TRANSACTIONS

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NATIONAL SAFETY COUNCIL, Inc.

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Foreword

THE Transactions of the Twenty-sixth National Safety Congress, 1937, are published by the National Safety Council in two volumes. This, the first, contains the general, the special subject, and the Industrial Section sessions. The second volume contains the sessions of the Child Education, Home Safety, Street and Highway Traffic, Commercial Vehicle and Transit Sections.

All industrial members of the Council automatically receive Volume I. Volume II is sent to members believed to be interested chiefly in the sessions it covers. Other Council members, however, may obtain it upon request.

Many members have found it worth while to distribute copies of the Transactions to supervisors, foremen, and others in an administrative or supervisory position who may make practical use of them for reference purposes. The following quantity prices are quoted on extra copies: 1 to 10 copies of the large volume (Volume I), $2 each; 11 copies or more, $1.75 each; copies of the smaller volume (Volume II), 75 cents each.

THE Transactions are published as a condensed record of the proceedings at the National Congress. The papers of each session or division of the Congress have been edited carefully to eliminate extraneous matter and to abbreviate the less essential portions because of space limitations. Thus the material herein presented is not a verbatim report of all the speeches presented at the Congress, but rather an abridged version made as compact as possible, yet without injury to the technical aspects of any address. The original manuscripts are on file in the Council's Bureau of Information, where they are available for additional reference. Where illustrations were sent by the speakers to the Council, these also are on file.

The National Safety Council at its Congresses seeks to eliminate from discussion matters which are not pertinent to the aim of the Congress or which are contrary to Council policies. It cannot accept responsibility for the views expressed either in the papers presented or in the discussions based upon the papers.

NATIONAL SAFETY COUNCIL, INC.
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Contents

the lessening of fatigue, increasing of efficiency and decreasing of the accident hazard.

Working Hours

Those who have had actual and practical experience know that in some instances shortening of the day's work has actually resulted in an increase in the amount of work done. One occupation will be found far more fatiguing than another. Our present interest is centered upon over-fatigue which is recognized as being causative of accidents.

There are in general use many labor-saving devices, the operation of which produce much noise and vibration and require high speed attention on the part of the operators. Such inventions unquestionably save much labor and yet they have a tendency to greatly increase fatigue.

Monotony, another cause of emotional fatigue, deserves consideration under this heading. Rest periods have been found to prevent and relieve fatigue when interspersed with the day's work. These rest periods may often be of no more than five or ten minutes' duration and their frequency governed by the monotonous nature of the employment. Actual experience of industries where such rest periods have been instituted has shown that fatigue has been lessened, production increased, and accidents minimized.

Noise

Though scientific experiment has not yet demonstrated that working under conditions of continuous noise is productive of fatigue, it is generally accepted as an axiomatic fact. Exceedingly loud noises, those of a droning nature rapidly repeated, and monotonous noises are particularly prone to induce fatigue. It would appear that the character and quality of noise is of the greatest importance and, where they cannot be eliminated, efforts at changing or supplanting the character of sound have met with remarkable success.

By means of loud speakers installed throughout many factories in Germany the rhythm of music has been used to overcome the hum of machinery. The practice is just beginning to permeate American industry; in English and South American factories it has been in vogue for some time.

Posture

Incorrect posture is a most important factor in the causation of fatigue and its attendant accident hazards. Man having assumed the upright position, all studies of posture must consider this as being his normal attitude. A perpendicular line drawn alongside of the standing figure should pass through the center of the ear, the center of the shoulder, center of the hip, center of the outside of the knee, and center of the external malelous at the ankle. Such a posture requires the minimum of physical exertion for its maintenance since the parts of the body are so superimposed upon each other that the force of gravity replaces much muscular effort.

The correct seated posture maintains the above relation with the head, torso and hips; the thighs are at an angle of approximately ninety degrees with the body, while the knees are flexed so that the feet rest firmly and comfortably upon the floor. When work requires that the body be inclined forward so as to accommodate itself to a desk or machine, this position should be assumed by a pivoting at the hip joints and not by permitting a slouch in the spinal column.

The general ill effects of an improper sitting posture result from the disturbances of function of the organs of the body resultant upon a flattened chest, rounded shoulders, obliteration of the natural curvatures of the spine, protrusion of the abdomen, removal of the natural support provided for the heavy abdominal viscera by a natural shelving of the spine where these organs rest and are retained by the abdominal muscles, undue stress upon supporting ligaments, retardation of circulation, undue pressure upon that sensitive area surrounding the lower end of the spine and the coccyx, and undue pressure upon the nerves, arteries and veins passing through the popliteal space at the back of the knee joint. When, due to improper posture, the heart's action is impeded there is noted a diminution in both the quantity and quality of the blood's supply with a corresponding depreciation in available oxygen and glycogen accompanied by a retention of the "fatigue substances." The invariable result is a rapid manifestation of fatigue symptoms. The subject begins to feel sleepy, yawns frequently, responds but sluggishly to external stimuli, lags in the performance of work, becomes inefficient, and is far more liable to accidental injuries

Many workers have been provided with no seat whatever, others with improper seats or chairs which do not admit of adjustment either to the individual's anatomy or to the work entailed. Due to the exceedingly inefficient character of such seats, piece workers can rarely be induced to use chairs of ordinary construction while doing their work.

Muscles will respond to an enormous amount of action before manifesting symptoms of fatigue. When, however, during muscular action, oxidation has been incomplete and the supply of glycogen inefficient, a rapid increase of the "fatigue substances" will occur in the muscle cells and fatigue will increase in direct proportion to the reduction of muscular efficiency. Muscles that have become fatigued will not be accurate in directing movements; there will be incoordination of action with other muscles—this uncertainty of movement and non-concerted action increases the accident hazards of the individual as the elements of fatigue increase.

Safety Control In Air Conditioning

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In our discussion we will deal only with the safety control which should be practiced in engineering design, which constitutes safety in material, safety in controls, and safety in physiological reactions of the occupants of the space. To obtain these safety measures the designing engineer must be selective in the materials used and lay out the system to produce comfortable conditions without hazards to the occupants. The engineer operating the system must maintain in the conditioned area the temperatures and humidities to produce comfort.

In comfort conditioning, refrigerating effect is required to produce cooling and dehumidifying of air, which in the majority of cases calls for a refrigerating machine. The refrigeration machine is used either for the direct expansion of the refrigerant in the path of air or for the cooling of water to cool the air. The types used today are absorption, rotary, reciprocating, centrifugal and steam ejector water vapor. Absorption systems are seldom used for air conditioning and the rotary type is seen infrequently.

The most commonly used refrigerants are freon, ammonia, carbon dioxide, sulphur dioxide, methyl chloride, water vapor and carrene. Due to their toxic or irritant values, in case of a leak, methyl chloride, ammonia and sulphur dioxide are seldom used in air conditioning. Carbon dioxide is used less and less, due to its high working pressure and the high temperature of condensing water found in some sections of the country. This leaves freon and carrene as the most generally used refrigerants, and while they are similar in some respects they are quite different in operating characteristics within the cooling range required for comfort air conditioning.

Freon is used in a reciprocating compressor which produces the cooling at a differential in pressure, both high and low side above atmospheric; while carrene is used in a centrifugal machine which produces its cooling at a differential of vacuum.

Of course, water is sometimes used as a refrigerant. It is used in the steam ejector and water vapor centrifugal machines. To produce the refrigerating effect, cooling water to 50 degrees, a very low vacuum is required, approximately 29.2 inches of vacuum. Water, without a doubt, is the safest refrigerant which could be used, but has its limitations due to its refrigerating characteristics.

Freon and carrene are considered safe refrigerants. Both are considered non-explosive, non-flammable, and non-toxic. The National Board of Fire Underwriters has made an elaborate report entitled "The Comparative Life, Fire and Explosion Hazards of Common Refrigerants."

Due to the safety of freon, it is acceptable to use for direct expansion work, as under normal operating conditions the amount of refrigerant leak would be so readily diffused and diluted that it would not be harmful. Since with the use of freon the refrigerating

effect is produced by a differential in pressure, both high and low side being above atmospheric pressure, any leakage of the refrigerant is outward.

The centrifugal machine using carrene cools water or brine direct. This refrigerant is not especially suitable for the direct expansion in coils of an air conditioning system. With this type of refrigeration the refrigerant is kept entirely within the bounds of the refrigeration apparatus room and does not come in contact with the air being cooled or otherwise conditioned. The centrifugal machine using carrene is always at a vacuum on the cooler or evaporator side where the refrigerant is evaporating; hence any leakage, no matter how slight, is inward rather than outward, which effectively prohibits the escape of the refrigerant gas into the surrounding apparatus room.

In certain cases ammonia has been, and is still being, permitted for use as a refrigerant in air conditioning, such as in meat packing, breweries, and other industries, where the occupancy in relation to floor area is relatively small. It presents a definite hazard when used in direct expansion coils in the path of air, and certainly should not be used in any form as a refrigerating medium in an air conditioning system for auditoriums or public buildings.

In those industrial establishments mentioned, where ammonia is used for industrial and commercial purposes, it should never be utilized for comfort conditioning except by means of the indirect system, namely, cooling brine or water which in turn is used for comfort conditioning.

Must Adapt to Conditions

Controlling of sound level in air conditioning installations has become quite important. Such installations as broadcasting studios, sound stages, theatres and court houses require sound treatment. The engineer designing the system should make certain that the materials used in sound treatment in ducts are fireproof. There has been a tendency toward using an acoustical material inside a duct to perform the function of insulation and sound absorbing. This material likewise should be fireproof, otherwise a hazard is always present.

Air conditioning installations play an important part in plants where solvents with explosives are used in the manufacturing process. In this type, explosion proof motors and starters must be used. The fans should also be equipped with copper scrolls to prevent the generation of a static spark.

The space requirements to permit adequate servicing of equipment is another detail requiring careful study by the designing engineer. He should exercise care and thought in the location and spacing of the apparatus. Conservation of space is sometimes over-emphasized, making it hazardous for the operating engineer to render the required service to motors, compressors, etc.

Safety control begins with the first nut or bolt that is manufactured for the apparatus, right on through to the rigging and installation of the equipment which necessarily must be regulated by insurance companies, underwriters and city ordinances, etc. One particular detail in the installation of refrigerating and air conditioning apparatus is often overlooked, and that is the safe working stresses of the floors upon which the equipment is being erected. In many cases it has been found that the floor load was designed for 100 to 150 pounds per square foot and not suited for the actual equipment of over twice that weight which was installed. Then too, suitable vibration absorbing pads of cork or rubber, or mechanical types using springs, should be installed to absorb the hazardous vibration that sometimes exists. Belt guards and pipe rails around apparatus have often been neglected due to lack of experience or "penny wise and pound foolish" economy.

Standard refrigerating apparatus requires the installation of certain safety devices to protect equipment against overload, breakdown and fire. Every installation should have high and low pressure gauges so that an inspector or operator can determine at a glance if the pressures are within the safe limits of operation. Likewise, every motor driven compressor should have the proper starting equipment with overload relays and under voltage relays to stop the apparatus in case of overload.

Where water is used for condensing purposes a positive supply should be provided. If this is pumped, the electrical hookup should be such that the apparatus will not operate unless there is sufficient and continuous supply of water to prevent building up of high refrigerant pressure beyond safe limits. A simple electrical hookup or a water failure switch can be installed at nominal cost.

Then too, thermometers are important so that the operator or inspector can make proper check-up at any time. Safety relief valves of the pop type should be provided on the condenser and connected to outside; suitable plugs, set to relieve at a reasonably low temperature should be provided to prevent excess pressure and possible explosion of the condensers and receiver in case of fire. Safety relief valves of the pop type only should be installed between the suction and discharge connections of the compressors as well as combination high and low pressure cutout to stop the compressor should the discharge valve be shut off. Where shell and tube apparatus is used for chilling water, safety relief valves of the pop type should likewise be connected to the outside to prevent explosion in case of fire because of excessive pressure.

All motors on all air conditioning apparatus should be provided with suitable safety switches as well as overload and under-voltage starter protection. Where automatic temperature control is used, safety thermostats and regulating thermostats must be provided to safeguard the operation of the equipment as well as to prevent excessive heating or excessive chilling in either summer or winter time.

In certain manufacturing, process conditioning, special mechanical laboratories, theatre projection booths, and wherever duct work extends through fire walls, suitable fusible link dampers must be provided on both sides of the wall to automatically close off in case of fire, thus retarding spread of smoke, fumes, or fire.

Drafts Must Be Avoided

It is necessary that the designing engineer take precautions to distribute the air in the conditioned area so that drafts will not occur on the occupants of the room. The suggested maximum velocity over a person at rest is 50 feet per minute. The design of outlets and method of distribution should be such that this maximum is not exceeded. This is particularly true in air conditioning installations in hospitals.

Sufficient outside air for ventilation should always be taken through the air conditioning equipment to dilute odors and smoke which may occur in an air conditioned space. This naturally requires reheaters and preheaters where the system is installed for year 'round air conditioning. In hospital installations, especially in operating rooms, the air supplied should preferably be all outside air. In apartment houses special precautions should be taken to avoid the contaminated air from one or more apartments being redistributed throughout the building; thus eliminating, or, at least minimizing the possibility of contagious diseases being transmitted.

The system of control for preheaters should be such that they will not freeze up due to low temperature outside air and the reheaters should be sized of sufficient capacity to heat the conditioned space to the desired winter temperature. Automatic control of temperature and humidity must be installed to obtain the correct conditions in the occupied space.

The engineer operating the system should be thoroughly instructed and competent to operate the air conditioning system correctly. The conditions maintained within the conditioned area should eliminate the spectacular over-cooling which is so often resorted to in conditioned spaces. A differential of 15 degrees with a relative humidity of 50 per cent, when outside temperatures are 95 degrees, are considered ideal conditions for comfort.

As the outside temperature increases this differential should increase slightly and as the outside temperature decreases the temperature differential should decrease. This is particularly desirable in public buildings for the comfort of the continuous occupants, as well as those who enter only to stay a short time before returning to outdoors. This will avoid the shock so often experienced due to the too great change in temperature.

From the safety point of view the record of the air conditioning industry is an excellent one, for the public interest in safety has in most cases been adequately protected. With the increased use of refrigeration for comfort conditioning, even greater precautions are being taken in the development of proper refrigerants and control.

Has Safety Value

There are a number of applications in which air conditioning has had a definite safety value. In the operating rooms of

hospitals where air conditioning is installed, the doctors and nurses are comfortable, which tends to promote a steadiness of the nerves. The freedom from perspiration avoids the possibility of a wound infection from that source. Since some types of anesthetics are definitely known to have explosive characteristics, it is important to prevent the generation of a static condition that may prove disastrous. This is accomplished by maintaining a relative humidity of 50 per cent at which condition static is entirely eliminated.

In mines, air conditioning has been beneficial to the health and well being of the men working. In deep mines, without air conditioning, temperatures and humidities are excessive, which frequently cause prostrations. In shallow mines the roof and walls are at a temperature of approximately 50 degrees the year round and in the summer, when moist air is induced for ventilation, rapid condensation occurs and accumulates on the shale rock which increases the hazard due to falls. By supplying dehumidified air with a dewpoint equal to or below the shale rock temperature, moisture condensation will not occur, disintegration and falls are minimized.

Many air conditioning installations have been made in industrial plants where excessive process heat is generated, such as enameling rooms where materials to be enameled are at intensive temperatures. Air conditioning has reduced the number of prostrations and hence benefited the health and increased the comfort of the employees.

Another important application is the removal of dust and small particles of irritant chemicals, such as are found in unconditioned match factories, some departments of chemical, paints and pharmaceutical plants.

In the manufacturing of rayon, an acid solvent is required in the process. Unless an exhaust system is tied into the air conditioning system, the acid fumes contaminate the air, producing unhealthful working conditions. The fumes affect the throat and eyes in particular.

Fuse loading departments in ammunition plants is another application where air conditioning produces safety for employees. The humidity is kept high enough to prevent a static spark. Cooling and dehumidifying in summer eliminate perspiration from the worker's hands, which prevents the powder from adhering to the steel dies.

Some lacquering processes require a solvent having explosive properties. Since in some plants doing this type of work the solvent has explosive properties, and dehumidifying is required, an exhaust system is installed and sufficient outside air supplied to prohibit an explosive mixture.

Humidification in tobacco plants keeps down dust, which otherwise would be hazardous to employees. In the drying process of manufacturing matches, uniform drying, which requires air conditioning, prevents flaring or sparking when ignited.

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