per cent were less than five years old and considered to be current under the existing ANSI review procedures.

This first report does not in any way deal with the quality of a standard, nor does it report that a standard is bad or obsolete. Our prime concern was to identify what was available, how old it was, and point out needed standards for the Department's programs. Based upon research, it was quite evident that there was a need to speed up the updating of older standards and the system for developing the new standards. It should also be noted that for every criticism made, the report contained an alternate suggestion as to how the situa-

tion might be improved. The Status Report outlined the many ways an effective voluntary system can be advantageous to both government and industry. Some felt that the status report was too critical and only served as a faultfinder. This is not the case; in reality, it served as a pathfinder. If this report helped to communicate, motivate, and generate a higher degree of interest and participation in helping to upgrade the status of the voluntary standards, then the report has served its purpose well.

From all indications, it appears that our status report has, in fact, served its purpose well, as evidenced by the following reactions: The published report was released at the ANSI meeting on December 10, 1968. On December 11, 1968, the Office of Occupational Safety started receiving numerous requests for the report.

On January 27, 1969 the ANSI called a special meeting to discuss the report, its findings, and the need for some serious commitments. It was concluded that a problem existed and that there was a need to establish some realistic priorities and goals for safety standards. Also needed were more effective time tables and rigid monitoring of the time schedules set. The need for more active cooperation and participation on the part of sponsors and committees was also highlighted. A series of actions and commitments were outlined, and they were as follows: (1) set up a task force immediately to review outdated standards with a view toward revising or reaffirming them by the end of 1969, or dropping them; (2) establish a list of new priorities for the new safety standards projects underway. This would involve a review of all work on current projects. Again, a "speed up" or a "drop action" would be directed to those projects making no progress; (3) review existing procedures or develop new ones, if necessary, to produce standards on a more timely basis; (4) establish specific goals and time tables for the development of new projects; and (5) set up necessary communication to reach sponsors, committees, and all concerned to advise them of these actions.

On January 30, 1969, the special ad hoc committee for the safety standards held its first meeting. The ANSI staff was directed to develop a current action report on all ANSI safety projects. The Bureau of Labor Standards was requested to provide a realistic listing of standards it urgently needed for its regulatory program. (Other needs would be covered later.)

On February 20, 1969, the Safety Standards Committee of the Industrial Conference, National Safety Council, volunteered to work up several pilot projects with a view toward broadening the scope of standards to permit wider application.

On March 6, 1969, the ad hoc committee received its detailed report on all committee actions. Identified were actions being taken; lagging actions; reports of sponsors failing to initiate action over a number of years, and a report of committees that were dormant. As requested, the Bureau of Labor Standards presented a realistic listing of some 83 standards, both old and new, it felt was essential to its programming needs. A critical review was made of each standard and priority actions assigned by the ad hoc group. Sponsors, committees, and working groups were to be contacted by special letters, telegrams, telephone calls, and personal contacts.

The ad hoc group held several subsequent meetings in April, May, July, and September, 1969 to monitor the various actions it had set in motion. Many constructive ideas and actions have emerged from the group to date. Some of the more significant ones dealt with the modification of rules to permit faster approval actions. A management machinery is being developed by ANSI's hierarchy to meet the current need for standards on a more timely basis; more staff help is being provided in the ANSI headquarters. Other suggestions dealt with the examination of the five-year review cycle, establishing permanent committees, changing the balloting rules, assigning new and broader technical responsibilities to standards boards members, giving more time to ANSI staff to keep pace with the more current needs. Suggestions were made by the National Safety Council for speeding up new projects, application of PERT systems to speed up the production of standards, the use of critical review patterns, and a production flow chart for monitoring time tables. Many new concepts and ideas have emerged as a result of the very serious effort being put forth to move some of these standards' projects off dead center.

Thus far, the answer to the big question still hangs in the balance—should the Federal government develop safety standards? Working on Phase Two of the standards evaluation project, together with the development of guidelines for the application of voluntary standards in the new PCA safety and health regulations, has been very revealing. These guidelines will be developed into a reference handbook containing an inspection survey system to be used by our field staff in determining compliance. The handbook will also be made available to the contractor subject to the PCA-SCA regulations, and thereby make him aware of what he can expect to be checked for during the course of a plant survey. Working on these two projects concurrently has enabled us to evaluate the standards more thoroughly with respect to coverage, content, applicability, conflicts, limitations, gaps, and other shortcomings.

This flow of information comes to light as we identify the hazard category and develop a capsule version of the requirements contained in the applicable standard. In keeping with one of the major recommendations made in last year's status report, this inspection system is being structured according to "Hazard Categories."

The inspection system has been developed into two major parts. The first part will cover the preoperational safety and health requirements and treat the conditions normally checked or looked for prior to the start of any operational process. Our studies reveal that there exists a series of situations that remain fairly static and that certain standards have common application.

For example, Part 1—Preoperational will treat walking and working surfaces, general illumination, fire suppression systems, heating and general ventilation, pressure vessels and piping, sanitation, electrical wiring apparatus and equipment, personal service rooms, stairs, ladders, exits, permanent building structures and appurtenances thereto. Part 2 of the system will treat the operational safety requirements in situations involving material handling equipment, cranes, derricks, hoists, a variety of machinery and machinery guarding, local exhaust ventilation, surface preparation and finishing, welding, burning, electrical grounding of machinery and equipment, occupational health exposures, flammable liquids, and other environmental controls.

Every situation or hazard category will not be covered in the first issue, nor in subsequent issues. There will always be something to add. This document will be a live document, and additional sections will be added as they are developed. Special industry requirements or situations will be handled on an individual basis and issued subsequently as an appendix to the original document.

In "searching out" the applicable safety standards to fit selected hazard categories, we have gained an excellent insight on the makeup of the standards. The exercise reveals that many standards are good, valuable, and useful. However, woven into the fabric of the standard are many paragraphs of extraneous information, rhetoric on separability, legislative and exclusionary clauses —all tending to confuse, rather than improve, the standard per se. Loosening requirements and conflicting requirements have also been found to exist within and between the NEPA and ANSI standards. These tend to create additional problems for us in our work and use of these standards.

One of the problems encountered was limitation of coverage. Some standards just don't go far enough. Coverage normally expected to be found in a selected standard is not there. As the search continues, the coverage may utimately be found in some other standard, usually a special industry standard.

Our policy for the inspection survey system will be, "whenever a position or requirement in one standard has application in other like situations, the principle involved will apply." One example of this was the search for specific dimensions for aisle spaces used by industrial trucks. We were unable to find the specific details in B56, but subsequently found them in the PI standard.

We have found conflicting requirements in both NFPA and the ANSI standards. These will be spelled out in detail and brought to the attention of both the ANSI and the NFPA organizations as soon as the project is finished.

Most interesting of all findings was the proliferation of terms used in characterizing safety factors and loading. Terms used to

characterize loading range from meaningless or nebulous terms such as ample, substantial, safely, substantially strong enough, to the more meaningful and specific terms which spell out explicit safety factors, x lbs. per square foot with deformation tolerances, lbs. per square inches, x lbs. per square foot with a safety factor of four, etc.

For example, in the A10.2, A10.4, and A10.5 standards alone we find more than 20 different ways of expressing safety factors for load-bearing surfaces. You can add to this the terms found in the A14 group, A39.1, A58.1, NFPA 101, A64.1, A113, B56, B30, Z50, A17.1, and MH9. Granted, a variety of techniques for expressing safety factors are essential, but standards writers should really take a closer look at these requirements. In some standards, specific factors of safety are cited and in others, they are merely expressed in number of pounds. I am certain that we will find the difference between "pounds" and "pounds per square inch" vital. It may make the difference between being able to safely work on a platform constructed of heavy timbers or steel, but not on one constructed of tissue paper.

Conflicts and questionable requirements were found in both the NFPA and ANSI codes, and they, too, need a closer look. In NFPA 30, in the restrictions for storage of flammable liquids, we find that "in industrial occupancy, you may apparently store more Class 2 flammable liquids outside a storage cabinet than you can within."

Conflicts exist between NFPA 58 and 505 v. ANSI B56.1 on the storage of LPG, and in the refueling requirements. The basic standard adopts by reference. Then it overrides its prohibition and changes "shall" requirements to "should." The same holds true for the battery-charging requirements.

Two sets of requirements for the storage of materials in proximity to the sprinkler heads will be found in P1.1 and NFPA 13 and NFPA 231.

A certain number of conflicts will be inevitable. Perhaps, the establishment of a joint clearinghouse mechanism within the standards organizations may help to reduce the number. All that has been discussed serves to point out that there are areas of vulnerability in the system. We would rather bring them to your attention for constructive purposes, than have others do it for destructive purposes.

The Bureau of Labor Standards is doing all it can to make the voluntary system work. There is no reason for it not to work if all interested parties participate. Based upon the Department's actions to date, legislative and regulatory, it is quite apparent that the Department is doing all it can to give the private system an opportunity to work effectively. But where they fail, the Government is obligated to take action.

Hearings on H. R. 13373 and the questions being asked about the ability of the private sector to handle the consensus standards needs of the nation are alarming and should serve as early warning signals that voluntary standards are under the gun. These signals should be as obvious to you as the flashing lights in a "psychedelic joot-joint."

Perhaps the title of this presentation should have been:

"Do you want the Federal Government to develop safety standards? We don't want to —but we can, if we have to."

SAFETY STANDARDS: BY PARTICIPATION OR PRESCRIPTION?

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The year 1968 was a momentous one in the history of employee safety activity. Several bills introduced in the Congress were designed to place the federal government in the field of employee safety and health on a broad, almost all encompassing plan. The introduction of these bills was followed by new and much more comprehensive employee safety and health proposals from the Department of Labor under the authority of the Walsh-Healey Public Contracts Act.

The legislation would have given the Secretary of Labor the authority to adopt any existing standard, modify it, or write an original standard as a part of his regulatory authority. The Labor Department proposals for regulating government contractors included some existing standards, modifications of other standards, and new regulations developed within the Labor Department.

In the extensive hearings which were held on both the legislation and the Labor Department proposals, the subject of standards was explored thoroughly. Those who were to be regulated by the government challenged the right of the Department of Labor to enact any rule or regulation which was not based on a nationally recognized standard developed on the consensus principle. The Department claimed that there were not enough such national standards; that many existing standards were out of date or lacked essential coverage, and the development process of new voluntary standards was far too slow. It felt its obligation to protect the working man permitted it to write its own rules.

The National Safety Council's position on both the legislation and the Department of Labor proposals reflected the Council's policy on standards. It urged that only national consensus standards be the basis for regulations. When no standard existed, the regulatory body should seek to have one developed through existing standard making organizations. Only in the face of failure to develop a voluntary national consensus standard within a reasonable time should the regulatory body be empowered to develop unilaterally any safety regulation.

Arguments to limit the right of the Department of Labor to write its own standards prevailed. The proposed legislation failed and the Department of Labor regulations under the Walsh-Healey Act were modified. The Walsh-Healey regulations as finally issued in May 1969 adopted without modification all national consensus safety standards. They also included some proprietary or industry standards which, though not strictly consensus standards, have been so widely recognized in safety circles that their use was recommended by the National Safety Advisory Committee appointed by the Secretary of Labor to advise the Secretary on broad policy issues.

Employee safety legislation has again been introduced in the Congress this year. Three of the four pending bills incorporate the principle of national consensus standards as the base for promulgating rules. They require that an attempt be made to establish a national consensus standard through existing standard setting organizations when new or revised regulations are deemed necessary. Only when the standards making body fails to provide such a standard within a reasonable time may a rule or standard be developed unilaterally by the Labor Department.

The use of standards is nothing new to the business community. Their development began in 1918 with the establishment of the American Engineering Standards Committee. There has been a steady growth in standards activity, both in the number developed and published and in the number of organizations which issue them.

In 1963 the Commerce Department established a Panel on Engineering and Commodity Standards to make a comprehensive review of the broad requirements for industrial and commodity standards in the United States and to make recommendations as to activities important to meeting national re-

quirements for standards. The Panel's report of March 1965, commonly known as the La Que Report, identified almost 14,000 standards issued by about 300 different technical and professional groups.

Before we move on farther, let us make sure we know what we mean when we talk about a "standard." The La Que Report defined a standard as a document to define properties, processes, dimensions, materials, relationships, concepts, nomenclature, or test methods.

The Occupational Safety and Health Bill of the present administration adopts the principle of the definition with modifications oriented to the purpose of the Bill. An occupational safety and health standard is defined as a "standard which requires conditions, or the adoption or use of one or more practices, means, methods, operations or processes reasonably necessary to provide safe or healthful employment and places of employment."

There are several techniques and procedures used by organizations in developing standards. Some organizations produce nationally recognized standards under the consensus principle. The approval of a standard by such organizations implies a consensus of those substantially concerned with its scope and provisions. "In standardization practice a consensus is achieved when substantial agreement is reached by concerned interests according to the judgment of a duly appointed authority. Consensus implies much more than the concept of a simple majority; but not necessarily unanimity. Such standards are known as national consensus standards."

There are two nationally recognized organizations producing standards developed under the consensus principle. They are: American National Standards Institute (ASNI), and the National Fire Protection Association (NFPA).

A considerable number of standards are produced by industry groups, organizations, societies, associations, and other professional organizations. These are commonly known as professional or proprietary standards. These standards are usually of unilevel membership concern and are developed by membership committees. While such standards do not utilize the consensus principle and are usually accepted by membership vote, they do present the best thinking by eminently qualified technicians. Some of the organizations producing proprietary and professional standards are: American Society for Testing Materials (ASTM); American Society of Mechanical Engineers (ASME); American Welding Society (AWS); Manufacturing Chemists' Association (MCA); Compressed Gas Association (CGA); National Electrical Manufacturers Association (NEMA); American Petroleum Institute (API), and Society of Automotive Engineers (SAE).

The use of these standards has become a part of the business idiom. They are incorporated by reference in countless specifications and provide a universal business language. Their use has simplified and expedited the carrying on of business activities over a wide range of subject matter.

Many of these standards have already found their way into the laws of this country, principally at state and municipal levels, either through direct reference in statutes and ordinances or through their use as source material for regulatory bodies which undertook the development of their own specific regulations. Few building codes, plumbing codes, electrical codes, or fire protection codes have been developed without heavy reliance on such standards issued by authoritative professional groups with specific interests in those areas.

With such a body of information available, why then are we concerned with the use of standards as a regulatory tool? The problem arises from the fact that acceptability for nation-wide application should be based on a requirement that the standard be a nationally recognized consensus standard. The La Que Report identified only about 2,400 standards which merited characterization as a national consensus standard. Today, there are more than 3,600. All of these have been issued through the procedures of the National Fire Protection Association and the American National Standards Institute.

What makes these standards different from mothers? What are the peculiar characteristics of a national consensus standard? Essentially, the difference involves making certain that every agency or group which can be affected by the standard has the right to be heard before the standard is adopted.

The critical words in the definition given for such a standard are "reached by concerned interests according to the judgment of a duly appointed authority." Inherent in these words is the need for participation by all parties who may be affected by the standard, a judgment by a single authority that all such concerned interests have participated in the development and review of the proposed standard, and that no substantial objection exists from any significant sector affected by the standard.

A typical consensus standard committee might include members representing the tool and equipment builders, product manufacturers, labor, the medical profession, insurance interests, governmental agencies, and the public interest.

The judgment that consensus has been achieved must be made by the duly constituted authority which reviews the work of the standards committee. American National Standards Institute President Francis K. McCune has explained this process as follows:

"To achieve consensus the vote of each participant must be weighed in light of his knowledge and competence, and approval must be based on a substantial preponderance of informed competence, not merely a numerical count. In this system, a reasoned objection by a single man of great competence may result in the reconsideration of a standard—yet with careful procedures even vociferous objections of the uninformed or prejudiced cannot block progress."

While the professional or proprietary standards may be as carefully developed, incorporate the same professional and technical integrity, and encompass all matters included in the scope of the standard, they have been developed primarily by and for the use of technical and professional specialists. Their development and review does not, in general, include participation by all users or all people who might be affected by the application of the standard.

The employee safety movement stands today on the threshold of national regulation. Through the inclusion of the concept of national consensus standards as a basis for regulation, industry can and should participate in the development of the rules by which it will have to live. It can and should help establish the public goals and implement the national policy established by the enactment of Federal employee safety and health laws. If it fails to do so the alternative likely will be the development of rules and regulations by government.

The situation today reflects what the United States Department of Labor has been saying for the past several years. It has said that it had no desire to write safety standards. It preferred to use those developed through the voluntary system by business and industry. It would be reluctant to establish its own regulations unless it was convinced that the voluntary standards procedure had failed to meet a currently existing problem. Even though the Occupational Health and Safety Act of 1969 did not reflect this position exactly, we do believe that the Department of Labor is sincere in enlisting the efforts of industry in the solution of this problem.

And there is good reason for it to take this position! For many years the voluntary, unregulated efforts of industry steadily reduced occupational injury rates. Only in recent years has there been a change in this history of progress. It would be naive for anyone to believe that the cause of employee health and safety could be furthered without enlisting the assistance of those who have been active for so many years in the voluntary occupational safety movement.

The Department of Labor must also take cognizance of the fact that the thousands of standards which do exist today have been created primarily through the efforts of industry. The people who developed these standards came from the ranks of business, and the organizations which published the standards draw most of their support from industry.

We have today, in dealing with standards for employee safety and health, no new problem. We have only an added dimension —urgency. The most recent catalogue of ASNI lists only about 200 standards which can be characterized as being chiefly oriented to safety and health. Almost a third of these, according to a recent Department of Labor study, are ten or more years old, and only about 40 per cent were considered to be current. About fifty safety standard projects are currently in process—many of them progressing at a lackadaisical rate

Many essential elements of the employee safety problem have never been reached by existing standards.

Traditionally, standards activity has moved at a relatively leisurely pace. The procedures under which the developers worked and the availability of personnel for meetings has often conspired to make the standard development cycle a matter of years rather than months. Under current technological conditions, many safety standards are becoming outdated more rapidly than new standards are being produced. Many companies who maintain their own standards for employee safety and health have found it necessary to go beyond the existing national standards to maintain the safety and health of their employees.

Industry today must reappraise its position with respect to standards activities, particularly in the employee safety and health framework. It should begin by evaluating its position with respect to the American National Standards Institute and the National Fire Protection Association, which currently produce our national consensus standards. It should give particular attention to the ASNI which produces by far the greatest majority of national consensus standards. If we are to have more and better standards rapidly, the ANSI must be geared to respond to the tasks which will be forced upon it. It must draw its support from all elements of business. Small business must recognize that it too has the same stake in the activities of ANSI as do the larger companies which have traditionally been its major area of support. The Institute needs much more support, both financially and in membership, if it is to cope with the demands which will be made on it.

Industry must also look at the many professional and technical associations in which it participates and examine their standards development procedures. Where these do not include the basic elements necessary to a national consensus rating for its publications, they should be urged to change their methodology and encouraged to promulgate their appropriate standards, both existing and new, as American national standards through the procedures of the Institute. Industry should make certain that these organizations take inventory of their activity and find to what extent they are now addressing attention to the safety and health problems related to the scope of their operations. They should be stimulated, where necessary, to undertake the development of appropriate safety and health standards.

The trade associations can become a much more positive factor in standards development activities. Business should insist that these associations evaluate the safety problems characteristic of the operations of its members and undertake to sponsor new standards designed to improve the safety and health of their employees. The associations must also become more active in soliciting competent people from among these member companies to participate on standard committees.

Above all, however, industry must make a new commitment to standard making activity. It must provide manpower to meet the needs for new and revised standards. A necessary part of this is to make a factual appraisal of the effect of standards activities on the normal work load, and to provide adequate staffing to make certain that standards work is recognized as an integral part of the companies' activities and not just a by product to be performed when it is convenient to release manpower and time for it. It must stimulate its representatives on standard making teams to approach the assignment with the same diligence as is given to any other assignment from management.

The rapid advances in technology, both in product and manufacturing process, have created new and complex safety and health problems. Personnel assigned to standards projects aimed at neutralizing such problems must be equal in competence to those who have created the new technology. No longer can safety standards activity be regarded as the sole province of the employee safety staff.

Both industry and the standards making organizations must join in an effort to explore new approaches to standards development. The use of detailed specification standards must give way to those which emphasize performance criteria. Both the Department of Labor and the National Safety Council have done preliminary work

on approaches to development of broader standards keyed to hazard class and industry or manufacturing systems. Success in following these investigations could lead to a major savings in standards making activity.

Employee safety and health has progressed to its present plateau as a result of responsible management action on a voluntary basis aimed at conserving the life and limb of its employees. Voluntary standards action should now be viewed as the next logical step in revitalizing the attack on occupational injuries. Whether governmental regulation exists or not, this renewed vigor is necessary.

Failure to meet this challenge effectively can only hasten the day when authoritarian rules will emerge, seeking to cope with identifiable needs. Such prescriptions for safety, produced without full evaluation of their feasibility from the standpoint of both engineering and cost, could be bitter medicine for industry to swallow.

DEVELOPMENT OF A SAFETY STANDARD IN TWELVE MONTHS

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Quick response to the need for standards and an accelerated pace in development are the principal areas to be discussed here. Function will be treated only incidentally. The point of reference is the development of the 02 Standard. From the PERT Network offered here, some generalized observations and recommendations can be made which will be fruitful for those engaged in standards-making activity. Moreover, although the 02 Standard was not a revision, I feel the recommendations offered are just as valid and applicable to revision of standards.

Of the forty-nine organizations, technical societies, governmental agencies, and associations invited to serve on the committee, approximately half—that is, twenty-six—elected to participate in the work. Interestingly enough, there were organizations who, expressing a desire to participate, joined the committee only after they had heard of its work. These late-comers did not affect adversely the even tenor and equilibrium of the committee but, rather, added to the expertise and broadened the base of participation.

Concurrent with the completion of the committee organization was the preparation of an outline of the entire sawmill operation, from preoperational environmental factors to operational-equipment facilities. This outline was not a casual activity, since it was given high priority among the staff people who did intensive research, preparation, and review of the document. At this point the outline was sent to the full committee to evoke comments in order to develop, for the first committee meeting, an outline the committee had agreed to support.

There are conclusions that can be drawn here and some recommendations which can improve the standards-making procedure. From the PERT Network you will note a lapse of four months before there was a response to the action of the Safety Standards Board. The following recommendations offer a partial answer to the ability to respond quickly to the need for a standard:

1. Massive preplanning in response to a request for a standard prior to the decision of the Safety Standards Board or General Conference for a standard.

2. Any contingency planning would be provisional. However, the dimensions of preplanning will extend to areas only in which "canned" materials would be prepared. These would be meaningful invitational lists of interested parties, form letters of invitation, informational kits to prospective sponsors, an apparatus within USASI for recruiting a host administrator or prospective sponsor. "Host administrator" refers to someone who would temporarily perform

the tasks of a sponsor until a sponsor could be found.

3. Organization of a committee by the host administrator with a tentative chairman and secretary who would prepare an outline to be submitted to a combination general conference-organizational meeting where the affirmative decision for a standard can be implemented by work assignments and target dates. This means basically that the machinery would be set in motion at the moment of request—should the staff decision be one in which it believes a standard will be warranted. Many hours of work exerted in preplanning may be washed out. But the extent of the washout can be minimized by staff leadership and well planned canned informational or instructional kits.

4. Among the items on the agenda of a general conference-organizational meeting should be the establishment of a PERT Network or time schedule—a continuation, in the operation of the committee this time, of preplanning. Focusing on the time objectives presents in material form a challenge to which the committee can address itself and find satisfaction in accomplishing it. As naive as it might seem, such was the reaction of the 02 Committee. Further, every sponsor shall be required to provide, after the first committee meeting, a PERT Network. To judge and secure adherence or to pass on the validity of the time schedule a mechanism should be set up in the S.S.B. Through implementation, an accelerated, definitive program can be launched.

The outline, after the committee comments had been collated, was supplemented with appropriate source material. The prime reason for providing the source material and references was to facilitate the sub-committee chairmen in their research efforts. Included in the source material were all applicable national standards and the 11 existing state sawmill codes.

As the committee took shape and the first meeting approached, the secretary and I preselected sub-committee chairmen and apportioned outlined sections of the standard to them. Such selection was not haphazard, but based upon more than 30 years of working with some of these men. You may question the wisdom of preselection; however, it is a method which permits the committee chairman to choose those he can best work with and who in turn will expedite the work of members of his committee. Service is voluntary, so the chairman must be able to present his case in a convincing manner to *each nominee.*

Fortunately, at our first committee meeting, held April 3, 1968, the five sub-committee chairmen were present. At that meeting our objectives were spelled out through establishment of the following ground rules:

1. The committee was advised and given an explanation that it would draft its standard under the procedures of the Standards Institute.

2. Performance requirements would be drafted, since the variables inherent in the sawmill industry had to be encompassed.

3. The inclusion of safe work practices would be eliminated or severely minimized.

4. The referencing of standards, or general orders, where applicable, with explicit instructions of drafting requirements where particular, almost unique application to the sawmill industry existed.

The last point presented the potential of splitting the committee into separate groups. You will recall the concept of total coverage of all hazards, the ordering of the pre-operational as well as operational facilities, had been accepted by the committee through the outline. However, the committee did not wish to err on the side of taking portions of existing standards and citing them in the 02 Standard. It exhibited a reluctance to deal with those areas where overlap existed.

To resolve the impasse, the reference materials were placed in the Appendix and, through the diligence of the sub-committee chairmen, those features that were unique to sawmills were incorporated in the body of the standard. Pertinent requirements are never drafted in this type of a standard by the expediency of referencing other documents which have limited applicability. In drafting a standard, attention should be focused primarily and exclusively on those particular, unique matters of a standard. When there is an overlap with an existing standard, the proposed standard should reference it and develop that portion which pertains to the subject matter of the proposed standard. It is important that the sub-committee chairmen agree that referencing is not to be considered a substitute for re-

search, analysis, and drafting appropriate requirements.

This reinforces my contention that preplanning and preparation of canned instructional kits can expedite the standards writing process. Validation is certified by the necessity to explain these points in committee sessions. The first order of business should have been the appointment of sub-committee chairmen, the setting forth of target dates through the PERT Network, and the review of other associated commitments.

The procedure for review of the outline and later the standard was a word-by-word, requirement-by-requirement method. You are correct in assuming that this was rather a tedious method. However, it avoids the creation of the impression of "steam rolling," which would have been the undoing of any effective work. Furthermore, it was positive knowledge that the documents were being read, it afforded an opportunity for an exchange of viewpoints, and ensuing conflicts generally were resolved before proceeding. An additional factor, playing a most significant role in this review procedure, was that each requirement, in context, was subjected to a thorough analysis from an engineering and editorial aspect.

The committee functioned quite smoothly, with one exception which has previously been discussed. There was reason for this apparent tranquility since the quality, diversification, and practical experience of each member indicated the respect these men accorded one another. Actually, many of the arguments or discussions had been pretty well thrashed out at the state level where various members of the committee representing labor and management had settled upon solutions. Where differences did exist, the general method of resolving the problems was to offer alternatives whereby each party could adjust his position in response to these alternatives. In all, there was an atmosphere of trust exhibited by each interest which is a necessity to committee work.

The first deadline was the commitment to prepare a basic document within six months of our first meeting. It was agreed that the document, to be useful, was to be complete and entire and within the accepted limits of the outline. Once this objective had been achieved, we reasoned, the work of the committee would be largely a cutting and pruning operation. The deadline was successfully met. But why was it met? I believe the motivating reason was the acceptance of the urgent need for a standard. This idea can be sold in any number of ways by all of the participating interest groups. Having marketed the idea, the challenge must be cultivated and translated into action. Action was provided in abundance by five dedicated sub-committee chairmen who worked vigorously in: (1) the rapid formation of their sub-committees with experts from across the nation; (2) the thorough research of all available materials; (3) the sound implementation of assignments and schedules; (4) the allocation of top time priorities to the sub-committee assignments.

The second and third meetings were held almost immediately one after another. Such scheduling was possible for two reasons; namely, availability of the committee membership and the desire of the committee to finalize the document. In the sequence of events which followed, the draft was amended by the full committee in session and was revised by the editorial committee consisting of the sub-committee chairmen, the chairman, and the secretary. From the editorial committee the standard was sent to the full committee, whose review comments were collated for a fourth committee meeting. A fourth meeting may not have been necessary, but the consensus was in favor of another exchange and final reconciliation of views.

From the finalization of the draft at the end of the third and fourth meetings I could envision an interminable delay in preparing the standard should an effective, vigorous editorial committee chairman not be appointed. The first revision was prepared within two months and the second revision for letter ballot action was prepared within one month—a truly remarkable feat.

The procedures—the letter ballot, establishing of consensus, letters of submittal to the sponsor and the Standards Institute, approval by the Safety Standards Board, and the promulgation of a national consensus standard—were executed precisely, as were all other events, within the time schedule of the PERT Network.

In the experience of the 02 Standards' development I feel there is a method which can be generalized to provide guidance for

other committees. Most apparent in all of this is the need for sufficient source material. We've already discussed how the host administrator can provide the source material and outline necessary for a committee to act almost upon request for a standard. It is evident that in the concept of a combination general conference-organizational meeting sufficiency or lack of source material will be reflected in the decision whether or not a standard is warranted. What, then, are the priorities?

1. Most important is the need for a basic document within a six month period. With sufficient source material available, a basic document is capable of being produced within six months. There is no doubt in my mind that a "forced" draft can be written post-haste. This is the keystone to speeding up the standard's writing process. From this initial step flow other actions, which must be implemented to keep within a time schedule.

2. Scheduling of meetings on a timely basis, say at six to eight week intervals, until the draft has been finalized, is a must. These meetings can and should be kept in session until specific sections or other definite bench marks in the review of the standards have been accomplished. In other words, through a pre-determined schedule, segments of the standard can be reviewed at these meetings. If the standard is not developed promptly interest lags, making it difficult to obtain attendance at meetings. Our attendance was excellent and averaged in the 70 to 80 percentile. Slow development not only will effect attendance but, extended over too long a period, will change the committee membership, resulting in considerable backtracking to re-discuss items which once had been settled.

3. Thorough review of the standard through the techniques of collating comments for the meeting for those not in attendance, and reviewing the document word-by-word to scrutinize the validity of the requirements.

4. Pre-selection of sub-committee chairmen avoids the mild coercion of the well-intentioned volunteer.

5. Selection of an editorial committee chairman who has the expertise, vigor, and will to execute the assignment successfully. This is such a critical assignment that it may be necessary to go outside the committee to recruit someone with these abilities.

6. Approval of the standard in committee session without the necessity for a letter ballot. There is great savings of time and man-power by approval of the standard through this means. In addition, it almost makes it mandatory for attendance at meetings and assures for these meetings representatives who will participate. However, should a letter ballot be necessary, restrict it to a duration of two weeks and date it from the closing of the meeting. To insure that all proper changes are made in the text of the standard, it will be necessary to circulate the minutes of the meeting at which approval is granted.

As a final thought, I suggest that a percentage, that is, a specific number of the committee in session and those polled by mail should be the determining factor in approval of the standard. There were no conflicts within the 02 Committee, since the alternatives offered to dissidents were real and viable, the committee did not form into factions, and all exchanges of views were amicably received. But I wonder, if there are opposing, hostile factions what will be the fate of similar documents?

Under the present interpretation consensus, virtual unanimity, could preclude the publication of a standard upon which much time and money has been spent. Numerical consensus reaches this problem. For all those engaged in the safety standards activity, giving so generously of time, effort and money we are compelled to suggest that expeditious methods should be found to accelerate and innovate the process for developing safety standards.

In reviewing the cost breakdown of the development of the 02 Standard, conservative assumptions were made:

1. Travel time to and from meetings is calculated at 12 hours per committee meeting or 48 hours should the representative have attended all four meetings. This is quite conservative when considering the number traveling from the Pacific Northwest.

2. To arrive at the dollar equivalent for man-hours it was decided to use a figure of $8.00 per man-hour. (The formula is 255 work days, seven hours in a work day, $56 per work day, totaling a little over $14,000.)

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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gaged in being a part of safety, by thinking and acting safely, otherwise, the supervisor's five-minute safety talk may just turn out to be another rest period. Encourage the suggestor to be specific, eliminating the blanket coverage proposal. Use a ¼ inch square sketch area on the back of the suggestion blank and, for clarity and speed of reply, encourage all safety investigators to use a Polaroid type camera and to submit a suggestion for analysis with accompanying photographs. Keep in mind to always photograph only the safety problem, thus replacing the poor descriptions, improper words, and ambiguous statements and misunderstandings with a picture worth 1,000 words.

The Maintenance System so often falls into the category of the "If"—if we only had "PM" (preventive maintenance) then all our troubles would be over—nonsense! We all believe that PM has its place. At this time we are concerned with the power vehicle operator and his machine. We suggest that his attitude should run in the same vein as Chevrolet's "Good Driving" recommendations. We will call them "Rules for Good Trucking" which, when followed, reduce maintenance:

1. I will treat my truck as though I had paid for it.

2. I will drive for the other fellow's safety.

3. I will learn and practice the proper method of operation.

4. I will conscientiously operate within the capabilities of my truck.

5. I will adhere to the maintenance schedule for my truck.

The Statistical System.

Items that cause statistics: "Boy! I wish they'd fix that floor!" "Pretty good, huh—Sealy?" "Who moved that van?" "All this for just one cigarette?" "Push back to back, not with forks!" "I just gotta keep m'forks up!" "Yippie! They fixed the brakes!" "Hang on, Joe!" "Not again!" The attitude of the driver has an important bearing on safety. Sure, the safety program has to be a balanced one! You are all familiar with the saying, "Partners in crime"—one, the killer; the other, the killed. We say to you, Partners in Safety!" One, the saver; the other, the saved!

The Quality System implies safety with dependability, with knowledge, with proper training both practical and theoretical. We believe in driver training for the highway. Why not a universal, mandatory vehicle operation training program, coordinated by the National Safety Council?

All too often, an inexperienced, untrained employe has a trucker's badge pinned to his shirt and is told to go to work. His only qualification is that he can drive a car. "Oh, but wait!" says the foreman, "I spent a whole afternoon with him!" This is good advice, not good training. A good training program is one similar to that outlined in the International Material Management Society publication, *A Training Program For Operators of Industrial Power Trucks*, by Elmer Clancey.

Dr. John V. Grimaldi, director of the Center for Safety, New York University, states that the time-proven approach to solving safety problems is simply "Evaluate the hazards, then eliminate them." In short, reducing hazards on the job is a much more attainable goal than trying to change people's behavior pattern.

On the other hand, we of Harrison Radiator suggest you consider the environment influence in which these safety problems arise. For example, I am sure you will agree that a clean plant is the best way to start a safety program! A dirty plant encourages sloppiness, and a sloppy attitude breeds accidents.

We also feel that participation is a direct way to improve safety and reduce accident frequency. Be a part of safety—not the accident! Sometimes the salaried employe is the forgotten man, especially management personnel. Here lies the greatest potential a company has. I am glad I work for a company that recognizes the efforts of all of its employees, even to the extent of publicly acclaiming their efforts. The latest of these programs revolves around the participation of an individual in his or her local community activities. Does it not follow that all of us in charge of administering safety programs should initiate a similar award system? It is time that all people who donate their efforts and talents in the behalf of their fellowmen be publicly recognized, not just given a pat on the back.

What is the best approach in order to improve your plant safety? Our answer is the industrial standard efficiency approach. This method is like the material handling flow and layout analysis, known as the frequency—distance—weight analysis, sometimes called the "ton-mile" comparison. This time we call it "accident frequency and severity analysis." It provides a two-pronged attack, for the two approaches do not necessarily coincide. Obviously, the greatest frequency could be the item of least severity.

Safety Problems. O. S. Carliss of Yale Materials Handling Division states that a common fault among users of industrial trucking equipment is the attitude that as long as it runs it does not need attention. A good mechanic will quickly tell you that an improperly adjusted carburetor can substantially increase the output of carbon monoxide. Failure to simply replace spark plugs results in sluggish, unsafe performance and objectionable exhaust fumes.

An attempt to reduce air pollution, especially in confined areas, has resulted in some of the trucks now in use being converted to LP gas. In other cases, new LP gas units have been purchased; however, these are not without hazards. The LPG requires good maintenance, for while it has lower emissions than gasoline powered trucks, the out of adjustment LPG truck can create a real exhaust problem.

We often hear the question, "Why don't you use Diesel trucks?" They may have lower hydrocarbon and carbon monoxide emissions than the gasoline type, but the diesel also has its combustion problems, mainly odor and smoke.

Accident Causes. So many times we hear that speed is the cause of accidents. Just cut the speed," they say, "and you won't have any more accidents." The change of speed or the inconsistency of speed is the real cause, especially in the undesirable condition of the blind alley, which we all try to avoid. If six miles per hour is to be the accepted standard for the sit-down fork truck, in-plant travel, then perhaps a governor is not the way to control the driver, for he has a job to do under varying conditions. Rather, a warning system such as a good loud bell that unhesitatingly announces that this vehicle is traveling over the set speed limit, regardless of the reason, and watch out! Also, to the driver it says, "You are exceeding the approved safety speed—be extra careful!" And, "Are you in an area where this speed is a safe speed to all concerned?"

We talk long and often about the equipment—how about the operator? Can the following be considered a new approach? Perhaps, but certainly here is a challenge! We are told by the medical people that the spine, assisted by the muscle of your back, stomach, and sides, carries the top half of your body weight. The spine also transmits this weight to the sacroiliac joint and then continues the distribution to your legs and feet. So, why not a milkman's approach to seating a driver of a fork truck? Why must a driver forever climb over mechanical efficiencies and strain his physical being just to sit down? Climbing of this nature often creates the same strain as picking up a weight when off balance, or carrying an object such as a ladder in an unbalanced position.

Again, we are told that when we sit down too hard we injure the small terminal bone. When injured or irritated it hurts! And now comes the crux of the problem: How can the truck manufacturer keep designing smaller, more compact trucks to suit the customer and still provide a comfortable posture for the driver? How can we make his equipment safer? To these questions we propose for your consideration the following suggestions, not necessarily new but worthy of universal application:

1. A tire within a tire, offering the air ride of a pneumatic combined with the inside security of the cushion tire.

2. The visibility of see-through independent telescoping masts whose lift is hydraulically kept in parallel.

3. Safety lights that are visible 360° to pedestrian and driver alike and are an integral standard part of all power trucks, not some adaptation at a later date.

4. Deadman seat brakes that shut off the power of any vehicle.

5. Elimination of all gadgets that check the checker. Let us all concentrate on eliminating the problem at the source, before the accident happens, not after the fact. Please do not give the user a piece of equipment that has the safety factor of shutting itself down to avoid a burned out motor due to an over-heating problem.

Rather, design into your equipment a cooling system that won't let the unit overheat in the first place.

6. Design the center driver position with the pocket seat so that overhead guards can be placed on even low headroom trucks. At the present time this seems more feasible with electric power than with gas, but why stop there? The fuel cell is not far away; perhaps not even atomic energy, as a power source.

7. Design into all lifting devices a hydraulic valve control that will not allow the capacity or safe load of the truck to be exceeded. Do not offer this as an extra; make the user buy it as a standard safety feature. It is *his* liability that you are protecting!

8. Members of the National Safety Council, together with I.T.A. personnel, should set forth a standard checkoff list that every driver should follow daily before he starts his day's work—he is no different than the pilot of a plane. Standardize the start-up and shutdown procedure for all trucks.

9. For equipment that is silent, such as the electric truck, build in an audible warning system other than the horn — one that is pleasant, heard for 10 to 15 feet, but does not create an undesirable decibel accumulation for the plant.

Sophistication of Industrial Trucking Safety. Does it not seem odd to you that with all the advancements made in the material management field, no where does there seem to be a concentration to combine our thinking? Let us join Dr. "Q" of quality with Harrison Radiator's safety symbol, Mr. "Les Hazard." The result is Mr. E. F. Thru, who, when he gets his name in the newspaper, is written up as "Mr. Efficient Follow Thru" but locally is called "Efthru"! Efthru is like the winged messenger, Mercury, except that Efthru goes into action after we initiate a project and makes sure we complete our obligations in an efficient and safe manner.

So, if we are to bring about a truly new look in safe material handling, then we must, in my opinion, bring about a wedding of "safety" and "quality".

That we may forever have a goal for achievement, we submit to you a safety code of ethics:

1. I resolve to recognize that the safety of my fellow man is paramount to his well-being.

2. I resolve to keep an open mind to all proposed solutions of safety problems.

3. I resolve to always set a good example through the application and practice of safety in my business and in my every day life.

4. I resolve to keep myself informed on the latest information and development of safety practices and equipment.

5. I resolve to use the defensive safety method, to avoid the accident before it happens.

6. I resolve to perpetually apply my safety knowledge in all that I do and to promote the safety of the society in which I am privileged to live.

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Power Press & Forging Section

POWER PRESS ACCIDENTS — A MANAGEMENT PROBLEM

By JOSEPH W. HART
Technical Consultant, Liberty Mutual Insurance Co.

Power presses are used commonly in the metal fabricating industry as well as in a wide variety of other manufacturing operations throughout the country. Power presses in metal stamping plants account for a fairly large percentage of the machines used and, therefore, are usually recognized as inherently hazardous machines requiring effective controls. There are many more other industrial operations, however, which utilize power presses as a relatively minor percentage of the machine operations. Consequently, the inherent hazards and necessary controls are frequently overlooked in these applications.

In spite of the tremendous improvements which have been made in power press design, control systems, guards, and safety devices, serious employee injuries continue to occur. The approach to the prevention of accidents on power presses, as compared with most other machine tools, takes on special significance because of the high severity of the injuries that can result from the operation of power presses.

To gain a better appreciation of the problem, we can resort to a time-proven method of securing the facts. This is through investigation and analysis. From a practical standpoint, experience can be an excellent teacher. A careful analysis of a large group of power press accidents, therefore, should produce some conclusive evidence relating to the accident causes and measures necessary to prevent recurrence. We investigate accidents to determine specifically what happened for the purpose of detecting what should be done to eliminate or control specific hazards.

On the premise that we can learn from experience, Liberty Mutual has made a study of 389 high cost power press accidents which occurred during the last few years. Each of these cases was investigated by one of our loss prevention representatives. The accidents occurred in many types of industrial operations throughout the country. The total direct cost of the 389 accidents analyzed was $2,800,000. This represents the temporary and permanent disability benefits and the medical costs involved. The minimum cost accident considered in this analysis was $2,500. The average cost per case was $7,200.

To arrive at meaningful conclusions, we chose to catergorize the accidents according to the type of operator protection involved. The categories were as follows:

	No. of Accidents
No guards or devices provided.....	135
Guards or devices provided, but not used.....	50
Guards or devices provided, used but protection not adequate.....	96
Guards or devices improperly adjusted, maintained, or installed...	59
Set up, test operating, and repairing	49

The largest single group involved operating presses with no guards or safety devices provided. This group accounted for 35 per cent of the total accidents. Most of these accidents occurred when the operator was loading or unloading the die and accidentally tripped the press. Others occurred while reaching into the danger area to remove the part, clear the scrap, readjust the stock, or clear a jam. Others include readjusting the part or stock after tripping the press. This large percentage of accidents occurring on press operations not provided with any guard or device dramatizes the fallacy of relying upon the operator alone to keep his hands out of the danger area during down stroke of the ram. For the effective prevention of power press accidents, some means must be provided to protect the press operator from the inherent hazards.

Guards or Devices Provided But Not Used

The mere availablity of a guard or safety device will not necessarily assure its use.

This is shown by the fact that in 50 cases, although a guard or device was provided, it was not used. In about half of these cases, investigation disclosed that the pull-out device was not connected at the time of the accident. Most of these were a result of the operator failing to attach the wrist bands before operating the press. This is usually a supervisory problem and can be overcome by training, close supervision, and enforcement of wearing of the pull-out device wrist bands. Putting out of operation the two-hand controls may point to one of several problems. The controls should be so designed that it is not easily possible for the operator to change from two-hand control to foot control. This is particularly true where the operator does not perform his own set up. Where selector switches are used to determine type of stroke such as hand or foot, single stroke or continuous, inch or run, etc., the selector switch should be a key locking type to prevent unauthorized changes. The two-hand controls should have a non-tie down feature so that both buttons must be depressed to actuate the press. On those press operations where it is necessary for the press operator to set his own dies and thereby select the type of stroke or control used, the problem is more one of training and supervision.

The removal of barrier guards, which resulted in seven accidents, is frequently a problem of poor guard design causing the operator or set-up man to dislike the inconvenience so much that he removes the guard. The problem can also be a lack of knowledge on the part of the operator as to the purpose of the guard or it can be a lack of enforcement in the use of the guards.

Guards or Devices Provided and Used But Protection Not Adequate

The second largest group of accidents occurred on presses during operaiton when a guard or safety device was provided, but for one or more reasons the protection provided for the operator was not adequate, and a serious injury resulted. Nearly half of these 96 cases involved presses equipped with two-hand controls. Numerous accidents have resulted when a press malfunction or a mechanical failure of the press resulted in a serious injury to the operator. In these cases, the operator was relying upon the two-hand controls as a safety device. Whenever the press operator is reaching into the danger area with the press running, he is exposed to serious injury because of a press or control failure possibility. The only real answer is to design the operation so that it is not necessary for the operator to be so exposed to the danger area. Several accidents have resulted from the installation of two-hand controls on slow positive clutch presses or on friction clutch presses where adequate "hold-time" was not provided. In such cases, it is possible for the operator to depress the two-hand controls and still reach into the danger area before the ram has descended to a point where there is no longer a hazard. The use of two-hand controls should not allow an operator to actuate the controls and still reach into the danger area before the ram has descended. On air-friction clutch presses, adequate hold-time can usually be provided through adjustment of the rotary limit switches.

Twenty-six per cent of the accidents in this group of 96 cases involved the use of sweep devices. In 14 of these cases, it was possible for the operator to reach over, around, or behind the device and into the danger area. On too many occasions an operator is allowed to reach either hand into the danger area and the sweep device is expected to remove both hands from the danger area before the ram descends. A right to left sweep action should usually only be expected to remove the right hand from the danger area. A left to right sweep action should usually only be expected to remove the left hand from the danger area. A high level of training and close supervision is essential to the effective utilization of sweep devices on power presses.

Although barrier guards or gates are usually considered among the most effective protection for press operators, poor design or improper use of them can result in serious accidents. Certainly guards which allow the operator to reach through, over, or behind them will not effectively protect the operator. A full and complete enclosure which meets nationally accepted standards is essential. Hinged or easily removed guards in many cases should be interlocked to prevent operation of the press when the guard is open or removed. If the guard is opened while the press is running and the press stops when the guard is opened, the re-

placement of the guard or closing of the guard should not, usually, cause the press to start again until the press is manually restarted at the normal "Start" position. When gates are used, it should not be possible for the operator to lift or raise the gate after actuating the press until the ram has stopped at the top of the stroke. Merely raising of the gate by the upward motion of the ram will not protect the operator against a repeat cycle of the press.

When the operator, wearing pullout device wristbands is expected to reach into the danger area, he is exposed to injury in some cases because of his hand being caught on a part being fed or removed, or his wristband may be caught on a projection in the die. These hazards can be overcome by using hand tools to feed the part, thereby keeping the hand out of the danger area or by training so that the operator grasps the part properly to avoid being caught. Unnecessary projections in dies should be eliminated to prevent the wristbands from catching on them, holding the hand in the danger area when the ram descends.

Guards or Devices Improperly Adjusted, Maintained or Installed

Another major group of accidents involves those resulting from the improper adjustment, maintenance, or installation of guards or safety devices. Because of the frequent changes necessary to provide adequate protection for press operators, improper adjustment of sweep devices and pullout devices may result. Sweep devices should be adjusted so that the hand is swept from the danger area as early as possible in the down stroke of the ram. Too often, the sweep arm travels a considerable distance before passing through the area where the operator's hand or arm would ordinarily be placed in order to sweep the arm from the danger area. Close adjustment of the sweep arm is essential to any success with sweep devices. Pullout devices should be adjusted at the beginning of each shift, at each die change, and at each change of operator. The press should be turned over by hand, where possible, to accurately determine if the pullout device or sweep device will effectively remove the hands from the danger area. It should be remembered that the danger area is not always only the point of operation, but it can be a pinchpoint between the part being processed and the dies. It also can involve other mechanisms in the area of the die, such as the shear point between the top of guide pins and the upper die shoe.

When a safety device is being used and is being relied upon to remove or keep an operator's hands out of the danger area during down stroke of the ram, only the best in maintenance procedures should be acceptable. Preventive maintenance programs should be developed to assure that all critical parts of safety devices, guards as well as the press, are inspected on a regular basis. Accurate records should be maintained to assist in assuring proper scheduling of inspection and repair work. To perform effective preventive maintenance inspections, it is frequently necessary to at least partially disassemble critical components to check their condition and function. Written procedures should be spelled out to assure effective completion of the preventive maintenance work.

The manufacturer's instructions should be closely followed in the installation of all safety devices for power presses. In regard to two-hand controls, it is particularly important to locate the control buttons so that operation by other than both hands of the operator is not possible. Placing the buttons where they can be actuated by a knee, hip, elbow, shoulder, or head should be avoided. Pullout devices and sweep devices should be installed so that the connection is made to the ram below the pitman or adjusting screw so that if the pitman screw fails, the falling ram will still actuate the safety device.

Set-Up, Test Operating, and Repairing

So far we have considered only accidents which have occurred during the so-called normal operation of the power presses. A significant number of power press accidents occur during set-up, test operation, and repairing of power presses. An investigation of the accidents during set-up will show that the set-up man usually cycles the press accidentally while reaching into the danger area. The practice of leaving the power on or flywheel turning while reaching in or around the danger area creates a risk to the die setter. This is the cause of nearly all serious press accidents occurring during set-up operations.

During test operating, the accidents usually result from the die setter not using any

guards or devices. Die setters will frequently expose themselves unnecessarily to danger for several reasons. These include the feeling that just because they are going to only run a few pieces, they will be careful and, therefore, will not get hurt. Also, they are reluctant to wear, adjust, or use the safety device or guard when only running a few pieces. Mismated punches and dies or failure to check the shut height of the press have resulted in shattered dies and flying parts, which have caused serious injuries. Leaving a turnover bar in a flywheel may result in a serious injury when the press is started under power.

Performing repair or cleaning operations with the power on or the flywheel coasting accounts for many very serious press injuries. Too often, the press is cycled accidentally when a person is reaching into the danger area to wipe off a die or make some minor adjustment. The rule of no hands between the dies unless the power is off and the flywheel is stopped is particularly applicable during repairing or cleaning operations.

As outlined in the U.S.A. Standard B11.1-1960—Safety Standards For Power Presses, maximum safety can be obtained by providing the means that make it unnecessary for the operator to place his hands or any other part of his body into the point of operation. This objective can be achieved by: (1) automatic or semiautomatic loading and unloading of the dies, with proper point of operation enclosure guards; (2) limiting any point of operation to ¼ inch; or (3) if the methods outlined in (1) and (2) cannot be applied, auxiliary protective devices should be used to control access to the point of operation. In addition to the use of safety devices, full consideration should also be given to the use of hand tools or feeding and stock removal methods, which would make it unnecessary for the operator to place his hands into the point of operation.

The unnecessary painful and costly accidents on power presses can be prevented. There is no single panacea that will solve all power press accident problems. A well organized approach to the problem is necessary to maintain control over the inherent hazards of power press operations. This approach involves action by management to establish an effectively operating control program:

1. Plan jobs to keep hands out of dies wherever possible.
2. Provide and use guard or safety device on every press operation.
3. Maintain effective preventive maintenance of all presses, guards and safety devices.
4. Establish press room safety standards.
5. Train supervisors; set-up personnel and operators to maintain press room safety standards.

SAFETY CONSIDERATIONS IN THE CONTROL OF PRESSES

By FRANK H. HOLLAND
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A modern power press is generally operated by a combination of two kinds of power—electric and fluid.

In hydraulic presses, the dies are driven together by one or more hydraulic cylinders. The fluid power is ordinarily provided by an electrically driven pump and is controlled with electrically operated sequencing valves by means of pushbuttons, limit switches, and pressure switches.

In mechanical presses, the dies are normally brought together by the release of energy stored in a flywheel driven by an electric motor. Fluid power in the form of compressed air has had steadily increasing usage over the last 40 years on mechanical presses to actuate clutches and brakes, counterbalance the slide, provide pressure for draw cushion cylinders, and eject parts from between the dies. The application of the air

pressure is usually controlled with electrically operated valves through pushbuttons and rotary limit switches. On some presses, air is also used for clamping the dies and driving "rolling" bolster carriages. Such bolsters are frequently clamped in place with hydraulic pressure.

On both mechanical and hydraulic presses, there are usually control panels with electromagnetic relays or solid-state electrical switching modules that coordinate the signals transmitted by pushbuttons, limit switches, and other pilot devices. Each press is either permitted or not permitted to make another stroke or complete a stroke that has already been started, depending upon the intelligence received and the circuitry employed.

Proper utilization of both electric and fluid power on presses has helped tremendously to improve safety conditions and increase production rates. Modern presses are a far cry from the old machines driven by lineshafts and tripped with mechanical foot treadles. In 1896, we didn't have continuous cold strip mills for making coils of steel. Light gauge material for stamping was rolled in hand fed, single stand mills, in the form of individual sheets usually not more than 12 feet long and three feet wide. The rolls were ordinarily driven by steam engines, as electrically driven mills weren't introduced until 1905. At the beginning of the twentieth century, many metal stamping operations were practically butcher shops. Oberlin Smith, in 1896, wrote:

"It is earnestly to be hoped that our modern inventors will soon supersede the antiquated methods used in producing this useful metal by some process that will give it to us in long strips from a reel. We can then double or treble the speed of our presswork upon it. In connection with hand feeding, the melancholy fact must be looked in the face that many of the best press operators in this and other lands may be found with mutilated hands or, as past masters of the art, with no hands at all. There seems to be a peculiar fatality in this respect, which perhaps is not so strange after all, when we consider the enormous number of operations performed by these faithful men and women and boys and girls, in some cases amounting to 10,000 to 20,000, and (with certain work) even over 100,000 per day of 10 hours. The worst danger is not usually, as might be supposed, with 'continuous feeding' but occurs in cases where a power press is stopped each time by an automatic clutch and started by the operator with the usual foot-treadle."

This quotation was sent to me recently by Clarence Makin, who probably did more than any other man to virtually eliminate mechanical foot treadles in the automotive industry. This, combined with the work of Mike McCarthy and others to get hands out of the dies, resulted in dramatic decreases in injuries in automotive stamping plants and in scores of other progressive companies.

We must also credit an important assist to the introduction in the 1920's of the continuous rolling mills that started producing steel in the long coils that Oberlin Smith had hoped for in 1896. Refinements in electrical control techniques helped to make the tandem cold reduction mills for light gauge steel possible. Today, even hot rolled steel in gauges thin enough for stamping is available in coil form.

Tin coated steel for so-called "tin" cans used to be made by dipping individual thin sheets of steel into huge pots of molten tin. Old-timers in the can making industry will recall that all tinplate used to arrive from the steel mills in boxes of small sheets. The process of electro-plating the tin on steel was introduced commercially in 1937 and made it possible to supply tin plate in coil form. By the late 1950's, much of the tin plate was being shipped in coils. Today, the new tin-free steel for cans is also produced in coil form.

There has been a similar situation with galvanized steel, used where greater resistance to rust is needed. It used to be made by dipping single sheets of steel into tanks of molten zinc. Continuous galvanizing lines are now used in many cases to apply the zinc to steel strip and provide coil stock.

As Oberlin Smith prophesied in 1896, the long reels of metal have made it possible to tremendously increase production rates of blanking and many forming operations where it's practical to feed strip instead of sheets into the presses. At the same time, safety has been improved by the automatic roll feeds that make hand feeding of the presses unnecessary. Improvements in mechanical designs of presses, plus the use of individual motors and more sophisticated controls, have also played an important role.

Electrification of machinery through the installation of individual motors in place of lineshafts got pretty well underway in the 'twenties. At about the same time, press clutches that could be disengaged at any point during the stroke were developed along with rather crude two-hand electrical clutch controls. By the late 'twenties, many large presses in the automotive industry had magnetically operated friction clutches and brakes.

Faster acting air operated clutches and brakes were in pretty general use by the early 'thirties on straightside presses, together with improved electrical anti-repeat controls that broke both sides of the circuit to give greater protection against grounded wires and short circuited contacts.

Prior to 1936, electrical controls on presses were installed in a pretty helter-skelter fashion, with separate boxes for each motor starter and the clutch control. Sometimes the power disconnect switches were in separate boxes on the press, and sometimes there was no disconnect at all on the machine—it may have been on a wall a hundred feet away.

The combination main panel was then developed to put everything in one enclosure, with a single main disconnect interlocked with the door so that the power had to be shut off before the door could be opened by an operator. This increased safety for operators and also for maintenance men, who could padlock the single main switch open before working on a press, thus preventing an accidental start of any motor.

In 1939, improved circuitry was developed in which the valve was connected in the 110-volt control circuit and put under direct control of the run buttons and rotary limit switch, to prevent a repeat stroke if the valve relay should stick in the closed position. A further safety improvement was made in 1939 by the introduction of a clutch air valve with an operating magnet that was not as prone to stick as the old direct acting solenoids.

Safety for personnel, protection of the machinery, and maximum production rates should be considered in that order when designing each element of a press control. The three considerations go hand in hand, because experience shows that the system safest for operating personnel will give maximum protection to the expensive equipment and will provide the highest production and the least downtime.

For maximum safety all motor starters should be of the magnetic type, actuated with momentary contact pushbuttons to provide loss-of-voltage protection so motors will not restart automatically after an interruption of power. They should restart only after the appropriate "start" pushbuttons have been pressed. Any type of control that automatically restarts a motor after a power interruption can be hazardous on a press.

With a friction or eddy current clutch, the main drive motor starter should be of the magnetic reversing type for maximum safety so the drive can be easily reversed without having to call an electrician if someone gets pinched between the dies. An air operated flywheel brake should be used to quickly bring the flywheel to a stop before reversing.

With a positive clutch, a non-reversing main motor starter is used, since the slide can't be stopped until the end of a stroke and the clutch operates in only one direction.

Most straight side and two-point gap frame presses have motorized slide adjustments to change the shut-height for different jobs. The starters must be of the reversing type, and since they're subjected to severe inching during each adjustment, the size should be based on the jogging rating, which is about 40 per cent less than the normal rating. To safeguard against a welded-in contactor that might cause the slide to drop off the adjusting screws or jam the screws, an additional safety contactor should be used so the motor can still be stopped if one contactor freezes in.

Various pushbuttons and selector switches are required for starting the motors on a press and selecting modes of operation. Pilot lights are used for indicating the state of various drives and for warning of grounds and other fault conditions.

Instead of using several separate pushbutton stations, it's more convenient for installation, operation, and maintenance to locate all the pilot devices together in a master control panel. This is usually mounted on the right front column of straight slide presses. On gap frame machines, it's frequently built into the side of the main panel.

"Start" and "Inch" buttons should be of the guarded type to minimize accidental operation. "Stop" buttons should be unguarded so a drive can be stopped readily with a gloved hand.

Any change in the slide adjustment that accidentally reduces the shut-height can cause a broken crown or other severe damage. To protect against this, the motor normally has a spring-set, electrically-released brake and the control should have a key-operated switch wired ahead of the up-down buttons. This lock switch should be built so the key cannot be removed in the "On" position. The control circuit should be arranged without holding contacts so the motor runs only while a button is pushed.

The stroking control is the most important part of any press control from both a safety and production standpoint, because it governs the vertical movement of the slide. Properly controlled closing of the dies performs the useful work the press was built to do. Unintentional or improperly controlled stroking can cause accidents ranging from crushed or amputated fingers to fatal injuries to a press operator, die setter, or maintenance man. In addition, thousands of dollars worth of damage can be done to the press, the dies, and to automation equipment in case of accidental die closure. It's imperative, therefore, that the control system be designed, built and installed with the greatest of care.

A good starting point in the design of the circuit is to assume that every relay, pushbutton, valve, and limit switch is going to fail some day, in either an open or a closed condition. This is not an unrealistic premise, because in many plants there's little, if any, preventive maintenance of electrical controls. After years of wear and the accumulation of dirt and oil, any component can fail.

The stroking control generally consists of pushbuttons for each operator, anti-repeat relays, limit switches, pressure switches, and magnetically operated valves.

Each press operator should ordinarily have two "Run" buttons and a "Stop" button with mushroom heads for ease of operation. The "Stop" button head should be red for good visibility and be within easy reach of the operator. The "Run" buttons should be located in a safe yet efficient position for production and should be properly guarded and mounted to prevent operation by accidental or unintended means, such as the use of one hand and elbow. Both "Run" and "Stop" buttons should have all metal exteriors that are securely grounded to prevent shock to the operators in case of internal electrical faults.

To make sure that the spacing between run buttons is always in conformity with company standards, the buttons are frequently assembled into press operating stations. This also simplifies installation and gives better protection to the wiring. Gap frame machines have no column for mounting a regular master panel and it isn't always possible to put a combination main and master panel on the side of the press. The most important thing is not the exact style or location of station, but the combination of run button guarding and die guarding.

The stroking control for mechanical presses ordinarily operates a clutch that engages the slide operating crank or eccentric shaft with the flywheel, to cause vertical movement of the press slide. Most modern presses have air operated friction clutches with air released, spring-set friction brakes. This arrangement permits starting or stopping the slide at any position in the stroke.

Each movement of the slide on a friction clutch press is accomplished by energizing the coils of one or two magnetic three-way air valves, thus opening the valves and permitting air to flow into the clutch and brake operating cylinders.

The clutch/brake air valve is the most critical control device on a press, as any failure of the valve to close instantly and completely whenever its magnet is de-energized can cause a repeat stroke or other faulty operation that may result in an accident. Valves used for clutch and brake service should be of the poppet type, to minimize sticking. Sliding type valves should not be used, as dirt or corrosion can cause them to stick. A slide valve designed for use with air operated resistance welding guns can operate 500 times a minute, but will stick if it isn't lubricated properly, if dirt gets in it, or if the moving surfaces become corroded. It's a little like a valve in a trumpet or cornet. It should never be used for press clutches.

A poppet valve is of the type used in most automobile engines. A three-way valve for press clutch service has two poppets, one for closing the air inlet and one for

closing the exhaust port when the inlet is open. The two poppets and seats are usually at opposite ends of a common stem. Poppet valves are not nearly as apt to stick because, roughly speaking, each poppet is a disc that seats on a round hole. They can be accidentally blocked open, however, by foreign particles, as described later.

A fine air-line filter (not a strainer) should always be provided in the air line ahead of the valve to remove as many dirt particles as possible. A lubricator should also be installed when needed for either the clutch or the valve. A surge tank should be connected ahead of the valve to maintain adequate air pressure throughout the stroke and reduce clutch slippage.

The connection between the valve and the clutch/brake should be as short as practical and should be the full size of the valve outlet connection so as not to restrict the exhaust of air from the clutch or brake when stopping. Undersize connections can prevent the slide from stopping quickly in an emergency, as more time will be required for exhausting the air.

To reduce the noise level, it's advisable to connect a muffler to the valve exhaust port. The muffler must be large enough to prevent restriction of the exhaust and delay in stopping.

Some particles of foreign material always find their way into valves despite filters. Sometimes they break off the inside of the piping or surge tank and, at times, they are blown back into the valve from the clutch or brake during exhaust. Such particles can prevent the valve from closing or can lodge in a seat and keep the valve cracked open sufficiently to cause a repeat stroke or sluggish stopping. The safest practice is to use dual valves with self-monitoring. This gives greatly increased protection against faulty operation because of particles entering the valve and against internal valve or operating magnet failures that would cause the press to repeat if a single valve were being used.

In one case, the operating section of a dual valve had tripped and could not be reset. The reason for the trip was that a piece of metal had caught between the inlet poppet and its seat. Investigation showed that the chunk of metal had broken off an air restrictor in the line to the clutch, had been blown back into the valve when the clutch cylinder exhausted, and prevented the unit from closing. The press would have repeated if the valve had not been of the dual type.

The greatest of care should go into the design of the clutch control, as an unreliable control is worse than having none at all. An anti-repeat clutch should have, as a minimum, the following safety requirements:

1. To prevent the tying down of any "Run" buttons, each stroke of the press should be contingent upon all "Run" buttons having been released prior to the start of each stroke.

2. The release of any "Run" button during the downstroke holding time should directly interrupt the clutch and brake air valve current and should not rely on any relay or electronic device to open, as either can fail.

3. The release of an "Inch" button at any time when in the inch mode of operation or the pushing of a "Stop" button at any time in any mode of operation should directly interrupt the valve current.

4. At the end of the stroke, the valve current should be interrupted directly by the rotary limit contacts and should not be dependent on the opening of any relay or the release of the "Run" buttons.

For these requirements to be fully effective, all control devices should have heavy duty contacts capable of easily interrupting the current for any combination of clutch and brake valves.

For a better margin of safety, it's best to use devices rated at 600 volts. Several components with 300 volt ratings are available and might be all right for ordinary machine tool service, but they don't have the electrical clearances and, in some cases, the mechanical strength of the slightly larger devices with 600 volt ratings. These components work every stroke of the press and may average 2,000,000 operations a year on the basis of 500 strokes an hour, 16 hours a day, five days a week, and 50 weeks a year. In 10 years, 20,000,000 operations have accumulated, so only the highest quality devices should be used.

Despite careful wiring, various connections become accidentally grounded on presses. Sometimes the grounds are caused by moisture, vibration, or damage to con-

duits by lift trucks. Because of the number of grounds that occur, and also to protect against short circuited contacts, I strongly recommend the use of ungrounded, double-break circuitry for the anti-repeat control. In this system, all critical relay and limit switch contacts are duplicated on each side of the circuit, and each operator has one "Run" button connected to each side of the circuit. Production can be safely maintained with a single ground fault, and the operator is warned of the condition by ground detector lights. The presses in most automotive stamping plants have been operating with the double break control for about 35 years.

In recent years, many improvements have been made in anti-repeat controls. Circuits that provide anti-repeat protection throughout the entire stroke, instead of only at the end of the stroke, are now available. With this arrangement, if an operator stops the slide by releasing a "Run" button during the downstroke, he can't restart the slide by accidentally repressing the button just released. To insure that any restart is intended, all buttons must be released and then repressed before the stroke can be resumed.

Another feature now available is "Run" button short circuit protection to prevent accidental operation of the press if either the normally open or the normally closed contacts of any "Run" button become shorted for any reason. Controls are also available in which all relays are automatically checked each stroke of the press.

The rotary limit switch on a press should have a most reliable drive mechanism, because the switch is a vital part of the anti-repeat control. Its contacts govern the length of "Run" button holding time, stop the slide at the end of the stroke, and operate anti-repeat devices. On presses operating at less than 100 strokes a minute, a cam type switch arranged so that the cams force normally closed contacts open is desirable, because this action is very positive and is usually strong enough to overcome any tendency of contacts to stick in the closed position. The use of spring opened contacts should be avoided.

Even with well engineered limit switch drives, experience has shown there can be failures. If rotation is stopped during the upstroke of the slide the press will repeat, as the stopping contacts will not open when the slide reaches the top. Various mechanisms and circuits are now available to protect against a broken drive, and we recommend the use of two electrically interlocked, separately driven limit switches, or loss-of-motion detection, on all presses that are single-stroked.

While progress has been made in reducing power press accidents, the total is still appalling. In Ohio in 1967, which is the most recent year for which I have statistics, there were 1,301 injuries from presses reported to the State Industrial Commission. They resulted in 157,022 days lost from work, or an average lost time per press injury of 122 days, which is more than 24 weeks.

Since Ohio has about eight per cent of the national manufacturing capacity, it can be projected that there were at least 16,000 press injuries throughout the United States in 1967, with about 2,000,000 lost days of work. Great strides in safety have been made in many plants, but it appears that some are not much better than in 1896.

For maximum protection of the hands and arms, every job should be tooled or guarded so operators never put a hand between the dies. Even when this is accomplished, the safest possible anti-repeat control is still needed, because an accidental repeat stroke can smash mechanical handling devices, or part of a die, and cause flying shrapnel that can result in serious injury. In Ohio alone, during the last five years, there have been about 170 eye, face, neck, head, and chest injuries to press operators.

Automated feeding and extracting devices should be used to the fullest extent possible, as they contribute tremendously to press safety by making it possible for operators to keep their hands and arms out of the die area. A crushed iron hand can be repaired, but it may not be possible to repair a crushed human hand.

PLANT IMPLEMENTATION OF CORPORATE PRESS-ROOM SAFETY STANDARDS

By J. M. CALLISON
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"Safety is everybody's business." There is probably no expression in the automotive industry that has had more exposure, but by the same token, there is probably no better phrase to illustrate our theme, "Plant Implementation of Corporate Press-Room Safety Standards." This collection of words describes very adequately the only means by which a sound safety program can be realized. It is unfortunate that this expression sometimes is relegated to the minor task of filling a void on the plant bulletin board or adorning the company stationery and, consequently, loses its significance.

When an expression becomes a slogan and is used repeatedly, over-and-over, to the point that when you look at it, you don't see it, it becomes monotonous; monotony breeds complacency, and complacency causes accidents. This happenstance and its resultant effect presents an opportunity to expose the major pitfall that can circumvent any meaningful safety program and which is our constant concern—complacency. On one side of the safety coin is a well organized and thought-out program, properly executed, on the opposite side is complacency. Ralph Waldo Emerson once proclaimed "Every sweet has a sour"; complacency is our sour. It's well that we establish this fact early, because the very industry we are talking about gains a substantial economic advantage from repetitive operations. Therefore, we will discuss both sides of the coin.

Because safety is everybody's business at Chrysler (in reality, it is a necessity of doing business), it presents no difficulty for a corporate-staff man to speak coherently on what appears to be a plant-oriented subject. Because it's our way of doing business, safety becomes a major function of the manufacturing engineering office, and lines of communication have been established and are maintained so that our office can be kept abreast of what is happening in our plants in the area of safety. In so doing, we have a thorough insight on the entire safety spectrum.

It should, by now, become increasingly evident to you that to treat the subject of plant implementation in the proper perspective, the inference that implementation is the sole responsibility of the plant must be removed. Many preliminary steps must take place involving many people in many different organizational components. A goal must first be established, a set of ground rules written to reach this goal, and an effective surveillance system organized to regulate the rules. In our corporation, the goal is a statement of intent published in our policy manual which emphatically states that the Chrysler Corporation will conduct all its operations with due regard for the maximum safety and health of its employees, and management expects compliance with this policy. Contained therein is a means of implementing the requirement for continuing surveillance.

Implementing is the responsibility of the manufacturing engineering office, which is charged with the development of technical instructions and standards relating to engineering, and use of applicable safety advantages in machines, tools, equipment, facilities, and processes. This is an all-encompassing responsibility but we will restrict ourselves here to stamping plant operations.

How does one go about developing safety instructions and standards for stamping plant operations? First, I think we have to make a brief review of what a stamping plant is in the automobile industry. It's an organizational component of our corporation that produces sheet-metal stampings and assemblies at high-volume production and quality workmanship at a competitive cost. The raw material is procured, stored, and processed in large bulk packages, primarily coils of 20 tons or better. The stamping operations are performed on a multiple of large, heavy, relatively fast presses which exert forces upward to 2,000 tons. With this magnitude of forces and the size of some of the product panels, the tools, out of necessity, are large and heavy.

This combination of presses and tools generates parts which by their very configuration present knife-sharp edges. The parts are, in some instances, conveyed with mechanical apparatuses to assure, mainly, a rhythm conducive to high productivity. Because this productivity will vary in relation to the size and complexity of the part and the mechanical capability of the equipment being employed, and because economics predicate producing many parts on one set of equipment, storage then becomes a major facet. The handling and storing of the raw material, parts, and tools and the nature of operation and rapidity of the equipment place a press-shop high on the priority list for safety considerations. With this in mind, we conduct a step by step analysis of each phase of operation, taking in each potential fault area and exploring its broad ramification even to the point of being ridiculous, to assure ourselves that it will be properly covered by the written word.

Don't ever lull yourself to sleep with the idea that because a man has a blue collar job he's not particularly smart; some of them border on genius, as displayed by the means they come up with to get around our safety devices. Sometimes it isn't ingenuity, but downright laziness. Recently, in one plant, we thought we had thoroughly investigated, engineering-wise, every possible thing that could be done to our press energizing system to put it in a safe operating mode, figuring that a dimension of 22 inches between a double set of energizing buttons would preclude the possibility of the operator using his elbow and hand in a one-arm operation. I assure you, we did not develop this dimension on the relationship of his toe-to-his-knee—and that's precisely what he used.

A good friend who is a methods engineer told me once that the easiest way to determine whether the motion study on a particular operation was the simplest way, was to put the laziest man in the plant on it. I think there is considerable merit to this philosophy in developing safety specifications.

Not all of the analyses, however, can be based entirely upon what an employee will or will not do in relation to certain operations; fortunately or perhaps unfortunately, there are years of historical data on disastrous accidents whose causes must take priority in the corrective action. All of the circumstances must go into a carefully-worded specification that leaves no doubt as to what it means. There can be no options to this kind of specification. Once the specification is on paper, it is always best to have it reviewed by safety-oriented people who are going to be responsible for its surveillance, to eliminate any possible loopholes or misinterpretations that might add up to trouble later. After the manufacturing engineer has walked this tightrope of decision as to what is the best and most economical engineering interpretation of what has to be done and all the applicable approval has been obtained, the specification is generated into a manufacturing technical instruction on safety. This is a mandatory instruction which then becomes our Bible. There are several such documents which cover every phase of stamping plant operations, such as:

Use of oxy-acetylene equipment; use of fire-resistant hydraulic fluid; safety in operation of sheet-metal stamping and welding presses; and the proper methods to handle and store sheet metal. These documents cover such specific items as the 100 per cent use of safety glasses; the chaining of coil stock in storage; the banding of flat stock in transport; the "hands out of die" technique in machine loading and unloading operations; the shielding of pinch points or moving components on tools and machines; the lock-out procedure to be employed for maintenance work on machinery; the use of die blocks in working on dies in press; the protection of employees' from automatic press lines; the red-tag procedure for returning major repaired equipment back to production, and releasing new equipment for production; housekeeping, etc.

This is not, however, the end of the engineer's phase, for now that we have the written word, we roll up our sleeves and go to work. New procedures involving new equipment have to be instituted and machinery, tools, and equipment surveyed and dispositions made. The machinery, tools, and equipment are divided into two categories: (1) existing machinery, tools, and equipment that have a number of useful remaining years but must be changed to conform; and (2) new machinery, tools, and equipment that must have incorporated in their designs the necessary safety features. The latter is somewhat easier to accomplish.

First, conformance to safety specifications are made a mandatory part of our purchase agreements; second, we orient our own design engineers and follow-up people to what is required of them; third, procedurally, we bring the safety engineer into the planning stage of all engineering programs by stipulating that he must review and concur with all projects in manufacturing involving safety; fourth, we instigate a test program and certify and standardize all commercial apparatuses or devices that have a reliability for or contribute to the mechanics of the safety specification; fifth, we change all our applicable technical procedures, instructions, and standards, to include all safety ramifications; and last, but not least, we adopt an auditing system to assure ourselves that all of this is taking place.

In the first category, where it was necessary to convert the old to the new is considerably more difficult. It is easy enough to make the proper surveys and get "our ducks in order," so-to-speak, but this area involves: (1) a lot of specific changes that necessitate large investments, and consequently must be programmed in line with the financial planning of the corporation; (2) machinery, tooling, and equipment whose design does not lend themselves to the specified change—more costly alternates must be incorporated; and (3) machinery, tools, and equipment which do not lend themselves to any acceptable conversion must be phased out of our operation early in its useful life. A good example of all three of the previous-mentioned categories was wrapped up in one of our decisions to outlaw the mechanical-rolling key clutch on stamping presses. At that time, there were well over three hundred presses of this type in our operations, and the price tag for each conversion started at $5,000 each. Needless-to-say, some of them didn't lend themselves to an air clutch conversion or were of a vintage that it was not economically sound to convert, and these had to be disposed of. The remainder, which represented about 60 per cent of the total, were converted at the tune of well over $1 million.

There are many other categories of this nature. This example has, perhaps, raised a serious question that I am sure has been foremost in your minds: The implementation of a safety program costs money, and how do I convince management to spend it? I'm using some pretty big figures here, but you must remember that the cost is geared to the size and complexity of the operation. The operation I'm discussing consists of 1,700 presses. Taking a practical approach to cost, one can almost justify a safety investment as a cost savings. The only drawback is that most of the savings are of an intangible nature. These fall within the areas of more and better productivity through an environment that is conducive to that end; and less labor interruption and the elimination of the bitter relationships because of safety complaints.

The various progressive stages I have discussed so far have been referenced to programs. The word "program" leaves the inference that there is a conclusion, that whatever you're describing will come to an end, but this is not the case when we get to the "everyday compliance" phase. The application of safety in the plant is a never-ending job in which you cannot relax for one moment. This is the prime consideration when choice of a system is necessary. In my way of thinking, there are two such systems to pick from: (1) all the responsibility can be instilled into one man, such as a safety-man, and you can hope and pray that he can do a job; or (2) you can place the responsibility in all the pertinent people—note that I said "place," and not divide. The latter system is the one stated in my opening remarks, "safety is everybody's business," and the one Chrysler instituted. Besides, the mortality rate of safety men is much lower this way.

The first and foremost consideration in the "everybody's-involved" system is communication. Communication is one of the vertebrae in the backbone of effectiveness, and effectiveness prefaced with vigilance is of prime importance. It then becomes a team effort, and each member of the team must know what the other team member is doing. The communicator in this system is the safety-man, who publishes, amongst other things, the status of performance through a frequency and severity report, investigates and makes known the cause and effect of all accidents, and in general is constantly "stirring the pot." Hand-in-glove with this responsibility of communicator goes the responsibility of prosecuting attorney, because the safety-man must assist

management in instituting prompt corrective action.

Trying to find the place where safety starts with the "everybody's-involved" system is a bit confusing even in my own mind, and you can liken it to what comes first—the chicken or the egg? Or, who won the game —the coach or the players? Knowing that I might be open to some criticism, I say that our safety performance begins with the workers themselves. If they properly utilize the tools they've been given, in conjunction with a constant awareness of the consequencies if they don't, then we can expect reasonable success.

How well he does his job safely depends on the coach, and in this instance, the coach is the line foreman. Safety control begins with him; in fact, he is the prime safety man in his working area. Note I said he is prime in his own work area. In reality, his concern has no boundary in the plant. He has the opportunity to talk to his crew once a month on safety, and at this time he should cover every facet of safety, from housekeeping to the proper way to do the job. When a new man is added to the crew, he must be thoroughly indoctrinated in all aspects of safety. The foreman's safety endeavor does not begin or end with conversation. He must see to it that all equipment within his area is safe to operate, and he must be absolutely sure that all provisions of all safety rules, regulations, and instructions are adhered to by the people under his supervision, as well as any other person who comes under his surveillance, whether it be within his area of responsibility or otherwise.

This responsibility spelled out for the line foreman pyramids through the general foreman, superintendent, production engineer, to the plant manager. The divisional and plant managers evidence their support of safety in their respective operations by maintaining an active safety program at all times and by discussing individual safety performance and problems in their top-level management meetings. The pyramid of responsibility does not apply only to the production line of authority; on the contrary, "everybody's business" takes in everybody in the plant, and it's not unusual for a quality control man to call you a minor infraction such as not having your safety glasses on. Pyramids will fall if one of the foundation stones starts to crumble. The corporation, to assure that this doesn't happen, has a system of checks and balances. Divisional and corporate staff activities have a periodical audit responsibility to report all infractions and see to it that immediate corrective action is taken.

Like the laws of the land, the laws of safety are broken occasionally, whether it be intentional or unintentional. I guess we have all, on one occasion or another, violated a traffic law unintentionally. Maybe we were preoccupied with other thoughts, maybe we were not physically able to react; regardless, we broke the law, and 99 per cent of the time we got away with it. We were not caught and disciplined, nor were we involved in an accident, but 99 per cent, in my book, is not a good risk factor and is not one we can afford to accept. Our accident reports point out that the majority of those involved are old-line employees who are well versed in all ramifications of their job, including safety. It's the electrician who does not pull the disconnect switch before correcting an eletrical fault, or the machine repairman who fails to crib up a ram on a press before he attempts to disassemble it, or a press operator who by-passes a safety guard to clear a piece of material from a die with his hands. This man, in all probability, has done this for years and never got caught before, but that one day when complacency sets in is the day of reckoning.

This business can be frustrating. Despite all the attention you direct toward safety, you still have accidents; people sometimes seem to go out of their way to get hurt. Managerial vigilance can never relax. One of our plant managers once remarked that he was going to weld everything to the wall or floor in order to make his shop "idiot-proof." We know this is not possible, and even if it was the welder would probably get hurt in the process. But it does point out that despite the best laid plans of mice or men, there is going to be something missing. A recent case in point—last year when the Detroit Tigers won the world series, interest in baseball was running at an all-time high. To our complete exasperation, we discovered some of the press operators had smuggled small pocket radios into the plants to listen to the game, and had them plugged into their ears while working. Now, we don't have an instruction to cover this situation, but common sense dictated that the radios must go—and they did. Along with

everything I've said so far, this example indicates the one strong overriding principle that needs to be applied to the plant implementation of good safety practices, and that is common sense.

In summary, to have good safety practices in a plant, you must have a goal decision, objective, or declaration of intent for your top management. The responsibilities for implementing and control must be precisely allocated, the elements of the program should be clearly stated, and all employees must be a collective part of its application. Lines of communications must be effective and a never-relaxing vigilance prevail.

I suppose this safety battle can never be conclusively won. I don't think we'll ever be able to eliminate our first-aid stations from the plant, but giant inroads in accident experiences have been made in the last ten years. There's no reason why we can't expect more in the future, if we continue to make safety "everybody's business."

INDUSTRIAL HYGIENE FACTORS IN POWER PRESS OPERATIONS

By ELGIN D. SALLEE
Mgr., Safety and Industrial Hygiene, American Can Co., New York, N.Y.

In many industries, insurance organizations, and government agencies, safety work and industrial hygiene work are handled as two distinct disciplines. There are several reasons or circumstances responsible for this, and in many situations this separation of effort works out well. Nevertheless, it's my opinion that the two should never be handled separately, at plant level particularly. Accident prevention and control of industrial hygiene factors are so closely related and the combined job is so big that we should take advantage of all the help available to us. Otherwise, control efficiency may be sacrificed unnecessarily.

Accident prevention is popularly regarded as that effort aimed at keeping people from falling down, from getting caught in machinery, striking against or being struck by objects, or any of the myriad of unplanned or uncontrolled events that might lead to sudden traumatic or bloody injury. Industrial hygiene hazards are those that, unless adequately controlled, can result in occupational disease, poisoning, or adverse effect on health. In the common concept of accidents, the bodily injury usually occurs instantaneously. With uncontrolled industrial hygiene hazards, the development of adverse effect on health may take a long time, possibly months, or years. In many instances the health effect may not even be apparent except through clinical examination by specialist physicians.

Regardless, both safety work and industrial hygiene work have the same overall purpose: that of protecting the worker, preserving his physical well-being, and maintaining his ability to perform his work with optimum efficiency. Because of this I consider industrial hygiene as a part of safety, that part which in some instances requires specialized training in chemistry, instrumentation, and various other sciences in order to evaluate the hazard or measure control effectiveness.

Accordingly, I maintain that a good safety program must include control of industrial hygiene hazards. They can't be divorced. The well-rounded safety effort has to include concern for industrial hygiene and a good industrial hygiene effort must also be concerned with accidents that might result in sudden injury. The bulk of the work in day to day effective control of industrial hygiene hazards does not require highly trained technologists.

In my company, our corporate staff specialists in safety are all qualified industrial hygienists. When they visit a plant, they make any pertinent air tests or other measurements and observations required for resolution of industrial hygiene problems,

as well as an evaluation of the overall safety program including guarding, housekeeping, safe operating procedures, control of unsafe practices and conditions, use of protective equipment, safety training, safety promotional activities, etc. I don't say that this exact type of safety organization is the most practical for your particular operations even though it works well in my company. In fact, in my company the safety men headquartered at the plants have had practically no academic training in industrial hygiene factors. Nevertheless, they are involved in a lot of industrial hygiene work as a result of the specific detail which we on the corporate staff furnish them that is applicable to the particular plant's operations.

If you work directly in the field of safety it's quite likely that you are doing a great deal of industrial hygiene work, whether or not you have used that terminology for it. If you aren't including it in your safety efforts you are leaving a wide gap in your protective and preventive program, and this will become increasingly important.

I make this rather prolonged pitch on this point because it is quite evident that safety specialists in general have had a tendency to shy away from involvement in industrial hygiene work because they felt they weren't adequately trained for it. This tendency should be dispelled for a great many reasons, the most compelling of which may be summarized as:

1. Industrial hygiene factors are becoming increasingly important. If you have doubts on this take another look at the Walsh-Healey safety and health standards adopted this year, and the proposed federal occupational safety and health legislation. Certainly all industry is going to be subject to much closer scrutiny by regulatory authorities on industrial hygiene factors. I can't conceive of any production or service work that doesn't involve a number of industrial hygiene factors. Many of them have been ignored or side-stepped for too long.

2. As in routine safety work, the effective control of industrial hygiene factors is primarily one of application of just plain common sense — only a minor part of it actually requires highly specialized academic training in chemistry or other sciences.

In power press operations in general, the extent of potential industrial hygiene problems is significantly less than in many other manufacturing operations. I'm sure everyone appreciates that by comparison with the chemical industry, for example, the industrial hygiene factors in metal stamping operations are relatively simple. Nevertheless, there are a number of important industrial hygiene factors in power press operations. There are a great deal more, obviously, in the production work which is closely related or accessory to the actual metal stamping work. I'm going to comment briefly on some of these that are common to power press operations. Certainly not all plants that use power presses have the same industrial hygiene problems, since conditions and detailed operations vary widely. I trust, however, that mention of certain of these factors will engender some ideas for consideration in your operations.

Noise

Undoubtedly, excessive noise is the most prevalent of industrial hygiene problems in power press operations. By far the majority cause critical noise levels in the work area, the extent varying with size and speed of the press unit, type and gauge of stock, type of stock feed and scrap ejection, the extent to which the press is automated, and many other factors. In a detailed study of noise emanating from a typical automatic press for punching out tops and bottoms for tin cans we found 37 different, readily measurable sources of noise. I mention this to emphasize the point that noise abatement can be exceedingly complex. Don't get the idea that all that need be done to quiet your presses is to reduce the punch and die noise; there are likely to be a considerable number of other important noise sources that will stand out once you are successful in quieting the noise from the punch and die.

There is no average figure for extent of noise level exposures in power press work areas. It is not uncommon to find noise levels in the regular work area near presses as high as 110 decibels on the *A* scale. Since noise levels are expressed on a logarithmic scale, in terms of loudness perception 110 db*A* is more than six times as loud as the 90 db*A* tolerance cited in the Walsh-Healey standards for continuous eight hour daily

exposure. If you haven't had noise measurements made in your pressroom and question whether the noise is of critical proportions, a practical rule of thumb evaluation is to see whether the ordinary conversation voice can be heard at a distance of three feet. If you have to raise your voice significantly in order to be heard and the din is continuous, you can be pretty sure that the noise is excessive.

Possibly the most practical method of abating press noise is isolation or total enclosure of the press unit, where this is possible. And don't jump to the conclusion that this is beyond reason in your situation, particularly if your units are automatic. Essentially complete enclosure has been done successfully in many instances. In many situations the most practical alternative is to assure that press room eemployees wear ear protectors.

Lubricants

Another common industrial hygiene problem in power press operations results from the use of lubricants on die parts or stock in metal forming, drawing, ironing, or cutting operations. Direction of an oil mist spray on the point of operation is fairly common practice. A popular attitude I have noted among press operation supervisors is that the extent of such lubricant spray or mist is too minor to warrant local exhaust ventilation, and that the resultant concentration of oil mist in the breathing zone "wouldn't hurt anyone." Such assumption may or may not be correct, depending on chemical composition of the lubricant used and how much.

Even where pure mineral oil of pharmaceutical grade is used and in seemingly small amounts, there may be a significant problem. Such inhaled oil mist might not have an immediate toxic or acute effect but assurance is in order that there will be no eventual cumulative effect such as an "oil pneumoconiosis." In contrast to many foreign materials inhaled by industrial workers, mineral oil is not readily eliminated from the lungs since it is not soluble in body fluids. Eventual accumulation of mineral oil in the lungs, even though the oil is classed as pure enough for human ingestion, has been known to cause pneumoconiosis.

Obviously, any inhaled lubricant that contains other ingredients can cause a variety of other problems. Commonly used oil additives such as heavy metal soaps, various amines, inhibitors, or other components intended for lubrication efficiency can compound the industrial health problems in spray or mist applications by having direct toxic effect when inhaled. Certainly supervision and the plant safety specialist should know the ingredients of any spray or mist lubricants used at presses. The problem can be remedied by various means, such as changing to an alternate lubricant-application method, by substitution of a less nocuous material, by installing adequate exhaust ventilation, etc.

In many instances wax is applied to point of press operation or to the metal stock, as a drawing or ironing lubricant. Again, extent of the problem is dependent on composition of the wax and whether effective exhaust ventilation is provided (when the wax is applied as a mist or spray). Even "table pure" paraffin wax when inhaled in significant quantity can eventually cause problems in much the same way as the pure mineral oil mentioned previously. The inhaled wax particles are not readily eliminated. They are retained in the lungs and can conceivably cause a condition quite similar to oil pneumoconiosis.

Local exhaust ventilation for control of paraffin wax mist at presses is not always a simple matter. Exhaust systems for wax mist may become clogged in relatively short order. If significant amounts of such mist are involved, ductwork, filters, or fans become fouled and require excessive maintenance attention. In our experience the best local ventilation systems for wax mist are those in which the exhaust system surfaces are kept warm, so that the wax particles liquefy and drip down into a trap rather than clogging ductwork, etc.

Alternative application methods of stock lubrication should be considered. In many situations a drip applicator, rather than spray, is practical. In some cases wick application or roller coating the stock with lubricant works well, but be on the alert for additional problems the alternate application method might involve, particularly if the lubricant material is thinned or dissolved in a solvent.

Dermatitis

In addition to potential adverse effect through inhalation of lubricant materials, dermatitis from the manual handling of lubricated stock is quite common. Again, this varies with the chemical composition of the lubricant and quantities involved. For example, if the lubricant contains heavy metal soaps, inhibitors, sulfur compounds, or other additives, potential for dermatitis is increased. In some situations a soluble cutting oil or coolant may be used at the power press, and such materials are commonly subject to bacterial growth which may cause dermatitis as well as offensive odor problems.

The most commonly successful control method for dermatitis caused by lubricants in press room operations is simply the minimization of skin contact. This might be accomplished through change in the detail of work practices, assuring that no more lubricant is used than actually needed, use of gloves and skin protective creams, insistence on good personal hygiene, or substitution of a less critical lubricant material. In our experience, by far the majority of such dermatitis problems are effectively controlled merely through insistence on reasonably good personal hygiene practices by the workers — insisting that they wash their hands at reasonable intervals rather than allowing the lubricant to remain on the skin for prolonged periods and insisting that they change to fresh clothing rather than wearing oil-contaminated clothing day in and day out. And, as an adjunct measure, assuring that they use mild soap and water to clean their hands, rather than solvent.

Metallic Dust

In some power press operations the work material is comparatively dry, and dust may be formed in the die area and at chutes or conveying system for the stock, the finished product, or scrap. Whether or not this dust is significant again depends on nature or composition of stock used. Rarely is such dust or particles of metal or scale of such proportions to cause an inhalation hazard, but this certainly is not beyond the realm of possibility, particularly if the stock contains such materials as lead, cadmium, beryllium, tellurium, or other relatively toxic metals. For instance, there are many reported cases in which press operators were exposed to excessive air borne concentrations of lead in which the stock itself was lead, brass, or terne plate.

Probably the most common exposure to the relatively toxic metals that might be encountered in power press operations results from ingestion of dust rather than inhalation. Ordinarily, such cases result from workers' failure to wash their hands before eating or smoking.

Overexposure to such materials in dust form can be prevented, of course, through use of local exhaust ventilation but actual need for this measure is comparatively rare. In most instances good housekeeping practices suffice — periodic clean up by use of vacuum. Clean up by means of compressed air, of course, should not be permitted, since this usually compounds the problem rather than remedying it. In some extreme cases, particularly in clean up of toxic metal dust accumulations, use of a respirator may be in order. Where a respirator is practical it is suggested that it be the type approved for protection against toxic metal fume, rather than a simple fibre filter.

Skin irritation difficulties have also been reported, allegedly due to dust particles formed in stamping or shearing operations. This has occurred even where the stock is nothing other than such innocuous materials as steel, black iron, tin plate, or aluminum. In our experience, most of this kind of skin difficulty among operators is due more to mechanical irritation rather than chemical or allergic reaction. Metal particles can accumulate in clothing and prolonged skin contact with these particles can result in difficulties, in most cases an abrasive effect which may be neglected to the extent that infection develops eventually.

There are also reported cases of dermatitis among power press operators where the metal stock has been previously coated with paint or other organic film. In some operations significant amounts of the coating flake off during stamping and material conveying operations. Obviously some of these difficulties were brought on by peculiar allergies that affect only rare individuals; however, here again the bulk of such difficulties can be avoided through reasonable attention to personal hygiene and changing into fresh clothing as warranted.

Machine Clean-up

Housekeeping and machine cleaning practices and materials have caused frequent industrial hygiene problems in power press operations. It is common practice to use an organic solvent to remove lubricant and other soil which accumulates on machine parts. Choice of the clean up material is important — some such materials can cause direct toxic effect through inhalation of solvent vapors or through skin contact. In most instances a bland aliphatic petroleum solvent will do the job adequately, one with a flash point of 100°F or more. In my company we specify mineral spirits unless there is a significant potential source of ignition in the immediate area. Where there is a significant fire hazard, inhibited methyl chloroform solvent is used rather than the 100°F flash point material. Obviously, reasonable care must be observed to avoid prolonged inhalation of vapors from these solvents even though they are relatively innocuous. We insist that every solvent material be handled with the same respect due the handling of gasoline.

Other Factors

Several additional factors of industrial hygiene interest are commonly encountered in power press operations. These same general factors are common to essentially all manufacturing operations, however, and for this reason I will comment on them quite briefly.

Proper lighting in power press areas is particularly important for obvious safety and efficiency reasons as well as prevention of eye strain. This includes attention to glare, diffusion, direction, uniformity, color, brightness and brightness ratio, all of which have significant effect on ability to see easily, accurately, and quickly. In my company's pressrooms we design for 50 foot-candles, but this is increased as warranted where extraordinary precision and inspection is needed.

Care is warranted in assurance of proper workroom temperatures and air movement, of course, in efficient power press operations.

Considerably increased attention should be given to the matter of worker fatigue in power press operations. There is room for a great deal of improvement in reducing work load or work stresses through concentration on such items as height of lift in manual handling of material during press feeding or off-bearing, provision of work platforms, proper type and location of controls, machinery layout, extent of repetitive motion required per unit time, character of the work motion (for instance, whether it is a straight lift or one involving a twisting motion). Any of these factors may result in unnecessary fatigue.

Closely related to the common concept of fatigue and certainly of industrial hygiene interest is the development of trauma such as tenosynovitis. This affliction is certainly not a rarity among power press workers. It is the result of repetitive motion under stress and occurs frequently among experienced workers as well as new hands.

Research work is on the increase on factors causing excessive fatigue, and I am all for it. However, I am still of the opinion that, as in the past, the greatest progress toward reducing fatigue and the undesirable effects of it will be made by persons closely involved with production rather than the research specialists.

Another common industrial hygiene factor in power press operations is vibration. I'm sure each of you has noted instances of excessive vibration of presses. In many situations the press vibration is imparted to the floor or platform on which the press operator stands, adding to the work stress or employee fatigue.

From the foregoing I'm sure you will agree that power press operations can involve a considerable number of industrial hygiene factors. I trust you also recognize that many of them can be effectively controlled without specialized training in industrial hygiene. This doesn't imply that you should by-pass the specialist. Certainly he should be consulted when the problem is beyond your scope — and don't be hesitant about asking for it.

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OPERATION PRIDE

By RICHARD C. KIDWELL
Corporate Safety Director, R. R. Donnelley & Sons Co., Chicago, Ill.

Safety analysts have concluded that 85 per cent of industrial accidents are caused primarily by unsafe acts, while only 15 per cent are mainly caused by unsafe conditions. With this in mind, it is my opinion that the most successful safety program is one which puts the attitude of its employees into positive gear. For too long safety engineers have limited themselves to engineering conditions. It's high time we began to "engineer employees."

Safety programs based on self-preservation are a miserable flop. This is a negative approach, such as, "Don't stick your hand into moving equipment, or you'll pull back a bloody stub."

Self-importance is a basic urge — people care less for their safety than they do for a feeling of importance. Professor John Harvey, America's most profound philosopher, said the deepest urge in human nature is the desire to be important. Freud called it the desire to be great. William James, our greatest American psychologist, calls it the craving to be appreciated. These people are not safety experts — they are people experts. But they teach us our greatest safety lesson. Race drivers, sky divers, and mountain climbers are good examples of this fact. The importance of proving to themselves, as well as others, that they are great, that they are something special; and that feeling of self-satisfaction that comes from proving their importance completely overrides their weaker desire for personal safety. How do we get them to be safe? By making them an important part of the safety program. By making safety the "in" thing. Everyone becomes important because one person can spoil their treasured record.

The safety function contains the substance and the method to fulfill these strong human needs. What better way is there for us to tell a man that he is important than for us to show our concern for his safety? What else presents so many opportunities for us to show our appreciation to a man than for his daily efforts to prevent accidents, but also increase productivity, improve quality, raise morale, reduce turnover, and eliminate many problems? They say, "Look what we did." They feel, "Our company cares." It creates a climate for accomplishment and a different kind of worker who thrives on record-breaking performance. They have an unquenching desire to be number one. The power of the positive approach is phenomenal!

We need a company safety and pride promotional program! Developing a first-class program is expensive, but if separate divisions share the same basic program the cost will be tremendously reduced. How can we work together? I hope the attached basic program will point the way.

Hit a Million Program

Give the Safety Committees a Taste of How Important They Are.

1. Send a letter from the Safety Director to their home.

2. Personally meet with them before kicking off the program. Challenge them! Tell them what they must do to make it successful. Make yourself available to help with their problems.

3. Get booklets, "You and the Safety Committees," for members to be presented after your challenge. These booklets can be purchased from the National Safety Council.

4. Get badges for committee members—*not tin badges, either.* Challenge them to wear them so fellow employees and management will know who is responsible for safety in their area.

5. Help them set some departmental goal. I like to encourage them to better their best record. Ask them to do something for departmental employees when they reach this goal. Serve coffee and doughnuts.

Be Sure Each Employee Knows the Divisional Goal.

1. First release should be a letter from the Division Director to the homes of all

employees. This will indicate the importance of your campaign as well as indicate the concern of top management.

2. Have pledge cards printed. Cards must be individualized. Have personal data provided in them. Encourage signing but don't push. Ask that they be returned. Check them. Refusals will be few, but will indicate areas where you will need to do some PR work.

3. Use promotional badges. Give to each employee. Some will wear for only a day or two, some will wear for months, but all will know the Division's goal.

4. Post signs at the entrances which are changed each morning (Monday thru Friday). Will help employees see the progress toward the goal. The goal also should be indicated on the board. Boards can be purchased for approximately $30 each. You will need one for each employee entrance. You will also need a stand which will cost approximately $24 and a font of magnetic letters, approximately $15.

5. You can also use posters in the Operation Pride series on a subscription basis for about $3.50 each.

When You Reach Your Divisional Goal.

1. Have Safety Committee Chairmen shake hands with employees at entrances as they come to work and congratulate them for making their goal. Use promotional vests and music. Dazzle them with festivity. This is a tremendous accomplishment—make them realize it.

2. Make news releases, local papers and radio stations; pictures of employees help. Tell the community what the employees have done.

3. Request an award from an insurance company and safety director. Have an award presentation ceremony as soon as possible and invite safety committee members. This is recognition which yields pride and importance so make it great! Have official present plaque. Have company officials present to make sufficient impression.

4. Give some token of appreciation—always go "first class." You want first class attitudes, so give first class awards.

Last but far from least—it can be done. The only problem is, how long will it take? Expect results—let everyone know you expect results! Remember—never a discouraged word.

THE GARAGE'S ROLE IN SAFETY FOR THE NEWSPAPER FLEET

By WALTER BOOTH
"Chicago Today," Chicago, Ill.

Most printing and publishing companies operate a fleet of some kind. It might be as few as ten vehicles or as many as several hundred. Body styles vary from station wagons and tractor and trailer runs to the step-in type delivery van used by many metropolitan newspapers.

We at *Chicago Today* operate a fleet composed of approximately 225 newspaper delivery trucks operating in Chicago and adjoining suburbs.

The *Chicago Today* fleet safety program is divided into two areas:

1. *Driver Safety*—the selection, training and development of the driver.
2. *Vehicle Safety*—providing the driver a properly selected and adequately maintained vehicle.

The driver portion of the safety program is under the direction of our Personnel Department and safety and teaming staff. As superintendent of garages, I am responsible for the vehicle.

The first step for initiating a safe, responsive, and profitable fleet operation begins with the selection of a vehicle suited for your specific fleet needs. A newspaper fleet, because of the constant stop-and-go city driving, demands a durable vehicle requiring

reasonable service while at the same time being easy for the driver to operate.

The vehicle selected for use by the *Chicago Today* fleet consists of step-in-type vans having aluminum Olsen bodies mounted on Ford P-350, P-500 and P-600 chassis. All units have dual wheels which, from a traction and safety viewpoint, contribute to a safe fleet operation.

Aluminum bodies were selected, rather than steel, because of the reduced weight, which means each truck can carry a larger load of papers and still be within the state limits. Also, aluminum does not rust; and providing the bodies are given reasonable maintenance, after five years, the body can be reconditioned and mounted on a new Ford chassis, resulting in a tremendous financial savings. The final major advantage is that aluminum is an impact-absorbing material and in the event of a collision this means a greater degree of protection for the driver.

It is interesting to note that we began the changeover from use of standard steel bodies to aluminum on the Ford chassis in 1964, and since then we have experienced an approximate ten per cent reduction in actual cash expenditure for the cost of materials used for both repair and maintenance. Through 1969, it is anticipated the total savings will be approximately $50,000.

Because vehicles were selected for our particular fleet needs, driver acceptance has been excellent, resulting in a less abused and more productive fleet.

Once the vehicle has been selected, the next step is a comprehensive preventive maintenance (PM) program. A properly maintained vehicle is a safe vehicle, less likely to break down in traffic or be involved in an accident because of mechanical failure.

The *Chicago Today* PM program operates at three levels of service: *A*, *B* and *C* service. Arriving at a service schedule for frequency of service at each level was based on the manufacturer's recommendations and a lot of experimenting. The delivery route, weather, mileage, and actual driving conditions were all taken into consideration. Most large fleets use automatic data processing equipment for maintaining their service schedules.

A service is quite basic. It is completed approximately every four weeks and consists primarily of an oil change, grease job, and a check for bad or worn axles, brake fluid leaks, transmission leaks, bad or worn springs, hangers, and U-bolts, cut and bruised tires, fan belt, muffler, battery and accessories (oil and gas gauges, horn and wipers), and all glass and door operations.

B service is performed every six to eight weeks, depending on driving conditions and mileage. At this time, the wheels are removed to inspect the brake lining (a gauge is used to estimate percentage of brake life remaining), the engine is given a tune-up, and the front-end alignment is checked. The complete electrical system for the vehicle is checked, using an ignition scope and analyzer. The *B* service is scheduled to coincide with *A* service.

Major repair and maintenance work is completed at the *C* service level, which is performed at least annually and could involve such major repairs as an engine being pulled, transmission being replaced, etc.

By following such a PM program, our service calls have been reduced to one per 40,000 miles of vehicle operation and there has been an approximate fifteen per cent reduction in fleet mechanical maintenance operations cost.

Forms and records play a major role in our fleet's garage operation. When a driver requests repairs or service to his truck, we do not rely on verbal instructions. Instead, the driver completes a work order form in duplicate. He keeps the carbon copy, with the original being given by me to the mechanic who will do the actual work. When the work has been completed, the mechanic signs the work order and returns it to me for my review, after which it is filed in the vehicle's service record folder.

For preventive maintenance service, we do not rely on memory. Instead, a check-off form is provided for each level of service with work to be performed itemized. When the work has been completed, the mechanic signs the form and returns it to me for my review. Then it is made a part of the vehicle's service record folder.

When a vehicle is purchased, a service record folder is created for the vehicle, with all repair and cost data pertaining to the vehicle's operation being kept there. If and when a question arises regarding work

completed or costs, it is all a matter of record.

The computer plays an important role in many fleet operations, both from a cost standpoint as well as for planning a maintenance schedule. For a computer to really be effective, it should be programmed for the particular fleet operation. There is an old saying in the computer field, "Put garbage in and you get garbage out."

I have attempted to briefly summarize the garage's role in a fleet safety program. It has long been my opinion that if you give a driver a clean and well maintained vehicle, he will respond with pride in his company and an accident-free driving performance.

FIRE PROTECTION IN PAPER STORAGE

By WILLARD L. HAIR
Ass't. Vice Pres. & Mgr., Engineering Dept.,
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Three general conditions prevail in the loss prevention field. The first is the fact that there is an historical marriage between the insurance industry and loss prevention. The reasons are obvious, and until a few years ago the insurance industry was almost the sole sponsor of loss prevention activities, at least in fire engineering. This situation has changed considerably in recent times, and there is now greater direct interest and participation and direction in fire engineering by general industry rather than complete reliance on the loss prevention departments of insurance companies. Probably the best example is the National Fire Protection Association. I can remember when the members of the various committees that set the NFPA standards consisted overwhelmingly of people related either to the insurance industry or to the manufacturers of fire equipment. Today, those same committees are manned mostly by representatives of all segments of general industry. In effect, industries are setting their own standards by which they have to live. I think the opinions are unanimous that this is the way it should be and that the trend should continue.

Still, there remains this close relationship between insurance and loss prevention, and it too shall continue. The result is that most of your considerations of loss prevention cannot be weighed soley on their merits in relation to your own company's specific needs, exposures, or philosophy; rather, they must also take into account the effect it will have on the cost and, perhaps more important today, the availability of insurance coverage. I have no intention of attacking or defending his situation, but I merely want to point it out as a fact and to admit that your insurance position is a very real pressure on your loss prevention program and, like it or not, commands serious attention.

The second condition in loss prevention is what could be called a time gap, and a very unfortunate one. Loss prevention relies heavily on experience. Its attention is directed mostly at situations that have already proved that they can produce losses. The normal sequence of events is that first a condition is created that has unrecognized hazards. Sooner or later, the hazards result in losses, and when the losses mount to a position of priority, attention is then given to how the losses can be avoided.

Sometimes, this time gap can be stretched over many years. Probably the best example of that is the storage arrangements today of rolled paper stock, which have changed comparatively little from the arrangements of twenty or thirty years ago. Until about five years ago, however, rolled paper storage was only of moderate concern. Some degree of hazard was recognized and loss prevention was recommended accordingly, but it was nothing like the hazard potential being attributed to it today, and the scope of recommendations we are faced with today.

What happened? Two things — first, general industry started to adopt similar storage

arrangements, that is, what is now called "high stock piling." A quick definition of high stock piling is the storage of combustible materials to heights in excess of 12 feet, and as we will discuss in more detail later, rolled paper stock is lumped into this newly formed category called high stock piling. Then losses started to occur and, ironically, these included losses in the rolled paper industry, so we reached the second stage in the time gap sequence of events.

We are now in the third stage, which is the attempt to avoid losses. I'm sure your managements must be wondering how this condition could go on for so many years without the concern it now commands. I am reminded, however, of all the attention being given to water pollution right now where, among others, the paper industry is being pressured to spend millions on changing disposal operations which have operated without great concern for many many years. It wouldn't be hard to find other time gap examples in industry and we just don't have time to analyze the lack of recognition in the past with the decisions facing us now that they are recognized. Maybe we should label it "progress."

The third condition in the loss prevention field, particularly in fire engineering, is that not only are technological advances being made with newer and better protective equipment, but we are seeing a reevaluation of some of the basic principles and theories in fire protection. You might say that the fire engineer is in the process of learning a lot more about his business. He is acquiring much more knowledge about the characteristics of an unfriendly fire, its development patterns, its potential emission of heat, smoke, and gas, and the rate of emission. In turn, he is approaching protection on an increasing sophisticated basis of trying to match protection to the potential hazard. For example, he may not refer to one of the three general classes of sprinkler systems: light, ordinary, or extra hazard types; rather he recommends a hydraulically calculated system to a density requirement necessary to handle the anticipated emission of heat from whatever is stored below.

In general, all of this is to the good, but it has made life very difficult for you in many cases. First, you may be caught in the time gap whereby a condition that has existed for many years is now called severely hazardous. When you consider upgrading the protection, you find the rules of the game changed because the engineering field has increased their knowledge of the subject, but you also find that this knowledge has not increased to the point of being purely scientific. There is still a lot of judgment involved. When an engineer recommends an expensive calculated sprinkler and water supply system, he can't fully prove his point and, therefore, you are in a bad position to prove the need to your management. Further, and this is an important factor, one of the insurance influences in the loss prevention field is that protection be designed for the most adverse circumstances rather than normal conditions. The principal concern of underwriters are the unusual set of conditions that lead to a catastrophe regardless of odds, and this creates the pressures towards ultimate protection. You may wish to be more practical in your approach, and to risk the rare set of circumstances that would render your approach inadequate, but as we discussed before, the insurance implications in today's corporate life commands serious attention.

Let's look at some of the more specific details of the problem in its admittedly simplest form. As we all know, when we combine ignition heat, oxygen, and fuel at a single point, we have combustion. The products of combustion, principally heat, tend to rise, so if there is more fuel and more oxygen above it, the rising heat will complete the triangle, and we have more combustion right up the line. Now let's add a measuring factor, the British Thermal Unit, or Btu. At the original point of ignition, say at the base of a 20 foot pile, it emits comparatively few Btu's at a comparatively slow rate, but as this heat rises and, of course, spreads a little to the right and left and in effect sets off new fires, it multiplies the emission of heat at a compounding rate. I cannot quote any specific factors, but for the purposes of our discussion we can accept the established principle that there is substantially more than twice the Btu's emitted from a burning two-foot pile than a one-foot pile, considerably more than twice from a 10-foot pile than a five-foot pile, and much more than twice from a 20-foot pile than a 10-foot pile.

Next, let's look at the objective of the sprinkler system. Despite all of the modern

day advances in new materials, be it solids, liquids, or gases, water is still considered the major fire fighting agent because of its ability to absorb heat and, of course, its availability. You only have three ways to fight a fire: remove the fuel, remove the oxygen, or remove the heat. In most cases, the most practical way is still to remove the heat, and the most efficient way to do this is to absorb the Btu's being emitted; the best available agent is water, and the best known form for applying this agent is the automatic sprinkler system. It is the purpose of a sprinkler head to break the water up into fine droplets or spray where it will do the most efficient job of absorbing heat. Any drop that reaches the floor is wasted. One of the better technological advances in sprinkler systems has been the development of heads that do a much better job in providing a fine spray, and this explains the strong recommendations for replacement of old type heads even though the old ones are quite operable.

Hopefully, the sprinkler discharge will proceed to absorb heat until the level of heat falls below that which will sustain combustion. Now we again add a measuring factor in terms of Btu's to the absorbtion capacity of the discharging sprinkler. After all, it does have a capacity limit which will be determined by the volume and pressure of its source. Obviously, if more heat is being emitted below than the heat absorbing capacity of the sprinkler above, you cannot put the fire out.

We have already discussed how the emission of heat compounds as the height of the stock or fuel increases, and this leads to one of the basic standards for classifying high stock piling. Generally, it is held that when storage of combustible material exceeds 12 feet, the potential development of heat is such that it requires much more in the absorption capacity from the sprinklers above, which involves greater volume and pressure. Personally, I believe the 12 foot mark is realistic or, if anything, conservative and fully justified from available experience and tests. From this point on, however, the matter becomes less scientific and depends more on judgment. To my knowledge, there is no accurate formula to determine the potential release of heat from a combustible pile, nor is there an accurate formula for determining the heat absorption capacity from a sprinkler for any particular combination of volume and pressure. Therefore, it's impossible to accurately or scientifically match the protection to the exposure, so it's now done by judgment. It is my personal opinion, however, that the fire engineer has also approached this particular factor reasonably and with some justification.

Unfortunately, we have to introduce some complications to our simplified theories.

First: When the Btu rate exceeds the absorption capacity of the sprinkler, even for a short period, the products of combustion, including the unabsorbed heat, will move out of the immediate area, usually along the roof or ceiling. This not only extends the area of damage, but it also causes additional sprinklers to discharge, thus reducing the capacity of the sprinklers in the immediate fire area. To guard against this, the fire engineer not only recommends a particular density requirement, or absorption power, if you will; he also recommends that the system be designed to continue to deliver the suggested density even though a number of extra heads are discharged. Here is where costs start to pile up. For example, it may be recommended that your sprinkler system be designed to deliver .4 gallons per square foot, but the recommendation actually reads to deliver .4 gallons per minute for 3,000 square feet or perhaps .4 for 4,000 square feet. At 3,000 square feet your system would have to be geared to delivering 1,200 gallons per minute, while at 4,000 square feet it would have to be able to deliver 1,600 gallons per minute which, when added to the allotment for hand hoses and hydrants, can be the difference between one fire pump and two, or perhaps $15,000 difference in cost. Here is where the engineer is on shaky ground, because he has no real basis to select the area of maximum coverage needed, and here is where the insurance philosophy of protecting against the worst circumstances becomes an influence. The engineer can't prove his point but, then, neither can you prove a lesser need.

Another complication: even if you get a proper match between exposure and protection, piled stock in excess of 12 feet will impede the desired spray pattern from the sprinklers so that, even with proper design, it can take sometime before the fire is totally extinguished. How long? I don't know and again, it is a point that cannot be proven

either way, so it is recommended to the worst circumstances, and again we are talking about large expenditures. If you receive a recommendation for a sprinkler system to deliver .4 gallons per minute per square foot for 4,000 square feet, plus a nominal 750 gallons per minute for hand hoses and/or hydrants, and to be able to maintain this for a two hour period, you need about 300,000 gallons of water to supply this demand. The difference between, say, a one-hour supply and a two-hour supply can be a lot of money.

These two complications are also partly responsible for other recommendations which are considered important to proper and reasonable protection. In view of the possibility of unabsorbed heat escaping from the immediate fire area, and the fact that considerable amounts of smoke and gas are moving out of the area while the fire fighting efforts are going on, it is recommended that these products of combustion be contained as much as possible within one area, and that vents be provided to expel these products from the building. There is no doubt that these recommendations make sense, but what size area should be contained by the curtains and how much venting should be provided is, once again, a matter of judgment which cannot be fully proven.

Also, in view of the potential delay in obtaining full extinguishment from sprinklers in high stock piling areas, hand hoses and outside fire hydrants assume importance. It is quite logical that the most efficient fire fighting method in high stock piling might be for sprinklers to get control and fire hoses to achieve final extinguishment.

Naturally, these are not the only complications to our simple theory, nor have we covered all of the types of recommendations that we see in relation to high stock piling, but I think they are representative of the problems, the reasoning and the necessary use of judgment.

One area we did not pursue is the fact that our simple theory was based on storage of combustible material and, of course, there are wide variations in the flammability of combustible materials, and they will vary widely in the rates in which they will release heat under combustion. The fact does not alter the theory, but it does explain why, with such a variation in materials and in storage arrangements, that there are limitations to the pure scientific approach and that so much is still judgment. We should discuss, however, the relative position of rolled paper stock within the general category of combustible material. I have heard many arguments about the flammability of rolled paper stock and how it is unjustly compared with loosely wound Kraft paper, and how rolled paper has survived bad fires with all but the outer layers completely untouched. Let's start by agreeing that tightly wound rolled paper stock is not as potentially hazardous as loosely wound Kraft paper, which unravels under fire conditions; but this doesn't alter the fact that we are dealing with combustible material. It isn't necessary that any of the interior of the roll be involved to create the fire conditions we have discussed. Just the exposed outer surfaces will do just fine. And when that surface is burned away, another combustible surface will replace it. Beyond the first inch or so of the exterior, it wouldn't make much difference if the rest was pig iron. I think we can agree that it burns at a slower rate than, say, cardboard packaging regardless of its contents, and this is normally acknowledged by recommending a lower sprinkler density for rolled paper than equivalent heights of storage in cardboard boxes. It is still, however, combustible material and properly belongs in the category of high piled stock.

Let's assume that you agree so far with this whole discussion, and that you are able to convince your management that the potential hazard is there and something really should be done in upgrading protection, but how far should you go, at what point does it cease to be reasonable or practical and, of course, what point will be the minimum acceptable to your insurance underwriter? These are very difficult questions, and as much as I would like to, I can't break my record by supplying answers.

I would like to offer some suggestions, however. Up to this point, we have looked at the major potential aspects of the exposure, and we have viewed the fire engineer's approach to minimizing the exposure, where he can base his reasoning on fact, and where it is necessary to employ judgment. Now, what about approaching it from management's viewpoint? We start by as-

suming there is agreement that a special exposure does exist. Management must consider what is at risk. I would consider five major items:

1. The value of the paper and warehouse facility at risk (believe it or not, this may be the least important consideration.)

2. The expenditure for protection should not be based on just what is at risk today, but also what will receive the benefits of protection in the future. If, for example, you have $300,000 worth of paper at any one time, but your average turnover is four times a year, then actually you are providing protection for $1,200,000 in stock over the year, and $6,000,000 in stock over five years.

3. What effect will the loss of paper stock have on the continuation of operations?

4. To what extent is there exposure between the paper storage area and any other facilities or operations?

5. What are the implications to your overall insurance program?

You will notice that all I've done is pose more questions. But I'll wager that if you seriously attempt to answer these questions, you will find that you can only go so far on fact, and from that point on you will have to rely on judgment, which puts you in a similar position as the fire engineer, but whereas the fire engineer has to contend with the insurance company influence, you will have to contend with a tight budget.

It is my honest opinion, however, that if the management viewpoint is pursued realistically, and sound judgment is applied in a logical manner, the differences between your position and the fire engineer's position will be in a negotiable range, and let's face it, there is always area for negotiation in loss prevention. Whether you agree with the ultimate conclusions or recommendations of the fire engineer or not, he has thought out and reasoned his position. I have never experienced a single instance, when management gave equal thought and equal reasoning, that the matter wasn't worked out. It is only at this point that you or I can arrive at any real answers.

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CURRICULUM FOR SAFETY EDUCATION SUPERVISORS

By ROBERT L. MARSHALL
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It is important when communicating with any group or person for everyone involved to be using the same word meanings. For this reason I would like to define the terms used in the title of this paper, since they may have different meanings to different people*.

Curriculum — a course of study, as in a college. The whole body of courses offered in an educational institution, or by a department thereof.

Curriculum Vitae — course of life; career. A short statement of the leading incidents in one's career and of one's qualifications, as prepared by an applicant for a position.

As I discuss the curriculum for Safety Education Supervisors, I will use the definition of curriculum vitae. Some may have heard me use the following definition of safety education before but I believe it is essential for this definition to be spelled out.

Safety Education — "The process of correlating through administration,** instruction,** and protection** a program designed to achieve (1) the prevention of accidents and preservation of lives by developing attitudes necessary thereto; by imparting helpful knowledge; and by developing habits and skills which help in safeguarding oneself and others; (2) the fusion of these elements into a discipline important in itself as a means of effective citizenship.

Safety education in the schools includes (topical areas):

1. Traffic safety education (K-12, adult education): pedestrian safety; bicycle safety; traffic safety patrols; motorcycle safety; and driver education. There are many programs in driver education: secondary school students (basic); adults, including high school drop outs (non-drivers); handicapped students; advanced driver education; defensive driving courses; school bus drivers; law enforcement officers; vocational programs (Goodwill Industries — core city area residents who are handicapped being trained as a career); fleet programs; specialized programs (practice on skid pans or blow-outs only); and driver improvement (violators).

2. Other topical areas of safety education are: disorders (student or other); civil defense (natural and man-made disasters); fire safety; safety patrols (other than traffic); aviation education (over 20 Kansas secondary schools now offer programs); home safety; rural and farm safety; school transportation (could be listed under traffic); accident reporting, analysis, and corrective action; school plant inspections; student safety committees (working with the National Student Traffic Safety Program, NEA); in-service programs for professional and other staff members; safety in the shops, laboratories, classrooms, and all areas of school buildings; and all other areas of safety.

If you combine the definition of curriculum vitae and safety education as given, you will have the point of view or philosophy of Missouri's Safety Center, located at Central Missouri State College, as we build our curriculum for future safety education supervisors who are being prepared at our institution.

Curriculum Vitae

In order to explain CMSC's curriculum vitae for safety education supervisors, seven

*These definitions are taken from *Webster's Collegiate Dictionary*, Eleventh Edition, 1959.

***Administration* — the assigned personnel in the field of safety; the areas of responsibility of these personnel, and the procedures to be followed in implementing this program.

***Instruction* — those activities carried out through classroom instruction; special projects; co-curricular or related activities in the teaching of safety education to students and staff.

***Protection* — those provisions for safety included in environmental conditions; control of vehicular traffic around schools; school building construction and supervision; movement of school population, and the safety services provided by inspection teams, resource people and others.

**Marshall's dissertation. See Bibliography.

major points need to be discussed: (1) courses and programs offered at the undergraduate and graduate levels; (2) internships in safety education supervision; (3) total scope of experiences at CMSC other than courses; (4) selection of staff for safety center; (5) facilities; (6) career planning and job selection; and (7) financial assistance.

Career Ladder

Again, in an effort for us to clearly communicate I will briefly review the career ladder in safety education as we see it at our institution:

Position	*Degree*	*Experience*
Individual school safety coordinator	BS	varies
Driver education teacher	BSE, D&SE	0
Driver education department head	MS, SE	3-5 years
Traffic safety supervisor	MS, SE, or MS in ED, SE	3-5 years
Safety education supervisor (state or local school systems)	MS, SE or MS in ED, SE	3-5 years
Safety organization or Federal government staff member (NEA, USOE, DOT, NSC, ASF, etc.)	MS, SE or MS in ED, SE or PhD or EdD, SE	3-5 years
College or university professor of safety education	MS, SE or MS in ED, SE or PhD or EdD, SE	5-10 years
Director of safety center or department head	PhD or EdD, SE	10 years†

The curriculum vitae that I will describe is designed to prepare individuals at these various levels.

Programs Offered

At the undergraduate level our institution offers a major or minor in driver and safety education and in law enforcement. The major in driver and safety education includes: (1) 30 semester hours of courses; (2) experience in a seven-phase driver education program — classroom instruction (60 hours) — educational television (varies) — multi-media programmed instruction (10 hours) — simulation (10 hours) — multiple car driving range (10 hours) — in-car instruction (at CMSC, two hours; at high school three hours) — individually prescribed instruction (varies); (3) one term of student teaching in a carefully selected school system under the direction of a master driver education teacher.

Graduate programs include: (1) Master of Science in Education, Safety Education (32 semester hours); (2) Master of Science, Safety Education (32 semester hours); (3) Specialist, Safety Education (62 semester hours).

Internship in Safety Education

In addition to a Master's or Specialist Degree in Safety Education (or as a part of one of those degrees) our institution offers an internship in safety education. The intern is placed for a period of time (one term, six months, one year, etc.) under the supervision of a well qualified Director of Safety Education at the local or state level. His internship experiences may include: planning and developing curriculum materials; preparing budgets; interviewing prospective teachers; analyzing accident reporting; preparing in-service programs; in short, becoming familiar with the duties and

responsibilities of the Director of Safety Education. At the end of the internship the prospective supervisor has an advanced degree plus experience on the job.

Other Experiences at CMSC

Colleges and universities have many opportunities available to them that will greatly enrich the total curriculum of the student. I will list seven:

Colloquiums. Once a month during the academic year and weekly during the summer term colloquiums are held which include a luncheon, a speaker, and discussion. These sessions provide an excellent vehicle for the students to get to know the staff better and for the staff members to see the students in an informal setting. National speakers bring up-to-the-minute information, excellent discussions are held (often with different points of view) and materials are made available. Job opportunities have followed for some students, and the students generally have an opportunity to find answers to questions of all types.

Seven-Phase Driver Education Program. Future safety education supervisors have an opportunity to study scheduling problems, assist in budget development, develop teaching schedules, and in general become thoroughly familiar with all seven phases of a 90-100 clock-hour driver education program.

Research Projects. Students may be assigned to work on local, state, or national research studies, having an opportunity to be familiar with the project from the early think stages to the submission of the final report.

Design and Drafting of Federal Proposals. With increasing funds available from various sources, it is important that students know how to draft and submit Federal proposals, whether the funds are coming from the Highway Safety Act of 1966, The Elementary and Secondary Education Act of 1965, the Walsh-Healy Act, the Safe Streets Act, or whatever source. We try to acquaint students with this process.

State and National Associations. If the future supervisor is to be fully aware of developments in his discipline he should have an opportunity to join his state and national professional associations. Since our staff serves as Secretariat for the Missouri Driver and Safety Education Association and for the South Central Region of the American Driver and Safety Education Association (NEA) we are in an excellent position to point out the benefits of and the need for his participation in his professional association.

Mailing Lists of Safety Organizations. The Safety Center receives approximately 50 newsletters or regularly issued bulletins from approximately that number of organizations. Students have an opportunity to become aware of these items and are informed how to receive them after they are on the job.

Staff Meetings. Graduate assistants and interested graduate students are invited to attend monthly Center staff meetings. They not only see current activities and projects developing or progressing in instruction, research, services, and publications, but they can also participate in the other numerous staff activities such as the continuous development of a five-year plan for the Center.

Staff

Future safety education supervisors can gain much insight by studying under professors from as many disciplines as possible. As CMSC began to expand its staff in July of 1967 for the Center, nine basic selection criteria were listed: an educator with national experience; an experienced safety specialist with Federal government experience; a sociologist or psychologist; law enforcement specialists (with Northwestern University Traffic Institute experience); an attorney; a traffic engineer from Yale's Institute of Traffic Engineering; a safety specialist from New York University; a traffic safety specialist from Michigan State University; and a school transportation specialist.

Now that the Center's staff complement has been reached, additional staff will be sought as needed, using two basic criteria: extensive experience in the discipline sought; and utilization of as many disciplines as possible in an effort to provide the best possible instructional program.

We believe it is important for the staff to continuously have available in-service courses or workshops. Examples of in-services staff activities completed or planned include: personal and family survival (C D

Course); shelter management (C D Course); radiological monitoring (C D Course); defensive driving course for instructors (NSC Course); accident investigation (NWU Course); systems analysis course (NSC).

Facilities

Undergraduate and graduate programs plus a highly qualified staff can be more effective with good facilities. CMSC has provided or is providing the following facilities for the Center: Office space for 45 professional staff members, graduate assistants, and secretarial personnel with room for expansion. New classrooms fully equipped. police laboratory, poligraph testing room, and safety education laboratory. Library facilities. Twelve-place driving simulator installation. Thirty-place multi-media programmed instruction equipment facility. Multiple car driving range, including practice area (27 basic skills), skid pan, freeway, and control tower. Availability of computer center. Instructional resources center. Television and radio studies. Recent teaching aids. Latest audio-visual materials (T.V. and audio-tapes), in new addition of the library, which can be checked out and used by individual students or groups of students.

Career Planning

As future safety education supervisors are being prepared, it is important that the candidates discuss career planning and job selection. The Center staff assists students when they are nearing completion of their programs in the following ways. Discussion of the career ladder (as earlier described in this paper) and the qualifications needed to move from step to step. The services of CMSC's placement office. The maintenance of current job opportunity folders to assist students in job placement. A careful analysis of available positions to determine if the Center's program is meeting the needs of the safety manpower user.

Although the Center's program is only 2½ years old, its graduates have accepted or are in the following types of positions: supervisors of safety education (state and local levels); industrial safety engineering position, Monsanto Corporation; college, department head, Driver and Safety Education; junior college department head, Law Enforcement; American Cancer Society staff member; Missouri Conservation Commission safety consultant; National Highway Safety Bureau staff; department head, secondary school Driver Education Program; driver education teachers.

Financial Assistance

With the availability of graduate programs for the preparation of safety education supervisors, financial assistance is needed to enable driver education teachers or others interested in this discipline to take off from their jobs and work on an advanced degree for a year or two. The Center has several types of assistance at CMSC for graduate students: (1) CMSC graduate assistantships; (2) NEA-Chrysler grants-in-aid; (3) National Defense Education Act loans; (4) State Department of Education — National Highway Safety Bureau scholarships ($75/semester hour) for teachers who do not meet state certification requirements in driver education; (5) State Department of Education — National Highway Safety Bureau scholarships ($75/semester hour) for supervisors of driver and safety education to enable them to pursue an advanced degree in safety education.

Summary

In summary, we, the staff of the Safety Center, believe that the curriculum for the preparation of safety education supervisors is many things far beyond classroom experiences in a certain number of courses. We believe that the curriculum vitae includes: the courses and programs at the undergraduate and graduate levels, internships in safety education supervision, other experiences such as Colloquiums, careful selection of an experienced staff on an interdisciplinary basis, adequate facilities, career planning and job selection, and financial assistance adequate to enable well qualified on the job educators to take leave and pursue a graduate degree in safety education.

We also believe:

1. That well prepared driver education teachers through quality driver education programs have much to offer the young people and adults in this nation through sound driver education programs.

2. That it is time to stop kidding ourselves by saying that 30 hours of classroom instruction and six hours of in-car practice

are adequate to prepare new drivers for today's highway environment.

3. That it is time to stop believing that three or four undergraduate courses in driver and safety education offered at the graduate level are adequate to prepare driver education teachers for today's needs.

4. That there is no conflict between driver education teachers, traffic safety supervision, and safety education programs or supervision as outlined in this paper. Each is an important part of the total safety education program as previously defined. Each can strengthen and support the other.

5. That there is no need for argument that a person is a driver educator, or a traffic safety specialist, or a safety education supervisor. All are part of the total safety education program and each strengthens the other as new knowledge from new research and on the job experience enable all to do a better job. As the career ladder in this discipline is reviewed, we do not see a need for the continuation of a controversy between traffic safety and safety education.

6. That these beliefs are in keeping with the 1969 National Safety Congress and Exposition theme, "Speak Up For Safety."

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STATES RESPONSIBILITY FOR SCHOOL BUS SAFETY

By THEODORE SORENSON
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and RICHARD OLSON
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Today we transport over 15 million pupils to and from school. This daily ride involves almost 40 per cent of the total enrollment of our schools.

School bus transportation in the United States is by far the largest transportation undertaking in the world. Based on figures released by the National Safety Council, it probably has the best safety record, too.

The creation of the Transportation Department within the Federal government has focused increased attention on all phases of highway safety, including school bus transportation. It is mandatory for each state to assume its rightful responsibility in providing leadership and funds to improve our safety programs. The penalty for failure to do so may mean that the state may lose a substantial percentage of Federal funds which they would otherwise receive.

The State Department of Education must provide leadership for school bus safety because: (1) Conformity is necessary, and (2) uniformity is needed. They should also provide leadership and direction in the proper training of bus drivers and bus riders. Next to the training of bus drivers, we believe that high on the list is the control and the supervision of the bus rider. *(There followed a film strip demonstrating a bus rider training program.—Ed.)*

TEXTILE NOISE PROBLEMS AND CONTROL THROUGH EQUIPMENT DESIGN

By J. D. PAGE
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The recent interpretations of the Walsh-Healey Act have undoubtedly accelerated noise control activities. My own organization is probably typical of most machinery manufacturers, where noise control work is motivated by a joint need to protect our customers and also remain competitive. Our efforts are split into three phases: survey; source; and reduction.

Noise Survey

The first phase is concerned with a survey of existing noise levels. Various sound levels have been published, ranging from 103 dB for weave rooms to 82 dB for opening and picking areas. To start on the problem, we first set out to make a survey of existing sound levels, particularly how our own equipment is performing in various installations. This survey is far from complete, but it is already apparent that an arbitrarily set sound level for a single machine is not reliable unless evaluated in a mill environment.

A sound survey data sheet is used to arrive at a standard method of collecting relative data and taking measurements. Data considered relevant includes speeds of major components, room dimensions and material, and a sketch of the machine being measured. Further guidance is given on microphone location in the instruction sheets. Readings are taken with three weightings in order to obtain some indication of frequency of the sound. Observations are made with a machine running, and again with the machine stopped, to check background.

The effect of a multi-machine installation is a complex problem. A treatment exists for combining decibels by adding on an energy basis.[1] This means that two equal noise sources of, say 80 dB, combined give three more decibels, resulting in 83 dB. Adding a third noise source has an even smaller effect on the decibel scale, adding only 1.6 dB. We recently measured 99 dB with a complete installation of cotton spinning frames running, whereas each individual frame measured 88 dB. If the theoretical treatment is followed, 13 noise sources are required to yield an increase of 11 dB. According to Beranek,[2] even in a room with poor sound absorption the noise level would attenuate at least that amount over a distance of seven feet. This is much closer than the machine spacing. The explanation for the 11 dB increase lies in the fact that the spinning room in question had tile walls; this resulted in abnormal sound reflection. It is felt that multi-unit installations normally give six dB increase over the single unit, and 10 to 11 dB would be the maximum under poor conditions.

Probably the biggest enemy of the noise control engineer is speed. It is interesting to note that on an energy basis the noise increase is about the 2.7 power of the speed ratio. This compares quite well with the electrical power consumption, where the increase is between the second and third power of the speed ratio, usually in the region of 2.4.

Noise Sources

Using the *A* scale of a standard sound level meter at slow response for the Walsh-Healey interpretation has simplified measurements in the field. However, the *A* scale tells an engineer very little, and usually some form of frequency analysis is required. Once the critical frequencies are identified, it should be possible to pinpoint the offending components. Unfortunately, this is not usually the case on a textile machine, as there are such a large number of noise producers. The use of a narrow band constant width filter has been developed to help pinpoint the noise sources,[3] and this may assist in identification.

One investigator[4] considers that among the large number of noise producers in a draw twister, three equally loud noise sources must all be eliminated. These are: spindle bearings; harmonics of the high speed bobbin; and the draw roll shaft assembly.

A draw twister takes undrawn yarn from an extruder take-up machine. The drawing action is accomplished by wrapping the undrawn yarn around one roll, then wrapping it around a second roll. The second roll rotates faster than the first and the yarn stretches to match the speed differential. The twisting of the yarn is effected by winding the drawn yarn onto a bobbin by a ring-traveler combination. It would be very difficult to modify this process so as to reduce or eliminate one of the noise sources.

The draw roll shaft assembly is a typical noise source. The surface speed of the faster roll is the delivery speed of the machine. A typical delivery speed is 4,000 fpm. As some draw rolls have a circumference of one foot, this readily converts to 4,000 rpm (66 Hz). The draw roll assembly is driven by a gear attached to a shaft, the other end of the shaft carries a draw roll which closely resembles a bell in effect, if not in shape. The noise is generated in the gear and is transmitted along the shaft, to be amplified by the roll.

The same sequence is followed in another area of the draw twister frame. A noise is generated in the spindles. It is transmitted along the spindle rail and is amplified either by the spindle rail covers or the end cabinets housing the controls.

On the question of high speed bobbin harmonics, this was explained by the investigator as vibration in the side of the bobbin.

Noise Reduction

Although it is not always practical to prevent noise, the designer has many opportunities to use his craft. The textile industry has always been very sensitive to vibration, mainly because of its adverse effect on yarn or cloth quality. Hence, the relatively recent emphasis on noise has found the designer with some techniques available to attack noise where it is generated.

Richards,[4] in making an investigation for a British fiber producer, tried some noise reduction techniques on the draw roll assembly. One approach used a polyurethane bonded bush between the gear and the shaft. It reduced the overall noise level of one shaft assembly seven to eight dB. Another trial was made, substituting a copper-manganese alloy shaft for the steel shaft. The use of this material not only introduced its high damping properties but also brought the shaft critical below the running range. The result of using the copper manganese shaft was to reduce the overall noise level by 4.5 dB.

An English company has used rubber bushings to isolate the torsional vibration set up by the gears. At 4,000 fpm a 14 dB.*A* reduction is achieved. With the regular design, the mechanical limit of the roll had been reached at 4,000 fpm. However, with the rubber bushings an increase in speed up to 7,000 fpm is possible.

Another good illustration of reducing vibration and consequently sound is in the spindle isolator. This technique is not new; it originated as early as 1836. A patent was issued in Great Britain (No. 7127) to William Wright for the use of an "elastic medium" to reduce spindle vibration. Wright had found the means, probably a leather washer, to allow the spindle "to find its own running center." This definition of a correctly designed spindle has stood the test of time although more precisely we now say "running on its own mass center."[5]

This eccentricity is a combination of manufacturing tolerances which result in non-concentric parts and mechanical looseness, especially in the yarn carrier. This results in a centrifugal force proportional to the mass of the rotating parts, the eccentricity of these parts, and the rotational speed squared. The use of the "elastic medium" allows the center of rotation of the mass to move from its normal position toward the center of gravity. Thus, the radius in the centrifugal force formula is reduced. In practice, this can amount to more than a 90 per cent reduction of the centrifugal force.

The self-balancing movement of the rotational center can only be achieved by running the spindle above the critical speed determined by the isolator. Once through the critical speed, a phase shift takes place through 180°, which effectively balances the spindle. The disadvantage of this system is that a large deflection takes place at the critical or resonant frequency, which has to be controlled by the use of proper damping in the isolator.

The use of cast iron for machine parts has often been promoted by expounding its damping properties. A properly designed

steel plate weldment can offer more damping than a cast structure.[6] In addition, the use of steel offers a stiffer material (E value 30×10^6 psi versus 18×10^6 psi for gray cast iron). This means that for a given disturbance a smaller amplitude or deflection is produced. Traditionally, cast iron structures are made heavier than the load carrying requirements so the part can be readily machined. This has resulted in many misconceptions regarding damping.

Spraying or painting on a damping layer is a technique used in the aircraft industry. Often its use in down-to-earth applications does not result in the anticipated reduction in noise. The first rule to remember is that the surface to be treated must be deforming in some way to allow the damping material to work. Even then, only the portion of the energy required to deform the damping material can be dissipated. As this portion is usually relatively small compared to the total available energy, a way must be found to make the damping layer work. The use of "spaced damping,"[7] where the damping material is held away from the resonating structure by short tee-sections or other spacers, solves this problem. Another way to use a damping film is bonding between two or more layers of sheet metal to give an effective use of the layer by subjecting it to shear during flexing.

Felt glued onto pressed steel fabrications is used quite extensively as a noise reduction treatment. This became necessary when the switch was made from cast iron doors and covers to sheet enclosures. The effect of the felt is not as a damping addition but to increase sound absorption and increase the mass of the resonating structure.

One aspect of machinery's use beyond the direct control of the manufacturer can influence the noise level. This is maintenance. Sufficient lubrication, the control of wear, and tightening of parts can pay good dividends in noise reduction.

The use of vibration pads has prompted a certain amount of discussion. To achieve pure isolation for a certain frequency a given amount of deflection must be provided. In many cases this is not possible, especially if the machine is not freestanding. An example is a cotton spinning frame where the attachment to the floor plays an important part in machine alignment. Another illustration can be found in the shuttle loom, where one attempt to suspend the loom was defeated by operator fatigue caused by a sea of swaying looms. The vibration pad is mainly useful as a barrier to the transmission of noise. The use of pads should be properly engineered, as mis-alignment or a reduction in stiffness could have an adverse effect.

Conclusion

The tools to identify and treat noise sources on a textile machine are available. Noise reduction programs are almost self-generating, once started. As soon as one noise source is dealt with, this usually allows another one to be identified. This may well be the reason why we have not seen an impressive reduction in sound levels.

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KEYNOTE ADDRESS

By R. C. GRAYSON
President, St. Louis-San Francisco Railway Co., St. Louis, Mo.

Recently there appeared on the front page of the *Wall Street Journal* an item which I am sure was disquieting to safety specialists. The gist of it was that on the job safety was getting a stronger push from employers, as well as union officials. But the sobering part of the item was the last sentence. It reported one carpenter union official as saying "Safety isn't always easy to sell. When the talk turns to safety at (union) meetings, half the audience leaves."

Most of us will agree that the safety message is repetitious. The rules for safe performance of duties have changed very little over the years. So the response they receive may be less than enthusiastic. These are days of non-conformity. It is also a time in which we are deluged with a variety of messages prepared by professionals. Our senses are tuned to catchy commercials and clever Madison Avenue ads. Against such competition, the safety message may sound humdrum. Non-conformity, however, has no place in an operation which requires strict compliance with the book of rules.

It is difficult to recall a past period when there has been so much public and governmental attention focused upon safety in transportation. Mishaps have generated headlines, and headlines have generated governmental inquiries and the threat of new legislation. Broad powers have been proposed to enforce comprehensive safety regulations for our industry.

By implication, and by direct statement, the safety of railroad operations has been under sustained attack. In one instance, the safety of rail operations was unfavorably compared with the safety of air operations. In the comparison, train accident casualties were inflated to include those killed in highway vehicles which collided with trains. The result was a death toll of 2,359 persons in the year 1968. Actually, the number of persons killed in train accidents in that year was 142, while the number killed in airplane crashes totaled 258.

We all agree that there is no phase of our operations today which calls for a more intense application of thought and energy than safety at grade crossings. Grade crossing accidents are the major cause of fatalities in railroad operations. They account for two-thirds of all the fatalities resulting from all types of accidents involving railroads.

The late Justice Brandeis held that "Where once the railroad was regarded as the prime instrument of danger and the main cause of accidents, now it is the railroad which requires protection from the dangers incident to motor transportation." Some states already have taken action to relieve rail carriers of the major financial responsibility for such safety projects. Grade crossing protection funds have already been established by ten states to help defray the costs for garde crossing protection. Several other states are sharing maintenance costs.

In gaining such acknowledgment of responsibility by other states, we will need the continued assistance of the National Safety Council which, in the last half century, has made some remarkable contributions toward reducing grade crossing accidents.

If we are going to make any significant progress in reducing grade crossing casualties, we will have to get our message across to the motorist, who is the cause of most of the accidents. Many railroads already have programs to promote off the job safety. The Frisco considers this an important part of its over-all safety program. Our personnel have appeared before a variety of civic organizations with the safety message. We've shown films, we've distributed booklets, we've given talks, all intended to make people conscious of the many ways in which they can jeopardize life and limb in their daily activities.

Fifty years ago, highways served only local traffic. Today, long-distance highways not only serve to deplete existing rail traffic and revenues, but they are also contributing to a staggering loss of life, limb, and property, through crossing accidents. The ideal solution would be to eliminate grade

crossings. Unfortunately, the cost of such an ambitious undertaking would be three times the net investment in class one railroads and more money than the Federal Government has spent on highways in the last fifty years. Other means will have to be found.

Federal funds to eliminate grade crossings have been of help. But only about 20 per cent of the total number of grade crossings in the United States are on the Federal-aid highways system. The remaining 80 per cent are not in any way eligible for Federal funds. There is, therefore, an imperative need for an expanded public program to bring some form of protection to these crossings.

Almost every American family now has at least one automobile. Counting trucks, there are about 100 million motor vehicles registered in the 50 states and the District of Columbia. Safety at grade crossings is, therefore, a subject in which the public has a vital interest. An important step forward would be for states to use more of the ten per cent of Federal highway funds authorized for grade crossing improvements. The states also should share more in the cost of installing and maintaining automatic grade crossing protection.

Over the years, we have spent a considerable sum of money on various kinds of crossing protection devices. These have been of help, but the Frisco continues to have accidents even at crossings so equipped. So do most other railroads. Part of the reason lies in the sharp increase in accident exposure created by the phenomenal growth of highway traffic. There appears to be nothing in the offing which will reduce vehicular traffic on our highway system. The amount of square footage devoted to parking around a modern-day high school sometimes equals the square footage assigned to classrooms. Bicycle racks are disappearing. The new symbol of mobility may have 200 horsepower under the hood and be capable of racing a train to a crossing. It follows that driver education courses in high school today are as basic to modern living as home economics. By reaching these and future drivers now, we may head off an accumulation of bad driving habits which later will find themselves translated into accident statistics.

The record shows that one of the major causes of collisions between trains and motor vehicle is the failure of the motor vehicle operator to exercise due care and caution or to comply with existing laws or regulations in the operation of his motor vehicle. In most of these accidents, the operator failed to stop in the face of flashing lights and ringing bells, or failed to stop his vehicle as required by law. In about one-third of the accidents, the operators of motor vehicles not only failed to stop but drove their vehicles into the sides of trains. Better driver education and a strict enforcement of traffic laws should improve rail-highway safety.

Grade crossings, however, are but part of the problem. One area in which new standards of measurement are needed is in train accident statistics. Most of us will agree that it would be financially restrictive to live on the amounts of money we budgeted in 1957. Yet, in our attempt to compile meaningful statistics to measure the safety of railroad performance, we find ourselves tied to the monetary standards of 1957, when $750 in railroad property damage became the criterion for reporting a train accident. In the last twelve years, there has been a 42 per cent increase in industry wage rates and material costs. In that same period, the average cost of a new freight car has more than doubled. As a consequence, what might have been considered only an incident twelve years ago — something like a rough coupling — now is a reportable accident. I think all of us want to see a more realistic approach to accident prevention, one in which everyone with a vital interest in the subject — management, labor, and government — puts forth a determined effort to effect an improvement.

What is needed is a calm, objective, cooperative analysis, not just a flurry of headlines and statistics which fail to pinpoint cause and effect. One such analysis is currently underway. Among other things, it is dealing with the movement of what have been called "hazardous materials." Out of this study may come a change in the specifications for wheels and the condemning limits respecting the tread wear on wheels. Specifications for tank cars also are under scrutiny. This includes investigation of the design of tank cars, specifications for the steel used in such tanks, the safety valves used on them, welding techniques, and the types of couplers used. Tank car center sills

also are being critically studied. What problems we have will yield to this kind of patient and careful investigation, followed by resourceful innovation.

The record shows the progress made in dealing with the hot box problem. Today, we have one-tenth as many failures as we did a decade ago. Some of the progress is due to better journals, some to better lubrication devices, some to roadside and yard-approach heat detection equipment, and some to better inspection and supervision. We need, and will see, more improvement in the years ahead.

Efforts to make railroading safer are not sporadic. Safety is a matter of continual concern, to any enterprise with turning wheels. It is especially so to an industry which pays out, for mishaps of one sort or another, a sum of money equal to half of the entire net railway operating income of Class One carriers.

"It is normal for us to become departmentalized in our thinking. The safety superintendent thinks in terms of personal injuries and fatalities. The manager of loss and damage thinks in terms of that aspect of the business. The transportation officer thinks in terms of moving trains, the mechanical officer in terms of equipment, and the chief engineer in terms of the fixed plant. But when you tie all of our mishaps together, you discover that last year the cost of personal injuries, damage to property, freight loss and damage, and the cost of clearing wrecks came to $340 million, an amount which was equal to more than 50 per cent of the entire net railway operating income of Class One railroads.

It is relevant to point out, however, that we have made some important strides in reducing employee casualties. At the turn of the century, railroading was considered one of the most dangerous of occupations, second only to mining. Yet in 1968, the casualty ratio for railroad employees was 12.15 per million man hours. The ratio for manufacturing in that year was 14; and for construction, 26 per million man hours. In the years between 1961 and 1968, casualties to employees on duty decreased almost 11 per cent. Total rail casualties — employees on duty and all persons — were the lowest in the last two of those eight years.

As encouraging as these figures are, there are ways in which they can be further improved. One way, we think, is to hold every supervisor accountable for injuries which occur under his supervision. For too long, safety has been regarded as the responsibility of the safety superintendent and his staff. The responsibility belongs to the line officer — the supervisor for whom the employee works. The specialists who staff our safety departments should have the opportunity to concentrate their time and efforts upon the formulation of effective programs to combat accidents. They should have the time to attend seminars, to participate in industry-wide discussions, and to share their knowledge so acquired with the line officers, who will have to implement the safety program. Division staff meetings should be held regularly, the policy of the company should be to require attendance by line officers from the various departments — transportation, mechanical, maintenance of way, communications and signals, and special services.

Beyond that, we have to strive for a stronger, sustained interest on the part of rank and file employees. Competition between departments can be helpful. This year, on the Frisco, we began an experiment to create a more material incentive to remain interested in the safety record. Employees are grouped according to their division, shop, or department. Prizes are awarded for commendable safety records. The first prize category is for the group which posts a casualty record of fewer than 100 days lost per million man hours. The second category ranges from 100 to 200 days lost; the third category from 200 to 300 days lost; the fourth category from 300 to 400 days lost; and the fifth category from 400 to 500 days lost. Prizes range from a boat, motor, and trailer or camper-trailer to color TV sets, transistor radios, and safety shoes. We hope in this way to increase employee involvement by giving a material incentive to keep interest — and people — alive!

Psychologists tell us that whether or not a man thinks and acts safely is dependent upon his state of mind. Healthy, alert individuals usually are persons with a good outlook on life. They bring to their jobs enthusiasm, a pride in their work, and a desire to succeed as an individual and as

a member of a team. Mental attitude is, therefore, an important ingredient in almost any kind of an operation.

For too long, railroad men have been subjected to negative influences. Our industry has been variously described as sick, ailing, and trouble-ridden. In the interest of objectivity, I think we need to accentuate the positive a little more. I know of no competent individual at this juncture of history who foresees the demise of the railway network. The transportation needs of this country for the foreseeable future will require a strong system of rail carriers. Rails are still prime movers for most of the heavy industry in this country. Industry is expanding. It is fanning out. Cities are growing. Sparsely settled areas are being developed.

We have the opportunity to make railroads safer and better than ever before. I suggest we make the most of it.

THE ROLE OF THE NATIONAL TRANSPORTATION SAFETY BOARD IN RAILROAD TRANSPORTATION

By HON. LOUIS M. THAYER, RADM, USCG, (Ret.)
Member, National Transportation Safety Board, Washington, D.C.

The National Transportation Safety Board came into being under the Transportation Act of 1966—Public Law 89-670. We are fewer than 300 in number to be considered together with, but still separate from, the total population of the entire Department—almost 100,000.

The idea of forming a department of transportation is by no means a new one. The first attempt to form such an organization was made by the Secretary of the Treasury Gallatin in 1805. Since that time, 33 separate pieces of legislation have been written for the same purpose, most of which died in committee. In 1910, a department of transportation would have included a Department of Commerce; Labor—Lighthouse Board; The Lighthouse Service; The Marine Hospital Service; The Steamboat Inspection Service; The Bureau of Navigation; and U. S. Shipping Commissioners. Many of those organizations are now consolidated in the U. S. Coast Guard.

In any case the Department as it is organized today brought together personnel from 30 agencies or functions, all of whom were working on transportation to some degree—about 100,000 employees in 3,000 locations in the United States and 40 overseas. The annual budget is about six billion dollars, including the Highway Trust Fund, which is about four and one-half billion.

The Secretary is assisted by an Under Secretary and a Deputy, five Assistant Secretaries, and a General Counsel. At the operating level we have an Administrator for each mode of transportation, plus two not modal oriented. They are the Urban Mass Transportation Administration and the Saint Lawrence Seaway Development Corporation. The Federal Railroad Administration reports directly to the Secretary and not to any particular assistant secretary. The National Transportation Safety Board is an independent organization reporting annually to the Congress.

The Secretary of the Department is required by the law to assure the coordinated, effective administration of the transportation programs; to facilitate the development and improvement of coordinated transportation service to be provided by private enterprise to the maximum extent feasible; to encourage cooperation of the Federal, state and local governments, carriers, labor, and other interested parties toward the achievement of national transportation objectives; to stimulate technological advances in transportation; to provide leadership in the identification and solution of transportation problems; and to develop, and recommend to the President and the Congress for approval, national transportation policies and programs to accomplish these objectives with full and appropriate consideration of the needs of the public, users, carriers, industry, labor, and the national defense. Much of this language is from the law; it gives to the Secretary

a broad overview. But there is no specific mention of safety, although safety is certainly a factor in each of these statutory mandates. On the other hand, safety is the sole concern of the National Transportation Safety Board.

The National Transportation Safety Board consists of five members appointed by the President and confirmed by the Senate. The full term of appointment is five years. The total population of the Safety Board is about 275 people. Under the Act, the National Transportation Safety Board has six functions or duties to perform, and we are authorized eight more. However, the Board has no authority to regulate, nor power to enforce. Railroad transportation is therefore affected by the role of the Board through the action the Federal Railroad Administrator may or may not take on any recommendation we may make to him, and through the activities of accident investigations we may undertake.

First, we are required to determine the cause or probable cause of transportation accidents and report the facts, conditions, and circumstances relating to such accidents. In the surface modes we have delegated this function, as authorized by the Act, to the Federal Highway Administrator and the Federal Railroad Administrator except for a few catastrophic cases we select each year. In aviation, we are required to determine the probable cause of all accidents, and the Safety Board and its staff conduct an investigation of every fatal air accident. We have delegated the investigation of most non-fatal accidents to the Federal Aviation Administration.

We have selected eight railroad accidents to report on. The first two we based on the investigations conducted by the Interstate Commerce Commission which included hearings conducted by an ICC examiner prior to the establishment of the Federal Railroad Administration. We have participated in the investigation of or have conducted public hearings in six railroad accidents. Of the eight railroad accidents that we have directed our attention to, we have issued six reports and two are pending.

We have made a number of recommendations to the Secretary, Administrator, the industry, and others as a result of these eight accidents and three special studies we have conducted. The board is fully aware of the fact that three of the eight cases we have looked at involved grade crossing accidents; and that some in the railroad industry consider these to be either highway or trespasser accidents, and in any event beyond the control of the railroad.

While we understand some of the rationale that leads to that conclusion, it is indisputable that the people involved are no less dead regardless of who might be more to blame. It is the function of the Safety Board to determine how to prevent accidents rather than to assess the blame for those that have already happened.

We have seen in recent years a change in this philosophy in that the railroad and the highway people are now jointly exploring the grade crossing problem in an effort to solve that problem for the benefit of the public in general rather than each disclaiming blame. We are pleased to see this cooperation and fully recognize that problems can be solved only with such joint efforts. We firmly believe that no segment involved in an accident can disclaim responsibility until it had done everything possible to prevent such accidents from happening regardless of who might be least at blame or most at fault.

The third requirement is that the Safety Board shall review on appeal, the suspension, amendment, modification, revocation or denial of any certificate or license issued by the Secretary or by an Administrator. This has no effect in railroad transportation since there are no certificates issued by the Secretary or by the Administrator. We do, however, receive about 10 appeals per year from seamen, and about 200 per year from airmen.

Next, we are required to make public all reports, orders, decisions, rules, and regulations issued, plus every recommendation made to the Secretary or to an administrator, every special study conducted, and every action of the Board requesting the Secretary or an administrator to take action. In our report on a railroad accident investigation, we make recommendations to the administrator, Federal Railroad Administration, and the industry as we deem it appropriate—always with an eye toward safety. I shall discuss this more fully later on.

The fifth requirement is that we shall report to Congress annually on the conduct of our functions under the Act and on the effectiveness of accident investigations in the Department, together with such recommendations for legislation as we may deem appropriate. This requirement also obviously is of interest to the Federal Railroad Administration which, of course, conducts accident investigations in the railroad mode. We have directed a letter to the Secretary of Transportation concerning the shortcomings of FRA accident investigations and we have made recommendations to overcome them.

The last of our required functions I shall discuss subsequently.

The first of our authorized functions is that we may make such recommendations to the Secretary or Administrator on the basis of the exercise of our functions, powers, and duties which, in our opinion, will tend to prevent transportation accidents and promote transportation safety. A by-product of our normal proceedings in determining the cause or probable cause of a railroad accident is to make recommendations which, in our opinion, will tend to improve transportation safety. Although the Board has no authority to regulate nor power to enforce, we believe that the authority to recommend together with the requirement that such recommendations must be made public is a powerful instrument in the safety field — assuming, of course, that our recommendations are sensible and well founded as we intend them to be. Note that our recommendations to the FRA are simply that—recommendations. He need not adopt them, but his reply also becomes part of the public information previously mentioned.

The fact that we have no authority to require acceptance of our suggestions in safety matters has been of concern to the Committee on Interstate and Foreign Commerce of the House of Representatives. In response to a request from that committee to report on the Board's relationship with FAA. The chairman said, "(the Board) is positive that the degree of acceptance by the FAA of our safety recommendations . . . demonstrates both the high quality of the recommendations forwarded and the quality of the response by the Administrator of the FAA. . . . Should the day ever come when the Board has made a safety recommendation deemed vital to aviation safety and no action is taken, we would not hesitate to report this matter to the Congress and, more specifically, to your Committee." This procedure is not, of course, confined to FAA but could be applied in any mode. Our chairman recently responded likewise to a similar question asked by the House Appropriations Subcommittee.

Second, we may conduct special studies on matters pertaining to safety in transportation and the prevention of accidents. We have made a special study in regard to vehicle crash cushion and deflection devices for locomotive front-ends and a special study on system safety concerning the Office of High Speed Ground Transportation.

Next, we may insure that, in the cases in which we must determine cause or probable cause, the reports of investigation adequately state the circumstances of the accident involved. This authority speaks for itself. It says simply that we have authority to insure that the reports of accidents are adequate. We may initiate on our own motion or conduct rail, highway, or pipeline accident investigations as the Board deems necessary or appropriate. You will note that this authority pertains only to rail, highway, and pipeline. We have no authority to investigate a marine accident. In these three modes, we select carefully only a few of the hundreds of accidents each year.

We may make recommendations to the Secretary or Administrators concerning rules, regulations, and procedures for the conduct of accident investigations. This likewise speaks for itself and its relation to FRA is obvious. As I have previously stated, we have made recommendations to FRA concerning accident investigations.

We may request the Secretary or Administrators to initiate specific accident investigations or conduct further investigations as the Board determines to be necessary or appropriate. We may arrange for the personal participation of members or other personnel of the Board in accident investigations conducted by the Secretary or Administrators in such cases as we deem appropriate. As I said earlier, someone from our Board usually proceeds to the site of major railroad accidents. Ordinarily an investigation is begun by FRA personnel; if we

should decide to declare it a major accident we then take over the investigation and follow it by a public hearing.

We may request from the Secretary or Administrators notification of transportation accidents and reports of such accidents as the Board deems necessary. We have made arrangements with the Administrator, FRA, whereby we receive notification of railroad accidents as they occur.

So much for those powers authorized. And now let me talk briefly about the last of our requirements. The law states that in the exercise of our functions, powers, and duties, we shall be independent of the Secretary and the other offices and officers of the Department. This requirement does not actually affect the FRA, but it is worthy of note since I find it almost completely misunderstood wherever I have been. Even among attorneys, who should be fully aware of our independence, it is either not understood or not believed; but our mission was well described by former President Johnson when he said that our "sole function . . . will be the safety of our travelers." He also said the Board will "review investigations of accidents to seek their cause . . . determine compliance with safety standards, and determine the adequacy of the safety standards themselves." Senator Magnuson said the Safety Board is "the Supreme Court of transportation safety." We have our own personnel department and authority to select and discharge employees, and our annual budget is prepared and presented separately from that of the Department. We have in fact been independent during these first two and one-half years of our existence.

One may properly ask what is the problem that concerns our Board. Reduced to a table, our problem is:

Total accidental fatalities 1968, all causes:		113,169
Transportation fatalities		
Motor vehicles	53,654*	
Aircraft	1,725	
Ships and boats	1,706	
Railroads	2,283	
	59,368	

*25,000 through misuse of alcohol.

Another way of thinking about the deaths on our highways is that every year we wipe out a segment of the population larger than that of the entire U. S. Coast Guard; or that the number of people killed on the highways represent a fatal crash of one completely full 727 jet aircraft every day; or each ten minutes two people are killed, 200 are injured, and there is a property loss of $380,000; or that in 1968 there were 13.7 million accidents on the highways, 53,654 people were killed, 1,900,000 were injured, and a total of $10.7 billion were wasted.

This, then, is the problem in brief: the loss of life in transportation accidents, together with billions of dollars of property damage, plus untold injuries and subsequent loss of earning power.

Our philosophy is: "Each segment of the transportation industry should be as free as possible to determine its own pattern of safety activities so long as it keeps its own house in order." Compare this with the regulations published in Executive Order 10173 for Coast Guard port safety which reads: "Nothing contained in this part shall be construed as relieving masters, owners, operators, and agents of vessels or other waterfront facilities of their primary responsibility for the protection and security of such vessels or waterfront facilities." The Rules and Regulations of FRA reflect, in certain parts, the same philosophy. The railroad company is held responsible, in Part 230, for the general design, construction, and maintenance of locomotive boilers and certain locomotives propelled by other than steam power, for efficiency and safety purposes.

In the future we plan to carry on with our current activity, i.e., to continue to investigate civil aviation accidents; to participate in or conduct the investigation of catastrophic accidents in the other modes; to determine the probable cause in all major cases; and to seek ways to prevent future accidents.

Let me emphasize at this point an important characteristic of the Board. We have made recommendations for immediate corrective action to the Administrators when deficiencies are suggested to us by facts at hand. We do not wait for the completion of an investigation or public hearing or a final report before we act. Once a fact relating to safety improvement is adduced in an investigation or from any other source,

we move with deliberate speed. We expect, of course, to continue to make recommendations to the Secretary and to the operating administrators when potential safety problems are found.

Our Board has been aware from the outset that no amount of searching through wreckage is an acceptable substitute for accident prevention. Our investigation at the scene of an accident and our conduct of a subsequent public hearing are useful as parts of the fact finding process. But we are also fully aware of the fact that accident prevention will be accomplished only through the cooperative efforts of all of us who are concerned with the problem—management, labor, and government. We applaud the accomplishments and recommendations of Secretary Volpe's Task Force of Railroad Safety and, finally, we look forward to working with you more in accident prevention and less in accident investigation.

REMARKS

By REGINALD N. WHITMAN
Administrator, Federal Railroad Administration, Washington, D.C.

We have only limited responsibility for railroad safety. Our authority covers signals, brakes, locomotives, and such safety appliances as handholds and ladders. Most of the laws providing for these regulations were passed in the early 1900's. Needless to say, they are outmoded, limited to particular hazards, and contain broad gaps.

Over the past several years, there has been a steady increase in train accidents, with derailments the most significant factor. In fact, the increase in accidents between 1963 and 1968 amounts to 66 per cent—an average monthly increase from 400 in 1963 to 669 in 1968.

Obviously, the problem has become acute, particularly since some of these accidents involve hazardous materials. Greater industrial uses of these materials has naturally led to the handling of more cars carrying chemicals by the railroads, thus increasing the potential for this type of accident. The overall number of employee injuries and fatalities has declined somewhat, but so has the number of employees. So employee safety in the railroad industry is, at best, static.

While statistics can't tell all of a story, there is one statistic that is meaningful: ninety-five per cent of all railroad accidents result from causes not subject to control by the Federal agency charged with the responsibility for promoting railroad safety.

The rail safety problem has become a critical public issue—one only has to look at the hearing record made before Congressional committees last year and as recently as yesterday. I think the tone of these hearings can be summed up very briefly: The public and the Congress want action!

Thus, the basic philosophy behind the railroad safety bill submitted to the Congress in October by the Department of Transportation is that broader authority will permit us, through the regulatory process, to get at the hard core of the railroad accident experience. Perhaps even more important than Federal regulatory authority however, is the fact that the proposed legislation would pull together the efforts of everyone concerned—the states, the Federal government, labor, and the industry itself—to provide for greatly improved safety practices. This is possible because, in a sense, the bill is the result of a joint effort.

Last April, Secretary of Transportation John Volpe appointed a special task force to look into all aspects of railroad safety and to recommend solutions. I was asked to be its chairman, and membership included representatives of railroad management and labor, and the state regulatory commissions. Our report to the Secretary provided the springboard for the current legislative proposal.

Basically, the bill follows the task force recommendation that the Secretary of Transportation be authorized to prescribe rules, regulations, and standards as he finds

necessary for all areas of railroad safety and to conduct railroad safety research. These would include safety standards for construction and performance of track, roadbed, and rolling stock, as well as qualifications of employees.

One major section of the bill covers transporting of hazardous materials. It calls for the Secretary to set up a round-the-clock central reporting system which could provide information and assistance in emergencies. This system would also make possible an accelerated review of all aspects of hazardous materials transportation. The proposed control center would be set up to assist in accidents involving all modes of transportation.

Another key area to be covered by the proposed legislation is that of grade crossing safety. It is one of our most complex problems, not only because of sheer numbers but because of the high fatality rate in grade crossing accidents and in the enormous costs in protecting or separating them. In grade crossing accidents reported to the FRA, for instance, the injury rate is almost one for every accident and the fatality rate is one in every two accidents. This is somewhat overstated because of Federal reporting rules, but the severity rate is extremely high by almost any measure. Also the rate has held steady for ten years, despite the gradual decrease in the number of grade crossings and a substantial decrease in total train miles. The tremendous increase in motor vehicle miles is a key factor.

The bill would provide for a one-year study into the problem. The results should help us to establish guidelines based on the hazards which, in turn, will help us to commit our resources to common sense solutions.

Basic research is another area of vital importance if safety is to keep pace with technological innovation. This legislation would authorize the Department to begin an immediate research program into the many unexplored problem areas of rail safety. For the first time, the Federal government would be able to couple rail safety research with regulation. This, to my mind, is an eminently logical step, for how can we produce effective regulations if we don't know why the accidents occurred?

The railroad industry, faced with continuing financial difficulties, rising costs, and increasing competition, simply doesn't have the resources to put into research on any large scale. And I personally see no reason why the burden of extensive research should be theirs. We are conducting some modest programs at the present time, but we haven't had the funds to carry out any large-scale projects. With this new bill, we should be able to open many new safety doors.

Provision has also been made for effective implementation of a bill of this scope. As I said earlier, this bill is largely the product of a joint effort. In order to continue this cooperative approach, the bill proposes establishment of a Railroad Safety Advisory Committee made up of representatives of management, labor, the state regulatory commissions, and the public. Its functions would be, in the language of the bill, "to advise and make recommendations to the Department in the development of safety standards and concerning railroad safety generally."

In addition, the legislation specifically encourages maximum cooperation between the Federal government and the various state governments in order to secure railroad safety in the most practicable and economic manner possible. To do this, the Secretary would be given the authority to enter into agreements with the states authorizing them to conduct railroad safety programs on his behalf. Also, Federal funds would be authorized to assist the States in providing inspection services and other functions which may be required in the implementation of rail safety programs.

The goal in our relationship with the states is to obtain uniformity in safety programs, not to become enmeshed in a Federal-versus-state conflict over competing programs. In short, we are faced with the bare facts that indicate only a nationwide program will meet the nationwide problem head on.

All of us at FRA hope to take advantage of the knowledge and expertise of people who are the real professionals in rail safety, who were working on promotion of safety long before it became fashionable.

Railroad safety is but a small part of the total safety picture, but a very important part. The smooth and safe flow of rail commerce is a major economic consideration. The safety of citizens as affected by ship-

ments of hazardous material by rail, as well as safe working conditions for railroad employees, demands that a major effort be made by all to reverse the present accident trend.

We feel very strongly that the industry, its employees and government bodies, as the regulatory agents, must come to grips with the problems. We must act now. The solutions must result from joint concern and joint action by both industry and government. The beginning is in sight; let us hope that concrete results aren't too far behind.

COLLECTING ACCIDENT STATISTICS

By JOSEPH MUSSELWHITE
Chief, Current Reports Branch, Bureau of Railroad Safety, Washington, D. C.

The provisions of the Accident Reports Act of 1910 require each railroad to make a monthly report, under oath, of all collisions, derailments, or other accidents resulting in injury to persons or damage to equipment or roadbed arising from the operations of such railroad under such rules and regulations as may be prescribed by the Federal Railroad Administration. This report shall state the nature and causes of the accidents and the circumstances connected therewith.

These reports are filed in the accident reports branch of the Bureau of Railroad Safety where they are examined for completeness and consistency, classified by class and type of accident, and tabulated. A regular series of monthly, quarterly and annual statistics based on these reports is published by the Bureau.

The accuracy and completeness of these statistics, the extent to which they can be used, and their value to the industry and the Federal Railroad Administration hinge largely on the accuracy and completeness of the reporting. Occasionally some carriers are more interested in making their statistics look good than they are in making them accurate. In this connection, a few appear to make an effort to keep from reporting even obviously reportable accidents. Such a practice is definitely to the disadvantage of the other carriers and certainly not to the advantage of the carrier which renders the report.

This point brings up another function of the Bureau: the continuous interpretation of the reporting rules and regulations, on the basis of information furnished by the carriers, as to the reportability of certain accidents. Many of the accidents in question are borderline cases and there may be an honest difference of opinion or judgment as to their reportability. In other cases, however, there is obviously an intentional misinterpretation of the reporting rules. Unquestionably, the accident reports and statistics are of great value to the carriers in determining the nature, causes, and effects of railroad accidents. To make them valuable requires the complete cooperation of each reporting officer, consistent and complete reporting under the effective rules, and an honest effort on the part of everyone connected with accident reporting to do the best job possible.

Only by knowing what happens, and why, can the railroads carry on their constantly changing safety program. Railroad representatives and representatives of manufacturers of railroad equipment are keenly interested in accident statistics. Persons doing engineering research often request these data long before they are available. Some even make detailed surveys from the Federal Railroad Administration's accident reports at their own expense.

We would like to help promote a good safety program or at least supply dependable statistics on which to build such a program. If sufficiently clear information is not supplied on the "T" reports to enable a proper classification to be made, what is there to do but a lot of calculated guess work? Do we want guess work?

For years our Bureau has sent out requests and instructions in an effort to have reports properly filled in. Many railroads

have complied. Some have not. In such a situation, how can we arrive at uniformity? Let's review some examples of actual 1969 "T" reports for which we requested further detailed information. First, we give you the original information submitted for item 23 on "T" form, followed by corrected information.

1. Original — engine pulling loads from track, engine and two cars derailed account of loose wheel. Corrected — car buckled and struck road crossing, causing derailment.

2. Original — engine shoving loaded ladles when rail broke, causing ladles to derail. Corrected — road bed had settled under track because of nearby excavation. Rail broke under load. (Note — nothing said on corrected copy about a derailment. First report, no cause; second report, no result).

3. Original — engine derailed due to broken switch point. Corected — engine derailed because of worn switch point.

4. Original — engine shoving loads through track when car and three and four truck of engine derailed account of rail turning over. Corrected — engine shoving cars when car and engine truck derailed because of rail spreading under car.

5. Original — engine and trailer derailed account of spread track. Corrected — light engine derailed because of wide gauge.

Don't get the idea we are trying to place the blame, this type of problem should have been corrected years ago. Perhaps we should have worked more closely with your committees; not to see just what should or should not be reported, but to get more reporting roads following the same guidelines and giving a reasonably true account of what happened and what caused it to happen. If this had been done, we probably would not be involved in our present changing of reporting forms, in an effort to compile meaningful statistics. I sometimes think that if as much effort were used in preventing a recurrence of an accident as is spent in an effort to get one deleted from our statistics, the safety picture would improve considerably.

We receive approximately 50 late "T" reports per month, many without a reasonable explanation as to why they are late. Realizing we have been put on the pan for always counting these late reports against the carrier's record and then, in some instances, advising the carrier that it is too late for deletion of a report that has subsequently been determined not reportable, we offer this explanation and solution.

When late reports come in, we simply add them to the current month being processed. When you call for a deletion, we must contact data processing, across town, and arrange for deletion from the following cumulative period being processed. Sometimes they delete and sometimes they don't. We are at their mercy because of the time involved and access to the computer.

Now, for the solution. We feel that 30 days, in addition to the month in which an accident occurred, is ample time to secure proper information (except in extreme or unusual cases). Extreme does not include train accidents involving thousands of dollars where everyone on the road knows about it except the reporting officer. Solution — get the reports in on due date.

After current rules have been in effect for eight or more years, we should have a reasonable approach and understanding as to reportability of most accidents, actual or alleged. However, something is wrong. We get a goodly number of requests for decisions where there is honest doubt and honest considerations. These we welcome and are always ready and willing to discuss, but when a reporting officer writes than an employee stepped off a moving car at 15 mph in the usual manner, no stones, no holes, nothing unusual in procedure, except the employee broke his leg or ankle or fractured a disc in his back, etc. — no accident — and asks, "Is it reportable?" we naturally question the sincerity of such questions.

We could go into many examples if time permitted. This would not solve the problem. How can we get every reporting officer from every road to use a reasonable approach and try to assist in recording a chronology of accidents involving railroad operation that can be used as a tool to reduce such accidents? We do not have the answer. You could supply the answer.

At this point I would like to refer to an excerpt from an exchange of ideas that I had with one of your more dedicated safety men, Roy P. Hamilton, of the 'Frisco Railway, now retired: "A safety job is never completed; you cannot become enthused today and forget it tomorow and think the

job can be accomplished, there is no gain when you make a safety record on paper. To put it bluntly, who are we fooling except ourselves when we withold useful information?"

Many of you are concerned with access to "T" reports by outside parties under the Freedom of Information Act, Title 5—US Code 552, 49 CFR part 7. This information is available when the stipulation is met that information will not be used in violation of Section 4 of the Accident Reports Act. Some, but not many parties are using this method to acquire copies of "T" sheets. I think we should realize, though, that this should not be considered a large problem. In matters involving litigation, avenues are open to permit a review of carrier records by opposing factions without resorting to "T" sheets from our department.

Our Bureau is always happy to cooperate with representatives of the industry and to assist them to the best of our ability towards the improvement of safety. In turn, we hope that we will continue to receive your assistance and cooperation.

REGIONAL CONFERENCE

By GUY R. McCONNELL
Regional Director, Bureau of Railroad Safety, Chicago, Ill.

To maintain an effective information and education program for its field staff, the Federal Railroad Administration uses a regional conference program. This type of program had been used by the Bureau of Railroad Safety for several years prior to our transfer to the Federal Railroad Administration.

Under the guidance of Director Rogers, the seven regional directors were given the responsibility of conducting a conference with instructions to develop a program that would be interesting and effective.

In planning a conference, there are three fundamentals to consider: 1. time; 2. location; 3. agenda.

The time element, both the time of year and the length of time must be determined first. The time of year can usually be arranged to suit specific needs. The length of time is determined by the agenda you have in mind.

In the past we conducted our conferences in the regional headquarters office. Since we were trying to improve our conference, we decided that the location should be changed. When we began to look for a suitable place, we found there were a number of conveniently located establishments available which catered to this type of meeting. These were live-in types that had all the facilities. After making a site selection, there is usually very little difficulty in getting a suitable time or, on the other hand, time selection may have some bearing on the sight selection.

Having chosen a site and selected our dates, the next project was the agenda.

In making up our agenda, we found our real opportunity to improve our conference. The first step was to solicit questions from the field staff. What did they want from a conference?

For the first conference we put together a program we felt would be interesting and informative. From the Washington staff, we called on the administrator, the director, the chief counsel's office, the administrative services officer, personnel officer, each division chief, and the individual branch chiefs. These people were able to give us the information we needed to understand, not only our overall program but also the technical programs of each branch. Since this was their conference, the staff was encouraged to ask questions.

Up to now we had not changed much from the old format, however, I am sure that the Washington staff did their home work very well and had made their programs quite interesting. But this alone was not enough to revitalize the program. This left us only one way to go and that was to the industry. We called on representatives of

the railroads and the manufacturers. In every instance, our requests have been enthusiastically met. We have had management representatives, chief mechanical officers, as well as many others; we have had manufacturers who have shown us their newest products and others who have furnished us with technical speakers. And, since our people are working everyday in the yards, shops, and enginehouses, we have had railroad safety supervisors put on safety programs to remind us of the ever present hazards on the railroads.

As a result of the new approach to our conference program, we now have our staff of inspectors looking forward to next year. We have requested them to give us a written evaluation of the conference, and it now appears that next year our biggest problem will be one of choosing the most sought after subjects, rather than trying to gather up enough people to make a program.

One other aspect is the availability of a wide variety of movies, film strip slides, and other visual aids available for these programs.

In summary, we have concluded from the response of our people that our conferences are successful as an information and education program, and that there are several factors which contribute to this success. I do not necessarily give them in order of importance, but they are:

1. Site selection.
2. Industry participation
3. Catering to the interests of the participants as indicated by their questions and suggestions.
4. Keep the program alive and moving.

Since the industry has contributed so much to making our conferences a success, we in turn, would like to make our people available to assist you with your staff conference, or your safety program, should you so desire.

THE MEDICO-LEGAL APPROACH TO ACCIDENT PRONENESS

By MAX P. ROGERS, M.D.
Chief Surgeon, Southern Railway System, Washington, D.C.

Accident proneness is like poverty and, as the Holy Writ says, "The poor ye shall have with you always." The industrial world has always had the accident prone employee on its hands, and we always will. The problem of accident proneness has been inadequately studied. Too little time has been spent on this problem and what can be done about it.

Before proceeding we should have a definition of 'accident proneness." The First Division of the National Railroad Adjustment Board in a decision in 1964 defined it as follows:

"An accident-prone employee is one who has demonstrated a propensity to get hurt in performing service in his occupation under conditions where successive injuries could have been avoided if the employee had exercised more care or foresight or had possessed better physical or mental traits, such as faster reflexes and better neuromuscular coordination. Evidence suggestive of accident-proneness would include a rate of accident frequency and/or severity that is significantly higher for said employee than the rates which in the light of past experience might reasonably be expected of him."

Therefore, in a discussion of the medical-legal approach to accident proneness we need to have a basic approach to determine if an employee is accident prone. In this basic approach, it seems to me, there are two general and broad divisions:

(1) What is the medical background of the employee?

(2) In the event of multiple injury history, is there evidence to show:

a. Whether the subject is personally accident prone?

b. Whether the work environment contributes to the multiple accidents?

c. Whether there are unsafe habits of fellow workers which contribute to accidents?

Let us go back to the first, or medical division of this subject. Here it seems to me that this subject itself has two divisions, pyschologic and physical.

In reviewing some of the available literature on this subject, I find that information on the psychologic background of accident proneness is very wordy and sometimes voluminous, but absolutely inconclusive in every respect. It has been long thought that accident prone individuals should show some sort of common denominator, but this has not been found. Even though intensive psychological testing has been done by many researchers, it has been impossible to demonstrate a single factor or group of factors that are common to any representative number of people with a long record of accidents and injury. Such testing has included sociological, environmental, and personality trait studies, but still no common factor has been discovered. This lack of a definite answer has caused to be built up a gradual reluctance on the part of some managements to provide pre-employment psychological testing, and in some cases some pre-employment testing programs have been discontinued.

With the above in mind, we can only come to the conclusion that in studying accident prone individuals, at the present, we do not find a great deal of help from psychological testing per se. However, I do not feel we should disregard the psychological studies entirely. Although we have little assistance in the field of personality and character trait studies, we can find help in psychometric testing as concerns motor skills and intelligence quotient studies. If such studies are abnormal they certainly will add to, if not be diagnostic of, a file of accident proneness, and will contribute to the exploration of the second component of the medical background of accident proneness. In other words, a common denominator can sometimes be found in the record of an individual that can be helpful in examining his case.

The second or medical component of accident proneness is basically much more clear but, on the other hand, has deeper ramifications. Industry has long been concerned with equating job requirements with physical ability. Most industry will now require a pre-employment physical examination, and the physical standards for the various job classifications have been clearly set forth. This is one step toward the prevention of accident proneness, as we certainly would not hire an individual with a physical disability to perform duties which would require the use of all faculties. Therefore, it then totals that we are far more successful in the prevention of accident proneness through the medium of a good pre-employment physical examination than we are in the field of pre-employment psychological testing.

However, once a carrier has an employee on its roles, we are faced with an entirely different situation. If we have an employee with a long multiple injury record which cannot be prejudiced by a pre-employment exam, just what is the situation? Here we often find circumstances of repeated injuries which contribute to a physical condition which would predispose to other accidents.

Let me give you an excellent example of this. Let us say we have a switchman who suffered a low back strain while throwing a switch. He was seen by a physician who rendered conservative treatment and he recovered. Subsequently, in repeated episodes, he strains his back again. Later, in x-ray studies, it is found that this employee has developed degenerative disc disease in his low back, with recurring lost time because of low back pain. This man is then accident prone because of physical susceptibility. If the carrier continues to employ this man in the presence of his low back disease, the carrier is then held responsible for aggravation of a known and pre-existing disease, in case there is another injury.

It is unfortunate that the carrier is not required by statute to insure the employment of physically qualified people, but once employed, the carrier is required to provide a safe environment and to be sure that an employee is not called upon to do specific job for which he is not physically qualified.

It should be shown then, that because of this man's low back condition, it would be hazardous to him to continue in this position and that he would be accident prone. This position has been taken and has been held by the Railway Adjustment Board in an

epoch making decision concerning the Brotherhood of Railroad Trainmen vs. Duluth, Missabe, and Iron Range Railway where it was held, among other things, that "the claimant, because of his physical condition, would be more accident prone in the future than he had been in the past." This decision has set a great precedent in the handling of accident prone employees. (Award 20438, Docket 38821).

Thus, it seems that we are only one-half successful in the study of accident proneness as concerns before-the-fact information as based upon the conclusion that certain medical findings indicate the possibility of accident proneness in a given individual. However, industry has more of a problem in the second large division of this subject—that is, as it concerns after-the-fact of a multiple injury history.

In this regard, we must develop some sort of a line study or review of the record of an individual who has a voluminous accident record. This study should contain the following points as a checklist: recency; frequency; severity;

In some respects, the recency factor is not as important as the others, but should be studied and related to the other factors. Also, the recency factor is important to argue against charges that management has in the past condoned or tolerated the numerous accidents of an employee, and that nothing in particular was done until possibly the employee has filed an FELA action. If we can prove a preponderance of accidents during a recent period of employment as compared to a similar period of previous employment, we are then on much better ground to substantiate accident proneness.

Of course, the frequency factor is the real key to accident proneness, provided the frequency rate is geared to other correlated findings. I refer here to the frequency of accidents in a certain employee as related to other employees under the same conditions. The more numerous the statistics of a comparative nature, the more absolute the basis for declaring an employee accident prone.

In determining this correlative frequency factor, the accident rate of a given employee should be compared to:

1. The rate of other employees in the same grade and service in the same location.
2. The rate of employees in other locations in the same grade and service.
3. In the same service but for other grades, such as the employee above and below the suspect in seniority.
4. Comparison with similar reporting from other railroads of this country.

When the above factors are determined, the accident rate of an accident-prone individual will clearly occur as a peak on plotting the statistics on a graph. However, one must be careful to show that all such employees, generally speaking, were exposed to essentially the same work hazards as other employees, and under essentially the same conditions.

Now that the basic premises have been established, what is the procedure, from the medical-legal standpoint, of approaching the problem of an accident prone individual?

First of all, we should do nothing concerning an employee who is working and doing well at the present time. We cannot very easily go through medical records to find those employees who have had a lot of accidents and then take them out of service. However, when a file comes across my desk that is voluminous, it immediately throws up a red flag to me. This means purely and simply that this man has had a lot of medical attention. The file is then examined to determine if the thickness of the file is due to accidents. If so, the following procedure is followed:

1. The accidents or injuries are listed chronologically with dates and diagnoses.
2. The list of injuries is then judged from the standpoint of recency, correlating the rate of accidents per time period.
3. If there have been many recent injuries, the pre-employment physical is then checked to see if there are any pre-disposing factors to such injuries. Frequently, one will find the history of a previous disability on the accident report which was denied on the pre-employment history.
4. The Personnel Department is then contacted to determine if there were any abnormalities in the pre-employment psychological and trait testing.
5. The local supervisory officer is then requested to furnish details as to the employee's reactiveness to his job environment and his attitude toward his fellow employees as well as his supervisor.

6. Frequency rate is then studied (the method being determined by how records are kept—either by the safety department, operating department, or medical department) as to the number of accidents occurring in that particular grade and service under similar circumstances.

7. Severity, if a factor should then be considered.

When the above material and information has been gathered and evaluated, the medical officer should then call for a joint conference with Labor Relations and Personnel. As a result of this meeting, there should be a consensus as to whether the employee under consideration is accident prone and what steps should be taken. If it is found that an employee is accident prone, he should be held out of service, notifying him of this action and the reasons therefore, with proper notification to the employee's union representative.

Such a procedure sounds ideal and easy, but it is not always so, and we all have to learn to live with decisions which may be contrary to our own. However, accident proneness is a serious and costly condition, and employees who are accident prone can and have been removed from service. Proving the status of accident proneness calls for a logical step-by-step approach, combining the efforts of the Medical, Personnel, and Labor Relations Departments.

ASPECTS OF SAFETY

By W. FINLEY
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We are interested in accident prevention first, to prevent human suffering and, second, to save the money that accidents cost. We all know the cost of accidents is in the hundreds of millions of dollars annually and getting higher each year. This, despite the progress our industry has made in safety. So it appears that a good safety record (by present day reporting rules) does not necessarily mean a low cost claim record nor, for that matter, happy employees.

Consider what the medical-legal impact does to your safety programs. Today's labor market has forced some railroads to lower the standards of qualification, and we find ourselves hiring men who have less than the physical fitness required for the job and who are not mentally alert. We, of course, don't expect to hire all college athletes, but at the same time we expose ourselves to large potential claims when we hire people with known physical defects. The latest medical aspect in the litigation field is the claim of *neurosis*. There are at least 140 different kinds of neurosis, but the kinds we are most often faced with are conversion reaction, conversion hysteria, and traumatic neurosis. The people most likely to suffer a neurosis are the ones who have had a meager education and are unable to cope with the reality of their accident. This is the basic problem (according to the psychiatrist) in almost every case. So, when we lower our standards we create our own safety and claim problem.

Perhaps to quote a court instruction to the jury hearing a case involving physical fitness will give you a better idea of just what the railroads are faced with. In the case of John F. Wyler v. The Southern Pacific Company the court said, "Under the Federal Employers Liability Act the word injury may include sickness, and it is negligence for a railroad company to assign a sick employee of whose illness it knew or should have known to tasks for which he is by reason of his condition unfitted, and the employee may recover the damages from the railroad if such assignment plays any part in proximately worsening or aggravating such condition." What we are really talking about here is not only related to sickness but to the physical fitness of the man when we hire him, as well as when he reports back to work following either an on the job injury or an off the job injury. The law places a duty on the railroads to see

to it that each man is physically able to do the job you require of him, and if you fail to exercise due care in seeing to his physical fitness, the railroad is responsible for all damages flowing from that failure.

There is another area which involves fitness, one over which we have very little control—it's called *moonlighting*. Here, we have a man holding two jobs. In one way I must admire those who put forth the effort required to work two jobs, but on the other hand I can tell you from experience that a man who puts in eight hours on the railroad and then goes elsewhere and works another six or eight hours is not getting the proper rest, and it is difficult for me to believe that he is not more prone to injury than the man holding just one job. We presently have a case pending that will give you a clearer picture of the problem. Mr. X, an employee of one of my roads, works his regular assignment from 7:00 A.M. to 3:00 P.M. each day, five days a week, and he also holds a job tending bar from 8:00 P.M. until 2:00 A.M., six days a week. The result is, this man has been involved in more than 90 incidents over the past 20 years and has now brought suit against the railroad for two injuries, claiming not only his lost wages from his railroad job as damages but also his lost wages from his bar tending job. Not only does this place us in a bad position from a claim standpoint, but his lack of proper rest, I am sure, was a factor in his poor safety record. So not only must we hire people who are physically fit, we must see to it that once they are in our employ they stay physically fit.

As you can see, the medical aspect does present some real problems, but despite that I feel the real culprit is the legal aspect—namely, the Federal Employers Liability Act. For those of you who do not know, the Federal Employers Liability Act is an act of Congress approved in 1908 and amended in 1939, which dictates the system by which the railroad employee is compensated for his injury. As part of the FELA we also have the Federal Safety Appliance Acts—the now outmoded Ash-Pan Act and the still existing Boiler Inspection Act. The Federal Employers Liability Act is based essentially on the doctrine of common law tort or negligence, and recovery is entirely through the courts. So in theory a man must be able to prove negligence on the part of his employer in order to get paid for his injury. This is not the case, however, if he is injured as a result of a safety appliance defect or a violation of the Boiler Inspection Act. If either of these latter acts are involved in proximately causing his injury in whole or in part, he does not have to prove negligence and can collect his damages by proving the defect caused his injury.

While only a limited number of injury cases reach the courts, the more spectacular (usually cases involving amputations, deaths, etc.) are among those which are widely publicized and have produced astronomical verdicts, the latest one being $800,000 for a double amputee in the Ohio area. It can, therefore, be readily understood that the system by which railroad employees are compensated for their injuries generates a great deal of rancor and distrust and destroys much of the mutuality of interest and objectivity on the part of management and the employee in the safety movement. It creates a tremendous moral problem and places a great strain on loyalty. Company spirit, which is so important to the success of railroading, is diminished, if not totally destroyed.

Even the cases which do not reach the courts are surrounded by a quasi-legal atmosphere which results in dissatisfaction on the part of both the company and the injured employe. The FELA breeds ill will between employee and employer and plays into the hands of the ambulance chasers. It fosters dishonesty and chicanery on the part of employee claimants, and the legal and medical professions as well. It tends to penalize honesty and reward dishonesty. Injured employees receive grossly varying amounts for comparable injuries; frequently the less severely injured may receive a far greater amount than the more severely injured.

Another and perhaps more vital area is equally affected by the FELA accident reporting. The name of the game is concealment; that is, concealment of fault by both the employee and the employer. The employee is reluctant about providing all the facts surrounding his accident, especially those involving man-failure, for he knows very well that any negligence on his part is going to weaken his case against the com-

pany, and each of his fellow employees who are called upon to give facts surrounding the accident take the same position for fear that the next time the situation may be reversed, and they will be the ones looking for a way to prove negligence on the part of the company and must rely to a great extent on their fellow employees. The company, on the other hand, shows the same degree of reticence in the preparation of reports of accidents to both the Department of Transportation and the various state agencies and are reluctant to show the cause of the accident if other than man-failure for fear that the reports might fall into the wrong hands and be used against them. Accident investigations should be designed to establish the cause of the accident in question but should not be a contest or a game to see who can prove negligence on one or the other. There should be a means of pinpointing the causes and pointing the way toward corrective action, which under today's rules and regulations are sometimes delayed until the claims are settled or have been adjudicated. All of us are concerned with the reportability of accidents, because this is the measuring stick used to determine whether or not the railroad has a good safety program and a reasonably safe operation. This, in my opinion, is not the correct measuring stick and should not be the total determinant as to whether or not the Safety Department of the railroad has a safe operation.

There has been so much written about accidents, injuries, and accident prevention as to create the idea that safety deals exclusively with these. For example, the Department of Transportation requires reports of only traumatic injuries, those which result from accidental occurrences. Actually, safety embraces far more than this, and just because an injury is not reportable to the Department of Transportation under the present reporting rules should not be cause for great joy on anyone's part, because some of the most costly claims I've been faced with weren't reportable.

This also seems to be the area where safety and claims start to reach some sort of impasse. Most of the arguments between the two departments seem to arise over reportability. Sometimes, whether or not the injured man should be paid for his time off when it is in question. Some contend that when the Claim Department pays a man for his lost time, the illusion of reportability is created and places the Safety Department in a bad light and may, as a matter of fact, make them consider reporting a case that they may not otherwise report. This is most unfortunate, and I do not believe that paying a man for time lost to get a release and save the expense of answering a summons and complaint should have anything to do with reportability of an accident. Sometimes discretion is the better part of valor, and we pay not because we owe it but because in the final analysis it is cheaper to pay a questionable case of a few days lost time rather than end up before a jury which is almost always going to give the plaintiff something. It is no longer possible in this society to defend a case involving a principle when a corporation is involved, and it is far too expensive.

You have a most difficult job — selling an intangible product for which there seems to be a limited market, not only among the wage earners but in some cases among the supervisors who are the first link of the safety chain. It takes a great deal of integrity on the part of all supervision to maintain a good safety program. Not all of us have that degree of integrity. Some of us fold our tent and silently steal away by settling a claim that on its face looks as phony as a three dollar bill. We have good reasons for paying, and it isn't the fear of getting licked—under the FELA we seldom win.

Some of the cases we have a great deal of difficulty with are the ones involving late reports. I don't mean those cases where the accident isn't reported to anyone; I am talking about those cases where an accident is reported informally by telling someone who for one reason or another doesn't make a written report. It may not be an attempt to hide an accident, but some people believe that if the Claim Department gets involved in making any kind of an investigation, they will stir up a claim when there is none and, therefore, would rather not risk the development of a reportable accident.

I have no desire personally, nor do I believe any other claim man has a desire, to ruin your safety record. But we do have a desire, in fact we have a great need, to have all injury cases reported promptly and a thorough investigation made, for this

is the only way we can protect ourselves and our companies at some future date when the insignificant back sprain turns into a ruptured disc which could easily cost our companies in excess of $50,000, and could prevent the ambulance chaser or the bad doctor from grasping another of our employees and ultimately discarding him to the industrial scrap heap.

The railroad industry is in the midst of great changes—automation, mechanization, and technology advances are some. Paralleling these and of equal importance are the changes in the character of the business and the effect they will have on the method of operation. Actually, everything points to a revitalization and strengthening of our industry. In the process, however, old ideas, customs, and philosophy will fall by the wayside or undergo substantial changes. We need a new approach. The keystone will be flexibility in the safety movement as well as in every other railroad endeavor. Management safety programming efforts must be disengaged from the past, kept pliable to permit molding and remolding to fit the changing patterns of the future. This, I think, also applies to labor, whose efforts to make a safer industry are commendable but seem to be firmly embedded in the past and lacking in the flexibility needed to meet changing conditions. They seem to be pointed in only one direction—safety by legislation, which they apparently view as a cure-all but in reality can only widen the gap between labor and management and government in the field of safety.

THE STATE OF ILLINOIS GRADE CROSSING PROTECTION FUND

By HARRY STERN
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Thirty-four years ago, in 1935, the Illinois Commerce Commission started a new system of keeping records and assembling information with which to make studies of safety at grade crossings within the state. That year, each railroad operating in the State of Illinois (52 in number) was issued a citation requiring, among other things, that it fill out and file forms provided by the Commission, one for each grade crossing of its tracks with a public highway. Each railroad was also required to assign a mile post designation number and railroad line number to each crossing, so that it could be readily identified. On receipt of this information, the Commission started a filing system in which there is a card for each railroad crossing with a public highway known to exist in the State of Illinois.

General Order 44 of the Commission requires each railroad to report every grade cossing accident, giving the time, date, location, number of injuries and fatalities, if any, and type of accident (whether the motor vehicle was struck by the train or vice versa), the type of train, and type of motor vehicle.

The citation also required each railroad to report every accident which had occurred at each of these crossings from 1928 to 1935. These were entered on the proper cards and, beginning in 1935, information regarding every grade crossing accident was entered on the proper card as it was reported. Thus, each card carries a record of every accident which has occurred at that crossing since 1928. Each card also shows the type of protection, if any, provided at the crossing: whether it be automatic bell, automatic flashing light signals with bell, automatic flashing light signals with gates and bell, manually operated gates, or watchman. If a watchman is listed, the hours during which he is on duty are shown.

A study of the information accumulated on these cards showed immediately the crossings that had the highest frequency of accidents. Armed with this information, the engineering staff of the Commission's railroad section has been able to direct its

efforts to the investigation of those crossings which have a combination of high frequency of accidents and high volume of railroad and highway traffic.

The State of Illinois has well over 16,000 highway-grade crossings and only through the fine cooperation of the railroads in providing the required information has it been possible to develop the basic data required.

From the records compiled, it was obvious that something should be done to try to improve safety at these crossings. Grade separations, the ideal solution to the grade crossing accident problem, were being constructed at certain selected locations with Federal funds. More often than not on highways which receive no Federal aid, neither the railroad company nor those maintaining the highway have available sufficient funds to build grade separations. Grade crossing protection in the form of automatic flashing light signals on single track main lines, and automatic flashing light signals and gates on multiple track crossings, seemed to be a more practical approach to the problem. Neither warning lights nor gates seem to prevent the daring driver from risking and sometimes losing his life and the lives of his passengers by fool-hardy attempts to cross the tracks ahead of an approaching train.

In the 1930's the minimum cost for a flashing light signal installation was approximately $1,200, and gate arms could be added for $800 to $1,000 more. Today, the cost of flashing light signal installations will average over $10,000 each, and gate installations up to $30,000 or more, depending upon the number of tracks and the complexity of track circuits in the crossing area.

Prior to 1920, before the advent of large number of motor vehicles, the cost of crossing protection, then largely manually-operated devices or hand flagging, was borne entirely by the railroads. This was not unfair, since in those horse and buggy days highways were not involved in competition with the railroads. However, as everyone knows, when automobiles and trucks became more numerous, they commenced taking both passenger and freight business from the railroads. With the highways becoming competitors with the railroads, it was recognized that the total costs for protecting highway-railroad grade crossings could no longer, in fairness, be charged solely to the railroads, and the concept of cost division between the railroads and the public agency that maintains the highway came into being. In the late 1930's, the accepted cost division in Illinois was a 50-50 split on the initial installation, with the railroads assuming the subsequent costs for maintenance and operation of the signals.

The Federal Bureau of Public Roads soon prescribed a more liberal cost division where Federal highways were involved. Illinois followed suit and commenced paying up to 90 per cent of the installation costs on all state highways, and later the Commission distributed the costs so that agencies other than the railroads paid up to 90 per cent of the cost at crossings on all public roads.

The Illinois statutes have permitted the Commission to close and abolish crossings no longer required by public convenience and where public safety requires the closing. Now, those statutes also obligate the Commission to divide the costs for crossing protection between the railroad and the public agency responsible for the highway involved. Even in the days of low costs for automatic protection, financing was a problem. The greatest difficulty was that counties, townships, and municipalities seldom had adequate funds available to pay their part of the cost of protecting the crossings with roads and streets not on the state highway system. In working with this problem, it was found that the railroads generally were willing to bear a larger part of the cost of protecting certain crossings, if others nearby were, at the same time, closed and abolished and highway traffic diverted to the protected crossings. A great deal has been done, and for that matter is still being done, in this way. The conservative estimate of the total number of Illinois communities involved in such projects where all crossings along a particular railroad were either protected or closed, would now be in the neighborhood of 400.

In the 1950's, secondary roads were being improved everywhere in the state. Many local, county, and township roads were being paved with smooth surfaces conducive to travel at high speeds.

Here was a condition demanding more crossing protection brought about by increased highway traffic and not by anything the railroads had done. In fairness, it

seemed the cost should be borne in substantial part by highway agencies. Yet, we often found counties with the least financial ability to have the most railroad crossings where expensive crossing protection was needed. Because the need for protecting these crossings was a matter of concern for the safety of the general public, the Commission appealed to the legislature for financial assistance with the result that the Illinois Grade Crossing Protection Fund was established in 1955. The legislation provided that the first $25,000 collected from the Motor Fuel Tax recepits each month was to be set aside in the Fund.

With the rising cost of labor and materials, and an increase in the number of requests for use of the Fund, efforts were made to increase the amount of Motor Fuel Tax money set aside each month. In 1959, the Commission was successful in urging the legislature to increase the amount to $50,000 per month, and in 1963, to $100,000 per month.

This money is held by the Department of Public Works and Buildings to be disbursed by them on order of the Commission in the interest of the safety of the "state-wide public." It may be used to pay part of the cost of construction or reconstruction of automatic protection at the crossings, at grade, of highways or streets in county, township, or district road systems and municipal street systems with tracks of railroads as provided for in Section 58 of "An Act concerning public utilities," as amended. Section 58, among other things, authorizes the Commission, after having made proper investigations, to designate certain crossings as extra-hazardous, requiring the installation of appropriate protective devices. At railroad grade crossings of state-maintained highways, the state pays its share of the cost of installing protection from money other than that in the Fund.

In order to make use of the Fund, either the railroad or the public agency maintaining the highway or street must file a petition with the Secretary of the Commission, seeking an order of the Commission requiring the installation of the grade crossing protection at the crossing involved, dividing the cost of installation among the parties and the Grade Crossing Protection Fund. The case must then be set for hearing before an examiner of the Commission. At the hearing the petitioning party must show need for protection of the crossing in question. From the evidence adduced at the hearing, the Commission makes its decision as to whether or not the crossing should be protected, and if the crossing protection is ordered, it distributes the costs among or between the parties, as the case may be.

The percentage of the costs allotted to the Fund varies with the conditions. In many cases, the governmental agency that maintains the highway will be required to improve the approach grades at the crossing. This could involve widening the approaches, so that there would be adequate space for two lanes of traffic over the crossing. Frequently the Commission finds it necessary to order the grade of the highway approaches to be raised to comply with provisions of General Order 138, which states that the highway should be level for at least sixteen inches from the outside of the head of the rail, then ascending or descending at a grade not to exceed one per cent for a distance of twenty-five feet and then, if practically possible, at a grade not to exceed five per cent to the railroad right-of-way, or as far as the Commission has jurisdiction. This sometimes requires a considerable amount of fill and the complete rebuilding of the approaches. The railroad may be required to widen the crossing proper to meet increased width of roadway; if the crossing proper is in poor condition, to rehabilitate it; or to adjust the elevations of tracks to provide a smooth surface over multiple track crossings. In some instances, a crossing is protected in an area where an adjacent crossing could be closed if a short connecting road on one side of the track could be constructed by the responsible highway authority to divert traffic from the crossing to be closed to the crossing to be protected.

Some of the less affluent counties, townships, and road districts need financial aid to build connecting roads and rehabilitate approach grades. In 1967, the Act was further amended to provide for the use of the Fund for reconstruction, alteration, relocation, or improvement of any grade crossings, including the necessary highway approaches thereto in accordance with Sections 57 and 58 of the Act. Section 57, among other things, gives the Commission the authority to require a public utility to install and

maintain protective devices, "... to promote and safeguard the health and safety of its employees, passengers, customers, and the public. ..."

An example of the contribution to safety on Illinois highways by closing of grade crossings and the use of the Fund for crossing protection is Carbondale, Illinois, where the double track main line of the Illinois Central extends through the city. Originally, there were eight grade crossings along the Illinois Central tracks. Before the Fund became available, in 1955, automatic flashing light signals and gates were installed at two of the crossings. In 1959, two crossings were closed and abolished and four were protected with automatic flashing light signals and gates. A portion of the cost of the latter installations was borne by the Grade Crossing Protection Fund.

Our records show that in the thirty-one years prior to installation of protection of the four crossings protected with the use of Fund money, there had been thirty-two accidents in which there were five fatalities and twenty-one injuries. In the ten years since the protection has been placed in service, there have been only three accidents at one of the crossings with one fatality and one injury, and no accidents at the other three.

There are many other such examples. The accident record in all of these cases has been good, but in some not as impressive as at Carbondale. Now, after many years' work by the Commission, only a few Illinois urban communities are left with unprotected crossings along major rail lines.

As of March 1, 1969, there were approximately 16,300 highway-railroad grade crossings in the State of Illinois. Even after the closing and abolition of hundreds of unneeded crossings by the Commission, this is still over one-fourth more than in any other state. Illinois has many more miles of main line railroad than any other state and the volume of railroad traffic handled here is also far greater than any of the others.

Since the establishment of the Fund in 1955, 809 crossings have been provided with modern warning signals, where the new protection was partially paid for by the Fund. Without this help, it is reasonable to assume that very few of these crossings would have been protected. At 323 of the 809 crossings protected through use of the Fund, flashing light signals with gates have been installed. Flashing light signals only, with or without bells, have been installed at 463 of the remaining 486. Flashing light signals with two train indicators have been installed at the remaining 23 crossings. In the orders calling for protection by the use of the Fund, some 244 crossings have been closed.

As of March 1, 1969, $9,200,000 has been set aside for use by the Fund, of which $8,778,096 has been spent on grade crossing installations or allotted to installations pending. The total estimated cost of the crossing protection in which the Fund participated in that time was $15,204,588, of which $6,426,492 was assessed to the railroads, cities, counties, or other public bodies as part of their cost.

The availability of Fund money has made it possible for Illinois to be in a favorable position in the country's over-all safety record. It is estimated that there are approximately 220,000 highway-railroad grade crossings in the continental United States. Illinois' 16,300 grade crossings constitute about 7½ per cent of this total. Approximately 32.5 per cent or 5,300 of the crossings in Illinois are provided with some form of special protection to warn of the approach of trains. For the most part, the protection is by modern flashing light signals alone or in combination with gate arms. The number of protected crossings in the remainder of the states is about 38,000, which is less than 19 per cent of the total number of protected crossings in Illinois.

The effectiveness of Illinois' program of crossing protection, in which the Grade Crossing Protection Fund plays a prominent part, is demonstrated by the fact that while Illinois has 7½ per cent of the crossings in the nation, only about five per cent of the nation's crossing fatalities occur here.

During the five-year period, 1951 through 1955, immediately before the Grade Crossing Protection Fund was established, 645 persons lost their lives in grade crossing accidents in Illinois. During the latest five-year period, 1964 through 1968, this figure had dropped to 577, a reduction of 10.5 per cent over the 1951-1955 period.

In the United States as a whole, during the five-year period 1951 through 1955,

7,228 persons were fatally injured at railroad crossings, and during the later comparable period, 1964 through 1968, this figure has risen to 8,293, an increase of 14.8 per cent notwithstanding the reduction which has been made in Illinois. Even though we feel our record is good, we know much remains to be done.

There is no doubt that the reduction in fatalities at Illinois crossings during this period of greatly expanded automobile traffic on the highways has resulted in a large part from the provision of modern crossing protection made possible through financial assistance from the Grade Crossing Protection Fund.

GETTING THE MOST OUT OF YOUR COUNCIL MEMBERSHIP

By F. J. PARKER
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The only way in which you can get the most out of anything is to know what is available to you. That is one reason they give you a menu in a restaurant, so you know that for an *X* amount of money you can get soup or fruit cocktail, meat and potatoes, perhaps another vegetable, coffee, rolls and butter, maybe even a dessert.

We don't have a menu but we do have a catalog. We also have a four-page leaflet which describes in part some of the materials you receive with the various classifications of membership. There are many materials and services available to our members, services which cost nothing over and above dues. There are also materials available at a reasonable cost, with the 20 per cent member discount.

I wonder how many of you have visited the Council Headquarters within the past two years? How many of you have visited the council headquarters within the past five years? How many of you have never visited us?

First, let me tell you a little bit about us. Presently we occupy 190,000 square feet (the entire 3rd, 4th, and 5th floors) of the Mandel Building, located on the Chicago River immediately north of the Michigan Avenue bridge. We currently have about 450 full-time employees, more than 400 of whom work in Chicago.

Far too many people think of the National Safety Council only as an agency that makes those horrible holiday traffic predictions; an organization that makes posters or one which promotes those little commercials that we see on TV about "watch out for the other guy." Many people think we go out and make factory inspections, or establish codes, standards, and regulations by which industry must live. Still others think we are available at any time to make talks, speeches, etc. Of course, nothing could be further from the truth.

The National Safety Council is a membership organization whose sole purpose is the prevention of accidents not only in industry but on our streets, roads, and highways; in our homes and even in our churches; on the farms and in our places of recreation; in our schools and colleges; within our labor organizations; and in the activities of our women's groups. We even have a Youth Department which works with YMCA's, with the 4-H Clubs, the Future Farmers of America, Junior Achievement, Boy Scouts, etc.

We do not bar or restrict anyone from membership so long as their interest is in the field of safety and accident prevention. There are a number of types of memberships but the major ones are the flexible dues groups, where the dues are keyed to

the size of the operation (based on number of employees), and the fixed dues group representing insurance agencies, labor organizations, trade associations, public service groups, etc. Agencies of the Federal Government do not hold memberships, as such, but they do participate in all National Safety Council activities.

When you become a member of the National Safety Council, what happens to your "dues dollar?" Your dues are now split 50-50. Fifty per cent is retained by the Council to operate the organization, and the other 50 per cent is returned to you in the form of materials and program aids. Those who choose the standard service plan automatically receive an administrative unit plus such additional materials that will benefit them. For those who choose the optional service plan, the 50 per cent becomes a service credit which may be used at any time during the year to purchase materials of their own selection.

Of the 50 per cent of dues that is retained in the organization, some is used to support membership services that can be of great help to you — if you know about them and use them:

1. Technical help: Section activities, consultation services; library services; statistical services; National Safety Congress.

2. Non-technical help: Council awards; public information. The Railroad Section has four award plans: Railroad Employees' National Safety Contest; Railroad Passenger Safety Award (this particular award is being held in abeyance this year pending a study by the Railroad Executive Committee); Railroad Public Safety Activities Award; and the award plan for recognizing good industrial safety records.

There are many materials and services which may be supplied to you or may be selected by you, depending upon the type of service you select. Some of these are:

1. For management: administrative units, technical manuals, and references; *National Safety News,* a monthly publication which deals primarily with industrial safety; *Accident Facts,* published annually, which is the standard statistical reference book on all phases of safety everywhere.

2. For supervisors: The Sixth Edition of the *Accident Prevention Manual for Industrial Operations; Industrial Hygiene* manual; training courses (the Industrial Department will conduct 18 of these training courses during 1969); home study courses, for which we have received excellent response; films and slide series; and *Industrial Supervisor* magazine.

3. For employees: Film and slide series; pass-out material; reading rack material; envelope stuffers; *Safe Worker* magazine.

4. For the plant program: posters, pop posters, banners; safety stickers; Green Cross flags and awards. Award of Honor — Award of Merit — Certificate of Commendation — President's Letter.

5. For the fleet driver: Motor transportation service; safe driver awards; monthly newsletter; *Safe Driver* magazine.

6. For off the job safety: Off the job campaigns; defensive driving course; *Family Safety* magazine.

7. Community safety programs: Local safety councils; field servicemen; three types of programs: (1) "Let's Have a Safe Community" for small cities under 50,000; (2) "The Community Safety Organization" for cities capable of supporting a staffed safety council; (3) "The County Manual" for areas where the county is the logical unit of organization. For further information on these programs, contact your field serviceman.

More than 1,300 safety posters are illustrated in the council poster directory. Many of them are addressed specifically to railroad problems. Most of them are of good use in railroad safety problems. We endeavor, with the assistance of the Railroad Section's visual aids committee to issue new railroad posters, dealing with special railroad problems, from time to time.

As a contribution to the grade crossing accident prevention program, we annually issue a three-color "Signs of Life" poster and furnish approximately 30,000 copies to the Safety Section, Association of American Railroads, at a price below our out of pocket cost; the Safety Section in turn distributes them to its members.

Several data sheets on railroad problems are in print and several more are planned. Our School and College Department is issuing two safety education data sheets, "Railroad Trespassing," (revised) and, for use in driver education courses, "Safety at

the Crossing," based on material released to us by the Illinois Central Railroad.

The 46th anual issue of the *Railroad Green Book* is in preparation. This book lists railroads winning all four types of awards, plus data on grade crossing accident programs, transportation accident statistics, and other helpful information. This is a special service for the railroads only.

In the industrial department we have 30 people. Besides the department manager and assistant manager, we have directors and 14 staff engineers. Included in this number is an industrial hygienist, a couple of chemists, a fire prevention specialist, electrical engineers, etc. We are there to serve our members in every way possible.

One might think that with all of this experience behind us that we would know all of the answers. We are the first ones to admit that we do not. We don't know all of the answers, but there is one thing we do know — we usually know where to get them. In many cases we are acting as a clearing house for information. When one of our members calls or writes requesting the solution to a problem, if we don't know and we find that no one else in our department knows, we begin calling some of our old friends who we think might have the answer. Rarely ever are we unable to come up with some possible solution.

As you might imagine, many of our inquiries are ridiculous. For example, a letter which says, "Please send me everything you have on safety." Or the person who writes, "I am preparing a term paper in industrial safety; please send me all of the information you have on the subject." Then, of course, there is the man who writes in to say, "I understand you have data sheets on safety. Please send me one of each."

Being a non-profit organization there are some requests which we simply cannot fill: "I want to distribute copies of such and such, please send me 500 copies."

"Who makes the best safety glasses?" or, "How many pairs of safety shoes are sold every year?"

Then there are "Don't you think there should be a law prohibiting 19 year old boys from working as a tree trimmer?" Or the attorney who writes, "Who in your organization is an expert on ladders? We want to use him as a witness." "Please send me a mailing list of all of your members." "Please furnish us with the registration list of the last National Safety Congress."

I have tried to point out to you some of the areas in which we think we can be of help to you. Whenever you are in doubt, call or write us. Let us be the judge of whether we can, or cannot help you.

The National Safety Council is your organization, we are here to serve you in any way possible, if you will give us a chance. This is the only way in which you can get the most out of your Council membership.

MAKING A SOUND SLIDE SAFETY PRESENTATION

By C. W. BAILEY
Director of Safety and Plant Protection,
Duluth, Missabe, & Iron Range Railway, Duluth, Minn.

Do you sometimes feel that they're not listening to you? The traditional way to hold a safety meeting is to get the men together and give them a short talk. The effect on your audience is often not what you hoped it would be. Why? We sometimes forget that we are living in an age of TV. Everyone is becoming more sophisticated in their viewing habits. All of us have become more adept at tuning out the commercials and loking only at what interests us.

As safety directors, we have a message to get across to our employees. How can we get this message across? Some of the ways available to us are talks, charts, posters and signs, magazine articles, slides, and movies.

Slides with sound hold the employee's interest and heighten his awareness of hazards. We believe that slides offer several advantages which you should consider when setting up your safety programs. Slides are relatively inexpensive. The equipment needed to make a sound-slide presentation consists of a 35mm camera, a tape recorder, and perhaps a device for making title slides. Between $300 and $400 would put you in business. Most railroads already have such equipment available. Once you have made your initial investment, however, you have great flexibility and a good attention-getter.

The 35mm cameras on the market these days are nearly foolproof. The skills needed to do the job can be developed easily with a little practice.

With a little ingenuity, a sound-slide talk can be made as attention getting as a color movie. Bring your employees in as consultants and actors. Shoot all the scenes on your property. This lends an air of familiarity to the program and gives those watching it a sense of participation and identification which they would not have with a movie made for general use.

Movies of a general nature do not say specifically what you want them to about your particular situation. A photograph of a man performing a specific operation on your property together with appropriate narration is much more effective than a whole movie on the general subject of your talk.

How often have you shown a film and heard some employee say, "Ya, sure, but that doesn't apply here." If he sees it happening on your property, it's a different story. Showing your employees doing things the wrong way is a very effective turn off for the guy who says, "It can't happen here."

Sometimes, the supervisor out on the line who is holding the safety meeting needs a boost to get his discussion going. A slide talk, and particularly one which ends with a question or states a problem to be solved can be particularly effective, especially in a meeting such as this.

Slide talks can be kept current. Operations change. When they do, it is easy to take slides of the new program or equipment and insert them in your presentation.

If you are filming a movie, generally several hundred feet of film are needed to get the scene just right. Equipment must be run through its paces several times. Men must be tied up posing and the costs mount by the hour. Slide presentations, on the other hand, are easier to film. If you make a mistake, it can be re-shot with little inconvenience in most cases. Titles and cartoons are easier to handle in a slide presentation, giving you greater flexibility.

Assuming that you now wish to try your hand at filming a slide talk, let's go through the steps required, giving you the benefit of our bitter experience.

Development

Step one, of course, is to decide upon your subject matter and the results which

you hope to achieve with your presentation. Who will be your audience? What message do you want to get across? Who will see this talk? Supervisors, old employees, new men? What will appeal to them?

For example, study of recent accident reports indicates a sharp increase in the number of reportable injuries to a track crew. You conclude that since these are new employees unaware of the many safety hazards, a sound slide presentation would promote better understanding. Your first move is to call your staff together, explain the problem to them and what you wish to accomplish. Their experience in safety problems is going to be a help.

Often, a brainstorming session will produce many excellent ideas. Since the whole group is familiar with the operation, they can develop worthwhile suggestions. Try to bring in knowledgeable operating supervisors and employees who can tell you about the problem. This would also be a good time to get the names of men to pose for the slides. These people should be respected by their fellow workers, have a good safety record, and be reasonably photogenic.

A stenographer should be present if possible, so accurate notes can be kept, thereby preserving all good ideas.

When the meeting is over the notes will have to be transcribed and a rough draft of the program prepared. This should generally set the stage for the entire production, and enough copies should be prepared for distribution to all persons who will work on the program.

After a selection has been made of the people who are to participate a meeting should be held with them to brief them on the program and what is expected of them. Go over the program one point at a time with everyone concerned. Make sure the participants understand and agree. Make careful notes of their ideas and change the program accordingly. Your employees can be extremely helpful in giving you ideas that the men will accept and understand.

Plan Photographs

Be sure to plan what slides will be required and list them in the sequence in which they will be photographed. Often pictures can be taken in one location that will appear in several places in the presentation.

Plan the art work for the title slides and put your artist to work. Title slides can be humorous and of a cartoon type of art. It might be well at this time to point out that art work is easily converted to slides. If there is someone available who can do this for you, you might consider doing the entire program in this manner rather than taking photographs.

Be sure to make the necessary arrangements for any equipment you will need on the scene and also have the area prepared by housecleaning if necessary. Get together equipment to be worn or used by the crew members, so it will be available when shooting begins. Delays cost extra money and frustrate participants.

When setting up the shooting, you should consider using three cameras so different angles can be shot to provide a good selection of finished slides. If your staff needs some introduction to cameras, be sure they get it and are familiar with their use.

Photography

Before the actual shooting begins, carefully inspect the employees to be photographed for dress and appearance. New clothing is not necessary, but clothing should be clean. Errors discovered after the slides are developed mean re-shooting the scene. You should keep in mind that others besides the crew you wish to train will probably be seeing the program, possibly persons on other railroads.

Take a good look at the equipment that is to be used. Make certain that there are no defects, that all safety appliances are in good order, and that obscenities written on equipment and other disturbing factors are removed. This also applies to any tools or mechanical equipment. Make sure that it is in good condition and will photograph well. Be sure that the area is clear of debris and rocks large enough for stumbling hazards; even tall weeds should be avoided. Photographs have a way of magnifying even a small amount of debris left in the area. However, I do not recommend that the ground be raked or swept, as this may give an artificial appearance to the area. After all, the men know what your property looks like.

You are nearly ready to photograph now, so check your light meter and make the

necessary adjustments to the cameras. At least one camera should be equipped with a flash attachment or strobe light, so any dark or shadowed areas can be covered. Remember to shoot from three different angles to produce the desired results. OK, get the job done.

Script

Now that we have completed the photography, we must review and prepare the script. Once the slides are developed, examine them carefully and decide which best illustrate the point you are trying to make. Be very critical and also be selective of the photographic quality.

Take your script and compare what you will say with the scene you are viewing. If it needs a slight change, make notes and move on to the next slide. When you are finished, the script will be completed and ready for recording.

Recording the Sound Track.

When you put the program together, it is essential that you have a quiet room and not be disturbed. No phones ringing or interruptions can occur, as the tape recorder will pick them all up and you will have to re-do that portion of the tape.

Many variations of the equipment needed to produce a sound slide talk are available. Basically, it consists of a two-track stereo tape recorder, slide projector, and a synchronizer that converts the signal from the slide changer into an inaudible signal on the tape. Your voice is recorded on channel one of the stereo tape. You then press the slide changer and the signal goes onto channel two. Simply keep repeating this process until finished.

If you find it difficult to coordinate the commentary and change the slides, you may want an assistant to work with you. He can operate the slide changer in accordance with the script. You might also wish to tape the commentary and then put the slide change signals on during a second run. With a little practice, you will soon master the entire operation by yourself in one run.

After completion, preview the program in order to catch any errors or changes that are necessary. Call in the people who helped you write the script for their comments — they can often catch things you aren't aware of.

Well, you did it. It really wasn't so tough after all. Now you can take it out on the property and show it with pride. You will be surprised how well employees will accept it, since their own people helped you to make it. They feel they all had a part.

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