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GENERAL SUBJECT AND INDUSTRIAL SESSIONS

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NATIONAL SAFETY COUNCIL, INC.
20 North Wacker Drive, Chicago

Foreword

THE Transactions of the 30th National Safety Congress and Exposition of the National Safety Council are published in two volumes. Volume I contains the General Subject Sessions and the Industrial Section Sessions. Volume II contains the Street and Highway Traffic, Commercial Vehicle, Transit, Child Education, Home Safety and Farm Safety Sessions.

Volume I is distributed automatically to the industrial members of the Council. Volume II is sent to those members who are believed to be interested chiefly in the sessions it contains. However, other members of the Council may obtain Volume II upon request.

All types of Council members have found it advantageous to distribute these Transactions volumes to foremen, supervisors, executives and other officers of their organizations, who make use of the information they contain in organized accident prevention programs. On page 9 of this volume some practical suggestions are made for the profitable use of these Transactions.

Extra copies of Volume I may be obtained by Council Members at the following rates: 1 to 10 copies at $2.00 each; 11 or more copies at $1.75 each. Extra copies of Volume II may be had at 75 cents each.

The Transactions are a condensed record of the proceedings of the Congress, reproduced here for reference purposes. The papers, addresses and many of the discussions have been edited to delete extraneous matter and emphasize those parts which outline ideas of particular usefulness in safety organization and all other accident prevention procedures. The volumes are, therefore, a somewhat abridged version; the original manuscripts, however, are available in the files of the National Safety Council.

The National Safety Council, at its Congresses, seeks to eliminate from discussion matters which are not pertinent to the aims of the Congress, or which may be contrary to the Council's policies. However, it cannot accept responsibility for all the views expressed, either in the matter presented or in the discussions based upon these papers.

NATIONAL SAFETY COUNCIL, Inc.
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Essentials of Healthful Industrial Environment

By MYRON A. SNELL

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In 1940 occupational accidents were responsible for 17,000 killed, 16,000 permanently disabled, and 1,350,000 temporarily disabled.

Although the recognized diseases of occupation are responsible for only a comparatively small proportion of these industrial injuries, many other factors in industrial environment are partly responsible for them. The personal habits of the individual as well as the nature of his home environment must also be charged with their share of this responsibility.

It is known that the incidence of the common diseases of life which are not due to the occupation is higher among industrial workers than among the balance of the population. Consequently, the life expectancy of the individual employed in industry is approximately eight years less than for the non-industrial worker. There is no doubt but that considerable improvement would result through the elimination of all of the unsatisfactory conditions to which workers are exposed in industry.

The Metropolitan Life Insurance Company conducted a study which revealed that approximately 2 per cent of all workers are incapacitated all of the time on account of illness. This means that the estimated 50 million workers in the United States lose four hundred million days annually on account of injury and illness, resulting in an average direct loss of wages at $5.00 per day of two billion dollars.

The Air Hygiene Foundation of America are engaged in a study of "Sick Absenteeism in Industry." Their records show that more than eight days are lost per male wage earner per year and more than twelve days per female wage earner per year because of sickness. A considerable proportion of this cost is assumed by the employer through lower production and poorer earnings.

Many companies have already discovered that a large proportion of the employees with poor health records also had poor safety records. These employers are spending [illegible] the health of the employees through the elimination of unhealthful conditions at home as well as on the job. They receive a large return on the investment, not only through the reduction of time lost from the job through sickness, but also from the reduction in the cost of industrial accidents and diseases.

Industrial Health

Although progressive employers recognize the importance to them of healthy, satisfied employees, it is unfair and unjust to impose upon them the legal liability for any illnesses or diseases among the employees that are not actually caused by the employment. Occupational disease laws should be carefully enacted and justly administered so that the employer will not be expected to provide general health insurance for his employees. The industrial environment is actually responsible for only a small proportion of the time lost from the job by employees.

Every employer should, of course, be required to provide his employees with a safe and healthful place in which to work. Such an environment can be achieved only through a study of every condition of industrial life followed by an adjustment of these conditions to the health requirements of the industrial worker.

Atmospheric Contaminants

Employees should not be subjected to the inhalation of atmospheric contaminants in sufficient concentrations to cause disease or poisoning, nor even in concentrations sufficient to cause any marked degree of discomfort. Polluted air is undesirable even though the foreign material in the air is not present in harmful quantities. Workers who are satisfied and contented with the working environment are not only happier and more efficient but healthier as well. Many individuals imagine all sorts of ill effects even from trivial industrial exposures, and may even worry themselves into an actual case of illness which was not caused by the environment but from the [illegible]

Atmospheric contaminants in industrial plants may consist of solid dispersoids, liquid dispersoids or gases or vapors. Solid dispersoids may be divided into dusts, fumes and smokes. Liquid dispersoids may be divided into mists and fogs.

Dusts

Industrial dusts are mechanically generated by many different processes and operations. Typical examples are drilling, blasting and crushing in mining and quarrying; polishing, buffing and grinding in metal finishing and stonecutting, polishing and abrasive blasting in the granite and monument industry. The dust generated in every case is of the inorganic or mineral variety. Animal and vegetable dusts are known as organic dusts and are generated by such operations as the processing of cotton, the working of wood, or the polishing of shells.

From the health standpoint, industrial dusts of above ten microns in size are of no importance because they are too large to be inhaled into the lungs themselves. Dusts below ten microns in size are not visible to the naked eye but can be seen with a microscope down to about two-tenths of a micron in size. Dusts containing sufficient percentages of free silica and asbestos may cause diseases known as silicosis and asbestosis if inhaled in sizes below ten microns in sufficiently high concentrations over a great enough period of time. Other dusts, with the exception of the metallic dusts, do not result in diseases, but many of them do result in certain changes in the lungs which are evidently not of great importance. Nevertheless, workers should not be allowed to inhale high concentrations of any kind of dust regardless of its composition.

Permissible limits or maximum allowable concentrations for these dusts have been established by various organizations, but as yet there has been no complete agreement for dust concentrations in workroom atmospheres. The American Standard Safety Code for the Protection of Heads, Eyes and Respiratory Organs recommends that no worker be continuously subjected without a protector to an atmosphere containing any form of mineral dust in quantity exceeding 50 million particles per cubic foot of air less than 10 microns. The Natural Silk Code Conference in 1937 suggested that the maximum permissible concentration should be found by multiplying the percentage of free silica by the total dust count. If the result is under five million, the condition may be considered permissible. If the result is over five million, the condition may be considered too high.

California, Connecticut and some other states allow no more than five million particles of dust running high in free silica. New York State, in the Industrial Code adopted September 1, 1941, for the control of silica dust in the stonecutting and stone finishing industry, allows five million particles if the dust contains more than 70 per cent free silica, 10 million particles if it contains from 10 to 70 per cent, and 100 million particles if it contains less than 10 per cent free silica. The State of California has established a permissible limit of 5 million particles per cubic foot of air for asbestos dust.

Metallic dusts may also be generated mechanically in such operations as weighing and mixing red lead and litharge in the manufacture of paints or storage batteries. The permissible limits for such toxic dusts are the same as for the fumes of these metals.

Fumes and Smokes

Inhalation of the freshly formed fume of any metal in sufficient concentrations may cause the condition known as "metal fume fever," also known as zinc chills or shakes. Although this condition causes a great deal of discomfort and may be alarming to those who are not familiar with it, it is actually not a disease and has no permanent effect on the individual. The inhalation of the dusts or fumes of the toxic metals can also cause systemic poisoning if inhaled in sufficient quantities.

As yet there are no definite standards established for most of the toxic metals. The American Standards Association's Sectional Committee on Allowable Concentrations of Toxic Dusts and Gases is developing standards for cadmium, chromium, lead and mercury. They also propose to develop standards for antimony, arsenic, manganese and zinc. All of these standards will probably be available in the near future.

The Journal of Industrial Hygiene and Toxicology in the June, 1940, issue published

a "Code for Safe Concentrations of Certain Common Toxic Substances Used in Industry." This code was prepared by a group of five expert industrial hygienists and contained a list of suggested permissible limits to be used as a guide until the time that the American Standards Association's committee had completed the standards for the substances mentioned. The maximum allowable concentrations for certain of the toxic metals were as follows: Cadmium 0.1 mg. per cu. meter; Chromium 0.1 mg. per cu. meter; Lead 0.15 mg. per cu. meter; Mercury 0.1 mg. per cu. meter, and Zinc 15.0 mg. per cu. meter.

Very little work has been done on maximum concentrations of smoke which can be tolerated without impairing efficiency or causing marked discomfort, and no limits have as yet been established.

Mists and Fogs

Mists are formed by the mechanical disintegration of a liquid by such processes as spray coating of paints or vitreous enamels. They usually range in size from about 50 to 100 microns.

Fogs are formed by the condensation of vapors. They vary in size from 5 to about 50 microns. Wherever hot alkaline cleaning or pickling vats are operated in a workroom in which the temperature is quite cool, the water vapor is apt to condense in the form of a fog in the room in the same manner that ordinary fog is formed in the outdoors. A mist which may be inhaled in spray coating operations may be rather complex in nature. In the case of spraying paints, it usually consists of a mixture of organic solvents of a varying degree of toxicity together with solid matter in solution or in suspension. These fine droplets in the form of mist may hold in suspension lead oxide as a pigment or other particulate matter of a toxic nature. In the spray coating of vitreous enamels a water vehicle is used but the particulate matter in suspension may contain toxic metals in the form of oxide, such as cadmium, lead and manganese. In addition, they sometimes contain finely divided particles of free silica in the form of quartz or flint.

The maximum allowable concentration in inspired air containing mist is the same as that for the vapors, fumes or dusts of the substances contained in the mist.

Vapors and Gases

While vapors are composed of the gaseous phase of substances which usually exist in the form of liquids under ordinary conditions, gases exist only in the gaseous state under ordinary conditions.

Vapors and gases are frequently but incorrectly termed "fumes." For example, "nitrous fumes" instead of nitrogen oxide gases. A liquid organic solvent such as carbon tetrachloride will evaporate from an open tank in a workroom and the vapors of carbon tetrachloride collect in the surrounding atmosphere. Thus the carbon tetrachloride can exist under the ordinary conditions of the workroom either as a liquid or a vapor. On the other hand, the oxygen and carbon dioxide gases in the air of the workroom cannot exist under such normal conditions in any other state.

There are a vast number of organic solvents in use in industry and the number is increasing each year through the discovery of new and better solvents in the industrial chemical laboratories. The extent of damage to the health of workers through the inhalation of the vapors of many of these solvents is not known.

American standards have been established this year for benzol of 100 parts per million parts of air, carbon disulfide 20 parts per million, carbon monoxide 100 parts per million and hydrogen sulfide 20 parts per million. The American Standards Association's Committee on Allowable Concentrations are at present engaged in the development of standards for acetone, carbon tetrachloride, diethyl ether, formaldehyde, hydrofluoric acid, methanol, nitrous gases, detrachlorethane, tetrachlorethylene, toluol, trichlorethylene and xylol. Tentative suggested standards for these as well as for about 23 additional gases and vapors are given in the June, 1940, issue of the Journal of Industrial Hygiene and Toxicology, as already mentioned.

Atmospheric Pollution

The only definite method of determining whether or not a concentration of atmospheric contaminants exists in the workroom that constitutes a health hazard is by means of collection and analysis of air samples.

These atmospheric pollution studies require the services of trained industrial hygienists and the use of proper field and laboratory equipment. Many private companies as well as individuals are equipped to do this work for themselves or for others.

In addition, there are at the present time 31 industrial hygiene units located in that many different states, who are prepared to do this work for industrial concerns at their request. In all but New York and Massachusetts these units are operated by State Departments of Health in cooperation with U. S. Public Health Service. In addition to supplying the plant owner with an analysis of the health hazards in this plant, these units make workable suggestions for their correction or elimination through the use of proper engineering control methods.

Ingestion of Toxic Substances

The vast majority of cases of industrial poisoning occur through inhalation of the toxic substances rather than by ingestion or by absorption through skin, for two reasons. In the first place, the principal exposure to toxic substances in industry is through inhalation and not ingestion or absorption. In the second place, in those few cases where poisonous substances are swallowed, they are almost entirely eliminated through the alimentary tract without being absorbed into the bloodstream and a large percentage of the small amount absorbed into the bloodstream is further eliminated through the liver. Consequently very little of the ingested poison gets into the general circulation to cause damage to the vital organs.

In the case of an employee who is working with lead oxide in the manufacture of storage battery plates, he is inhaling any dust which may contaminate the working area at the rate of 16 times each minute during the entire day. On the other hand, he usually eats but once a day on the job. In addition he may swallow at other times during the day an amount of lead which in itself could not cause poisoning.

Skin Contact

A few of the organic liquids such as tetraethyl lead used in leaded gasoline and benzol may cause poisoning by absorption through the skin. Most cases, however, are caused relatively few and most of the known toxic substances do not readily enter the bloodstream by skin absorption.

Approximately two-thirds of all occupational disease claims, however, are for dermatitis and other skin affections. Industrial employees come in contact with a considerable number of substances which invariably result in the development of a dermatitis condition. In addition, there are a great many other substances used in industry which cause abnormal skin conditions to develop in certain few individuals but not in others. This highly specialized subject has been given a great deal of attention in recent years and much information has been published about it.

There are two methods of prevention available. The first involves the use of skin tests to determine individual reaction to substances which are generally known to cause dermatitis. This is done before employment in the exposure, and employees who show a positive reaction are placed in other jobs.

The second method consists of preventing contact between the individual and the harmful substance through complete enclosure, exhaust ventilation, the use of rubber gloves or other protective clothing, of protective skin creams. Personal cleanliness also is an extremely important factor in the prevention of industrial dermatitis.

Infectious Diseases

A considerable number of industrial cases of anthrax, glanders, undulant fever and tularemia are reported every year. These diseases of animals are invariably contracted by man through ignorance or negligence on the part of the employees or their supervisors. Industrially they are easily contracted through contacts with infected hair or hides or the diseased animals themselves. Practically every such case could have been prevented either through sterilization of the animal parts themselves or through the use of protective clothing on the part of the employees.

Miscellaneous Diseases

There are miscellaneous conditions to which industrial workers may be exposed which are responsible for a considerable number of actual cases of disease. Com-

pressed air illness or caisson disease results from too rapid decompression after working under pressures greater than one atmosphere. Time and pressure tables have been established for maximum rates of compression and decompression which should be followed in all cases. In some states this is required by law.

Radiant energy when used in industry may result in serious consequences if adequate safety precautions are not taken. Workers should not be exposed to harmful amounts of radioactive substances or X-rays. In every case the protective measures published by the National Bureau of Standards should be religiously followed.

Both ultra-violet and infra-red rays have certain beneficial effects on human beings if they are absorbed by the body in moderate amounts. Light rays produced industrially, however, may have a serious effect upon the health of workers if proper personal protection is not provided. Cataract may result from exposure to the heat and glare of molten glass. Serious eye and skin burns may result from undue exposure to the bright arc produced in electric welding. The use of goggles with properly colored lenses, face shields, gloves, and proper clothing afford adequate protection.

Pressure, Motion and Shock

Synovitis, or tenosynvitis, or bursitis, or cellulitis of any of the joints of the body may result from any occupation involving continual or repeated trauma, vibration, pressure or friction. Examples are the diseases suffered by workers who spend many years in handling pneumatic tools used in such operations as riveting and drilling. If possible the employees of concerns engaged in such operations should be rotated so that no one individual is exposed to the harmful effects of conditions such as these for long periods of time.

Temperature and Humidity

The average comfort zone in the wintertime is from 66 to 71° E. T. (Effective Temperature). 66° E. T. is the most popular effective temperature as adopted by the American Society of Heating and Ventilating Engineers for individuals at rest wearing customary winter clothes living in the broad geographical belts across the United States in which heating of the convection type is generally used during four to eight months of the year. It doesn't apply to rooms heated by radiant energy, rooms with excessive glass area or those with poorly insulated or cold walls. In densely occupied spaces somewhat lower temperatures may be necessary. Satisfactory comfort conditions for men at work have been found to vary from 40 to 70° E. T. depending on the rate of work and the amount of clothing worn. In hot industries 80° E. T. is considered the upper limit compatible with efficiency and whenever possible this should be reduced to 70° E. T. or less.

In the summertime the average comfort zone is from 66 to 75° E. T. with 71° E. T. as the popular average. This is 4 to 5° higher average than in the wintertime.

The temperature differential between indoors and outdoors which should be maintained depends on a number of factors. A drop in temperature of 10° F. or more may be extremely harmful if it occurred suddenly, especially when the skin and clothing are wet with perspiration.

No standard has been established for the proper amount of humidity. It may vary from 30 to 70 per cent without discomfort. The air should be dry rather than damp. The common belief that dry air in itself exerts a harmful effect on the skin and mucous membranes has never been proved by convincing evidence, although there have been numerous investigations on the subject. The addition of moisture to the air of occupied rooms by any practical method has not been shown to have any beneficial effect upon health and comfort. Experiments have shown that the respiratory membranes of industrial workers exposed to hot, moist air are distinctly more abnormal than those of workers exposed to hot, dry air.

The maximum air movement should be 50 feet per minute with not less than 10 cubic feet per minute per occupant of the room taken from an outdoor source. Mr. Yaglow states that "an air movement of not over 40 f.p.m. is permissible under present engineering practice, when the temperature of the air current is 2° F. or less below ordinary room temperature. Current velocities as high as 200 f.p.m. may prove desirable

tration they not only result in poor efficiency but also in a high accident frequency. The number of foot-candles for proper industrial illumination varies up to a point beyond 100. They are published in table form for various occupations in Safe Practice Pamphlet No. 22 on "Industrial Shop Lighting."

Other Factors which should be considered in the subject of industrial health are working postures, and the proper kind of floor covering. Standing or walking on concrete or other hard surfaces produce fatigue and may even be harmful to some individuals in prolonged exposures. The Gilbreth International Committee on Industrial Fatigue place great stress on the ill effects of improper posture among industrial workers. The use of proper chairs eliminates fatigue and greatly improves efficiency.

The comfort and efficiency of industrial workers are also affected by the color scheme of the environment, the length of the working hours and the rest periods used in connection with them, the general housekeeping conditions and cleanliness of the plant, locker, washroom, sanitation and eating facilities, medical facilities, and by proper provisions for recreation. Most of these, however, have little or no important effect upon the actual health of the industrial worker.

ADJOURNMENT

in hot industries, but velocities much higher than this are uncomfortable and irritating and may blow dust off the floor."

Work in the hot industries may be responsible for a number of physiological derangements, the best known of which is heat exhaustion or heat cramps. The condemnation of salt tablets by the employees in such industries has largely eliminated the disability and discomfort which were prevalent a few years ago.

Since the amount of rise in body temperature of employees in hot atmospheres has been shown to indicate disturbances in physiological equilibrium, the American Society of Heating and Ventilating Engineers has suggested an average "temperature rise of one-half degree in the average worker qualified by physical makeup and experience to work in hot industries, or a one and one-half degree rise in an occasional worker" as the limiting factor.

The A.S.H.V.E. state that "the thermal environment cannot be properly adjusted to the requirements of human health and comfort without control of all the four basic factors concerned—temperature (free air temperature free from radiation effects) movement of the air, humidity of the air, and mean radiant temperature of the surrounding surfaces." Their research laboratories are at the present time engaged in a general program with the aim of establishing minimum requirements for air conditioning for industries which would be acceptable to everyone concerned.

Miscellaneous Conditions

Abnormal noise levels have a profound effect upon industrial workers and may result in deafness or other pathological conditions. The A.S.H.V.E. 1941 Guide contains a table giving the acceptable noise levels under various conditions. These noise levels vary from 10 to 100 decibels depending on the source and location. Dr. Knudsen reported that "long exposure to sounds above a level of 80 to 90 decibels or a brief exposure to more intense noises invariably impairs hearing. Other results are vestibular disturbances, mental fatigue, loss of efficiency, and extreme nervousness which can be traced to excessive noise. Some persons are more susceptible to excessive noise than others, but no one is immune to long continued intense sound. Noise has become more than a nuisance—it is a menace impairing the hearing of millions, robbing them of quiet leisure, restful sleep and taking a toll of the general nervous system of mental workers, neurotics, hospital patients and others who are noise sensitive." Noise reduction at the source may be accomplished by insulation, absorption or by reducing the noise from machinery and equipment. Most employees object to wearing ear stoppers but Dr. Knudsen has devised an ear defender providing an insulation of 35 to 40 decibels which is very effective.

Tobacco Smoke and Body Odors, with the exception of toxic atmospheric contaminants, are the principal factors to be considered relative to comfort and efficiency. Such odors are not harmful but nevertheless have a profound effect on individuals. In the same manner other disagreeable odors adversely affect the efficiency of workers.

The amount of outdoor air needed for body odors should be somewhere between 10 and 30 cfm. per person depending on age, sex, economic status, air space in cubic feet per person, outside and inside temperatures and humidity. The minimum air change requirements for tobacco smoke has not yet been definitely determined but probably should be in the neighborhood of 5 to 15 cfm. per person. These air requirements are in addition to those needed for indoor recirculation in order to maintain the humidity and temperature at the proper level.

Space Allotments for industrial workers are of questionable value and minimum requirements for them cannot be given at the present time because this factor is so closely associated with many others, principally that of the ventilation problem.

Illumination of the proper intensity for the type of work to be performed should be provided for all industrial workers. The equipment providing illumination should be of the proper type and installed so as to give maximum efficiency with a minimum amount of glare, eyestrain, or other adverse effects. Improper lighting may be responsible for actual disease of the eye in addition to eyestrain and eye fatigue. Improper illumi-