

6. HEALTH HAZARD

EVALUATIONS are studies of a workplace, such as a particular department in a factory, industrial plant, office building, or other worksite. The study is conducted by NIOSH in response to concerns expressed by employees, employee representatives, or employers, to find out whether there is a health hazard to employees caused by exposure to hazardous materials (chemical or biological contaminants) or working conditions (e.g., noise, heat, musculoskeletal stresses). The reports resulting from these studies are generally referred to as Hazard Evaluation and Technical Assistance (HETA) reports. Please note that each report discusses the conditions only at a specific worksite evaluated. The reports are listed alphabetically by company name.

1. American Fuel Cell and Coated Fabrics Company, Magnolia, AR, May 1993.

HETA NO: 90-246-2314. 71 pp.

NTIS NO: PB93-234037 PRICE: Check NTIS

In response to a request from a representative of the United Rubber Workers Union concerning chemical exposures, heat stress, and ergonomic problems occurring during the manufacture of coated rubber fuel cells by workers at the American Fuel Cell and Coated Fabrics Company (SIC-3069), Magnolia, Arkansas, an investigation was undertaken by NIOSH. The company manufactured fuel bladders for aircraft. Ergonomic assessments were performed in six areas; factors investigated included repetitive tasks, awkward postures, manual force requirements, and exposure to hand/arm vibration. Exposures to methyl ethyl ketone (MEK) ranged as high as 421 parts per million (ppm), exceeding the 300 ppm NIOSH short term exposure limit. Concentrations of 1,1,1-trichloroethane ranged from 293 to 878 ppm (NIOSH limit 350 ppm). Local exhaust systems were either absent or ineffective. The authors conclude that multiple health hazards existed at this facility, including overexposures to 1,1,1-trichloroethane and MEK,

inadequate confined space entry program, ergonomic hazards, and inadequate personal protection. Mechanical and chemical trauma to the skin could occur in workers handling organic solvents, rubber adhesive, and rubber stock. The authors recommend measures for reducing solvent exposures, ergonomic problems, and heat stress, and for improving local exhaust ventilation, respirator selection, and personal protection.

2. Anchor Swan Division, Harvard Industries, Inc., Bucyrus, OH, August 1990.

HETA NO: 87-428-2063. 23 pp.

NTIS NO: PB91-151720 PRICE: Check NTIS

In response to a request from the management of Anchor Swan Division (SIC-3079) of Harvard Industries, Inc., Bucyrus, Ohio, an investigation was made of the incidence of carpal tunnel syndrome (CTS) among employees at the site. The facility employed about 600 workers in the manufacture of automotive, industrial and garden hoses. A self-administered questionnaire concerning musculoskeletal symptoms was mailed to all employees. Responses indicated that employees in the formed hose department reported hand/wrist pain and other CTS related problems lasting for at least 4 days about twice as frequently as did workers in all other manufacturing departments, and ten times more often than did office workers and sales employees. An ergonomic evaluation of pin and cure jobs and other potentially high exposure jobs was conducted, including braiding in the industrial hose department, coupling in the plastic hose department, and cut, trim, pack and assembly in the formed hose department. Ergonomic analysis indicated that the pin and cure and braiding jobs involved high levels of exposure to musculoskeletal stressors, that the coupling job had medium exposures, and that the cut, trim, pack and assemble had low to moderate exposures. The authors conclude that potential musculoskeletal hazards existed at the facility. The authors recommend specific measures to reduce the hazards.

3. Armco Composites, Hartford City, IN, February 1982.

HETA NO: 81-143-1041. 27 pp.

NTIS NO: PB83-201426 PRICE: Check NTIS

Occupational exposures to cured resin particulates, styrene monomer, and ergonomic stresses at Armco Composites (SIC-3079), Hartford City, Indiana were investigated. About 120 production employees work on site. The study was a result of a confidential request and was performed on March 1 and 12, and July 20 and 21, 1981. Air samples were analyzed and medical interviews were conducted with 29 workers and an ergonomic study was performed. Personal breathing zone time-weighted-average concentrations of cured resin particulates peaked at 20.1 milligrams per cubic meter (mg/m³). Two samples exceeded the OSHA standard of 15 mg/m³. Styrene values were all below the OSHA standard of 435 mg/m³. Eighteen employees exhibited early signs of carpal tunnel syndrome (CTS) with symptoms of nocturnal numbness, swelling, and pain. Postures assumed during work included wrist flexion and extension, ulnar and radial deviation of the wrist, and open hand pinch. These postures have been associated with CTS. The authors conclude that a health hazard did exist from tasks involving repetitive hand and wrist movements. Exposures to cured resin particulates exceeded the nuisance dust criteria. Recommendations for decreasing the incidence of CTS and exposure to cured resin dusts are provided.

4. Bennett Industries, Peotone, IL, June 1990.

HETA NO: 89-146-2049. 32 pp.

NTIS NO: PB91-115758 PRICE: Check NTIS

In response to a request from the International Chemical Workers Union an evaluation was undertaken of potential ergonomic hazards to workers involved in the production of metal and plastic containers at Bennett Industries (SIC-3070), Peotone, Illinois. Bennett Industries was involved in the manufacture of small to medium sized plastic and metal containers and

employed 181 individuals. Several cases of carpal tunnel syndrome had been reported. An ergonomic evaluation of tasks in the plastics container division classified the jobs of shrink ring operator, cutter and handle attacher as high risk for the development of cumulative trauma disorders (CTDs). Jobs in the metals division were assessed as low to moderate risk. A questionnaire survey indicated that the prevalence of upper extremity pain was higher among workers in the plastics division compared to those in the metals division. Two job tasks, shrink ring operator and cutter, were identified with 83% of the reported CTD cases from January 1986 through June of 1989. These two job tasks involved only 15% of the workforce. The authors conclude that an upper extremity CTD hazard existed in the plastics containers division for these two jobs. The authors recommend that these tasks be redesigned.

5. Budd Company, North Baltimore and Carey, OH, June 1988

HETA NOS: 84-459-1905 and 84-110-1905. 87 pp.

NTIS NO: PB89-120588 PRICE: Check NTIS

In response to confidential requests, a study was undertaken of possible hazardous working conditions at the Budd Company (SIC-3079) locations in North Baltimore and Carey, Ohio. Concern was expressed over worker exposure to isocyanates, methylene chloride (MeCl), and other chemicals. The Budd Company produced molded plastic automobile body parts and skis in compression mold presses from sheet molding compound. Primary sources of worker exposures to MeCl were in the prime wipe operation, and the use of MeCl as a general cleaning solvent at various jobs and locations. MeCl exposures ranged up to 239 ppm; NIOSH has recommended that levels be maintained at the lowest feasible level. All but one of the time-weighted-average exposures to styrene were below the recommended limits. Some association was found between MeCl exposure and neurological symptoms. There were also associations between work

involving repetitive motion and hand and arm symptoms; jobs involving potential isocyanate exposure were also associated with irritative and respiratory symptoms. The authors conclude that a potential hazard existed from overexposure to MeCl. The authors recommend that measures be taken to reduce or eliminate MeCl exposures, that isocyanates be monitored continuously, and that jobs requiring repetitive motion be evaluated and redesigned.

6. Caldwell Manufacturing Company, Williamsport, MD, December 1990.
HETA NO: 88-361-2091. 21 pp.
NTIS NO: PB91-197368 PRICE: Check NTIS

In response to a request from Caldwell Manufacturing Company (SIC-3442), Williamsport, Maryland, an evaluation was undertaken of carpal tunnel syndrome in assembly department workers. Caldwell Manufacturing employed about 65 hourly workers in the manufacture of window balance systems. A medical evaluation and an ergonomic evaluation were conducted. All of the assembly line jobs appeared to involve risk factors commonly associated with cumulative trauma disorders of the upper extremity: numerous hand/wrist manipulations, in combination with varying degrees of force and deviated wrist positions. At the time of the survey there were 5 medically confirmed cases of carpal tunnel syndrome and 6 additional possible cases among the 28 assembly workers. Two tasks were determined to represent the greatest risk: pulling springs to attach them to window liners, and hooking springs. In addition, defective material and pressure to increase production were identified as contributing factors. The authors conclude that a carpal tunnel syndrome hazard existed at the facility. The authors recommend specific measures to minimize the risk of carpal tunnel syndrome.

7. Cargill Poultry Division, Buena Vista, GA, November 1989.
HETA NO: 89-251-1997. 51 pp.
NTIS NO: PB90-183989 PRICE: Check NTIS

In response to a request from OSHA, an evaluation was made of cumulative trauma disorders (CTDs) reported among employees at the Cargill Poultry Division (SIC-2016), Buena Vista, Georgia. The facility produced boneless chicken products for wholesale distribution. There were two shifts in operation. The first shift slaughtered, eviscerated, dissected, deboned, and packaged chickens. The second shift only dissected, deboned, and packaged. Most of the 490 workers were employed in the deboning department. There were 143 upper extremity (UE) CTDs recorded on the OSHA 200 logs during 1988. Questionnaires were given to 112 workers selected by job title. Based on the findings along with physical examinations of these 112 workers, a high prevalence of UE CTDs, particularly of the hand/wrist type, was found among current employees. There was a high employee turnover at this facility. Several steps had been taken by the company to curb CTD problems at this site. The authors conclude that an upper extremity cumulative trauma disorder hazard existed at this facility. The authors recommend specific measures to prevent or reduce morbidity.

8. Chef Francisco, Inc., Eugene, OR, January 1985.
HETA NO: 83-053-1554. 16 pp.
NTIS NO: PB86-108362 PRICE: Check NTIS

A health hazard evaluation at Chef Francisco, Incorporated (SIC-2038), Eugene, Oregon, was conducted. The evaluation was requested by teamsters Local 670 due to a high incidence of musculoskeletal disorders among employees that were thought to be job-related. Ergonomic

assessments of selected jobs in the soup, and new and old bakery departments were performed. The OSHA log of injuries and illnesses and company medical records were reviewed. Several jobs were identified that imposed stressful ergonomic demands such as unaided heavy lifting and transporting of loads, repetitive lifting that involved twisting of the trunk, excessive lifting and reach distances, and fatiguing postures and motions of the trunk and upper limbs. A total of 146 injuries were reported during the period January, 1982 to May, 1983. Of these, 24 were related to pulled muscles, bursitis, tendinitis, or arm numbness, 21 to hand and wrist problems, 21 to smashed appendages, and 20 to back strains. The authors conclude that manual material handling jobs were potentially hazardous to workers at the facility. Recommendations include providing safety and accident training for new employees and moving or redesigning equipment to reduce stress during heavy lifting or transporting of loads.

9. Devil's Lake Sioux Manufacturing Corporation, Fort Totten, ND, July 1987.
HETA NO: 87-097-1820. 20 pp.
NTIS NO: PB88-153234 PRICE: Check NTIS

In response to a request from employees at the Devil's Lake Sioux Manufacturing Corporation (SIC-2352) located in Fort Totten, North Dakota, a study was made to determine a possible health hazard from n-hexane exposure and other organic solvents used in the manufacture of Kevlar combat helmets at this facility. Ten women working as edgers had been treated for carpal tunnel syndrome. Air samples revealed concentrations of xylene ranging from not detectable to 6.44 mg/m³, toluene ranging from 0.46 to 33.2 mg/m³, hexane ranging from 0.27 to 83.3 mg/m³, and methyl ethyl ketone ranging from 20.0 to 310 mg/m³. These levels were highest in the areas of the facility where edgers and glue spray booth operators worked. The author concludes that solvent exposures in these locations posed a potential health hazard. The carpal tunnel syndrome complaints appear to be related to

ergonomic factors. The author recommends the substitution of less toxic materials in the workplace; applying proper engineering controls; improving local exhaust ventilation; providing protective clothing for workers; sampling of employees for organic solvent exposure at regular intervals; and informing the employees of all hazards inherent in their work.

10. Eagle Convex Glass Company, Clarksburg, WV, January 1990.
HETA NO: 89-137-2005. 48 pp.
NTIS NO: PB91-108134 PRICE: Check NTIS

In response to a request from the management of Eagle Convex Glass Company (SIC-3231), Clarksburg, West Virginia, an evaluation was made of possible worker exposure to hazardous conditions resulting in occupational pneumoconiosis, hearing loss, and cumulative trauma disorders. The company produced a wide variety of speciality glass products for the automotive, furniture, and major appliance industries, employing 171 workers over 3 shifts. Hydrofluoric acid concentrations ranging from 0.34 to 3.0 mg/m³ were measured in the etching department. Analysis of the two solvents used in the decorating department indicated one contained mostly C10 to C11 alkyl substituted benzenes plus naphthalene. The following compounds were also identified: trimethylbenzene, methyl ethyl benzene, and indan. Noise levels in excess of the NIOSH recommended exposure level of 85 decibels-A, as a time-weighted-average, were found in some departments. Respirable dust levels ranged from 0.08 to 0.20 mg/m³. Symptoms consistent with hand/wrist, shoulder, and neck cumulative trauma disorders were noted among 20 to 30 percent of the workers in the decorating, processing, mirror and polishing departments. The authors conclude that some workers were potentially exposed to cumulative trauma, acid mists, and noise. The authors recommend specific measures, including work practices, ergonomic changes, a hearing conservation program, and a respiratory protection program.

11. Electric Machinery-McGraw Edison Company, Minneapolis, MN, April 1985.
HETA NO: 81-466-1591. 37 pp.
NTIS NO: PB86-133758 PRICE: Check NTIS

Environmental and breathing zone samples were analyzed for amines, aliphatic aldehydes, boron trifluoride monoethylamine, epichlorohydrin, total volatile fluorides, formaldehyde, lead, methyl tetrahydrophthalic anhydride, and n-butyl glycidyl ether at Electric Machinery/McGraw Edison Company (SIC-3621), Minneapolis, Minnesota in December, 1981 and February, 1983. The surveys were requested by the union local because of irritative symptoms and respiratory problems reported by employees exposed to epoxy resin compounds and impregnated materials. Medical questionnaires were administered to 51 employees in the hand taping and pole winding departments and 57 comparisons. Formaldehyde, acetaldehyde, and lead were the only contaminants detected. All concentrations were below their OSHA standards. Skin rash and irritation, eye irritation, and throat irritation were the most frequently reported symptoms. Fifty-six percent of the exposed workers had evidence of carpal tunnel syndrome versus seven percent of the comparisons. The authors conclude that mucous membrane irritation and dermatitis are common among workers exposed to epoxy resins. A high prevalence of carpal tunnel syndrome was also found. Recommendations include reducing formaldehyde concentrations, using personal protective equipment and barrier creams, and maintaining proper work practices and good personal hygiene to minimize contact with epoxy resin materials.

12. FL Thorpe & Company, Inc., Deadwood, SD, August 1991.
HETA NO: 90-273-2130. 34 pp.
NTIS NO: PB92-133321 PRICE: Check NTIS

In response to a request from FL Thorpe and Co. (SIC-3911), Deadwood, South Dakota, an evaluation was made of the upper extremity musculoskeletal disorders among their employees.

The company manufactured gold jewelry for wholesale and retail distribution and has been in operation since 1878. The facility employed 115 people, 105 of whom were production employees. Work activities were video taped for analysis. Posture, force and static muscle contraction hazards were present in most jobs; two jobs involved exposure to hand/wrist vibration. All production employees completed a questionnaire designed to gather information on upper extremity musculoskeletal disorders. Of the 94 employees tested, 76 reported symptoms. Neck symptoms were reported most frequently (60%), but the hand/wrist area contained the most reported work-related musculoskeletal symptoms. The bright cut, wriggle, and wax departments had the highest prevalence of employees with these disorders. In 1989 and 1990, seven employees were diagnosed with carpal tunnel syndrome by local physicians. All were given at least 5 weeks off to recover from their carpal tunnel release surgery. The authors conclude that an upper extremity musculoskeletal hazard existed at this facility. The authors recommend the development of an ergonomics program, including specific engineering interventions.

13. Flexfab, Inc., Hastings, MI, September 1991.
HETA NO: 89-267-2139. 48 pp.
NTIS NO: PB92-133230 PRICE: Check NTIS

In response to a confidential request, an evaluation was made of possible adverse health effects related to workplace exposures at Flexfab, Inc. (SIC-3052), Hastings, Michigan. Flexfab manufactured lightweight, flexible, nonmetallic parts for the automotive, trucking, aircraft, aerospace, and other industries as well as for the government and military. These products included flexible hose, ducts, and connectors made of silicones, neoprenes, and other elastomers. A workforce of approximately 285 hourly employees operated 3 shifts per day. The results of the study showed that the workers operating the mills in the rubber room were at risk of exposure to crystalline silica and that workers applying the sealant to

flexible utility dusts were exposed to levels of tetrahydrofuran near the action limit. There was also a high incidence of upper extremity cumulative trauma disorders at this company. The authors conclude that the workers who operated the mills in the rubber room were at risk of exposure to crystalline silica. Workers who applied sealant to flexible utility ducts were exposed to tetrahydrofuran at levels near the action limit. The authors recommend that modifications be made to the ventilation system in an effort to reduce chemical and dust exposures. Specific measures to prevent and control cumulative trauma disorders are recommended.

14. Genie Home Products, Shenandoah, VA, January 1987.

HETA NO: 85-480-1771. 28 pp.

NTIS NO: PB87-205951 PRICE: Check NTIS

In response to a request from the International Union of Electronic, Electrical, Technical, Salaried and Machine Workers in Shenandoah, Virginia, an investigation was made of the health effects of repetitive motions required in many of the jobs at Genie Home Products, Inc. (SIC-3699), Shenandoah, Virginia. Remote control garage door openers, motorized remote control switches, heavy duty rotators, and antenna rotors were produced at this facility. Data were gathered concerning the number of injuries and workers' compensation reports as they related to job activities, symptoms, and illnesses for 1984, 1985, and January through March of 1986. The incidence of hand/wrist cumulative trauma disorders (CTDs) was significantly reduced over this period of time. Many of the job interventions undertaken at Genie during this time, particularly the torque limiters on the air powered nut drivers, represented not only technology and design that reduced stressful work postures, but also facilitated production. The author concludes that ergonomic improvements in jobs where workers had experienced CTDs have reduced the incidence

of these disorders over the previous 2 years. Recommendations are made by the author for further reducing biomechanical demand on some specific jobs.

15. Harley-Davidson, Inc., Milwaukee, WI, September 1990.

HETA NO: 90-134-2064. 48 pp.

NTIS NO: PB91-184531 PRICE: Check NTIS

In response to a request from the Allied Industrial Workers, the International Machinist Unions, and management, an investigation was undertaken of possible hazardous working conditions at Harley-Davidson, Inc. (SIC-3751), Milwaukee, Wisconsin. The facility manufactured and assembled motorcycle parts 24 hours a day, 7 days a week. An ergonomic evaluation of job risk factors for musculoskeletal disorders at the flywheel milling area was performed, and employee medical record data were reviewed. The cumulative weight handled in lifting and transporting flywheels during the milling process was in excess of 14 tons for one worker and in excess of 9 tons for another worker. Data gathered indicated that potential musculoskeletal disorders could result at the elbow, shoulder, back, and hip during manual handling of the flywheel during the milling process. Job risk factors which may cause disorders included manual transport of the flywheel between milling processes, placement of the flywheel in the milling machinery, and removal of this part when milling was complete. Hand and wrist disorders may also result from exposure to hazardous vibration frequencies from a hand held power grinder used to remove metal burrs from milled flywheels and during manual tightening of this part onto the index milling machine. The authors conclude that musculoskeletal hazards existed for the upper limbs and back.

16. Harvard Industries, Inc., Trim Trends Division, Bryan, OH, July 1992.
HETA NO: 91-086-2235. 35 pp.
NTIS NO: PB93-119915 PRICE: Check NTIS

In response to a request from management and the Allied Industrial Workers of America, an investigation was made of possible hazardous working conditions in the Trim Trends Division of Harvard Industries (SIC-3442), Bryan, Ohio. Concern was expressed about exposure to welding fumes and grinding dust, and repetitive motion. The company manufactured automobile parts including window sashes, spinners (transmission parts), stampings, and door beams. There were 230 hourly employees at the time of the site visit. Sample concentrations for iron, magnesium, manganese, and zinc were below existing guidelines and standards. One personal breathing zone sample for a welder contained 0.167 mg/m³ copper fume, while the NIOSH recommended exposure limit was 0.1 mg/m³. Videotape of work activities indicated that many of the production jobs exposed employees to risk factors commonly associated with upper extremity cumulative trauma disorders including repetitive hand/wrist movements and excessive manual force application. The greatest risk was associated with the grinding task during which workers were also exposed to vibration. The authors conclude that a potential health hazard for upper extremity cumulative trauma disorders existed for workers in the welding and grinding areas. The authors recommend specific measures to reduce the ergonomic risk factors and improve safety conditions.

17. ICI Americas, Inc., Charlestown, IN, May 1983.
HETA NO: 83-142-1431. 11 pp.
NTIS NO: PB85-184125 PRICE: Check NTIS

An evaluation of the incidence of ganglionic cysts and tendonitis at ICI Americas, Incorporated (SIC-3483), Charlestown, Indiana, was conducted in May 1983. The request for evaluation was made by the International Chemical Workers

Union due to the occurrence of nine cases of ganglionic cysts and two of tendonitis among quality assurance personnel working on load lines 5A, 6A, 6B, and 2B. The evaluation consisted of observing work practices and job tasks, employee interviews, and a questionnaire survey. Jobs on load lines 5A, 6A, and 6B were the most physically stressful. The most stressful work posture involved carrying 28 pound ammunition charges with both hands at the end of the charge. The proportion of employees reporting somatic complaints involving upper extremities, back, and lower extremities ranged from 19 to 42 percent. Thirty-one percent of the employees reported a lesion diagnosed as a ganglionic cyst. The authors conclude that quality assurance personnel perform certain tasks that may be associated with the development of cumulative trauma disorders such as ganglionic cyst. Recommendations include carrying the charges by cradling them, and management evaluation of production personnel for biomechanical health problems.

18. ICI Americas, Inc., Indiana Army Ammunition Plant, Charlestown, IN, December 1987.
HETA NO: 85-534-1855. 30 pp.
NTIS NO: PB88-204524 PRICE: Check NTIS

In response to a request from the International Chemical Workers Union, a study was made of carpal tunnel syndrome, ganglionic cysts, and tendonitis of the wrists in production workers at ICI Americas, Inc. ammunition facility (SIC-3483) in Charlestown, Indiana. About 1800 workers were employed in the assembly of solid propellant charges used to propel projectiles. Questionnaires were completed by 463 production workers. Workers in the assembly, lace, and tie job classification had the highest prevalence of upper extremity symptoms. Ergonomic evaluations were performed on the six jobs having the highest incidence of upper extremity symptoms. Analysis of the video tapes indicated the tying of pull straps on the propellant charges to be one of the most difficult tasks performed by these workers. Movements were highly repetitive,

caused awkward and forceful manipulations of the hand and wrist, and involved many factors causally related to cumulative trauma disorders. Additional problems included excessive reach distances, improper work height, and improper seated work postures. The authors conclude that this production work is associated with a high prevalence of musculoskeletal disorders. The authors recommend specific improvements in each job. Training sessions should be conducted to instruct the workers how to accomplish their given tasks with less bodily strain. All hand and wrist injuries should be reported to their employer and accurate records should be kept.

19. John Morrell & Co., Sioux Falls, SD, April 1989.

HETA NO: 88-180-1958. 42 pp.

NTIS NO: PB90-128992 PRICE: Check NTIS

In response to a request from OSHA, technical assistance was rendered in evaluating possible harmful working conditions at John Morrell and Company (SIC-2011), Sioux Falls, South Dakota. This facility employed about 2000 workers in the production of beef and pork products, predominantly for wholesale distribution. Cumulative trauma disorders (CTDs) were diagnosed 880 times in a 1-year period, for an upper extremity CTD incidence rate of 41.7 per 100 full-time workers per year, which was high when compared to the 6.7 incidence rate reported for the meat packing industry. Videotapes were made of 185 jobs for ergonomic evaluation. Based on these tapes, 14 jobs were considered to be low risk, 114 jobs were intermediate risk, and 57 jobs were high risk for developing upper extremity CTDs. The strongest predictor of hand/ wrist CTDs was vibration, followed by force as measured by peak effort. A higher than expected incidence of carpal tunnel syndrome was also diagnosed. The authors conclude that an upper extremity CTD hazard existed at the time of the survey. The authors recommend engineering changes to reduce the job demands of high

repetition, high force, and extreme postures. Administrative changes were suggested to reduce the hazards including training, job rotation, rest pauses, and changes in the temperatures of the work rooms. Other recommended changes included employee education, early detection, slowing the work pace on returning to work, and the institution of a medical reevaluation of the capability of the worker to return to work.

20. KP Manufacturing Company, Minneapolis, MN, March 1983.

HETA NO: 81-375-1277. 85 pp.

NTIS NO: PB84-209717 PRICE: Check NTIS

The existence of excessive musculoskeletal demands associated with particular jobs was investigated at KP Manufacturing Company (SIC-3499), Minneapolis, Minnesota in September 1981 and February 1982. The survey was requested by management and the United Electrical, Radio and Machine Workers of America Union Local 1139 on behalf of 157 employees. Nineteen complaints of hand, wrist, and forearm problems were recorded in a 2-year period. These were diagnosed as carpal tunnel syndrome. Eight employees required surgery. Nine of the complaints were reported by production workers, while ten were in assembly. Production complaints could not be attributed to any specific job. A walk-through tour was conducted to identify problem areas. Still photographs and motion pictures were taken of problem areas for further evaluation. After reviewing the films, an in-depth ergonomic study of 15 jobs was performed. Operators were forced to assume fatiguing postures. Excessive radial deviation of the hand and excessive hand forces were required in some jobs. Other problems were reaching excessive distances and performing excessive bending motions. The author concludes that poor orientation of worker position to machines and parts presented risks to the musculoskeletal system. Risk factors associated with overexertion should be reduced.

21. Longmont Turkey Processors, Inc., Longmont, CO, April 1988.
NO: 86-505-1885. 32 pp.
NTIS NO: PB89-106546 PRICE: Check NTIS

In response to a request from the United Food and Commercial Workers Union Local 7, an evaluation of possible hazardous working HETA conditions was made at the Longmont Turkey Processors, Inc. (SIC-2017), Longmont, Colorado. The facility processed live turkeys and some partially processed chilled or frozen birds. Workers were concerned about carpal tunnel syndrome (CTS) and other musculoskeletal injuries. Injuries to personnel were reviewed, based on OSHA logs and facility medical logs. Job types were classified as high, intermediate, or low in risk for incurring a repetitive trauma injury due to job performance. Persons employed in boning, bird hanging, evisceration, production, and raw manufacturing were more likely to experience difficulties than those who fell in jobs classified as low risk. Video tapes of 14 production jobs in the eviscerating department and 22 in the boning and specials lines were analyzed. One primary risk factor involved the number of cuts made per day. Considerable under-reporting of incidents was noted in the OSHA logs. The authors conclude that identifiable groups of workers are at greater risk for developing carpal tunnel syndrome and repetitive strain disorders. The authors recommend specific actions which should be taken to control biomechanical hazards.

22. Los Angeles Times, Los Angeles, CA, January 1993.
HETA NO: 90-013-2277. 126 pp.
NTIS NO: PB93-188456 PRICE: Check NTIS

In response to a request from the management of the Los Angeles Times (SIC-2711), an investigation was made of the occurrence of work-related musculoskeletal disorders among workers using video display terminals at the facilities located in Los Angeles and in Costa Mesa, California. Of 1050 eligible employees, 973 participated in the study. Symptoms meeting the

case definition for at least one upper extremity work-related disorder were reported by 395 of the participants. The most common symptoms were problems of the neck (26%), the hand/wrist (22%), the shoulder (17%), and the elbow (10%). The department with the largest number of employees reporting symptoms was the Circulation Department followed in decreasing order of frequency by the Accounting and Finance Department, Classified Department, and Editorial Department. Women were more likely to report symptoms. The authors conclude that a high prevalence of possibly work-related musculoskeletal disorders and symptoms was observed. The authors recommend specific measures to lessen this problem at these work locations.

23. Miller Electric Company, Woonsocket, RI, June 1982.
HETA NO: 81-217-1086. 23 pp.
NTIS NO: PB83-202119 PRICE: Check NTIS

In June of 1981, a preliminary ergonomic evaluation at the Miller Electric Company (SIC-364), Woonsocket, Rhode Island, was conducted. During prior surveys, cumulative strain disorders had been reported. The workforce comprises 415 production workers, who are mostly female. Observation of jobs revealed that repetitive flexion and extension of the wrist, radial and ulnar deviations, and pinching were commonplace. Stressful motions in particular jobs included: wrist flexion while inserting blades into the fixture on the Miller Molder; extension and ulnar deviation of wrists while performing the blading operation; and open hand pinching while packing light socket assemblies. The author concludes that a hazard of developing musculoskeletal disorders of the hand and wrist existed. These disorders are likely to continue unless work practice modifications are implemented. Biochemical stresses could be reduced by workplace redesign and administrative controls.

24. Minneapolis Police Department, Minneapolis, MN, November 1986.
HETA NO: 84-417-1745. 10 pp.
NTIS NO: PB87-185591 PRICE: Check NTIS

A request was made by the American Federation of State, County and Municipal Employees to examine reasons for diagnoses of carpal tunnel syndrome and tendinitis occurring in the wrists of clerical workers at the Minneapolis Police Department (SIC-9221). Police transcribers are responsible for typing all pertinent information relating to arrests made by law enforcement officers. The typed copies are made on multi-carbon report forms. When completed, the copies are hand separated and distributed into mail boxes for dissemination to other areas. Of the 33 clerk/typists available, 10 were full-time police transcribers covering 3 shifts, 7 days a week. Ergonomic measurements were taken from 12 employees of the transcription, homicide, and juvenile departments during normal operating hours. In general, those individuals who reported symptoms were found to type with their wrists in extension (24 degrees) beyond the normal typing position of 10 to 15 degrees. Employees who had been employed for shorter periods of time in the transcription department appeared to be at the greater risk for wrist problems. It is recommended that wrist rests be provided for the typists. Chairs should also be of the kind where quick adjustment of the seat height and the height and angle of the back support are possible. Typing tables must be adjustable in height, have adequate knee clearance horizontally and vertically, and have adequate surface areas for the typewriter and documents being processed.

25. Newsday, Inc., Melville, NY, May 1990.
HETA NO: 89-250-2046. 76 pp.
NTIS NO: PB91-116251 PRICE: Check NTIS

In response to a request from the Graphics Communication International Union and the Management of Newsday, Inc. (SIC-2711), Melville, New York, a study was undertaken of cumulative trauma disorders (CDT) among

employees. Newsday published a daily newspaper and employed about 4,600 persons at several offices on Long Island, New York, and in New York City. A survey was conducted to estimate the prevalence of CTD among the employees, determine whether CTD symptoms occurred more often in particular jobs or departments, and determine whether there was any relation between the use of computer keyboards or other job-related factors and CTD symptoms in this group of workers. Of the 834 participating employees, 331 (40%) reported symptoms consistent with upper extremity CTDs during the past year. The most prevalent were hand/wrist symptoms followed by symptoms of the neck, elbows/forearm, and shoulder. The authors conclude that a hazard for upper extremity cumulative trauma disorders existed at these facilities. The authors recommend establishing a joint labor management committee to oversee ergonomic control measures, early recognition of symptoms, and evaluation of the effectiveness of interventions.

26. Perdue Farms, Inc., Lewiston and Robersonville, NC, February 1990.
HETA NO: 89-307-2009. 38 pp.
NTIS NO: PB91-104620 PRICE: Check NTIS

In response to a request from the North Carolina Department of Labor for technical assistance in evaluating cumulative trauma disorders (CTDs) of the neck and upper extremity, an investigation was made at two Perdue Farms facilities (SIC-2016) located in North Carolina at Lewiston and Robersonville. Concerns included repetitive and forceful motions and/or extreme and awkward postures of the upper extremity. Perdue Farms, Inc. produced and packaged boneless chicken products, chicken parts, and whole chickens for wholesale distribution. About 2,600 workers were employed at the Lewiston facility, processing over 420,000 chickens/day. About 550 workers were employed at the Robersonville facility, processing over 120,000 chickens/day. Jobs were classified into higher exposure (HE) or lower exposure (LE) groups. Questionnaires, and physical examinations were administered to groups of

workers. Questionnaire results indicated that 36% of the 174 employees participating at the Lewiston site had evidence of work-related CTDs, largely involving the hand and/or wrist. Workers in HE jobs were 4.4 times more likely than employees in the LE jobs to have these difficulties. At the Robersonville site, 20 percent of the 120 participants had similar findings. The author concludes that a neck and upper extremity CTD hazard existed at these facilities. The author recommends some specific measures to prevent and manage CTDs at both sites.

27. Point Adams Packing Company, Hammond, OR, April 1986.
HETA NO: 83-251-1685. 11 pp.
NTIS NO: PB87-108312 PRICE: Check NTIS

Management of Point Adams Packing Company (PAPCO) (SIC-0912), Hammond, Oregon initiated a request for an evaluation concerning the excessive number of cases of carpal tunnel syndrome, tendinitis, and other musculoskeletal disorders suffered by filleters, trimmers, and slimmers at the fish filleting facility. An ergonomic evaluation was conducted on June 6 and 7, 1983; 145 production workers were employed at that time. Based on observations and a review of videotapes and still photographs, the authors conclude that a combination of factors seems to be associated with the musculoskeletal injuries afflicting these workers. These included: work rate, awkward hand and wrist deviations, use of gloves that compromise grip strength, cold temperature, use of high muscular forces for prolonged periods, excessive workplace reaches and heights that stress shoulder muscles, and improper tool handle design. Recommendations are offered for workplace modification, tool redesign, and training with the ultimate goal of reducing or eliminating biomechanical hazards associated with the development of cumulative trauma disorders.

28. Schnuck's, National, & Dierberg's Supermarkets, St. Louis, MO, April 1993.
HETA NO: 92-294-2301. 23 pp.
NTIS NO: PB94-110376 PRICE: Check NTIS

In response to a request from Local 655 of the United Food and Commercial Workers Union, an investigation was made into biomechanical hazards at the checker unload workstations in supermarkets (SIC-5411) in St. Louis, Missouri. An ergonomic evaluation was undertaken at three supermarket chains (Dierberg's, Schnuck's, and National). Videotaping and photography were performed of cashier work activities at each of these locations. The dimensions of the checkout stand and the grocery carts were also determined. All three chains required the cashier to unload the customer's cart for scanning. Two chains used shallow carts designed for cashier unload operations, while one used conventional carts. An analysis was undertaken of cashier postures and movements during grocery scanning activities. Data were compared to similar information obtained from workers where grocery items were unloaded by the customer and placed on conveyors. The use of checker unload workstations increased the normal degree of stress on the cashier, which may exacerbate the risk of musculoskeletal disorders associated with this job. The frequency of long reaches was increased, as were awkward shoulder postures and lifts. The authors conclude that a health hazard existed at these supermarkets from excess biomechanical stress due to the use of checker unload checkstands. The authors recommend that such checker unload stations be replaced by customer unload stations.

29. Schulte Corporation, Cincinnati, OH, September 1991.
HETA NO: 90-232-2138. 23 pp.
NTIS NO: PB92-133263 PRICE: Check NTIS

In response to a confidential request from employees of the Schulte Corporation (SIC-3496), Cincinnati, Ohio, an evaluation was undertaken of complaints of chest tightness, itching, metallic

taste in the mouth, and discharge of black dust from the noses of workers in the machine shop of the facility. The facility was involved in the manufacturing and shipping of epoxy coated steel wire shelving. Total dust samples taken in the breathing zone of the workers ranged from 0.49 to 4.78 mg/m³, well below the permissible limits. Respirable dust samples ranged from 0.05 to 0.43 mg/m³. Exposures to nitrogen oxides were well below acceptable limits. Aldehydes were not detected in samples evaluating exposure to two resistance welders. The NIOSH ceiling level of 0.1 part per million for ozone was exceeded near welders. Six workers interviewed reported symptoms including black nasal discharge, headaches, sore throat, cough, hoarseness of voice, metallic taste and chest tightness. There was a potential ergonomic problem due to repetitive wrist motion. The authors conclude that a potential hazard from ozone exposure existed. The authors recommend measures to reduce exposures and development of a program for the prevention of cumulative trauma.

30. Scott Molders, Inc., Kent, OH, July 1992.
HETA NO: 91-003-2232. 21 pp.
NTIS NO: PB93-119360 PRICE: Check NTIS

In response to a request from the Allied Industrial Workers of America, a health hazard evaluation was conducted at Scott Molders (SIC-3089), Kent, Ohio regarding ergonomic concerns and potential exposures to ammonia, fibrous glass, formaldehyde, phenol, and styrene. The company employed about 70 workers in molding plastic and fibrous glass parts of automotive, military and custom order clients. Workers were observed and videotaped in the molding and finishing areas. The major upper extremity stressors of these jobs were postural and muscular force demands which occur while performing the following task elements: unloading parts from molding machines and breaking or cutting off the excess plastic from parts; filing, reaming and sanding flashing from parts; reaching to activate press control buttons; and reaching to dispense completed parts into boxes or barrels. A general ergonomic risk factor

for all workers was prolonged standing. Eight of 21 workers gave histories consistent with cumulative trauma disorders, and 4 workers had undergone surgery for chronic carpal tunnel syndrome. All air quality readings taken indicated that the levels of fibrous glass molding materials and other chemicals were within acceptable limits. The authors conclude that there were exposures to several postural and muscular force stressors. There were no overexposures to the chemicals. The authors recommend redesigning several work areas to minimize ergonomic stressors and reduce exposure to the chemical substances.

31. Shoprite Supermarkets, NJ-NY, January 1991.
HETA NO: 88-344-2092. 63 pp.
NTIS NO: PB91-212431 PRICE: Check NTIS

In response to a request from the United Food and Commercial Workers Union in Clifton, New Jersey, NIOSH conducted an evaluation of possible hazardous working conditions at the Shoprite Supermarkets (SIC-5411) located in New Jersey and New York. The nature of the problem involved cumulative trauma disorders (CTDs) among employees serving as checkers. CTDs occurred in workers whose jobs required repetitive exertion, most often of the upper extremities. Multiple logistic regression (MLR) analysis revealed elevated odds ratios for checkers compared to noncheckers for all parts of the upper extremities. However, only the associations for shoulder and hand were statistically significant. MLR analysis of the checkers alone revealed a statistically significant dose response relationship between checking and disorders for all parts of the upper extremities. Differences were also noted between prevalences of disorders in those using different checkstand designs. The ergonomic analysis examined repetitiveness, posture and efficiency of movements for the different checkstand designs. The total repetitions per hour based on normal customer orders ranged from 1,432 to 1,782 for the right hand and 832 to 1,260 for the left hand. Multiple awkward postures were detected involving all parts of the upper

extremities. Recommendations were made for ergonomically improving checkstand design as well as temporarily altering the existing checkstand designs.

32. Standard Publishing Company, Cincinnati, OH, May 1989.

HETA NO: 84-187-L1966. 11 pp.

NTIS NO: PB89-230528 PRICE: Check NTIS

In response to a request from the management of the Standard Publishing Company, Cincinnati, Ohio, an investigation was made of working conditions at the site which might be contributing to the incidence of carpal tunnel syndrome (CTS) and ganglionic cysts among employees engaged as machine helpers in the bindery area. A self-administered questionnaire was completed by 75 full-time employees in the bindery area to determine the frequency of wrist and forearm symptoms occurring in the preceding month. Questions also addressed specific diagnoses which had been rendered for certain wrist conditions. Eighteen workers were medically evaluated, and videotapes were made of these workers for ergonomic evaluation. Of four individuals identified as potential CTS cases, only one was considered to actually have CTS based on both initial and follow-up questionnaires and the results of a physical examination. In a subsequent review of OSHA 200 logs for 1978 through March of 1984, 17 conditions associated with cumulative or repeated trauma were uncovered among bindery workers. The author recommends that specific measures be taken to reduce postural stress.

33. The Donaldson Company, Inc., Dixon, IL, April 1983.

HETA NO: 81-409-1290. 25 pp.

NTIS NO: PB84-209758 PRICE: Check NTIS

Reports of carpal tunnel syndrome (CTS) and possible polyneuropathy among employees at Donaldson Company, Incorporated (SIC-3714), Dixon, Illinois were evaluated in August, 1981 and January and February, 1982. Evaluation was

requested by Teamsters Local 455. A detailed ergonomic evaluation was conducted followed by air sampling for perchloroethylene (PCE), vinyl chloride (VC), and freons. Company medical records of CTS cases over a 5-year period were reviewed. A medical survey of current employees was also conducted. A VC concentration of 0.29 parts per million (ppm) was found in an area sample which was lower than the NIOSH recommended ceiling. Air concentrations of individual freons ranged from 4.2 to 7.4 ppm which were considerably below OSHA standards. Three-hour time-weighted-average air concentrations ranged from 12.6 to 76.2 ppm; 15-minute ceiling concentrations were 14.2 to 103.1 ppm. Eighteen cases of CTS were diagnosed during the 5-year medical record review. The medical survey suggested CTS symptoms in 92 of 96 current employees; 6 reported numbness or tingling in the feet. Work practices in several departments which might induce or exacerbate CTS were identified. The investigators conclude that a potential health hazard from exposure to airborne PCE exists and recommend changes in work practices and tool design.

34. United States Postal Service, General Mail Facility, Denver, CO, July 1993.

HETA NO: 92-0073-2337. 21 pp.

NTIS NO: PB94-133824 PRICE: Check NTIS

In response to a confidential request from employees working at the Denver General Mail Facility (SIC-4311) in Colorado, an evaluation was undertaken of ergonomic hazards associated with the use of two types of automated mail processing machines, the Bar Code Sorter (BCS) and the Optical Character Reader (OCR). Subsequent requests asked that the study be expanded to include the Delivery Bar Code Sorter (DBCS), the Pitney-Bowes (PB) OCR, and the stool or rest bar used in the manual letter casing area. The OCR and sorters required a worker to feed mail and a worker to sweep mail out. Several hazards were identified which put the users of the equipment at risk for low back and upper

extremity musculoskeletal disorders. The tasks were moderately repetitive, and workers had to work in awkward positions when operating these automated mail processing machines. Design flaws at the DBCS sweeper position were deemed to be particularly hazardous. The authors recommend that several of the positions be automated, particularly the sweeping positions linked to mail processing machines. Changes should be made to eliminate extreme trunk flexion while retrieving trays of mail and to minimize the number of reaches to the tray racks while sweeping.

35. U.S. Army Corps of Engineers, North Central Division, Chicago, IL, January 1992.
HETA NO: 90-385-2173. 36 pp.
NTIS NO: PB92-176809 PRICE: Check NTIS

In response to a request from the Deputy Commander of the U.S. Army Corps of Engineers (SIC-4441), North Central Division, a study was made of possible hazards to maintenance and construction workers. The work force in question was involved in maintaining 18 dams and 22 lock chambers on the Mississippi River from Saverton, Missouri, to Guttenberg, Iowa and also on the Illinois Waterway from La Grange Lock and Dam to Chicago, Illinois. Data gathered through on site studies indicated that potential musculoskeletal disorders could result at the elbow, shoulder, back and hip during the manual material handling in the maintenance shop in Peoria, Illinois, at the Lock and Dam Facility among the lock persons and during lock maintenance and repair. Job tasks that involved ergonomic risk factors included manual handling and transport during a roller repair operation, tying off of barge ropes while barges are locking through, and grinding during repair of lock gates. Hand and wrist disorders may also result from exposure to vibration from a hand held power sander. The author concludes that musculoskeletal hazards existed for the upper limbs and back. The author recommends measures to lower the ergonomic risks to the workers.

36. U.S. West Communications, Phoenix, AZ, Minneapolis, MN, and Denver, CO, July 1992.
HETA NO: 89-299-2230. 61 pp.
NTIS NO: PB93-119329 PRICE: Check NTIS

In response to a request from US West Communications (SIC-4813) and the Communications Workers of America, an evaluation was undertaken of the effects of the use of video display terminals on the musculoskeletal systems of Directory Assistance Operators. A cross sectional study was made of 533 workers employed by the company in Phoenix, Minneapolis/St. Paul, and Denver. Information on the type of workstations, job requirements, and worker health was gathered. Two types of musculoskeletal outcomes were identified for analysis: potential work-related upper extremity musculoskeletal disorders defined by physical examination and questionnaire, and upper extremity musculoskeletal symptoms defined by questionnaire alone based on a cumulative score of symptom duration, frequency and intensity. The authors conclude that there was a high prevalence of potential work-related musculoskeletal disorders and symptoms. Factors associated with these disorders include demographics, prior medical conditions, work practices, psychosocial aspects of the workplace, and electronic performance monitoring. Most of the physical workstations observed were of high ergonomic quality. The psychosocial work environment may be related to the occurrence of work-related upper extremity musculoskeletal symptoms and disorders. The authors recommend specific measures to improve working conditions and possibly prevent and control musculoskeletal disorders.

37. WBZ-TV News, Boston, MA, July 1994.
HETA NO: 93-0860-2438. 12 pp.
NTIS NO: PB95-147260 PRICE: Check NTIS

In response to a confidential request from employees of WBZ-TV News, Boston, Massachusetts, a study was undertaken of carpal tunnel syndrome (CTS) and other musculoskeletal

problems among videotape editors. The medical component of the health hazard evaluation included a review of Occupational Safety and Health Administration injury and illness logs (OSHA 200 logs), pertinent medical records, and confidential interviews with employees. The ergonomic assessment was accomplished via walk-through inspections and videotape evaluation. Four medically-confirmed cases of carpal tunnel syndrome occurred among employees at this workplace within the past two years. Two CTS cases occurred among the eight videotape editors. Risk factors that have been associated with carpal tunnel syndrome and other musculoskeletal disorders were observed to be present in the videotape editing jobs. Several sources of musculoskeletal stress associated with news editing were identified, including suboptimal workstation and chair design. In addition, stressful work organization and psychosocial factors, including working under deadline pressure, and a lack of control over the workload, the work environment, and equipment were also identified. Recommendations include engineering and administrative controls, and the creation of a joint labor/management committee. Because of the upcoming move into a new facility, a unique opportunity exists to consider ergonomic principles when designing the new videotape editing rooms and workstations.

**38. Western Publishing Co., Racine, WI,
*June 1988.***

HETA NO: 84-240-1902. 40 pp.

NTIS NO: PB89-120562 PRICE: Check NTIS

In response to a request from the management of the Western Publishing Company Inc. (SIC-2732), Racine, Wisconsin, a study was made of cases of carpal tunnel syndrome (CTS) among workers. The company printed, bound, and packaged books, along with other printed materials including pamphlets, coupons, and playing cards. Ergonomic stress levels were compared for 11 workers diagnosed with probable CTS and 22 persons without musculoskeletal symptoms; CTS cases had higher stress scores for

all 4 body areas assessed. A review of the work-related injuries and illnesses at the facility identified a group of 25 cases with disorders associated with repeated trauma during the period from 1979 through 1984. The highest number of these injuries occurred in the cylinder press department; work in that area was repetitive, excessive force was required, postures were awkward, and vibrating tools were used. The rate of disorders associated with repeated trauma was seven times higher at this facility than at similar firms. The authors conclude that there was an association between work-related stresses and the development of cumulative trauma disorders at this facility. The authors recommend that action be taken to control ergonomic factors that may contribute to the rate of cumulative trauma disorders.

**39. Yorktowne, Inc., Mifflinburg, PA,
*August 1990.***

HETA NO: 88-384-2062. 30 pp.

NTIS NO: PB91-152082 PRICE: Check NTIS

In response to a request from company management, an on site visit was made to Yorktowne, Inc. (SIC-5712), a cabinet manufacturing company located in Mifflinburg, Pennsylvania. A high number of musculoskeletal disorders had been reported among the workers at that location. Approximately 450 full-time workers were employed at the site. A significant amount of work involved pushing, pulling, lifting, and carrying heavy materials. Selected jobs in raw materials handling, sawing, frame assembly, sanding and painting, cabinet assembly, and packaging/shipping departments were subjected to ergonomic assessments. Several jobs were identified that imposed potentially stressful biomechanical demands on the workers. These demands included fatiguing postures, repetitive lifting that involved twisting of the trunk and excessive reach distances, and repetitive motions of the trunk and upper limbs. Most injuries (70%) occurred during a worker's first year of employment. The authors conclude that certain tasks were potentially hazardous to workers at the

facility. The authors recommend the following: offering basic safety training to new employees, and moving or redesigning equipment to reduce stress during heavy lifting, pushing, and transporting of loads, and while performing repetitive motion tasks.

B. SELECTED NON-NIOSH PUBLICATIONS

This section includes references on cumulative trauma disorders selected from non-NIOSH sources. Copies of the references can be obtained from university or public libraries.

Amadio P [1985]. Pyridoxine as an adjunct in the treatment of carpal tunnel syndrome. *Journal of Hand Surgery* 10A(2):237-241.

Armstrong T, Castelli W, Evans F [1984]. Some histological changes in carpal tunnel contents and their biomechanical implications. *Journal of Occupational Medicine* 26(3):197-201.

Armstrong T, Fine L, Goldstein S, Lifshitz Y, Silverstein B [1987]. Ergonomics considerations in hand and wrist tendinitis. *The Journal of Hand Surgery* 12A(5)Part 2:830-837.

Armstrong T, Foulke J, Joseph B, Goldstein S [1982]. Investigation of cumulative trauma disorders in a poultry processing plant. *American Industrial Hygiene Association Journal* 43(2):103-116.

Armstrong T, Radwin R, Hansen D, Kennedy K [1986]. Repetitive trauma disorders: job evaluation and design. *Human Factors* 28(3):325-336.

Arndt R [1987]. Work pace, stress and cumulative trauma disorders. *Journal of Hand Surgery* 12A(2)Part 2:866-869.

Bauman T, Gelberman R, Murbarak S, Garfin S [1981]. The acute carpal tunnel. *Clinical Orthopaedics and Related Research* 156(May):151-156.

Birbeck M, Beer T [1975]. Occupation in relation to the carpal tunnel syndrome. *Rheumatology and Rehabilitation* 14(4):218-221.

BLS [1993]. Occupational injuries and illnesses in the United States by industry, 1991. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, Bulletin 2424.

BLS [1994]. Workplace injuries and illnesses in 1993. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, USDL 94-600.

Brain W, Wright A, Wilkinson M [1947]. Spontaneous compression of both median nerves in the carpal tunnel. *The Lancet* March:6443-6445.

Bruner J [1972]. Carpal tunnel syndrome. *The Hand* 4(3):220-223.

Cannon L, Bernacki E, Walter S [1981]. Personal and occupational factors associated with carpal tunnel syndrome. *Journal of Occupational Medicine* 23(4):255-258.

Das S, Brown H [1976]. In search of complications in carpal tunnel decompression. *The Hand* 8(3):243-249.

Dionne E [1984]. Carpal tunnel syndrome. Part I - the Problem. *National Safety News* 129(3):42-45.
(A copy of this article is in Part I, pages 143-146.)

Dionne E [1984]. Carpal tunnel syndrome - Part II: Some Answer. *National Safety News* 129(4):53-58.
(A copy of this article is in Part I, pages 147-152.)

Duncan K, Lewis R, Foreman K, Nordyke M [1987]. Treatment of CTS by members of the American Society for Surgery of the Hand: results of a questionnaire. *The Journal of Hand Surgery* 12A(3):384-390.

Feldman R, Travers P, Chirico-Post J, Keyserling W [1987]. Risk assessment in electronic assembly workers: carpal tunnel syndrome. *Journal of Hand Surgery* 12A(2) Part 2:849-855.

Feldman, R Goldman, R, Keyserling, W [1983]. Classical syndromes in occupational medicine. Peripheral nerve entrapment syndromes and ergonomic factors. *American Journal of Industrial Medicine* 4(5):661-681.

Fisette J, Onkelinx A [1979]. Treatment of carpal tunnel syndrome. Comparative study with and without epineurolysis. *The Hand* 11(2):206-210.

Franklin G, Haug J, Heyer N, Checkoway H, Peck N [1991]. Occupational carpal tunnel syndrome in Washington State, 1984-1988. *American Journal of Public Health* 81(6):741-746.

Franzblau A, Werner R, Valle J, Johnston E [1993]. Workplace surveillance for carpal tunnel syndrome: a comparison of methods. *Journal of Occupational Rehabilitation* 3(1):1-14.

Gelberman R, Hergenroeder P, Hargens A, Lundborg G, Akeson W [1981]. The carpal tunnel syndrome. A study of carpal canal pressures. *The Journal of Bone and Joint Surgery* 63A(3):380-383.

Gelberman R, Rydevik B, Pess G, Szabo R, Lundborg G [1988]. Carpal tunnel syndrome. A scientific basis for clinical care. *Orthopedic Clinics of North America* 19(1):115-124.

Green D [1984]. Diagnostic and therapeutic value of carpal tunnel injection. *The Journal of Hand Surgery* 9A(6):850-854.

Hagberg M, Morgenstern H, Kelsh M [1992]. Impact of occupations and job tasks on the prevalence of carpal tunnel syndrome. *Scandinavian Journal of Work, Environment and Health* 18(6):337-345.

Hagberg M, Nystrom A, Zetterlund B [1991]. Recovery from symptoms after carpal tunnel syndrome surgery in males in relation to vibration exposure. *The Journal of Hand Surgery* 16A(1):66-71.

Hales T, Bertsche P [1992]. Management of upper extremity cumulative trauma disorders. *American Association of Occupational Health Nursing Journal* 40(3):118-128.
(A copy of this article is in Part I, pages 119-129.)

Harter B [1989]. Indications for surgery in work-related compression neuropathies of the upper extremity. *Occupational Medicine: State of the Art Reviews* 4(3):485-495.

Hopkins A [1990]. The social recognition of repetition strain injuries: an Australian/American comparison. *Social Sciences & Medicine* 30(3):365-372.

Hudock S, Keran C [1992]. U.S. Bureau of Mines Information Circular No. 9319: Risk profile of cumulative trauma disorders of the arm and hand in the U.S. mining industry. Minneapolis, MN: Twin Cities Research Center, U.S. Bureau of Mines, 8 pp.

Hybbinette C, Mannerfelt L [1975]. The carpal tunnel syndrome. A retrospective study of 400 operated patients. *Acta Orthopaedica Scandinavica* 46(4):610-620.

Hymovich L, Lindholm M [1965]. Hand, wrist, and forearm injuries. The result of repetitive motions. *Journal of Occupational Medicine* 8(11):573-577.

Joseph B [1989]. Ergonomic considerations and job design in upper extremity disorders. *Occupational Medicine: State of the Art Reviews* 4(3):547-557.

Katz J, Larson M, Fossel A, Liane M [1991]. Validation of a surveillance case definition of carpal tunnel syndrome. *American Journal of Public Health* 81(2):189-193.

Katz J, Larson M, Sabra A, Krarup C, Stirrat C, Sethi R, Eaton H, Fossel A, Liang M [1990]. The carpal tunnel syndrome: diagnostic utility of the history and physical examination findings. *Annals of Internal Medicine* 112(5):321-327.

Keyserling W, Stetson D, Silverstein B, Brouwer M [1993]. A checklist for evaluating ergonomic risk factors associated with upper extremity cumulative trauma disorders. *Ergonomics* 36(7):807-831.

Kilbom A [1988]. Intervention programmes for work-related neck and upper limb disorders; strategies and evaluation. *Ergonomics* 31(5):735-747.

Kroemer K [1992]. Avoiding cumulative trauma disorders in shops and offices. *American Industrial Hygiene Association Journal* 53(9):596-604.

Kulick M, Gordillo G, Javid T, Kilgore E, Newmeyer W [1986]. Long-term analysis of patients having surgical treatment for carpal tunnel syndrome. *Journal of Hand Surgery* 11A(1):59-667.

Lanz U [1977]. Anatomical variations of the median nerve in the carpal tunnel. *The Journal of Hand Surgery* 2(1):44-53.

Laubli T [1987]. Preferred settings in VDT work: the Zurich experience. In: Knave B, Wideback P, eds. *Work with Display Units 86*, International Scientific Conference on Work with Display Units, Stockholm, Sweden. New York, NY:Elsevier Science Publishers, pp. 249-262.

Louis D [1987]. Cumulative trauma disorders. *The Journal of Hand Surgery* 12A(5)Part 2:823-825.

Lubbers L, Wilson C, Gordon C [1992]. Cumulative trauma disorders of the upper extremity. *Physical Medicine and Rehabilitation: State of the Art Reviews* 6(2):233-244.

Lynch R, Rodriguez A [1992]. Carpal tunnel syndrome: considerations for rehabilitation. *Journal of Applied Rehabilitation Counseling* 23(3):23-29

Masear V, Hayes J, Hyde A [1986]. An industrial cause of carpal tunnel syndrome. *The Journal of Hand Surgery* 11A(2):222-227.

McDermott F [1986]. Repetition strain injury: a review of current understanding. *The Medical Journal of Australia* 144(4):196-200.

Moore A, Wells R, Ranney D [1991]. Quantifying exposure in occupational manual tasks with cumulative trauma disorder potential. *Ergonomics* 34(12):1433-1453.

Pfeffer G, Gelberman R, Boyes J, Rydevic B [1988]. The history of carpal tunnel syndrome. *The Journal of Hand Surgery* 13B(1):28-34.

Phalen G [1972]. The carpal tunnel syndrome: clinical evaluations of 598 hands. *Clinical Orthopaedics and Related Research* 83(March-April):29-40.

Phalen G [1966]. The carpal tunnel syndrome: seventeen years' experience in diagnosis and treatment of six hundred fifty-four hands. *Journal of Bone and Joint Surgery* 48A(2):211-228.

Phalen G, Kendrick J [1957]. Compression neuropathy of the median nerve in the carpal tunnel. *Journal of the American Medical Association* 164(5):524-430.

Phillips R [1967]. Carpal tunnel syndrome as a manifestation of systemic disease. *Annals of the Rheumatic Diseases* 26(1):59-63.

Rempel D, Harrison S, Barnhart S [1992]. Work-related cumulative trauma disorders of the upper extremity. *Journal of the American Medical Association* 267(6):838-842.

Rodgers S [1987]. Recovery time needs for repetitive work. *Seminars in Occupational Medicine* 2(1):19-24.

Rothfleisch S, Sherman D [1978]. Carpal tunnel syndrome. Biomechanical aspects of occupational occurrence and implications regarding surgical management. *Orthopaedic Review* VII(6):107-109.

Silverstein B, Fine L, Armstrong T [1986]. Hand wrist cumulative trauma disorders in industry. *British Journal of Industrial Medicine* 43(11):779-784.

Skubick D, Calsby R, Donaldson S [1993]. Carpal tunnel syndrome as an expression of muscular dysfunction in the neck. *Journal of Occupational Rehabilitation* 3(1):31-44.

Smith E, Sonstegard D, Anderson W [1977]. Carpal tunnel syndrome: contribution of flexor tendons. *Archives of Physical Medicine and Rehabilitation* 58(9):379-385.

Spinner R, Bachman J, Amadio P [1989]. The many faces of carpal tunnel syndrome. *Mayo Clinic Proceedings* 64(7):829-836.

Stock S [1990]. Workplace ergonomic factors and the development of musculoskeletal disorders of the neck and upper limbs: a meta-analysis. *American Journal of Industrial Medicine* 19(1):87-107.

Stone W [1986]. Occupational overuse syndrome in other countries. *Journal of Occupational Health and Safety* 3(4):397-404.

Thorson E, Szabo R [1989]. Tendinitis of the wrist and elbow. *Occupational Medicine: State of the Art Reviews* 4(3):419-431.

United States Congress, Office of Technology Assessment [1985]. Ergonomics and prevention of musculoskeletal injuries. In: *Preventing Illness and Injury in the Workplace*. OTA-H-256, Washington, DC, pp. 127-135. (A copy of this reference is in Part I, pages 131-142.)

Webster B, Snook S [1994]. The cost of compensable upper extremity cumulative trauma disorders. *Journal of Occupational Medicine* 36(7):713-717.

Wieslander G, Norback D, Gothe C, Juhlin L [1989]. Carpal tunnel syndrome (CTS) and exposure to vibration, repetitive wrist movements, and heavy manual work: a case-referent study. *British Journal of Industrial Medicine* 46(1):43-47.

Young V, Nemecek J, Higgs P, Ball D [1992]. Cumulative trauma disorders: an overview of the problem. *Journal of Occupational Rehabilitation* 2(3):139-156.

Yu G [1992]. Preoperative factors and treatment outcome following carpal tunnel release. *The Journal of Hand Surgery* 17(6):646-650.

NTIS Order Form

U.S. DEPARTMENT OF COMMERCE
Technology Administration
National Technical Information Service
Springfield, VA 22161



(703) 487-4650

or FAX this form to (703) 321-8547

To verify receipt of your FAX order,
call (703) 487-4679.

For Rush Service—Call 1-800-553-NTIS

Rush service is available for an additional fee.
To order subscriptions, call (703) 487-4630.
TDD (For hearing impaired only), call (703) 487-4639.

Ship to Address

Date _____

Company _____

Attention _____ Title _____

Last Name _____ First Initial _____

Suite or Room Number _____

Full Street Address Required _____

City _____ State _____ ZIP _____

() ()

Telephone number _____ Fax number _____

DTIC Users Code _____

Contract No. _____ Last six digits _____

Return Policy: Although NTIS cannot accept returns for credit or refund, we will gladly replace any item you requested if we made an error in filling your order, if the item was defective, or if you received it in a damaged condition. Just call our Customer Service Department at (703) 487-4660.

Order Selection

Unless microfiche or other is specified, paper copy will be sent.

Enter NTIS order numbers (Ordering by title alone will delay your order)	Customer Routing ¹ optional (up to 8 digits)	Unit Price	Quantity			Specify density for tape orders			Internat'l Air Mail Fee (see above)	TOTAL PRICE
			Paper Copy	Microfiche	Other	1800 bpi	6250 bpi	3480 cartridge		
1.										
2.										
3.										
4.										
5.										
6.										
7.										
8.										

¹NTIS will label each item with up to eight characters of your organization's routing code.

Value of Order	Handling Fee
\$10.00 or less	\$2.00
\$10.01 - \$50.00	\$4.00
\$50.01 - \$100.00	\$6.00
Over \$100.00	\$8.00

Add \$2.00 to above for orders sent outside of the U.S., Canada, and Mexico.

Total	
Handling Fee per order (see chart at left)	
Payment not included. Please bill me, add \$7.50 (Available for U.S., Canada, and Mexico only)	

GRAND TOTAL

Prices are subject to change.
The NTIS Sales Desk (703) 487-4650
can provide pricing verification.

Payment

Charge my NTIS Deposit Account _____

Charge my

Account No. _____

Exp. _____ Cardholder's name _____ (Please print)

Signature: _____ (Required to validate all orders)

Check/Money order enclosed for \$ _____ (Payable in U.S. dollars)

Bill me *—Add \$7.50 per order if full payment does not accompany order. Purchase orders accepted only from government agencies, educational institutions, or corporations in the U.S., Canada & Mexico.

Purchase Order No. _____

After the original stock of a technical report is exhausted, NTIS reprints directly from the master archive copy. These printed-to-order copies are the best possible reproductions.

International Shipping
Paper copy reports and microfiche copies are shipped surface mail unless Air Mail is requested

Air Mail Fees
Canada and Mexico add \$4 per paper copy report;
\$1 per microfiche copy.
Other countries add \$8 per paper copy report;
\$1.25 per microfiche copy.
Computer products are shipped by air courier as part of the regular handling fee.

Please PRINT or TYPE

Please PRINT or TYPE

7/94
All previous versions of this order form are obsolete.

