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PLAINTIFF'S EXHIBIT
PPI-141

APPENDIX F
RESPIRATORY PROTECTION
OSHA 29 CFR 1910.134

(a) Permissible Practice

(1) In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the primary objective shall be to prevent atmospheric contamination. This shall be accomplished as far as feasible by accepted engineering control measures (for example, enclosure or confinement of the operation, general or local ventilation, and substitution of less toxic materials). When effective engineering controls are not feasible, or while they are being instituted, appropriate respirators shall be used pursuant to the following requirements.

(2) Respirators shall be provided by the employer when such equipment is necessary to protect the health of the employee. The employer shall provide the respirators which are applicable and suitable for the purpose intended. The employer shall be responsible for the establishment and maintenance of a respiratory protection program which shall include the requirements outlined in paragraph (b) of this section.

(3) The employee shall use the provided respiratory protection in accordance with instructions and training received.

(b) Requirements for a Minimal Acceptable Program

(1) Written standard operating procedures governing the selection and use of respirators shall be established.

(2) Respirators shall be selected on the basis of hazards to which the worker is exposed.

(3) The user shall be instructed and trained in the proper use of respirators and their limitations.

(4) Respirators shall be regularly cleaned and disinfected. Those used by more than one worker shall be thoroughly cleaned and disinfected after each use.

(5) Respirators shall be stored in a convenient, clean, and sanitary location.

(6) Respirators used routinely shall be inspected during cleaning. Worn or deteriorated parts shall be inspected during cleaning. Worn or deteriorated parts shall be replaced. Respirators for emergency use such as self-contained devices shall be thoroughly inspected at least once a month and after each use.

(7) Appropriate surveillance of work area conditions and degree of employee exposure or stress shall be maintained.

(8) There shall be regular inspection and evaluation to determine the continued effectiveness of the program.

(9) Persons should not be assigned to tasks requiring use of respirators unless it has been determined that they are physically able to perform the work and use the equipment. The local physician shall determine what health and physical conditions are pertinent. The respirator user's medical status should be reviewed periodically (for instance, annually).

(10) Approved or accepted respirators shall be used when they are available. The respirator furnished shall provide adequate respiratory protection against the particular hazard for which it is designed in accordance with standards established by competent authorities. The U.S. Department of Interior, Bureau of Mines, and the U.S. Department of Agriculture are recognized as such authorities. Although respirators listed by the U.S. Department of Agriculture continue to be acceptable for protection against certain specified pesticides, the U.S. Department of the Interior, is the agency now responsible for testing and approving pesticide respirators.

(c) Additional Guidelines

Selection of Respirators

Proper selection of respirators shall be made according to the guidance American National Standard Practices for Respiratory Protection Z88.2-1969. (Note; this ANSI Standard has now been updated to Z88.2-1988)

Air Quality

(1) Compressed air, compressed oxygen, liquid air, and liquid oxygen used for respiration shall be of high purity. Oxygen shall meet the requirements of the United States Pharmacopoeia for medical or breathing oxygen. Breathing air shall meet at least Grade D breathing air as described in Compressed Gas Association Commodity Specification G7.1-1966. Compressed oxygen shall not be used in supplied-air respirators or in open circuit self-contained breathing apparatus that have previously used compressed air. Oxygen must never be used with air line respirators.

(2) Breathing air may be supplied to respirators from cylinders or air compressors.

(i) Cylinders shall be tested and maintained as prescribed in the Shipping Container Specification Regulations of the Department of Transportation (49 CFR Part 178).

(ii) The compressor for supplying air shall be equipped with necessary safety and standby devices. A breathing air-type compressor shall be used. Compressors shall be constructed and situated so as to avoid entry of contaminated air into the system and suitable in-line air purifying sorbent beds and filters will be installed to further assure breathing air quality. A receiver of sufficient capacity to enable the respirator wearer to escape from a contaminated atmosphere in event of compressor failure, and alarms to indicate compressor failure and overheating shall be installed in the system. If an oil-lubricated compressor is used, it shall have a high-temperature or carbon monoxide alarm, or both. If only a high-temperature alarm is used, the air from the compressor shall frequently be tested for carbon monoxide to insure that it meets the specifications in paragraph (d)(1) of this section.

(3) Air line couplings shall be incompatible with outlets for other gas systems to prevent inadvertent servicing of air line respirators with nonrespirable gases or oxygen.

(4) Breathing gas containers shall be marked in accordance with American National Standard Method of Marking Portable Compressed Gas Containers Identify the Material Contained, Z48.1-1954; Federal Specification BB-A103a June 21,1968, Air Compressed for Breathing Purposes; or Interim Federal Specification GG-B00675b, April 27,1965, Breathing Apparatus, Self-Contained.

Use of Respirators

(1) Standard procedures shall be developed for respirator use. These should include all information and guidance necessary for their proper selection, use, and care. Possible emergency and routine uses of respiratory protection should be anticipated and planned for.

(2) The correct respirator shall be specified for each job. The respirator type is usually specified in the work procedures by a qualified individual supervising the respiratory protection program. The individual issuing them shall be adequately instructed to insure that the correct respirator is issued.

(3) Written procedures shall be prepared covering safe use of respirators in dangerous atmospheres that might be encountered in normal operations or in emergencies. Personnel shall be familiar with these procedures and the available respirators.

(i) In areas where the wearer, with failure of the respirator, could be overcome by a toxic or oxygen-deficient atmosphere, at least one additional man shall be present. Communications (visual, voice, or signal line) shall be maintained between both or all individuals present. Planning shall be such that one individual will be unaffected by any likely incident and have the proper rescue equipment to be able to assist the other(s) in case of emergency.

AIGRM

(ii) When self-contained breathing apparatus or hose masks with blowers are used in atmospheres immediately dangerous to life or health, standby men must be present with suitable rescue equipment.

(iii) Persons using air line respirators in atmospheres immediately hazardous to life or health shall be equipped with safety harnesses and safety lines for lifting or removing persons from hazardous atmospheres or other equivalent provisions for the rescue of persons from hazardous atmospheres shall be used. A standby man or men with suitable self-contained breathing apparatus shall be at the nearest fresh air base for emergency rescue.

(4) Respiratory protection is no better than the respirator in use, even though it is worn conscientiously. Frequent random inspections shall be conducted by a qualified individual to assure that respirators are properly selected, used, cleaned, and maintained.

(5) For safe use of any respirator, it is essential that the user be properly instructed in its selection, use, and maintenance. Both supervisors and workers shall be so instructed by competent persons. Training shall provide the employees an opportunity to handle the respirator, have it fitted properly, test its face-to-facepiece seal, wear it in normal air for a long familiarity period, and, finally, to wear it in a test atmosphere.

(i) Every respirator wearer shall receive fitting instructions including demonstrations and practice in how the respirators should be worn, how to adjust it, and how to determine if it fits properly. Respirators shall not be worn when conditions prevent a good face seal. Such conditions may be a growth of beard, sideburns, a skull cap that projects under the facepiece, or temple pieces on glasses. In addition, the absence of one or both dentures can seriously affect the fit of a facepiece. The worker's diligence in observing these factors shall be evaluated by periodic check. To assure proper protection, the facepiece fit shall be checked by the wearer each time he puts on the respirator. This may be done by following the manufacturers facepiece fitting instructions.

(ii) Providing respiratory protection for individuals wearing corrective glasses is a serious problem. A proper seal cannot be established if the temple bars of eye glasses extend through the sealing edge of the full facepiece. Wearing of contact lenses in contaminated atmospheres with a respirators is not allowed. Systems have been developed for mounting corrective lenses as part of the facepiece. The facepiece and lenses shall be fitted by qualified individuals to provide good vision, comfort, and gas-tight seal.

(iii) If corrective spectacles or goggles are required, they shall be worn so as not to affect the fit of the facepiece. Proper selection of equipment will minimize or avoid this problem.

AIGRM

Maintenance and Care of Respirators

(1) A program for maintenance and care of respirators shall be adjusted to the type of plant, working conditions, and hazards involved, and shall include the following basic services:

(i) Inspection for defects (including a leak check),

(ii) Cleaning and disinfecting,

(iii) Repair,

(iv) Storage

Equipment shall be properly maintained to retain its original effectiveness.

(2) All respirators shall be inspected routinely before and after each use. A respirator that is not routinely used but is kept ready for emergency use shall be inspected after each use and at least monthly to assure that it is in satisfactory working condition.

(i) Self-contained breathing apparatus shall be inspected monthly. Air and oxygen cylinders shall be fully charged according to the manufacturer's instructions. It shall be determined that the regulator and warning devices function properly.

(ii) Respirator inspection shall include a check of the tightness of connections and the condition of the facepiece, headbands, valves, connecting tubes, and canisters. Rubber or elastomer parts shall be inspected for pliability and signs of deterioration.

(iii) A record shall be kept of inspection dates and findings for respirators maintained for emergency use.

(3) Routinely used respirators shall be collected, cleaned, and disinfected as frequently as necessary to insure that proper protection is provided for the wearer. Respirators maintained for emergency use shall be cleaned and disinfected after each use.

(4) Replacement or repairs shall be done only by experienced persons with parts designed for the respirator. No attempt shall be made to replace components or make adjustments or repairs beyond the manufacturer's recommendations.

(5) After inspection, cleaning, and necessary repair, respirators shall be stored to protect against dust, sunlight, heat, extreme cold, excessive moisture, or damaging chemicals. Respirators placed at stations and work areas for emergency use should be quickly accessible at all times and should be stored in compartments built for this purpose. The compartments should be clearly marked. Routinely used respirators may be placed in plastic bags. Storage should not be in a place that might subject the respirator to physical damage.

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APPENDIX G
BACK INJURY INFORMATION

-5176 (1/87)

Comparison of Different Approaches for the Prevention of Low Back Pain

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Three major approaches have been used to reduce the problem of low back pain: training and education, job design (ergonomics), and job placement (selection). Training is the oldest and most common approach. Teaching the worker to lift with a straight back and bent knees is one of the oldest types of training found in industry. Unfortunately, it has been difficult to prove the effectiveness of this approach in reducing compensable low back pain. More effective results have come from training the worker in strength and physical fitness and in training management on how to respond to low back pain when it does occur. The training of practitioners in treating low back pain is also important since many long-term disability cases result from inappropriate treatment and/or the prolonged use of ineffective treatment.

The ergonomic approach of designing the job to fit the capabilities of the worker has received greater attention in recent years. Unnecessary bending, twisting, and reaching are risk factors to be avoided in good job design. Criteria for determining excessive loads have been developed for use in evaluating and designing jobs. Studies have shown that good job design can reduce up to one-third of compensable low back pain. The use of ergonomic principles in job design can reduce the probability of initial and recurring episodes, allow the worker with moderate symptoms to stay on the job longer, and permit the disabled worker to return to the job sooner.

The third approach to controlling low back pain is job placement, or the selection of the worker to fit the job. This approach is particularly useful for jobs that are difficult to design or control such as firefighters, police, and certain construction and delivery operations. The use of medical criteria in job placement can identify up to 10 percent of young workers susceptible to low back pain. Studies on strength testing indicate that the probability of a musculoskeletal disorder is up to three times greater when job lifting requirements approach or exceed the worker's isometric strength capability.

It is concluded that there is no simple solution to low back pain and that all three approaches are necessary for the best possible control of the disorder. However, some approaches are more effective than others and should be considered first in any program to reduce low back pain. Although knowledge about low back pain is limited, enough is already known to adequately control the problem. Instead of waiting for a major medical breakthrough to occur, emphasis should be placed on applying the knowledge that is already available. **Snook, S.H.: Comparison of Different Approaches for the Prevention of Low Back Pain. App. Ind. Hyg. 3:73–78; 1988.**

Introduction

Low back pain is not a new problem—it was one of the major concerns of Bernardino Ramazzini, the founder of occupational medicine, back in the late 1600s.[1] Low back pain also afflicted the ancient Egyptians of 5000 years ago.[2] Authorities now believe that low back pain existed before humans stood up on their hind legs and that many four-legged animals currently suffer from this problem.[3]

The specific cause of low back pain is unknown.[3-6] There are many hypotheses, but few objective data. Given the limited knowledge that exists about low back pain, it is doubtful whether the disorder can be totally prevented at the present time. However, there is little doubt that the disability and compensation from low back pain can be substantially reduced to controllable levels.[4,7,8]

Many different preventive techniques have been used in attempting to reduce the problem of low back pain in industry. These techniques can be grouped into three general approaches: 1) training and education, 2) job design (ergonomics), and 3) job placement (selection). The purpose of this paper is to review the three general approaches and to compare them in their effectiveness in reducing low back pain.

Training and Education

Training and education is the oldest and most commonly used approach for reducing low back pain in industry. Training programs have been directed toward workers, management, and practitioners who treat low back pain.

Training the Worker

Safety and/or personnel departments have typically used education and training to instruct employees in proper methods and work procedures. Training in safe lifting has been a part of safety programs in industry for over 50 years. More recent years have seen an increased emphasis on strength and fitness training and on the use of back schools.

Training in Safe Lifting

Several studies have shown that approximately one half of all compensable low back pain is associated with manual lifting tasks.[9-11] Consequently, there has been a major effort in industry to train workers to lift safely. The original concept of safely lifting an object from the floor required the worker to maintain a straight back, bending the knees to lower the body, and then lifting with the leg muscles. Additional principles of safe lifting were eventually added, including holding the object close to the body; slow, smooth lifting without jerking; turning with the feet instead of twisting the trunk; and the correct positioning of the feet, chin, arms and hands.[12-15] Unfortunately, there is not always consistency in the content of various safe lifting programs.[16,17]

Two studies have reported a 65 and 70 percent reduction in low back disability as a result of training workers in the principles of safe lifting.[18,19] Unfortunately, these studies were neither controlled nor of sufficiently long duration. According to the National Institute for Occupational Safety and Health (NIOSH), the value of training programs in safe lifting is open to question because there have been no controlled studies showing a consequent drop in manual handling accident rate or back injury rate.[20] On the other hand, several studies have reported little or no effect in such training.[11,21,22] Two studies at the University of Michigan investigated the biomechanical aspects of lifting with straight back/bent knees versus lifting with bent back/straight knees. One study concluded that straight back/bent knees should be recommended only for small, compact objects that can be lifted between the knees and close to the body.[23] The other study could find no clear biomechanical rationale for deciding between the two lifting postures.[24]

Strength and Fitness Training

Exercises to increase strength and fitness have been a part of low back pain treatment programs for many years, but only recently have strength and fitness programs been advocated in industry to reduce or prevent the onset of low back pain. Several studies have indicated a positive role for strength and fitness training in reducing the onset of low back pain.[25-27] Three other studies have demonstrated the effects of muscle strengthening exercises in recovering from low back pain.[28-30] However, not all investigations of strength and fitness have demonstrated reductions in low back pain.[31-34]

Although there are conflicting data on the effectiveness of strength and fitness training, the positive evidence appears to outweigh the negative evidence. The most convincing study was conducted by Cady and his associates who used a five component scale to evaluate the fitness of 1,652 firefighters.[35,36] The five components were 1) endurance work measured (in watts) at the end of 20 minutes of heart rate controlled exercise, 2) total isometric strength of selected muscle groups; 3) total of spine flexibility measurements, 4) diastolic blood pressure during exercise at a heart rate of 160 beats per minute; and 5) heart rate after standardized bicycle exercise. The firefighters were placed into three groups (most fit, middle fit, and least fit) and monitored for compensable low back pain for a period of four years. Approximately 7 percent of the least fit group experienced low back pain compared to 3 percent of the middle fit group and less than 1 percent for the most fit group. These investigators were also able to show reduced compensation cost for the most fit individuals. It was concluded that physical fitness and conditioning are preventive of back injuries.

Back Schools

The back school is an attempt to educate the worker in all aspects of back care. It represents a much more comprehensive approach to back care and includes the previous topics of safe lifting, strength, and physical fitness. Most back schools include discussions on anatomy and physiology of the lower back, body mechanics, posture, physical fitness, and nutrition. Some back schools will also offer advice on stress management, coping with pain, relaxation, drug use and abuse, first aid and acute care, epidemiology, activities of daily living, and vocational guidance. Job simulation or actual visits to the work place can also be a part of the back school.

The original concept of the back school was to educate patients who were already suffering (or had recently suffered) from low back pain; i.e., it was a form of treatment. A more recent use of the back school is to educate workers in industry on how to prevent or reduce low back pain. The curriculum is similar, but the students are different in that they may not have experienced low back pain.

There have only been two controlled studies of the effectiveness of a low back school used as a treatment for patients. The first study investigated the effect of the Swedish back school on acute low back pain patients from the Volvo Company in Goteborg, Sweden.[7] Two hundred seventeen patients were randomly assigned to one of three types of treatment: back school, physical therapy, or placebo (treatment with short waves of the lowest possible intensity). The authors concluded that the back school is superior to the placebo and physical therapy in the amount of time required for return to work and that the back school is superior to the placebo in the time required for pain relief. The second study investigated the effect of the Swedish back school on chronic low back patients from an orthopaedic center in England.[35] Seventy-eight patients were randomly assigned to the back school or an exercise-only group. Patients in both groups improved in pain and functional disability over the first six weeks. However, patients in the exercise-only group reverted to their original levels of disability at 16 weeks, while back school patients continued to improve.

Preliminary results have been reported for a controlled study of the effectiveness of a low back school as a preventive technique for workers.[36] The program was modeled after the Swedish back school and given to 3,424 employees of the Boeing Company in Everett, Washington. There was no significant difference in the incidence of low back pain between the back school students and a similar size control group. The back school also appeared to have little effect on lost work days. The final results of this study have never been published. Other studies have been reported for preventive types of back schools in industry, but they have not been controlled studies. For example, the Southern Pacific Company used the California Back School as a preventive program for 30,000 workers; they report a 22 percent reduction in low back cases and a 43 percent reduction in lost work days after two years.[37] PPG Industries used the Atlanta Back School as a preventive program for 2,000 workers and reported between 70 and 90 percent reduction in the number of injuries and the cost of injuries after two years.[38] The Spine Education Center in Dallas reported a 40 percent reduction in lost work days for the year following back schools conducted in eight industries.[39] It is difficult to assess the results of these studies, however, because of the lack of control groups.

G 00197

Training Management

The use of training and education to prevent or reduce low back pain in industry has been almost exclusively directed toward the worker. Equally important is the training of management. As noted previously, it is doubtful whether low back pain can be totally prevented at the present time. "Secondary prevention" is a recognition that is used by management to prevent poor results (i.e., long-term disability) from low back pain that does occur. Poor results are associated with adversary situations, litigation, hospitalization, and lack of follow-up and concern. Management can prevent some of these situations by training foremen, supervisors, and managers in appropriate responses to low back pain.

Data from the Weyerhaeuser Company indicate that workers with back injuries who are off work more than six months have only a 50 percent possibility of ever returning to productive employment; for more than one year's absence, the possibility is only 25 percent; for more than two year's absence, the possibility of returning is almost nil.[40] Rosen presents similar statistics.[41] Another study concludes that, with the passage of time following injury, patients increasingly elaborate and exaggerate their symptoms but are less truly depressed by their predicament.[42] Even if the physical disability remains constant, the patient's psychological posture and the likelihood of returning to work change. These studies emphasize the importance of providing modified, alternative, or part-time work as a means of returning the worker to the job as quickly as possible.[43] Nachemson reviews the evidence suggesting the benefits of early return to work.[44]

Fitzler and Berger describe a program at American Biltrite where management was trained in the positive acceptance of low back pain.[45,46] An atmosphere was created where workers were encouraged to report all episodes of low back pain (even minor episodes) to the company clinic. Immediate and conservative in-house treatment was provided by the company nurse, including worker education. Attempts were made to keep the worker on the job, often with modified duties that were consistent with the worker's condition. If necessary, referrals were made to the company doctor where treatment and progress were closely monitored. Over a three year period, workers' compensation costs for low back claims were reduced from over $200,000 per year to less than $20,000 per year—a tenfold decrease. Although this was not a controlled study, the results are certainly impressive.

Training the Practitioner

Company medical personnel should be trained in the benefits of early intervention, conservative treatment, patient follow-up, and job placement techniques. Both physicians and nurses should be familiar with recent literature that objectively evaluates various types of treatment for low back pain.[6,47,48] Medical personnel should also be familiar with the physical demands of jobs performed in the company in order to adequately place injured workers and new employees.

There is little consensus on how low back pain should be diagnosed or treated. Diagnostic criteria and treatment regimens vary greatly among physicians and may even vary among patients being treated by the same physician.[49] The great variety of treatments and their relative lack of success has frustrated many physicians and patients alike. The most frequently cited source of dissatisfaction with medical care among patients with low back pain is failure to receive an adequate explanation of the problem, resulting in requests for more diagnostic tests.[50]

Wiesel and his associates have offered a standardized approach to the diagnosis and treatment of low back pain.[49] This approach was used by the authors at the Potomac Electric Power Company to monitor the course and treatment for employees with low back pain. If there was any disagreement between the authors (who were orthopaedic surgeons) and the treating physician, the latter was contacted for full discussion. Usually, an agreement was reached between the physicians; if not, another physician was consulted for an independent opinion. The number of low back patients decreased 29 percent the first year and 44 percent the second year; days lost from work decreased 51 percent the first year and 89 percent the second year; low back surgery dropped 88 percent the first year and 76 percent the second year.

Job Design (Ergonomics)

The ergonomic approach of designing the job to fit the capabilities of the worker has received greater attention in recent years. Statistics have been compiled that indicate the relationship of certain job activities and postures to the incidence of compensable low back pain. These activities and postures include manual handling tasks, certain body movements, excessive loads, prolonged sitting, vibration, and falling.

Manual Handling Tasks

More than half of all compensable low back pain has been related to the manual handling of objects.[9-11,51] Lifting has been implicated in 37 to 49 percent of the cases; pushing, 9 to 16 percent; pulling, 6 to 9 percent; and carrying, 5 to 8 percent. Redesigning jobs to reduce or eliminate the amount of manual handling has been recommended by ergonomists in an attempt to reduce job related low back pain. Benson reviewed six industrial examples of ergonomic task redesign that resulted in the reduced incidence and cost of compensable low back pain.[52] Working primarily with static loads, Westgaard and Aaras demonstrated a reduction of work-related musculoskeletal illnesses through improved workplace design.[53,54] A 33 percent reduction in long-term sick leave followed implementation of ergonomic improvements in the workplace.

Body Movements

Excessive bending, twisting, and reaching have been related to the onset of compensable low back pain in industry. Twisting has been reported in 9 to 18 percent of low back pain; bending in 12 to 14 percent.[9-11] Twisting the trunk often results from crowded or cramped workplaces where there is not enough room to turn the feet. Bending is necessary when lifting from the floor. Reaching is required when handling bulky objects. Swedish studies have reported that the distance between the object and the body was found to influence the stress on the back much more than the method used to lift.[12]

Excessive Loads

Several studies have related the handling of heavy loads to an increased incidence of low back pain and disability. Hult found almost twice as much low back disability in the heavy occupations as he did in the light occupations.[4] Bergquist-Ullman and Larsson found that manual workers had significantly longer periods of disability during both the initial episode of low back pain and during recurring episodes than office workers.[7] Chaffin and Park concluded that the incidence of low back pain is increased when the lifting load is greater than 35 pounds.[55]

Biomechanical, physiological, psychophysical, and epidemiologic

G 00198

logical criteria have been used for determining excessive loads.[illegible] These criteria have been used to develop various methods for evaluating manual handling tasks, e.g., lifting strength rating, job severity index, psychophysical tables, and NIOSH guidelines.[illegible] Methods based upon biomechanical and psychophysical criteria have been particularly effective in relating low back pain to excessive loads.[illegible] Herrin and his associates conclude that the best simple index is the percentage of the population capable of performing the most stressful aspect of a job based upon either psychophysical strength or isometric strength.[illegible] Snook used this type of index based upon psychophysical strength and concluded from a study of 191 cases of low back pain that the proper design of manual handling tasks can reduce up to one-third of industrial back injuries.[11]

Additional Risk Factors

Additional risk factors include prolonged sitting, vibration, and falls. Magora's survey of 3316 individuals indicated that too much or too little sitting was related to a higher incidence of low back pain.[62] Nachemson reported that intradiscal pressure during sitting is significantly higher than during standing.[3] Frymoyer and his associates present evidence that implicates vibration as a significant factor in low back pain.[63] Truck drivers, who are exposed to both prolonged sitting and vibration, have a higher incidence of acute herniated lumbar intervertebral discs.[64] Finally, slips and falls have been cited in 7 to 13 percent of compensable low back pain.[9-11,51] These additional risk factors are important considerations in good job design. Thus far, however, no intervention studies have been reported.

Job Placement (Selection)

Although job design may be applicable to many manufacturing operations, there are other jobs that are difficult to design and control, e.g., firefighting, police work, and certain construction and delivery operations. These jobs require greater dependence upon preplacement testing and selection of workers. Selection techniques that have been used or suggested for identifying individuals susceptible to future low back pain can be grouped into medical examinations, strength and fitness testing, and job rating programs.

Medical Examinations

The preplacement medical examination has been used in many industries, especially since the enactment of workers' compensation laws. However, there are various opinions in the medical literature regarding the effectiveness of preplacement medical examinations in preventing health and safety problems in industry.[65] Some investigators believe the medical examination should be used only for older workers; others believe it should be used only for hazardous jobs.[65,66] Two studies were unable to demonstrate the effectiveness of preplacement medical examinations in identifying workers who are susceptible to low back pain.[11,67]

Working with 1,500 cases of industrial low back pain over a 20-year period, Rowe estimates that with careful history taking and thorough examination, around 7 or 8 percent of young individuals prone to future back problems might be identified.[68] The identification rate would be significantly higher in applicants in older age groups where the findings of disease are more frequent and more obvious. Many authorities feel that the medical history is the most important part of the medical examination in identifying workers who are susceptible to future low back pain.[69] Knowing that the worker has had previous low back pain is significant because the probability of additional episodes of low back pain is four times greater after the initial episode.[69] However, the worker is sometimes reluctant to reveal previous low back pain during a preplacement examination.

Routine x-rays of the lumbar spine have often been part of the preplacement medical examination although recent evidence indicates that the small yield does not justify the radiation exposure or increased cost.[70,71] Recent advances have been made in measuring the size of the spinal canal by ultrasound. This noninvasive technique was used to show that patients with symptomatic disc lesions had lumbar spinal canals that were significantly more narrow than asymptomatic subjects.[72] A more recent study revealed that coal miners with disabling low back pain also had narrower canals.[73] Other investigators, however, have not yet been able to reproduce these results.[74]

Strength and Fitness Testing

Several studies have demonstrated the relationship between strength/fitness and the incidence of low back pain. In a series of four studies, Chaffin and his associates investigated isometric strength testing as a technique for selecting workers for strenuous jobs.[47,75-78] Workers were tested from various industries (e.g., electronics, steel, aluminum, rubber) and monitored for medical incidents. These studies are consistent in finding that the probability of a musculoskeletal disorder is up to three times greater when job lifting requirements approach or exceed the worker's isometric strength capability.

Several attempts have been made to develop dynamic lifting tests, since dynamic lifting represents a better simulation of the actual lifting task.[79,80] Sophisticated machinery for testing dynamic strength has also been introduced by several manufacturers. Unfortunately, there have been no studies showing the effectiveness of dynamic strength testing as a preplacement technique for reducing the incidence and/or severity of musculoskeletal disorders.

In a Danish study of 449 men and 479 women, Biering-Sorensen was able to show that men who experienced low back pain for the first time had lower isometric endurance of the back muscles when measured up to one year before the episode.[81] In addition, these men also had greater anterior spinal flexion (hypermobility). The results for women were not the same, suggesting a possible sex difference. Biering-Sorensen concludes that good isometric endurance of the back muscles seems to prevent first-time experience of low back pain in men.

Job rating programs

Job rating programs are structured attempts to evaluate the job as well as the worker and then to obtain a good match between the two. It represents an extension of not only screening out the inappropriate applicant, but finding suitable work for people of varying abilities. Job rating programs began during World War II when military assignments with varying requirements were being filled with millions of new recruits with varying capabilities and when women, handicapped workers, and older workers began to work in defense factories. Job rating efforts continued after the war when suitable work was being sought for disabled veterans.

One of the pioneers of job rating programs was Hanman, who worked in both Europe and the United States.[82] Koyl developed a job rating program for the Canadian civil service, called GULHEMP (G-general physique, U-upper extremities, L-lower extremities, H-hearing, E-eyesight, M-mentality, P-personality).[83,84]

The U.S. National Council on the Aging has advocated the use of GULHEMP for placing older workers on jobs.[39,40] The most recent job rating program has been developed by the County of San Bernardino in California.[41] This program, called the Medical Standards Project, was developed in response to new federal legislation (Civil Rights Act of 1964, Occupational Safety and Health Act of 1970, Vocational Rehabilitation Act of 1973) and increasing disability retirement and workers' compensation claims.

It is not surprising that so much time and effort has gone into the development of job rating programs. These programs appear to provide valuable information regarding worker capabilities and job requirements. It is surprising, however, that not a single study could be found that objectively evaluated the effectiveness of any of the job rating programs in reducing the incidence, severity or cost of musculoskeletal injuries in the workplace. These programs have good potential, but they remain unproven with respect to injury reduction.

Recommendations

The reviewed data indicate that primary prevention of low back pain (preventing the onset of symptoms) is best achieved through good ergonomic design of the workplace. Studies have shown that good job design can reduce up to one-third of compensable low back pain. In addition, ergonomics has the advantage of being a more permanent engineering solution to the problem; it reduces the worker's exposure to the risk factors of low back pain and reduces the medical and legal problems of selecting the worker for the job (as well as finding replacements for absent workers). Good job design also places less reliance upon the worker's willingness to follow established training procedures, such as lifting properly.

Strength testing is an effective selection technique but should only be used for jobs that are difficult to design or control. Strength testing can also be used on a temporary basis until the job is redesigned. Strength testing should never be used as a substitute for good job design.

Training the worker in strength and fitness also appears to be effective in preventing the onset of low back pain symptoms. Although fitness is difficult to enforce, management can encourage worker participation by supplying facilities and training programs.

Secondary prevention (preventing long-term disability and high cost after low back pain has occurred) is best achieved through training programs. Specifically, management should be trained in appropriate responses to low back pain, practitioners should be trained in effective treatment, and patients should be sent to back school to learn their responsibilities in the recovery process. Ergonomics also plays an important role in secondary prevention. Not only can good job design reduce the probability of initial and recurring episodes, it will also allow the worker with moderate symptoms to stay on the job longer and permit the injured worker to return to the job sooner.

There is no simple solution to the problem of low back pain. No single preventive approach will solve the problem; all approaches are necessary for the control of low back pain. However, prevention programs should emphasize those approaches that objective studies have shown to be most effective. Although knowledge about low back pain is limited, enough is already known to adequately control the problem. Instead of waiting for a major medical breakthrough to occur, emphasis should be placed on applying the knowledge that is already available.

References

1. Mastromatteo, E.: From Ramazzini to Occupational Health Today from an International Perspective. J. Occup. Med. 17:390 (1975).
2. Finneson, B.E.: Dr. Finneson on Low Back Pain. G.P. Putnam's Sons, New York (1975).
3. Nachemson, A.L.: Towards a Better Understanding of Low Back Pain: A Review of the Mechanics of the Lumbar Disc. Rheum. Rehab. 14:129 (1975).
4. Hult, L.: Cervical, Dorsal and Lumbar Spine Syndromes. Acta Orthop. Scand. Suppl. No. 17 (1954).
5. Jayson, M.I.V.: Back Pain: Some New Approaches. Med. J. Austral. 1:513 (1979).
6. Rowe, M.L.: Backache at Work. Perinton Press, Fairport, NY (1983).
7. Bergquist-Ullman, M.; Larsson, U.: Acute Low Back Pain in Industry. Acta Orthop. Scand. Suppl. No. 170 (1977).
8. Cust, G.; Pearson, J.C.G.; Mair, A.: The Prevalence of Low Back Pain in Nurses. Int. Nurs. Rev. 19:169 (1972).
9. Cady, L.D.; Bischoff, D.P.; O'Connell, E.R., et al: Letters to the Editor: Authors' Response. J. Occup. Med. 21:720 (1979).
10. Snook, S.H.; Campanelli, R.A.; Ford, R.J.: A Study of Back Injuries at Pratt and Whitney Aircraft. Liberty Mutual Insurance Company, Research Center, Hopkinton, MA (1980).
11. Snook, S.H.; Campanelli, R.A.; Hart, J.W.: A Study of Three Preventive Approaches to Low Back Injury. J. Occup. Med. 20:478 (1978).
12. Andersson, G.B.J.; Ortengren, R.; Nachemson, A.: Quantitative Studies of Back Loads in Lifting. Spine 1:178 (1976).
13. Anderson, T.M.: Human Kinetics in Strain Prevention. Br. J. Occup. Safety 8:248 (1970).
14. Himbury, S.: Kinetic Methods of Manual Handling in Industry. Occupational Safety and Health Series No. 10. International Labour Office, Geneva (1967).
15. National Safety Council: Human Kinetics . . . and Lifting. National Safety News 44 (June 1971).
16. Hall, H.W. Sr.: "Clean" vs "Dirty" Leaning, an Academic Subject for Youth. ASSE J. 20 (October 1975).
17. Ring, L.: Facts on Backs—A Simplified Approach to Back Injury Prevention and Control. Institute Press, Loganville, GA (1981).
18. Glover, J.R.: Prevention of Back Pain. The Lumbar Spine and Back Pain. M. Jayson, Ed. Grune and Stratton, New York (1976).
19. Miller, R.L.: Bend Your Knees! Nat. Safety News 57 (May 1977).
20. NIOSH: Work Practices Guide for Manual Lifting. DHHS (NIOSH) Pub. No. 81–122 (March 1981).
21. Brown, J.R.: Lifting as an Industrial Hazard. Labour Safety Council of Ontario, Ontario Department of Labour, Toronto (1971).
22. Dehlin, O.; Hedenrud, B.; Horal, J.: Back Symptoms in Nursing Aides in a Geriatric Hospital. Scand. J. Rehabil. Med. 8:47 (1976).
23. Park, K.S.; Chaffin, D.B.: A Biomechanical Evaluation of Two Methods of Manual Load Lifting. AIIE Trans. 6:105 (1974).
24. Garg, A.; Herrin, G.D.: Stoop or Squat: A Biomechanical and Metabolic Evaluation. AIIE Trans. 11:293 (1979).
25. Cady, L.D.; Bischoff, D.P.; O'Connell, E.R.; et al: Strength and Fitness and Subsequent Back Injuries in Firefighters. J. Occup. Med. 21:269 (1979).
26. Cady, L.D.; Thomas, P.C.; Karwasky, R.J.: Program for Increasing Health and Physical Fitness of Firefighters. J. Occup. Med. 27:110 (1985).
27. Rowe, M.L.: Low Back Pain in Industry. A Position Paper. J. Occup. Med. 11:161 (1969).
28. Kraus, H.; Nagler, W.; Melleby, A.: Evaluation of an Exercise Program for Low Back Pain. Am. Fam. Physician 28:153 (1983).
29. Kendall, P.H.; Jenkins, J.M.: Exercises for Backache: A Double-blind Controlled Trial. Physiotherapy 54:154 (1968).
30. Lindström, A.; Zachrisson, M.: Physical Therapy on Low Back Pain and Sciatica. An Attempt at Evaluation. Scan. J. Rehabil. Med. 2:37 (1970).
31. Pedersen, O.F.; Petersen, R.; Staffeldt, E.S.: Back Pain and Isometric Back Muscle Strength of Workers in a Danish Factory. Scan. J. Rehabil. Med. 7:125 (1975).
32. Gyntelberg, F.: One Year Incidence of Low Back Pain Among Male Residents of Copenhagen Aged 40–59. Dan. Med. Bull. 21:30 (1974).
33. Hertkson, M.; Schultz, A.; Nachemson, A.; Andersson, G.: Voluntary

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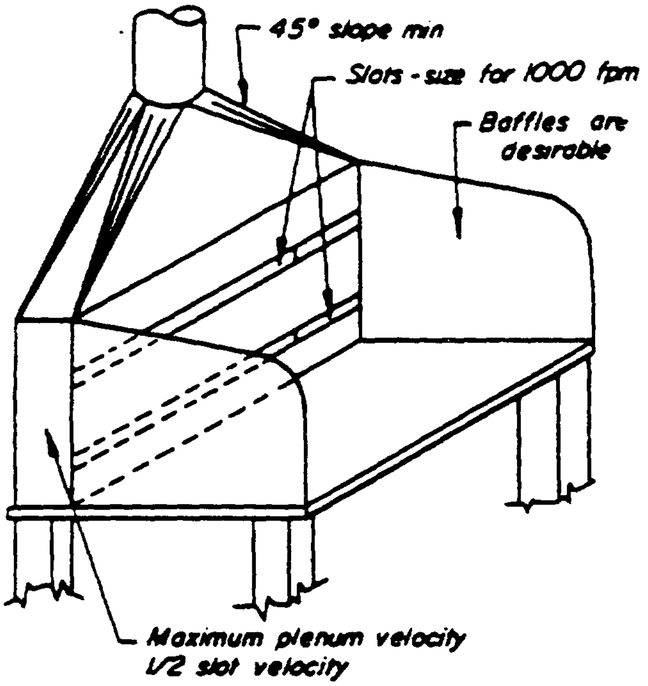
APPENDIX H
WELDING HOOD INFORMATION



Q = 350 cfm/lineal ft of hood
Hood length = required working space
Bench width = 24" maximum
Duct velocity = 1000 - 3000 fpm
Entry loss = 1.78 slot VP + 0.25 duct VP

GENERAL VENTILATION, where local exhaust cannot be used:

Rod, diam	cfm/welder*
5/32	1000
3/16	1500
1/4	3500
3/8	4500

OR

A. For open areas, where welding fume can rise away from the breathing zone: cfm required = 800 x lb/hour rod used
B. For enclosed areas or positions where fume does not readily escape breathing zone: cfm required = 1600 x lb/hour rod used

*For toxic materials higher airflows are necessary and operator may require respiratory protection equipment.

OTHER TYPES OF HOODS
Local exhaust: See VS-416.1
Booth: For design See VS-415, VS-604
Q = 100 cfm/sq ft of face opening

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WELDING BENCH

DATE 1-76 | VS-416

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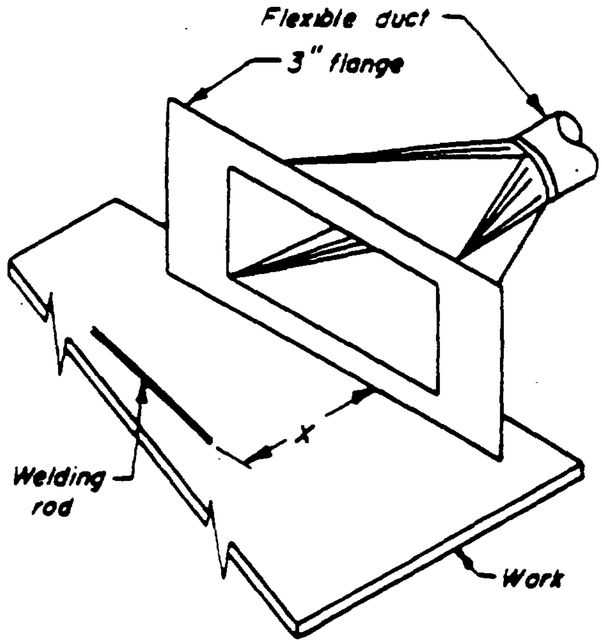

PORTABLE EXHAUST

X, inches	Plain duct cfm	Flange or cone cfm
up to 6	335	250
6 - 9	755	560
9 -12	1335	1000

Face velocity = 1500 fpm
Duct velocity = 3000 fpm minimum
Plain duct entry loss = 0.93 duct VP
Flange or cone entry loss = 0.25 duct VP

GENERAL VENTILATION, where local exhaust cannot be used:

Rod, diam	cfm/welder
5/32	1000
3/16	1500
1/4	3500
3/8	4500

OR

A. For open areas, where welding fume can rise away from the breathing zone:
cfm required = 800 x lb/hour rod used

B. For enclosed areas or positions where fume does not readily escape breathing zone:
cfm required = 1600 x lb/hour rod used

For toxic materials higher airflows are necessary and operator may require respiratory protection equipment.

OTHER TYPES OF HOODS

Bench: See VS-416

Booth: For design See VS-415, VS-604
Q = 100 cfm/sq ft of face opening

"Granite Cutting" VS-909

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WELDING BENCH

DATE 1-78 | VS-416.1

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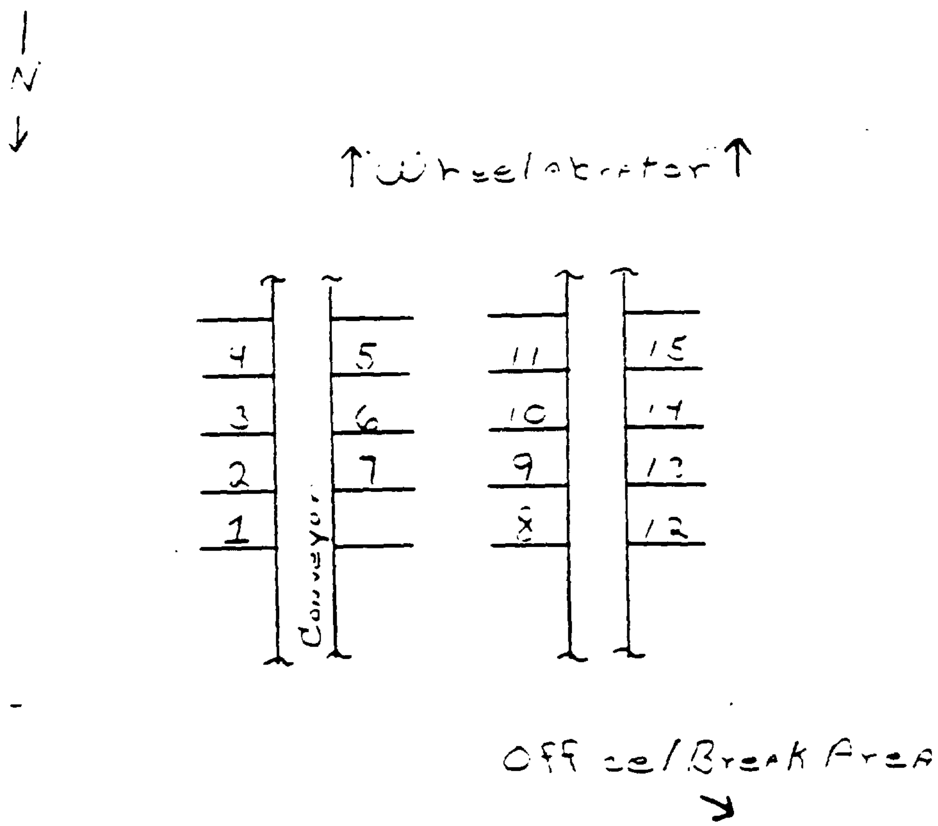
Table Layout

(Not to Scale)



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