federal register

Tuesday
November 23, 1999

Part II

Department of Labor

Occupational Safety and Health Administration

29 CFR Part 1910
Ergonomics Program; Proposed Rule

DEPARTMENT OF LABOR

Occupational Safety and Health Administration

29 CFR Part 1910

[Docket No. S–777]

RIN No. 1218–AB36

Ergonomics Program

AGENCY: Occupational Safety and Health Administration (OSHA), Department of Labor.

ACTION: Proposed rule; request for comments; scheduling of informal public hearing.

SUMMARY: The Occupational Safety and Health Administration is proposing an ergonomics program standard to address the significant risk of work-related musculoskeletal disorders (MSDs) confronting employees in various jobs in general industry workplaces. General industry employers covered by the standard would be required to establish an ergonomics program containing some or all of the elements typical of successful ergonomics programs: management leadership and employee participation, job hazard analysis and control, hazard information and reporting, training, MSD management, and program evaluation, depending on the types of jobs in their workplace and whether a musculoskeletal disorder covered by the standard has occurred. The proposed standard would require all general industry employers whose employees perform manufacturing or manual handling jobs to implement a basic ergonomics program in those jobs. The basic program includes the following elements: management leadership and employee participation, and hazard information and reporting. If an employee in a manufacturing or manual handling job experiences an OSHA-recordable MSD that is additionally determined by the employer to be covered by the proposed standard, the employer would be required to implement the full ergonomics program for that job and all other jobs in the establishment involving the same physical work activities. The full program includes, in addition to the elements in the basic program, a hazard analysis of the job; the implementation of engineering, work practice, or administrative controls to eliminate or substantially reduce the hazards identified in that job; training the employees in that job and their supervisors; and the provision of MSD management, including, where appropriate, temporary work restrictions and access to a health care provider or other professional if a covered MSD occurs. General industry employers whose employees work in jobs other than manual handling or manufacturing and experience an MSD that is determined by the employer to be covered by the standard would also be required by the proposed rule to implement an ergonomics program for those jobs.

The proposed standard would affect approximately 1.9 million employers and 27.3 million employees in general industry workplaces, and employers in these workplaces would be required in the first year after promulgation of the standard to control approximately 7.7 million jobs with the potential to cause or contribute to covered MSDs. OSHA estimates that the proposed standard would prevent about 3 million work-related MSDs over the next 10 years, have annual benefits of approximately $9.1 billion, and impose annual compliance costs of approximately $900 per covered establishment and annual costs of $150 per problem job fixed.

OSHA is scheduling informal public hearings to provide interested parties the opportunity to orally present information and data related to the proposed rule.

DATES: *Written comments.* Written comments, including materials such as studies and journal articles, must be postmarked by February 1, 2000. If you submit comments by facsimile or electronically through OSHA's internet site, you must transmit those comments by February 1, 2000.

Notice of intention to appear at the informal public hearing. Notices of intention to appear at the informal public hearing must be postmarked by January 24, 2000. If you submit your notice to intention to appear by facsimile or electronically through OSHA's Internet site, you must transmit the notice by January 24, 2000.

Hearing testimony and documentary evidence: If you will be requesting more than 10 minutes for your presentation, or if you will be submitting documentary evidence at the hearing, you must submit the full testimony and all documentary evidence you intend to present at the hearing, postmarked by February 1, 2000.

Informal pubic hearing. The hearing in Washington, DC, is scheduled to begin at 9:30 a.m., February 22, 2000 at the Frances Perkins Building, U.S. Department of Labor. The hearing in Washington, DC, is scheduled to run for 4 weeks. It will be followed by a hearing March 21–31, 2000, in Portland OR, and April 11–21, 2000, in Chicago, IL. Time and location for the regional hearings will be announced later in the **Federal Register**.

ADDRESSES: *Written comments: Mail:* Submit duplicate copies of written comments to: OSHA Docket Office, Docket No. S–777, U.S. Department of Labor, 200 Constitution Avenue, N.W., Room N–2625, Washington, DC 20210, telephone (202) 693–2350.

Facsimile: If your written comments are 10 pages or less, you may fax them to the Docket Office. The OSHA Docket Office fax number is (202) 693–1648.

Electronic: You may also submit comments electronically through OSHA's Homepage at *www.osha.gov.* Please note that you may not attach materials such as studies or journal articles to your electronic comments. If you wish to include such materials, you must submit them separately in duplicate to the OSHA Docket Office at the address listed above. When submitting such materials to the OSHA Docket Office, you must clearly identify your electronic comments by name, date, and subject, so that we can attach them to your electronic comments.

Notice of intention to appear: Mail: Notices of intention to appear at the informal public hearing may be submitted by mail in quadruplicate to: Ms. Veneta Chatman, OSHA Office of Public Affairs, Docket No. S–777, U.S. Department of Labor, 200 Constitution Avenue, N.W., Room N–3647, Washington, DC 20210, Telephone: (202) 693–2119.

Facsimile: You may fax your notice of intention to appear to Ms. Chatmon at (202) 693–1634.

Electronic: You may also submit your notice of intention to appear electronically through OSHA's Homepage at *www.osha.gov.*

Hearing testimony and documentary evidence: You must submit in quadruplicate your hearing testimony and the documentary evidence you intend to present at the informal public hearing to Ms. Chatmon at the address above. You may also submit your hearing testimony and documentary evidence on disk (3½ inch) in WP 5.1, 6.0, 6.1, 8.0 or ASCII, provided you also send the original hardcopy at the same time.

Informal public hearing: The informal public hearing to be held in Washington DC will be located in the Frances Perkins Building, U.S. Department of Labor, 200 Constitution Avenue, N.W., Washington, DC 20210. The locations of regional hearings in Portland, OR, and Chicago, IL, will be announced in a later **Federal Register** notice.

FOR FURTHER INFORMATION CONTACT: OSHA's Ergonomics Team at (202) 693–2116, or visit the OSHA Homepage at *www.osha.gov.*

SUPPLEMENTARY INFORMATION:

Table of Contents

The preamble and proposed standard are organized as follows:

References to the rulemaking record are in the text of the preamble. References are given as ''Ex.'' followed by a number to designate the reference in the docket. For example, ''Ex. 26–1'' means exhibit 26–1 in Docket S–777. A list of the exhibits and copies of the exhibit are available in the OSHA Docket Office.

I. Introduction

A. Overview

The preamble to this proposed ergonomics program standard discusses the data and events leading OSHA to propose the standard, the Agency's legal authority for proposing this rule, requests for information on a number of issues, and a section describing the significance of the ergonomic-related risks confronting workers in manufacturing, manual handling, and other general industry jobs. The preamble also contains a summary of the Preliminary Economic and Initial Regulatory Flexibility Analysis, a summary of the responses OSHA has made to the findings and recommendations of the Small Business Regulatory Fairness Enforcement Act Panel convened for this rule, a description of the information collections associated with the standard, and a detailed explanation of the Agency's rationale for proposing each provision of the proposed standard.

B. The Need for an Ergonomics Standard

Work-related musculoskeletal disorders (MSDs) currently account for one-third of all occupational injuries and illnesses reported to the Bureau of Labor Statistics (BLS) by employers every year. These disorders thus constitute the largest job-related injury and illness problem in the United States today. In 1997, employers reported a total of 626,000 lost workday MSDs to the BLS, and these disorders accounted for $1 of every $3 spent for workers' compensation in that year. Employers pay more than $15–$20 billion in workers' compensation costs for these disorders every year, and other expenses associated with MSDs may increase this total to $45–$54 billion a year. Workers with severe MSDs can face permanent disability that prevents them from returning to their jobs or handling simple, everyday tasks like combing their hair, picking up a baby, or pushing a shopping cart.

Thousands of companies have taken action to address and prevent these problems. OSHA estimates that 50 percent of all employees but only 28 percent of all workplaces in general industry are already protected by an ergonomics program, because their employers have voluntarily elected to implement an ergonomics program. (The disparity in these estimates shows that most large companies, who employ the majority of the workforce, already have these programs, and that smaller employers have not yet implemented them.) OSHA believes that the proposed standard is needed to bring this protection to the remaining employees in general industry workplaces who are at significant risk of incurring a work-related musculoskeletal disorder but are currently without ergonomics programs.

C. The Science Supporting the Standard

A substantial body of scientific evidence supports OSHA's effort to provide workers with ergonomic protection (see the Health Effects, Preliminary Risk Assessment, and Significance of Risk sections of this preamble, below). This evidence strongly supports two basic conclusions: (1) There is a positive relationship between work-related musculoskeletal disorders and workplace risk factors, and (2) ergonomics programs and specific ergonomic interventions can reduce these injuries.

For example, the National Research Council/National Academy of Sciences found a clear relationship between musculoskeletal disorders and work and between ergonomic interventions and a decrease in such disorders. According to the Academy, ''Research clearly demonstrates that specific interventions can reduce the reported rate of musculoskeletal disorders for workers who perform high-risk tasks'' (Work-Related Musculoskeletal Disorders: The Research Base, ISBN 0–309–06327–2 (1998)). A scientific review of hundreds of peer-reviewed studies involving workers with MSDs by the National Institute for Occupational Safety and Health (NIOSH) also supports this conclusion.

The evidence, which is comprised of peer-reviewed epidemiological, biomechanical and pathophysiological studies as well as other published evidence, includes:

- More than 2,000 articles on work-related MSDs and workplace risk factors;
- A 1998 study by the National Research Council/National Academy of Sciences on work-related MSDs;
- A critical review by NIOSH of more than 600 epidemiological studies (1997);
- A 1997 General Accounting Office report of companies with ergonomics programs; and
- Hundreds of published ''success stories'' from companies with ergonomics programs;

Taken together, this evidence indicates that:

- High levels of exposure to ergonomic risk factors on the job lead to an increased incidence of work-related MSDs;

• Reducing these exposures reduces the incidence and severity of work-related MSDs;

• Work-related MSDs are preventable; and

• Ergonomics programs have demonstrated effectiveness in reducing risk, decreasing exposure and protecting workers against work-related MSDs.

As with any scientific field, research in ergonomics is ongoing. The National Academy of Sciences is undertaking another review of the science in order to expand on its 1998 study. OSHA will examine this and all research results that become available during the rulemaking process, to ensure that the Agency's ergonomics program standard is based on the best available and most current evidence. However, more than enough evidence already exists to proceed with a proposed standard. In the words of the American College of Occupational and Environmental Medicine, the world's largest occupational medical society, ''there is an adequate scientific foundation for OSHA to proceed with a proposal and, therefore, no reason for OSHA to delay the rulemaking process * * *.''

D. Employer Experience Supporting the Standard

Employers with companies of all sizes have had great success in using ergonomics programs as a cost-effective way to prevent or reduce work-related MSDs, keeping workers on the job, and boosting productivity and workplace morale. A recent General Accounting Office (GAO) study of several companies with ergonomics programs found that their programs reduced work-related MSDs and associated costs (GAO/HEHS–97–163). The GAO also found that the programs and controls selected by employers to address ergonomic hazards in the workplace were not necessarily costly or complex. As a result, the GAO recommended that OSHA use a flexible regulatory approach in its ergonomics standard that would enable employers to develop their own effective programs. The standard being proposed today reflects this recommendation and builds on the successful programs that thousands of proactive employers have found successful in dealing with their ergonomic problems.

E. Information OSHA is Providing to Help Employers Address Ergonomic Hazards

Much literature and technical expertise already exists and is available to employers, both through OSHA and a variety of other sources. For example:

• Information is available from OSHA's ergonomics Web page, which can be accessed from OSHA's World Wide Web site at *http://www.osha.gov* by scrolling down and clicking on ''Ergonomics'';

• Many publications, informational materials and training courses are available from OSHA through Regional Offices, OSHA-sponsored educational centers, OSHA's state consultation programs for small businesses, and through the Web page;

• Publications on ergonomics programs are available from NIOSH at 1–800–35–NIOSH. NIOSH is also a ''link'' on the OSHA ergonomics Web page;

• OSHA's state consultation programs will provide free on-site consultation services to employers requesting help in implementing their ergonomics programs; and

• OSHA is developing a series of compliance assistance materials and will make them available before a final ergonomics standard becomes effective.

II. Events Leading to the Proposed Standard

In proposing this standard, OSHA has relied upon its own substantial experience with ergonomics programs, the experience of private firms and insurance companies, and the results of research studies conducted during the last 30 years. Those experiences clearly show that: (1) Ergonomics programs are an effective way to reduce occupational MSDs; (2) ergonomics programs have consistently achieved that objective; (3) OSHA's proposal is consistent with these programs; and (4) the proposal is firmly grounded in the OSH Act and OSHA policies and experience. The primary lesson to be learned is that employers with effective, well-managed ergonomics programs achieve significant reductions in the severity and number of work-related MSDs their employees experience. These programs also generally improve productivity and employee morale and reduce employee turnover and absenteeism (see Section VIII of this preamble and Chapters IV (Benefits) and V (Costs of Compliance) of OSHA's Preliminary Economic Analysis (Ex. 28–1).

OSHA's long experience with ergonomics is apparent from the chronology below. As this table shows, the Agency has been actively involved in ergonomics for more than 20 years.

OSHA Ergonomics Chronology

Early 1980s	OSHA begins discussing ergonomic interventions with labor, trade associations and professional organizations. OSHA issues citations to Hanes Knitwear and Samsonite for ergonomic hazards.
August 1983	The OSHA Training Institute offers its first course in ergonomics.
May 1986	OSHA begins a pilot program to reduce back injuries through review of injury records during inspections and recommendations for job redesign using NIOSH's Work Practices Guide for Manual Lifting.
October 1986	The Agency publishes a Request for Information on approaches to reduce back injuries resulting from manual lifting. (57 FR 34192)
July 1990	OSHA/UAW/Ford corporate-wide settlement agreement commits Ford to reduce ergonomic hazards in 96 percent of its plants through a model ergonomics program.
August 1990	The Agency publishes ''Ergonomics Program Management Guidelines for Meatpacking Plants.''

OSHA Ergonomics Chronology—Continued

Fall 1990	OSHA creates the Office of Ergonomics Support and hires more ergonomists.
November 1990	OSHA/UAW/GM sign agreement bringing ergonomics programs to 138 GM plants employing more than 300,000 workers. Throughout the early 90s, OSHA signed 13 more corporate-wide settlement agreements to bring ergonomics programs to nearly half a million more workers.
July 1991	OSHA publishes ''Ergonomics: The Study of Work,'' as part of a nationwide education and outreach program to raise awareness about ways to reduce musculoskeletal disorders.
July 1991	More than 30 labor organizations petition Secretary of Labor to issue an Emergency Temporary Standard.
January 1992	OSHA begins a special emphasis inspection program on ergonomic hazards in the meatpacking industry.
April 1992	Secretary of Labor denies petition.
August 1992	OSHA publishes an Advance Notice of Proposed Rulemaking on ergonomics.
1993	OSHA conducts a survey of general industry and construction employers to obtain information on the extent of ergonomics programs in industry and other issues.
March 1995	OSHA begins a series of meetings with stakeholders to discuss approaches to a draft ergonomics standard.
January 1997	OSHA/NIOSH conference on successful ergonomic programs held in Chicago.
April 1997	OSHA introduces the ergonomics web page on the Internet.
February 1998	OSHA begins a series of national stakeholder meetings about the draft ergonomics standard under development.
March 1998	OSHA releases a video entitled ''Ergonomic Programs That Work.''
February 1999	OSHA begins small business (Small Business Regulatory Enforcement Fairness Act (SBREFA)) review of its draft ergonomics rule, and makes draft regulatory text available to the public.
April 1999	OSHA's Assistant Secretary receives the SBREFA report on the draft ergonomics program proposal, and the Agency begins to address the concerns raised in that report.
November 1999	OSHA publishes proposed ergonomics program standard.

A. Regulatory and Voluntary Guidelines Activities

In 1989, OSHA issued the *Safety and Health Program Management Guidelines* (54 FR 3904, Jan. 26, 1989), which are voluntary program management guidelines to assist employers in developing effective safety and health programs. These program management guidelines, which are based on the widely accepted industrial hygiene principles of management commitment and employee involvement, worksite hazard analysis, hazard prevention and control, and employee training, also serve as the foundation for effective ergonomics programs. In August 1990, OSHA issued the *Ergonomics Program Management Guidelines for Meatpacking Plants* (Ex. 2–13), which utilized the four program components from the safety and health management guidelines, supplemented by other ergonomics-specific program elements (*e.g.*, medical management). The ergonomic guidelines were based on the best available scientific evidence, the best practices of successful companies with these programs, advice from the National Institute for Occupational Safety and Health (NIOSH), the scientific literature, and OSHA's experience with enforcement actions. Many commenters in various industries have said that they have implemented their ergonomics programs primarily on the basis of the OSHA ergonomics guidelines (Exs. 3–50, 3–61, 3–95, 3–97, 3–113, 3–121, 3–125), and there has been general agreement among stakeholders that these program elements should be included in any OSHA ergonomics standard (Exs. 3–27, 3–46, 3–51, 3–61, 3–89, 3–95, 3–113, 3–119, 3–160, 3–184).

OSHA has also encouraged other efforts to address the prevention of work-related musculoskeletal disorders. For example, OSHA has actively participated in the work of the ANSI Z–365 Committee, which was tasked with the development of a consensus standard for the control of cumulative trauma disorders.

1. Petition for Emergency Temporary Standard

On July 31, 1991, the United Food and Commercial Workers Union (UCFW), along with the AFL–CIO and 29 other labor organizations, petitioned OSHA to take immediate action to reduce the risk to employees from exposure to ergonomic hazards (Ex. 2–16). The petition requested that OSHA issue an emergency temporary standard (ETS) on ''Ergonomic Hazards to Protect Workers from Work-Related Musculoskeletal Disorders (Cumulative Trauma Disorders)'' under section 6(c) of the Act. The petitioners also requested, consistent with section 6(c), that OSHA promulgate, within 6 months of issuance of the ETS, a permanent standard to protect workers from cumulative trauma disorders in both general industry and construction.

OSHA concluded that, based on the statutory constraints and legal requirements governing issuance of an ETS, there was not a sufficient basis to support issuance of an ETS. Accordingly, on April 17, 1992, OSHA decided not to issue an ETS on ergonomic hazards (Ex. 2–29). OSHA agreed with the petitioners, however, that available information, including the Agency's experience and information in the ETS petition and supporting documents, supported the initiation of a rulemaking, under section 6(b)(5) of the Act, to address ergonomic hazards.

2. Advance Notice of Proposed Rulemaking

At the time OSHA issued the *Ergonomic Program Management Guidelines for Meatpacking Plants,* (Ex. 2–13), the Agency also indicated its intention to begin the rulemaking process by asking the public for information about musculoskeletal disorders (MSDs). The Agency indicated that this could be accomplished through a Request for Information (RFI) or an Advance Notice of Proposed Rulemaking (ANPR) consistent with the Administration's Regulatory Program. Subsequently, OSHA formally placed ergonomics rulemaking on the regulatory agenda (Ex. 2–17) and decided to issue an ANPR on this topic.

In June 1991, OSHA sent a draft copy of the proposed ANPR questions for comment to 232 parties, including OSHA's advisory committees, labor organizations (including the petitioners), trade associations, occupational groups, and members of the ergonomics community (Ex. 2–18). OSHA requested comments on what questions should be presented in the ANPR. OSHA received 47 comments from those parties. In addition, OSHA met with the Chemical Manufacturers Association, Organization Resources Counselors, Inc., and the AFL–CIO and several of its member organizations. OSHA reviewed the comments and submissions received and incorporated relevant suggestions and comments into the ANPR.

On August 3, 1992, OSHA published the ANPR in the **Federal Register** (57 FR 34192), requesting information for consideration in the development of an ergonomics standard. OSHA received 290 comments in response to the ANPR. Those comments have been carefully considered by the Agency in developing the proposed ergonomics program standard.

3. Outreach to Stakeholders

In conjunction with the process of developing the proposed ergonomics rule, OSHA has established various communication and outreach efforts since publication of the ANPR. These efforts were initiated in response to requests by individuals who would be affected by the rule (stakeholders) that they be provided with the opportunity to present their concerns about an ergonomics rule and that they be kept apprised of the efforts OSHA was making in developing a proposed rule. For example, in March and April 1994, OSHA held meetings with industry, labor, professional and research organizations covering general industry, construction, agriculture, healthcare, and the office environment. A list of those attending the meetings and a record of the meetings has been placed in the public record of this rulemaking (Ex. 26–1370).

In March, 1995, OSHA provided a copy of the draft proposed ergonomics rule and preamble to these same organizations. Thereafter, during April 1995, OSHA met again with these groups to discuss whether the draft proposed rule had accurately responded to the concerns raised earlier. A summary of the comments has been placed in the public record (Ex. 26–1370).

During 1998, OSHA met with nearly 400 stakeholders to discuss ideas for a proposed standard. The meetings were held in February, July and September of 1998. The first series of meetings was held in Washington, DC and focused on general issues, such as the scope of the standard and what elements of an ergonomics program should be included in a standard. The second series of meetings was held in Kansas City and Atlanta and focused on what elements and activities should be included in an ergonomics program standard. The third set of meetings was held in Washington, DC and emphasized revisions to the elements of the proposal based on previous stakeholder input. A summary of those meetings has been placed on the OSHA web site and in the public docket (Ex. 26–1370). After OSHA released a working draft of the proposed ergonomics standard to members of the Small Business Regulatory Enforcement Fairness Act Panel for review under that Act., the draft was posted on the OSHA web site (February 9, 1999).

4. Small Business Regulatory Enforcement Fairness Act (SBREFA) Panel

In accordance with SBREFA and to gain insight from employers with small businesses, OSHA, the Office of Management and Budget (OMB), and the Small Business Administration (SBA) created a Panel to review and comment on a working draft of the ergonomics program standard. As required by SBREFA, the Panel sought the advice and recommendations of potentially affected Small Entity Representatives (SERs). A total of 21 SERs from a variety of industries participated in the effort. The working draft, supporting materials (a brief summary of a preliminary economic analysis and risk assessment and other materials) were sent to the SERs for their review. On March 24–26, 1999, representatives from OSHA, SBA, and OMB participated in a series of discussions with the SERs to answer questions and receive comments from the SERs. The SERs also provided written comments, which served as the basis of the Panel's final report (Ex. 23). The final SBREFA Panel Report was submitted to the Assistant Secretary on April 30, 1999. The findings and recommendations made by the Panel are addressed in the proposed rule, preamble, and economic analysis (see the discussion in Section VIII, Summary of the Preliminary Economic Analysis and Initial Regulatory Flexibility Analysis).

B. Other OSHA Efforts in Ergonomics

In 1996, OSHA developed a strategy to address ergonomics through a four-pronged program including training, education, and outreach activities; study and analysis of the work-related hazards that lead to MSDs; enforcement; and rulemaking.

1. Training, Education, and Outreach

a. Training. The OSHA ergonomics web page has been an important part of the Agency's education and outreach effort. Other OSHA efforts in training, education and outreach include the following:

- Grants to train workers and employees about hazards and hazard abatement;
- Training courses in ergonomics;

- One day training for nursing home operators in each of five targeted states;
- Booklets on ergonomics, ergonomics programs, and computer workstations; and
- Videotapes on ergonomics programs in general industry and specifically in nursing homes.

OSHA has awarded almost $3 million for 25 grants addressing ergonomics, including lifting hazards in healthcare facilities and hazards in the red meat and poultry industries. These grants have enabled workers and employers to identify ergonomic hazards and implement workplace changes to abate the hazards.

Some grant program highlights follow.

- The United Food and Commercial Workers International Union (UFCW) conducted joint labor-management ergonomics training at a meatpacking plant that resulted in a major effort at the plant to combat cumulative trauma disorders. The program was so successful that management asked the UFCW to conduct the ergonomics training and work with management at some of its other facilities.
- The University of California at Los Angeles (UCLA) and the Service Employees International Union (SEIU) both had grants for preventing lifting injuries in nursing homes. SEIU developed a training program that was used by UCLA to train nursing home workers in California. UCLA also worked with some national back injury prevention programs. At least one of the nursing home chains has replicated the program in other states.
- Mercy Hospital in Des Moines, Iowa, had a grant to prevent lifting injuries in hospitals. It trained over 3,000 hospital workers in Des Moines and surrounding counties. It had a goal of reducing lost work days by 15 percent. The goal was surpassed, and, six months after the training, none of those trained had had a lost workday due to back injury.
- Hunter College in New York City is training ergonomics trainers for the United Paperworkers International Union. The trainers then return to their locals and conduct ergonomics training for union members. As a result of this training, changes are being made at some workplaces. Examples include purchasing new equipment that eliminates or reduces workers' need to bend or twist at the workstation, rotating workers every two hours with a ten-minute break before each rotation, and modifying workstations to reduce worker strain.

b. Education and Outreach. To provide a forum to discuss ergonomic programs and to augment information in the literature with the experience of companies of different sizes and from a variety of industries, OSHA and NIOSH sponsored the first in a series of conferences that brought industry, labor, researchers, and consultants together to discuss what works in reducing MSDs. The 1997 OSHA and NIOSH conference was followed by 11 more regional conferences across the country. OSHA and NIOSH held the second national conference on ergonomics in March of 1999. More than 200 presentations were given at the conferences on how companies have successfully reduced MSDs. Presentations were made by personnel from large and small companies in many different industries.

Other examples of successful ergonomics programs have come from OSHA's Voluntary Protection Program (VPP). The VPP program was established by OSHA to recognize employers whose organizations have exemplary workplace safety health programs. Several sites that have been accepted into VPP have excellent ergonomics programs.

2. Ergonomics Best Practices Conferences

During the period from Sept. 17, 1997 through Sept. 29, 1999, OSHA and its Regional Education Centers co-sponsored 11 Ergonomics Best Practices conferences. These Conferences were designed to provide good examples of practical and inexpensive ergonomics interventions implemented by local companies. The concept was that if OSHA and its Regional partners could initiate the development of a network of local employers, contractors, and educators to provide practical information to solve ergonomics problems, it would be assisting employers in providing a workplace for employees that would be "free of recognized health and safety hazards." To date, attendance has exceeded 2,400 participants, including employers, contractors, and employees. Finally, OSHA has made numerous outreach presentations to labor, trade, industry and professional organizations during the development of the proposed rule.

3. Studies and Analyses

Throughout the 1990s and continuing to the present, OSHA staff have monitored the ergonomics literature, developed analyses, and reviewed the work of other Federal and non-Federal agencies and organizations related to ergonomics issues. In some cases, OSHA staff have conducted site visits to observe ergonomics programs at first hand. Much of the information learned through these activities is reflected in the material in this preamble.

The most important reports and studies to appear in the last few years are listed below. OSHA has reviewed each of these documents in detail, and findings from them that are relevant to the discussions in this preamble are referenced in the text. Important recent studies that have supported the conclusion that ergonomic interventions and programs are a successful way to reduce MSDs:

- Elements of Ergonomics Programs, NIOSH, 1998 (Ex. 26–2);
- Musculoskeletal Disorders and Workplace Factors, NIOSH, 1997 (Ex. 26–1);
- Worker Protection: Private Sector Ergonomics Programs Yield Positive Results, GAO 1997 (Ex. 26–5); and
- Work-related Musculoskeletal Disorders, NRC 1998 (Ex. 26–37).

Other reports that support the use of ergonomic interventions in the context of an ergonomics program include:

- ASC Z–365 draft, Control of Cumulative Trauma Disorders, June 1997; and
- Applied Ergonomics, case studies, Volume 2 (case studies from the OSHA/NIOSH conference 1999).

In addition, in 1994, OSHA conducted eight site visits to companies that have implemented ergonomic controls. These site visits were at the invitation of companies in industries including meatpacking, manufacturing, and automotive manufacturing. In conjunction with three of these site visits, OSHA also held "town meetings" with other industry, labor and professional representatives in the geographical area. These meetings allowed OSHA to learn about other ergonomic programs that have been implemented by companies in the same area as well as issues regarding an OSHA ergonomics rule.

4. Enforcement

In the absence of a federal OSHA ergonomics standard, OSHA has addressed ergonomics in the workplace under the authority of section 5(a)(1) of the OSHAct. This section is referred to as the General Duty Clause and requires employers to provide work and a work environment free from recognized hazards that are causing or are likely to cause death or serious physical harm.

OSHA has successfully issued over 550 ergonomics citations under the General Duty Clause. Only one case has been decided by the Occupational Safety and Health Review Commission. In the majority of these cases, employers have realized that the implementation of ergonomics programs is in their best interest for the reduction of injuries and illnesses. Examples of companies cited under the General Duty Clause for ergonomics hazards and which then realized a substantial reduction in injuries and illnesses after implementing ergonomics programs include: the Ford Motor Company, Empire Kosher, Sysco Foods, and Kennebec Nursing Home.

When serious physical harm cannot be documented in the work environment but hazards have been identified by OSHA, Compliance Officers both discuss the hazards with the employer during the closing conference of an inspection and write a letter to the employer. These letters are called ''ergonomic hazard alert letters.'' As of June 1, 1999, approximately 260 letters had been sent to employers. Ergonomic hazard alert letters have been sent to employers in approximately 50% of OSHA ergonomic inspections.

Since ergonomic solutions vary from one industry to another, OSHA has provided both general and industry-specific training to compliance officers. There are currently three main ergonomic courses offered to OSHA compliance staff: Introduction to Ergonomics, Ergonomics in Nursing Homes, and Ergonomics Compliance (an advanced ergonomics course). Over 600 compliance staff have been trained in just the past three years. These courses cover three weeks of material.

In addition, OSHA has appointed one Area Office Ergonomic Coordinator and a Regional Ergonomic Coordinator in every region. These coordinators meet monthly to discuss recent case developments and the scientific literature on ergonomics, share knowledge of ergonomic solutions, and ensure that enforcement resources are provided to compliance staff for enforcement. A PhD level, professionally certified ergonomist serves as the National Ergonomics Enforcement Coordinator in OSHA's Directorate of Compliance Programs.

5. Corporate Wide Settlement Agreements

Among the companies that were cited for MSD hazards, 13 companies covering 198 facilities agreed to enter into corporate-wide settlement agreements with OSHA. These agreements were primarily in the meat processing and auto assembly industries, but there were also agreements with telecommunications, textile, warehousing grocery, and paper companies. As part of these settlement agreements, the companies agreed to develop ergonomics programs based on OSHA's Meatpacking Guidelines (Ex. 2–13) and to submit information on the progress of their program.

OSHA held a workshop in March 1999, in which 10 companies described their experience under their settlement agreement and with their ergonomics programs. All the companies that reported results to OSHA showed a substantially lower severity rate for MSDs since implementing their programs (Ex. 26–1420). In addition, most companies reported lower workers' compensation costs, as well as higher productivity and product quality. A report from the March 1999 workshop on corporate wide settlement agreements summarizing the results from 13 companies involved in the agreements has been placed in the docket (Ex. 26–1420). Only 5 of the 13 companies consistently reported the number of MSD cases or MSD case rates. All five companies that reported data on MSD-related lost workdays showed a significant decline in the number of lost workdays. None of the companies that reported severity statistics showed an increase in lost workdays as a result of the ergonomics program.

C. Summary

As this review of OSHA's activities in the last 20 years shows, the Agency has considerable experience in addressing ergonomics issues. OSHA has also used all of the tools authorized by the Act—enforcement, consultation, training and education, compliance assistance, the Voluntary Protection Programs, and issuance of voluntary guidelines—to encourage employers to address musculoskeletal disorders, the single largest occupational safety and health problem in the United States today. These efforts, and the voluntary efforts of employers and employees, have led to a recent 5-year decline in the number of reported lost workday ergonomics injuries. However, in 1997, more than 626,000 such injuries and illnesses were still reported. Promulgation of an ergonomics program standard will add the only tool the Agency has so far not deployed against this hazard—a mandatory standard—to these other OSHA and employer-driven initiatives. Over the first 10 years of the standard's implementation, OSHA predicts that more than 3 million lost workday musculoskeletal disorders will be prevented in general industry. Ergonomics programs can lead directly to improved product quality by reducing errors and rejection rates. In an OSHA survey of more than 3,000 employers, 17 percent of employers with ergonomics programs reported that their programs had improved product quality. In addition, a large number of case studies reported in the literature describe quality improvements. Thus, in addition to better saftey and health for workers, the standard will save employers money, improve product quality, and reduce employee turnover and absenteeism.

III. Pertinent Legal Authority

The purpose of the Occupational Safety and Health Act (''OSH Act''), 29 U.S.C. 651 *et seq.*, is ''to assure so far as possible every working man and woman in the nation safe and healthful working conditions and to preserve our human resources.'' 29 U.S.C. 651(b). To achieve this goal Congress authorized the Secretary of Labor to promulgate and enforce occupational safety and health standards. 29 U.S.C. 655(b) (authorizing promulgation of standards pursuant to notice and comment), 654(b) (requiring employers to comply with OSHA standards).

A safety or health standard is a standard ''which requires conditions, or the adoption or use of one or more practices, means, methods, operations, or processes, reasonably necessary or appropriate to provide safe or healthful employment or places of employment.'' 29 U.S.C. 652(8).

A standard is reasonably necessary or appropriate within the meaning of Section 652(8) if:

- A significant risk of material harm exists in the workplace and the proposed standard would substantially reduce or eliminate that workplace risk;
- It is technologically and economically feasible;
- It is cost effective;
- It is consistent with prior Agency action or supported by a reasoned justification for departing from prior Agency action;
- It is supported by substantial evidence; and
- If this standard is preceded by a national consensus standard, it is better able to effectuate the purposes of the OSH Act than the standard it supersedes.

International Union, UAW v. *OSHA (LOTO II),* 37 F.3d 665 (D.C. Cir. 1994); 58 FR 16612—16616 (March 30, 1993).

OSHA has generally considered an excess risk of 1 death per 1000 workers over a 45-year working lifetime as clearly representing a significant risk. *Industrial Union Dept.* v. *American Petroleum Institute (Benzene),* 448 U.S. 607, 646 (1980); *International Union* v. *Pendergrass (Formaldehyde),* 878 F.2d 389, 393 (D.C. Cir. 1989); *Building and Construction Trades Dept., AFL–CIO* v. *Brock (Asbestos),* 838 F.2d 1258, 1264–65 (D.C. Cir. 1988).

A standard is technologically feasible if the protective measures it requires already exist, can be brought into existence with available technology, or can be created with technology that can reasonably be expected to be developed. *American Textile Mfrs. Institute* v. *OSHA (Cotton Dust),* 452 U.S. 490, 513 (1981), *American Iron and Steel Institute* v. *OSHA (Lead II),* 939 F.2d 975, 980 (D.C. Cir. 1991).

A standard is economically feasible if industry can absorb or pass on the costs of compliance without threatening the industry's long-term profitability or competitive structure. See *Cotton Dust,* 452 U.S. at 530 n. 55; *Lead II,* 939 F.2d at 980.

A standard is cost effective if the protective measures it requires are the least costly of the available alternatives that achieve the same level of protection. *Cotton Dust,* 453 U.S. at 514 n. 32; *International Union, UAW* v. *OSHA (LOTO III),* 37 F.3d 665, 668 (D.C. Cir. 1994).

All standards must be highly protective. See 58 FR 16612, 16614–15 (March 30, 1993); *LOTO III,* 37 F.3d at 669. However, health standards must also meet the ''feasibility mandate'' of section 6(b)(5) of the OSH Act, 29 U.S.C. 655(b)(5). Section 6(b)(5) requires OSHA to select ''the most protective standard consistent with feasibility'' that is needed to reduce significant risk when regulating health hazards. *Cotton Dust,* 452 U.S. at 509.

Section 6(b)(5) also directs OSHA to base health standards on ''the best available evidence,'' including research, demonstrations, and experiments. 29 U.S.C. 655(b)(5). OSHA shall consider ''in addition to the attainment of the highest degree of health and safety protection * * * the latest scientific data * * * feasibility and experience gained under this and other health and safety laws.'' *Id.*

Section 6(b)(7) authorizes OSHA to include among a standard's requirements labeling, monitoring, medical testing and other information gathering and transmittal provisions, as appropriate. 29 U.S.C. 655(b)(7).

Finally, whenever practical, standards shall ''be expressed in terms of objective criteria and of the performance desired.'' *Id.*

IV. Summary and Explanation

Based on the best currently available evidence, OSHA has preliminarily concluded that the requirements of the proposed Ergonomics Program Standard are reasonably necessary and appropriate to provide adequate protection from hazards that are reasonably likely to cause or contribute to work-related musculoskeletal disorders.

In developing this proposed rule, OSHA has carefully considered the large body of scientific articles and studies, as well as other data that OSHA has collected since the initiation of the Agency's ergonomic efforts more than a decade ago. In particular, OSHA has carefully considered the large number of pathophysiological, biomechanical and epidemiologic studies on MSD hazards, including those that were reviewed by NIOSH and NRC/NAS in their comprehensive studies in 1997 and 1998, respectively. Examples of other data OSHA has carefully considered in developing the proposed rule include case studies, papers, and ''best practices'' about ergonomics programs and controls that have been successfully implemented by a number of establishments.

OSHA also met with more than 400 stakeholders in several informal meetings during the development of the proposed rule, and considered the major points raised by the stakeholders during these meetings. In addition, the proposed rule has undergone the Panel review process required by the Small Business Regulatory Enforcement Fairness Act (SBREFA) 5 U.S.C. Chapter 8. All of the information developed to assist the small entity representatives (SERs) involved in the SBREFA process, the comments of the representatives, and the Panel's report and recommendations to OSHA have been placed in the rulemaking record (Ex. 23). Moreover, in conjunction with the SBREFA process, OSHA released a draft, on the OSHA web page, of the proposed rule and carefully considered stakeholder comments on that draft.

When a final standard is published, OSHA will undertake a number of outreach and compliance assistance activities. These will be particularly beneficial to small businesses. Outreach and compliance assistance activities OSHA intends to make available include:

- Publication of booklets summarizing the standard and providing specific information about different ways in which employers can comply with the standard;
- Development of computer-based materials to help small businesses identify and respond to MSDs and MSD hazards;
- Development of a Small Entity Compliance Guide, as required by SBREFA; and
- Development of a compliance directive that answers compliance-related questions about the standard.

In this summary and explanation for the proposed rule, OSHA has provided a number of examples of practices and controls that the Agency believes will work to reduce MSDs and exposure to MSD hazards. Although these certainly are not the only ways employers could comply with the proposed rule, the discussion provides information that employers can use or adapt for their workplaces. OSHA has used a variety of methods to help stakeholders understand the proposed requirements. For example, the summary and explanation includes a number of tables, exhibits and figures to show data, examples, requirements and ways to comply with the requirements. To make the preamble easier to use, the discussion of each provision of the proposed rule begins with a reprint of that provision from the proposed rule. In addition, the summary and explanation is included at the beginning of the preamble so stakeholders understand what the proposed rule would require when they examine other sections of the preamble, such as the information on the costs and impacts of the proposed rule.

OSHA believes that this proposed ergonomics program standard fulfills a promise President Clinton and Vice-President Gore made in the 1995 National Performance Reveiw document, ''The New OSHA: Reinventing Worker Safety and Health.'' That document promised that OSHA would address the issue of ergonomics by working with business and labor to develop a flexible, plain-language ergonomics standard. The standard being proposed today reflects OSHA's commitment to common-sense rulemaking.

Does This Standard Apply to Me? (§§ 1910.901–1910.904)

The discussion of ''Does this standard apply to me?'' (*i.e.*, Scope of the proposed ergonomics program rule) is divided into three parts. Part A explains what employers and jobs the proposed standard covers. Part B discusses the definitions of the covered jobs and the other sections related to the Scope of the standard. Part C addresses OSHA's authority to limit the scope of the ergonomics program standard.

A. Industries, Employers and Jobs This Standard Covers

1. How Serious Is the Problem of Work-Related MSDs?

The problem of occupational musculoskeletal disorders (MSDs) is serious and widespread, and the scope of the proposed standard is also broad, so that it will capture a substantial portion of these MSDs. Lost workday MSDs constitute one-third of all job-related injuries and illnesses reported to BLS every year.

a. MSD cases. Since 1993, the first year BLS began reporting data on musculoskeletal disorders, private industry employers have reported more than 620,000 MSDs every year that have been serious enough to result in days away from work for the employee, according to the Bureau of Labor Statistics (BLS). (These MSDs are referred to in this preamble as ''lost-workday MSDs'' or ''LWD MSDs.'') MSDs now account for one-third of all reported LWD injuries and illnesses. The total number of reported MSDs, lost-time and non-lost-time MSDs combined, is much higher. The combined total is estimated to be almost three times higher than the number of LWD MSDs. (BLS data indicate that about two-thirds of all injuries and illnesses do not involve days away from work.)

b. Annual MSD rates. In addition, BLS data shows that annual incidence rates for LWD MSDs are high. In 1996, LWD MSD rates were as high as 36.58 per 1,000 full-time employees (FTE) (SIC 45—Transportation by Air). For a number of 2-digit industry sectors, LWD MSD rates exceeded 10 per 1,000 FTE. And only three industry sectors had an annual rate of less than 1 LWD MSD per 1,000 FTE. (A detailed discussion of LWD MSD cases and rates by industry and occupation are presented in the Preliminary Risk Assessment Section VI.)

c. Lifetime MSD rates. The lifetime rates for LWD MSDs are substantially higher. The estimated probability that a worker will experience at least 1 work-related MSD during a working lifetime (45 years) ranges from 24 to 813 per 1,000 FTE, depending on the industry sector. In addition, it is possible for a worker to experience more than one MSD in a working lifetime. There is evidence in the record indicating that many employees working in establishments without an ergonomics program have suffered more than one serious MSD (Exs. 26–23, 26–24, 26–25, 26–26, 26–1263, 26–1370). For example, a number of employees have had multiple surgeries for carpal tunnel syndrome (CTS). The expected number of MSDs that will occur during a working lifetime among 1,000 FTE workers who begin working in an industry at the same time ranges from 24 to 1,646, for various general industry sectors (see Section VII, Significance of Risk).

d. MSD costs. Each year MSDs alone account for about $15–20 billion in workers' compensation costs, which is roughly $1 of every $3 spent for workers' compensation. The average costs for MSD cases are higher than those for other injuries. For example, the average per case costs for carpal tunnel syndrome cases are $8,070, which is more than double the $4,000 average per case costs for all other injuries and illnesses (Exs. 26–43, 26–1286). According to Liberty Mutual Insurance Company, low-back pain is the most prevalent and costly work-related MSD in the nation. Low-back pain MSDs account for 15% of all Liberty Mutual workers' compensation claims and 23% of the costs of these claims (Ex. 26–54).

e. MSDs widespread. Data and other evidence show that the problem of work-related MSDs is widespread. Stakeholders have told OSHA that MSDs and MSD hazards are found in every industry in the nation (Ex. 3–59, 3–183, 3–184, 3–217). And each year employers in every industry report substantial numbers of LWD MSDs. In 1997, more than 626,000 LWD MSDs were reported in private industry, about 567,000 of which were in general industry. (See Section VI, Preliminary Risk Assessment, for a more detailed discussion of the number and rates of MSDs reported to the Bureau of Labor Statistics.)

2. Why and How Is OSHA Limiting the Scope of the Proposed Ergonomics Program Standard?

Although these and other data indicate that the problem of MSDs is serious and widespread, for several reasons OSHA believes it is prudent to proceed with the ergonomics rulemaking in phases. Regulating workplace exposure to MSD hazards presents special problems. In particular, the analysis and control of MSD hazards involves complex issues, because most often several ergonomic risk factors combine to create an MSD hazard, and these risk factors occur in many different combinations. The multi-factoral nature of MSD hazards also makes the development of a rule to address these hazards more complex, because it requires more Agency resources for the rulemaking, for additional analyses, and for materials for effective outreach and training.

OSHA applied two general principles in determining the scope of the first phase of the Ergonomics Program Standard. OSHA decided to focus on those areas where: (1) The problems are severe, and (2) the solutions are well-understood.

These principles are consistent with statutory factors governing OSHA rulemakings, including the criteria in section 6(g) of the OSH Act that OSHA must consider when setting rulemaking priorities. 29 U.S.C. 655(g). They are also consistent with the feasibility and substantial evidence requirements in the OSH Act. 29 U.S.C. 655(b)(5).

Applying these principles, OSHA made two basic decisions on the scope of the first phase of the Ergonomics Program Standard. OSHA first decided to limit the proposed standard to general industry because that is where the Agency has the most data and evidence on ergonomics solutions. And OSHA decided to focus on three areas within general industry where the problem is likely to be severe.

a. General industry. The vast majority of the large body of evidence and data showing that ergonomics programs and control interventions are successful in reducing MSDs pertains to general industry. (Exs. 26–1, 26–37). For example, the vast majority of studies reviewed in the NIOSH and NRC/NAS reports pertain to general industry. Almost all of the studies on the effectiveness of ergonomics programs and control interventions focused on general industry (see Section VI, Preliminary Risk Assessment). The vast majority of the success stories OSHA has gathered on the accomplishments of employers with ergonomics programs pertain to general industry employers. (See discussion of Job Hazard Analysis and Control below in this section, and the Preliminary Economic Analysis, for control scenarios and success stories.)

Evidence on ergonomic solutions from OSHA's own experience dealing with MSD hazards is also primarily derived from general industry. For example, all of OSHA's ergonomics enforcement experience under the General Duty Clause is in general industry. This includes more than 550 uncontested cases and 13 corporate settlement agreements covering 198 facilities.

Information about ergonomic solutions that OSHA has derived from the hundreds of ergonomics consultations the Agency pertains primarily to general industry. OSHA's ergonomics guidance and outreach efforts have been directed to general industry because most of the data and information are there. For example, the ergonomics program management guidelines OSHA published in 1990 focused on the red meat industry (Ex. 26–3). OSHA's other major ergonomics initiative targeted the nursing homes industry, a service industry within the general industry sector.

OSHA recognizes that MSD problems are also serious in the construction, maritime and agricultural industries. In 1996 alone, employers in these industries reported more than 60,000 LWD MSD. In the Construction—Special Trades industry sector (SIC 17), more than 35,000 LWD MSDs were reported, and the incidence rate was 11.57 per 1,000 FTE. OSHA intends to conduct rulemaking for those sectors at a later date. However, at this time the Agency has less well-developed data on ergonomics solutions in the construction, maritime and agriculture industries, and these industries have unique characteristics that warrant separate rulemakings. (Part C discusses the characteristics in those industries.)

b. Covered jobs. Within general industry, OSHA is applying the proposed rule to the following three areas where the problem is especially likely to be severe:

- Manufacturing production jobs;
- Manual handling jobs requiring forceful exertions; and
- Jobs where ''OSHA recordable'' MSDs meeting the screening criteria are reported.

Manufacturing and manual handling jobs. Data and other evidence in the record indicate that in these jobs MSD hazards are especially likely to be present. (In the proposed rule MSD hazards are defined as ''physical work activities and/or physical work conditions in which risk factors are present, that are reasonably likely to cause or contribute to a covered MSD.''). BLS data and evidence in the record indicate that there is a heavy concentration of reported MSDs and MSD hazards in manual handling and manufacturing jobs. These jobs account for about 60% of all reported MSDs that are severe enough to have resulted in days away from work, even though manufacturing and manual handling jobs employ less than 28% of the general industry workforce, according to BLS.

For many occupations involving manufacturing or manual handling, MSD rates are high. In 1996, LWD MSD rates for occupations involving manufacturing and manual handling were as high as 30.4 and 42.4 per 1,000 FTE, respectively. For example, among nursing aides, orderlies and attendants, the LWD MSD rate was 31.6 per 1,000, and about 58,400 cases were reported. (For the entire health services industry sector, which involves a variety of patient handling tasks, more than 103,000 LWD MSDs were reported, or almost 15% of all private industry cases.)

The fact that manufacturing production and manual handling jobs account for the largest share of workers' compensation costs is another indication that there is likely to be a high concentration of MSD hazards in those jobs. MSDs of the back are one of the most costly workplace injuries and account for a very large percentage of permanent occupational disability cases and costs. As mentioned above, according to Liberty Mutual Insurance Company (1988, Ex. 26–54), MSDs of the back are the most prevalent and costly work-related MSD in the nation.

Other general industry jobs in which covered MSDs occur. In general industry jobs other than manufacturing and manual handling, exposure to MSD hazards is more variable, depending on particular work activities and conditions. There are, however, a very large number of MSDs reported outside manufacturing and manual handling jobs. An employer's report of a work-related MSD that is serious enough to result in work restrictions, days away from work or medical treatment, is a logical indicator that MSD hazards are likely to be present in a job. OSHA is therefore extending coverage to jobs in which covered MSDs occur. This scope of coverage will reach jobs in which MSD hazards are likely to be present while excluding other jobs unless and until a covered MSD occurs in them.

Evidence of the severity of the MSD problem outside of manufacturing and manual handling includes the following. In 1996, about 230,000 LWD MSDs were reported in jobs other than manufacturing and manual handling. The annual LWD MSD rates that year exceeded 1 per 1,000 in all but three general industry sectors that typically do not involve manufacturing or manual handling jobs.

A significant percentage of carpal tunnel syndrome (CTS) cases, the type of MSD generally requiring the most extensive recovery time, is found in jobs other than manufacturing or manual handling. In 1996, CTS cases resulted in the highest median number of days away from work for any injury or illness: 25 days for CTS compared to 5 days for all injuries and illnesses combined. That year, more than 57% of lost-workday CTS cases involved more than 20 days away from work, and more than 42% of all lost-workday CTS cases involved more than 30 days away from work. For amputations and fractures, 32% and 36% of cases, respectively, involved more than 30 days away from work.

In conclusion, although the proposed rule applies to only three categories within general industry, it will capture those jobs in which 90% of LWD MSDs have been reported in recent years in private industry. And because there are so many well-recognized ergonomic solutions to MSD problems in general industry, OSHA believes the proposed standard should substantially reduce MSD hazards as well as the number and severity of work-related MSDs in covered industries. OSHA requests comment on the scope of the proposed rule, particularly on whether and to what extent the scope of the rule should be expanded or reduced.

B. Definitions of Manufacturing Jobs, Manual Handling Jobs and Jobs With MSDs and Explanation of Other Scope Sections

Part B discusses the Scope sections of the proposed rule. The first section explains the definitions of the jobs the proposed rule covers: manufacturing jobs, manual handling jobs, and jobs with covered MSDs. The second section discusses the other sections of the Scope of the proposed rule (§§ 1910.901–1910.904).

1. Definitions of Covered Jobs

The proposed rule is job-based, and the scope of the proposed rule is defined in terms of jobs: manufacturing jobs, manual handling jobs, and jobs in which an employee has experienced a covered MSD. The proposed rule applies to employers who have any of these jobs, but only to the extent that their workplaces have such jobs. Where employers do not have manual handling or manufacturing jobs that have given rise to a covered MSD, the Ergonomics Program Standard would not apply at all.

a. Why is OSHA using a job-based approach for defining the scope of the proposed rule? OSHA is proposing a job-based approach for defining the scope and application of the ergonomics standard because this approach focuses on areas where MSD hazards are likely to be present, is relatively easy to apply, and appears to be more cost-effective than other approaches. OSHA believes employers should be able to determine whether the standard applies to them without having to do a job hazard analysis for all jobs in their workplace. In addition, the three job categories addressed by the scope should include most jobs in which MSD hazards are present.

Easy to apply. The three job categories OSHA is proposing to cover should help employers quickly focus on the areas where they need to be looking for ergonomic problems. Employers should know whether they have manufacturing production jobs or jobs where employees are regularly handling heavy loads. In addition, it should not be difficult for employers to determine whether they have OSHA recordable MSDs, since most of them are already familiar with recording work-related illnesses and injuries in order to comply with the OSHA recordkeeping rule, 29 CFR Part 1904. Even employers who do not keep OSHA 200 logs should not have difficulty identifying whether any of their employees has been injured to the extent that they require medical treatment, restricted work, transfer to an alternative duty job, or time away from work to recuperate.

''Proxy'' for MSD hazards. These three job categories are appropriate because each is an accurate and reasonable proxy for an increased risk of exposure to ergonomic hazards that are reasonably likely to cause or contribute to serious physical harm, that is, to a covered MSD. For example, manufacturing production jobs frequently involve repetition of the same task throughout the workday, without much variation. A large body of evidence, which is discussed in greater detail in the Health Effects section (Section V), shows that employees who have frequent and/or prolonged exposure to highly repetitive motions (particularly when they are carried out in combination with high force and/or awkward postures) have a much higher risk of developing an MSD as compared to employees with lower levels of exposure (See *e.g.,* NIOSH, 1997, Ex. 26–1; Bernard, 1993, Ex. 26–439; Higgs *et al.* 1992, Ex. 26–1232; Burt *et al.* 1990, Ex. 26–698; deKrom *et al.* 1990, Ex. 26–41; Silverstein *et al.* 1987, Ex. 26–34; Armstrong *et al.* 1987, Ex. 26–48). The high incidence rates in manufacturing production occupations confirm this. OSHA is not saying that all manufacturing jobs present MSD hazards. OSHA is saying that manufacturing jobs present an increased risk of such hazards, and it is therefore logical to cover them in the proposed standard.

The same is true for manual handling jobs. Manual handling jobs typically involve regular lifting of heavy loads. A large body of evidence shows that doing forceful exertions repeatedly or for a prolonged period of time significantly increases the risk of developing an MSD of the back (*See e.g.,* NIOSH, 1997, Ex. 26–1; Holmstrom *et al.,* 1992, Ex. 26–36; Punnett *et al.,* 1991, Ex. 26–36; Liles *et al.,* 1984, Ex. 26–33). Occupations and industries where these hazards are present have very high LWD MSD rates and a large number of cases. As mentioned above, in 1996, nurses aides, orderlies and health care attendants, who spend much of their time doing patient lifting tasks, had an annual LWD MSD rate of 31.6 per 1,000 FTE, and the health services industry alone accounted for almost 15% of all LWD MSD cases. Finally, the report of an MSD that is serious enough to warrant recording on the OSHA 200 log is a logical indicator that MSD hazards may be present, especially since assessing the work-relatedness of the MSD for the purposes of this standard involves a determination by the employer about whether the MSD has a connection to the activities and conditions of the job.

More practical and less-burdensome. Although not a perfect indicator of the presence of MSD hazards, reliance on the these job categories to determine the scope of the proposed standard is more practical than other approaches. Using this approach, employers do not have to do a job hazard analysis of their facility or use a checklist to screen all of their jobs, and do not have to measure the total weights lifted by an employee or the number of repetitions made, to determine whether the standard applies to them. Thus, the job-based approach does not require employers to spend much time and resources reviewing the standard to determine whether they are covered or reviewing jobs where no hazard exists. OSHA believes that determining in the first instance whether the standard applies should require nothing more of employers than a common sense determination as to whether they have manufacturing productions jobs, forceful manual handling jobs, or jobs with OSHA recordable MSDs. OSHA anticipates that employers should be able to make this determination based on existing knowledge rather than on formal job analysis.

OSHA agrees with stakeholder and SBREFA Panel comments to the effect that the scope should be easy to understand. Accordingly, to help employers understand the scope of the rulemaking, the definitions of manufacturing and manual handling jobs include examples of jobs that would typically be included in and excluded from the definition (see § 1910.945).

b. What about other methods for defining scope? OSHA believes the job-based approach is superior to other ways of defining coverage, because, on balance, it is the most accurate of the cost-effective approaches to reducing MSD hazards. OSHA presents alternative approaches below and requests comment on this issue.

Preliminary job hazard analysis. OSHA considered requiring all general industry employers to do an initial job hazard analysis for all jobs in the workplace to identify those jobs where MSD hazards are present. That approach is similar to the approach OSHA uses in other health standards. In those standards, employers make an initial assessment about the presence of hazardous substances in the workplace (*i.e.,* ''Do I have operations that involve formaldehyde in my workplace?''). Requiring a preliminary job hazard analysis to screen for ergonomic hazards is analogous to this initial assessment for toxic substances. Although conducting a preliminary analysis is the most thorough and accurate way to initially determine whether MSD hazards are present, it is more resource-intensive for employers. To the extent that doing an initial job hazard analysis would require employers to expend considerable resources and efforts where no MSD hazards are present, it would not be cost-effective. In contrast, the practical design of the proposed job-based approach allows employers to make common sense determinations about whether the proposed rule applies, rather than requiring that the determination be based on a formal job hazard analysis. At the same time, since evidence in the record shows that MSD hazards are likely to be present in these jobs and that these three categories account for such a large proportion of all reported MSDs, using the three job categories is a reasonably accurate approach.

Specification. OSHA also could have used a specification approach in the proposed rule, defining coverage by specific measurements such as weight limits, number of repetitions, or number of hours performing a certain job or task demand. A number of studies have identified exposure-response relationships in particular circumstances (Holmstrom *et al.* 1992, Ex. 26–36 ; Punnett *et al.* 1991, Ex. 26–39; de Krom *et al.* 1990, Ex. 26–41; Liles *et. al.* 1984, Ex. 26–33), and a number of models exist for equating safe levels of exposure (*e.g.,* NIOSH Lifting Index, Ex. 26–572; Snook ''Push-Pull'' tables, Ex. 26–1008).

Specification approaches, however, are more likely to be overinclusive or underinclusive. See *International Union, UAW* v. *OSHA (LOTO II),* 37 F.3d 665 (D.C. Cir. 1994). For example, if the proposed rule were to cover any task that required lifting a certain weight (*e.g.,* more than 40 pounds), the proposed rule might not cover a number of very hazardous lifting tasks in which MSDs are reasonably likely to occur. This is because the weight limit might not adequately consider the impact of other factors on the force required to complete a lift. To illustrate, a task requiring an employee to lift 40 pounds may be safe if twisting, bending or reaching is not involved, but it could be unsafe if long horizontal reaches or bending is required.

On the other hand, a proposed rule that defined coverage in terms of a weight limit that takes other ergonomic risk factors into account could be overinclusive because the recommended lift weight could vary greatly with each lifting task. For example, a lifting task that does not involve any risk factors other than force would be treated the same as a lift involving many risk factors. However, to expand a specification approach to make it more precise (*i.e.,* so that it was not underinclusive or overinclusive) would necessarily make the approach more complex. It would require employers to determine what risk factors are present in order to determine their impact on the weight limit, and thus would essentially require a basic job hazard analysis simply to make a decision about whether they are subject to the rule.

Checklist. OSHA could also have used a checklist approach for defining coverage under the proposed ergonomics standard. A simple checklist has advantages: it can be administered by a person with limited training and is simple and fast to administer. However, some checklists are not designed to capture complex situations and thus might be underinclusive. For example, a simple checklist that omits questions that are important to a particular job might erroneously exclude a hazardous job or treat it as no more hazardous than another job. On the other hand, making a checklist more thorough and accurate would make it harder to use and more costly and complex.

Industry. Finally, OSHA could have defined the coverage of the standard purely by industry (*i.e.,* industries with the highest MSD rates), as some stakeholders have recommended. For several reasons, however, OSHA believes that this approach would not be as accurate as the proposed approach in focusing the standard on areas where the problem is severe. Regardless of the industry in which employees work, they face a significant risk of material harm when they are exposed to physical work activities and conditions that are reasonably likely to cause or contribute to a covered MSD. For example, in an industry where manual handling is rarely performed or is restricted to a small group of employees, the overall incidence rate for the industry is likely to be low. But even if the overall industry incidence rate is low, those employees who do perform manual handling and are exposed to MSD hazards are at significant risk of material health impairment. Conversely, an industry-based approach would result in low-hazard jobs in a covered industry being included, while employees performing identical jobs in other industries would be excluded. Defining coverage by industry, therefore, would make the standard both underinclusive and overinclusive.

In addition, using industry incidence rates is not necessarily an accurate measure of the prevalence of MSD hazards. For example, even where large numbers of MSDs are reported in an industry, the rate may still be low because the industry employs so many workers, some of whom are not exposed to the same degree to MSD hazards. In part, this is due to the fact that available industry classifications were established for purposes other than occupational safety and health analysis. Therefore, the courts recognized that such classifications ''appear essentially irrelevant'' to the task of regulating hazards. *LOTO II,* 37 F.3rd at 670.

In the remainder of this discussion, OSHA will describe the specific provisions of the proposed standard that deal with Scope.

c. *Manufacturing jobs.* Section 1910.901 Does this standard apply to me?

This standard applies to employers in general industry whose employees work in manufacturing jobs or manual handling jobs, or report musculoskeletal disorders (''MSDs'') that meet the criteria of this standard. This standard applies to the following jobs:

(a) Manufacturing jobs. Manufacturing jobs are production jobs in which employees perform the physical work activities of producing a product and in which these activities make up a significant amount of their worktime;

There are many kinds of jobs in manufacturing firms (*e.g.,* production, professional and technical, maintenance, repair, sales, etc.), some of which do not have exposure to MSD hazards. The proposed rule focuses on manufacturing jobs involving the physical work activities of production because these jobs present an increased risk of MSD hazards.

Production jobs. The manufacturing jobs the proposed rule covers are production jobs in manufacturing, those that directly involve production work tasks; they are the hands on jobs of processing, assembling, or fabricating finished or semi-finished products (durable and non-durable). Production work involves the range of tasks from handling raw materials or components through packaging the final product to leave the production facility. Manufacturing production jobs are frequently referred to as assembly line, production line, paced work, piecework, or factory jobs.

Evidence in the record indicates that MSDs reported in manufacturing are heavily concentrated in production jobs. All of the manufacturing occupations, as defined by the BLS, with high LWD MSD rates are production jobs. In 1996, for instance, the manufacturing jobs with the highest LWD MSD rates were the following production occupations:

• Machine feeders and offbearers	34.6 per 1,000 FTE
• Punching and stamping machine operators	30.4 per 1,000 FTE
• Sawing machine operators	18.9 per 1,000 FTE
• Furnace, kiln, oven operators (except food)	18.0 per 1,000 FTE
• Grinding, abrading, polishing machine operators	17.9 per 1,000 FTE
• Assemblers	16.2 per 1,000 FTE

The rate for each of these manufacturing production occupations substantially exceeded and in some cases was 5 times as high as the rate for all manufacturing injuries and illnesses combined (10.3 per 1,000 FTE). These rates were also more than 4 times higher than the LWD rate for all injuries and illnesses combined (2.5 per 1,000 FTE).

MSDs reported in manufacturing are heavily concentrated in production jobs because these are the jobs that are likely to involve significant exposure to the combinations of ergonomic risk factors that are associated with significantly elevated risks of harm. Studies show that production work tasks, which frequently involve highly repetitive tasks and are often combined with high force and awkward postures, are the jobs in manufacturing that are most closely associated with significantly-elevated risks of harm (See *e.g.*, NIOSH, 1997, Ex. 26–1; Bernard *et al.* 1993, Ex. 26–439; Higgs *et al.* 1992, Ex. 26–1232; Silverstein *et al.* 1987, Ex. 26–34; Armstrong *et al.* 1987, Ex. 26–48).

Duration. The manufacturing production jobs that the proposed standard covers are those in which employees perform production tasks for a ''significant amount'' of their worktime. In general, significant amount means that performing production tasks is a key or characteristic element of the employee's job. It will probably be obvious that employees are performing production tasks for a significant amount of their worktime. The purpose of the significant amount of the worktime aspect of the definition of manufacturing jobs is to reinforce that the definition is intended to include jobs in which production work is characteristic of the job, while excluding jobs in which an employer might, on rare occasions, perform production tasks. This is illustrated by the examples of jobs that are and are not typically included in the definition (see discussion of § 1910.945).

Evidence in the record, including that discussed in the Health Effects section (Section V), indicates that MSD hazards may be present where production work is performed for a significant amount of time. Job tasks that require the use of the same muscles or motions for long periods of time increase the likelihood of both localized and general fatigue. In general, the longer the period of continuous exertion, the longer the recovery or rest time required (NIOSH , 1997, Ex. 26–1). Studies show that one of the biggest contributors to the occurrence of MSDs in manufacturing production jobs is lack of adequate recovery time (Exs. 26–1, 26–1275). Inadequate recovery time may be the result of the length of time work tasks are performed (deKrom *et al.* 1990, Ex. 26–102), or the frequency with which job cycles are performed.

For example, the risk of developing carpal tunnel syndrome (CTS) increases steadily with increases in daily exposure to flexed or extended wrist postures (deKrom *et al.* 1990. Ex. 26–102). The odds ratio for wrist disorders for a group of employees exposed to flexed wrist postures between 8–19 hours a week (*i.e.*, an average of 1 to <4 hours per day) was 3, while that for employees exposed to these postures for between 20–40 hours a week (*i.e.*, an average of 4 to 10 hours per day) was 9 (deKrom *et al.* 1990, Ex. 26–102).

Other studies reach the same general conclusions. Researchers who reviewed the literature found that exposure to a combination of repetitive motions and either high forces, awkward postures or vibrating tools, or to various combinations of risk factors, for more than 4 hours a day puts workers at high risk of developing MSDs (Exs. 26–1163, 26–1352). (The relationship between duration of exposure to repetitive tasks and the occurrence of MSDs is discussed in greater detail in the Section V, Health Effects, of this preamble.) Although adverse effects have been reported following extremely high levels of exposure for very short durations (Hagberg, 1981, Ex. 26–955), studies show that exposure to workplace risk factors for less than 2 hours normally permits sufficient recovery time for the muscles, nerves and tendons in most workers to prevent chronic adverse health effects (Punnett *et al.,* 1991, Ex. 26–39; Punnet, 1998, Ex. 26–38)).

To clarify further the definition of manufacturing job, the proposed rule includes a list of examples of jobs that typically are included in and excluded from the proposed definition. This list is intended to be a practical guide about the kinds of jobs that OSHA intends to include as manufacturing production jobs. Table IV–1 includes this list:

Table IV–1

EXAMPLES OF JOBS THAT TYPICALLY ARE MANUFACTURING JOBS	EXAMPLES OF JOBS THAT TYPICALLY ARE NOT MANUFACTURING JOBS
• Assembly line jobs producing: • Products (durable and non-durable) • Subassemblies • Components and parts • Paced assembly jobs (assembling and disassembling) • Piecework assembly jobs (assembling and disassembling) and other time critical assembly jobs • Product inspection jobs (*e.g.,* testers, weighers) • Meat, poultry, and fish cutting and packing • Machine operation • Machine loading/unloading • Apparel manufacturing jobs • Food preparation assembly line jobs • Commercial baking jobs • Cabinetmaking • Tire building	• Administrative jobs • Clerical jobs • Supervisory/managerial jobs that do not involve production work • Warehouse jobs in manufacturing facilities • Technical and professional jobs • Analysts and programmers • Sales and marketing • Procurement/purchasing jobs • Customer service jobs • Mail room jobs • Security guards • Cafeteria jobs • Grounds keeping jobs (*e.g.,* gardeners) • Jobs in power plant in manufacturing facility • Janitorial • Maintenance • Logging jobs • Production of food products (*e.g.,* bakery, candy and other confectionary products) primarily for direct sale on the premises to household customers

d. Manual handling jobs.

(b) Manual handling jobs. Manual handling jobs are jobs in which employees perform forceful lifting/lowering, pushing/pulling, or carrying. Manual handling jobs include only those jobs in which forceful manual handling is a core element of the employee's job;

Note: Although each manufacturing and manual handling job must be considered on the basis of its actual physical work activities and conditions, the definitions section of this standard (§ 1910.945) includes a list of jobs that are typically included in and excluded from these definitions.

The second group of jobs OSHA is proposing to cover are manual handling jobs. Manual handling is the forceful movement (*i.e.*, lifting, lowering, pushing, pulling, carrying) of materials, equipment, objects, people or animals. The movement may be done by hand, as in lifting an object or pushing hand carts or pallets. The movement can also be done with the help of automated equipment or aids, such as forklift trucks, storage and retrieval systems, conveyors, and mechanical lift devices; such assisted handling would be considered manual handling as long as the movement still required forceful exertions by the employee.

The vast majority of MSDs reported in manual handling jobs are back disorders (*i.e.*, overexertions). For example, the jobs with the highest rate of time-loss injuries due to overexertion are those in nursing and personal care facilities, where employees are required to do frequent patient handling and lifting. Manual handling tasks are also associated with back pain in 25–70% of all worker's compensation claims (Snook and Ciriello, 1991, Ex. 26–1008; Cust *et al.*, 1972, Ex. 26–1194). There is also strong and consistent evidence that MSDs of the lower back are associated with work-related lifting and forceful exertions (see Section V below).

Most employees handle and move objects occasionally at the workplace. A number of stakeholders have expressed concern that the ergonomics standard would apply to any lifting, lowering, pushing, pulling or carrying tasks (collectively referred to as lifting) that employees do. That is not OSHA's intention, and the proposed definition of manual handling jobs clarifies that. Table IV–2 contains the examples of jobs from the definition that typically would be included in and excluded from the proposed rule:

Forceful lifting. Manual handling jobs are defined to include only those jobs that require forceful manual handling tasks. Force is the mechanical effort required to carry out a specific movement (NIOSH Elements of Ergonomics Programs, 1997, Ex. 26–2). Forceful exertions place higher loads on the muscles, tendons, ligaments, and joints (NIOSH 1997, Ex. 26–1; see also section V, Health Effects, of this preamble. Increasing the force required to lift a load also means increasing body demands (*i.e.*, greater muscle exertion is necessary to sustain the increased effort), and imposing greater compressive forces on the spine (Marras *et al.* 1995). As force increases, muscles fatigue more quickly. Prolonged or recurrent exertions of this type can also lead to MSDs where there is not adequate time for rest or recovery (NIOSH 1997, Ex. 26–1).

Studies indicate employees who perform forceful manual handling tasks face a significant risk of developing an MSD (See Health Effects, Chapter V). The majority of epidemiologic studies (13 of 18 studies) in the 1997 NIOSH review show that odds ratios are higher—in the range of 5.2 to 11—for employees who have high exposure to force and lifting. (These results are consistent with biomechanical and other laboratory evidence regarding the effects of lifting and dynamic motion on back tissues.) NIOSH also found that the high odds ratios for employees with high exposure were ''unlikely to be caused by confounding or other effects of lifestyle covariates'' (NIOSH 1997, Ex. 26–1).

Table IV–2

EXAMPLES OF JOBS THAT TYPICALLY ARE MANUAL HANDLING JOBS	EXAMPLES OF JOBS/TASKS THAT TYPICALLY ARE NOT MANUAL HANDLING JOBS
• Patient handling jobs (*e.g.,* nurses aides, orderlies, nurse assistants) • Package sorting, handling and delivering • Hand packing and packaging • Baggage handling (*e.g.,* porters, airline baggage handlers, airline check-in) • Warehouse manual picking and placing • Beverage delivering and handling • Stock handling and bagging • Grocery store bagging • Grocery store stocking • Garbage collecting	• Administrative jobs • Clerical jobs • Supervisory/managerial jobs that do not involve manual handling tasks or work • Technical and professional jobs • Jobs involving unexpected manual handling • Lifting object or person in emergency situation (*e.g.,* lifting or carrying injured co-worker) • Jobs involving manual handling that is so infrequent it does not occur on any predictable basis (*e.g.,* filling in on a job due to unexpected circumstances, replacing empty water bottle, lifting of box of copier paper) • Jobs involving manual handling that is done only on an infrequent ''as needed'' basis (*e.g.,* assisting with delivery of large or heavy package, filling in once for an absent employee) • Jobs involving minor manual handling that is incidental to the job (*e.g.,* carrying briefcase to meeting, carrying baggage on work travel)

Core element. Manual handling jobs are jobs in which manual handling tasks are a core element of the employee's job. A core element of a job refers to the tasks or physical work activities that are a key function of a job. Manual handling tasks may be a core element because they are a basic or essential function of a job. They may be a core element because they are frequently repeated or performed for a period of time. The following are examples of jobs in which manual handling would typically be considered a core element:

• Jobs where the basic purpose is to lift loads. These types of jobs include furniture moving, package and product delivery, and airline baggage handling;

• Jobs where lifting or pushing/pulling is an essential function of the job. Patient lifting, for example, is an essential element of nurse aide or health aide jobs and pushing is an essential element for orderlies;

• Jobs where manual handling is a regular element of the job cycle. These types of jobs typically include bringing supplies to a production workstation, loading machines for processing, and moving partially assembled products to the next workstation or onto or off a conveyor;

• Jobs where forceful exertions comprise a significant amount of the employee's work time. These jobs typically include warehousing, stocking and garbage collection;

• Jobs where employees end up doing manual handling on a routine or regular basis even if manual handing is not included in their job description. These jobs typically include unloading supplies or products that are delivered on a regular basis.

Including the concept of core element in the definition of covered manual handling jobs serves several purposes. First, it helps to ensure that employer attention is focused on those manual handling jobs for which data indicate that MSD hazards are most likely to be present: manual handling jobs with high MSD rates and numbers of cases. Studies indicate that manual handling jobs in which employees do forceful exertions repeatedly or for an appreciable period of time are associated with elevated risks of harm. For example, studies show a positive association between duration of exposure to workplace risk factors during manual handling and back pain (Wild 1995, Exs. 26–1104, 26–1105, 26–1106; Liles *et al.* 1984, Ex. 26–33). Studies also show that odds ratios for back MSDs increase significantly as daily duration of exposure to forceful manual handling increases (Holmstrom *et al.* 1992, Ex. 26–36; Punnett *et al.* 1991, Ex. 26–39; Liles *et al.* 1984, Ex. 26–33). Other studies indicate that the rate and duration of continuous lifting significantly reduces the worker's lifting capacity, making the worker more susceptible to MSDs associated with lifting (Snook and Ciriello, 1991, Ex. 26–1008).

Second, OSHA used core element rather than a duration component because, while duration and frequency play a role in determining whether the manual handling job imposes a risk of harm, studies show that employees can be at risk of developing an MSD at relatively short durations of lifting if the tasks involve extreme force (Hagberg 1981, Ex. 26–955) (see Section V of the preamble).

Finally, core element is a reasonable, shorthand way to inform employers that OSHA does not intend to cover manual handling that is so isolated or so incidental to the job that it is not reasonably likely to lead to an MSD. These types of jobs are not associated with high numbers or rates of MSDs.

OSHA requests information and comments about whether the Ergonomics Program Standard should include manual handling jobs. If so, how should manual handling jobs be defined? Should the definition use a flexible approach or be based on quantitative methods such as the NIOSH Lifting Equation?

c. Jobs with MSDs.

(c) Jobs with a musculoskeletal disorder. Jobs with an MSD are those jobs in which an employee reports an MSD that meets all of these criteria:

(1) The MSD is reported after [the effective date];

(2) The MSD is an *OSHA recordable MSD,* or one that would be recordable if you were required to keep OSHA injury and illness records; and

(3) The MSD also meets the screening criteria in § 1910.902.

Note to § 1910.901(c): In this standard, the term covered MSD refers to a musculoskeletal disorder that meets the requirements of this section.

The final group of jobs this standard proposes to cover are those in which an employee reports a musculoskeletal disorder (MSD).

What is an MSD? Musculoskeletal disorders are injuries or disorders of the:

- Muscles
- Tendons
- Joints
- Spinal discs
- Nerves
- Ligaments
- Cartilage

MSDs develop as a result of repeated exposure to ergonomic risk factors. The proposed rule covers the following ergonomics risk factors:

- Force (including dynamic motions)
- Repetition
- Awkward or static postures
- Contact stress
- Vibration
- Cold temperatures

MSDs covered by the proposed standard do not include injuries to muscles, nerves, tendons, ligaments, or other musculoskeletal tissues that are caused by accidents such as slips, trips, falls, being struck by objects, or other similar accidents.

Table IV–3 contains examples of MSDs that may develop as a result of exposure to the ergonomic risk factors the proposed rule covers:

Table IV–3

EXAMPLES OF MUSCULOSKELETAL DISORDERS THE ERGONOMICS PROGRAM STANDARD WOULD COVER IF CONDITIONS OF THE STANDARD ARE MET
• Carpal tunnel syndrome • Epicondylitis • Herniated spinal discs • Tarsal tunnel syndrome • Raynaud's phenomenon • Sciatica • Ganglion cyst • Tendinitis • Rotator cuff tendinitis • DeQuervain's disease • Carpet layers knee • Trigger finger • Low back pain

The presence of MSD signs and/or symptoms is usually the first indication that an employee may be developing an MSD. The proposed rule defines both terms.

MSD signs are objective physical findings that an employee may be developing an MSD.

MSD symptoms, on the other hand, are physical indications that an employee may be developing an MSD. Symptoms can vary in severity, depending on the amount of exposure to MSD hazards. Often symptoms appear gradually, for example, as muscle fatigue or pain at work that disappears during rest. Usually symptoms become more severe as exposure continues. For example, tingling in the fingers that formerly occurred only when the employee was doing a repetitive task subsequently continues even when the employee is off work or at rest. If the employee continues to be exposed, symptoms may increase to the point that they interfere with performing the job. For example, as exposure continues the employee's grip strength (*e.g.,* ability to hold or grip an object or exert pressure with the hand) may decrease to the point where the employee has difficulty holding tools or gripping objects. Finally, pain may become so severe that the employee is unable to perform physical work activities). Table IV–4 includes examples of MSD signs and symptoms that OSHA is proposing to cover in this standard:

Table IV–4

EXAMPLES OF MSD SIGNS AND SYMPTOMS	
MSD SIGNS	MSD SYMPTOMS
• Deformity • Decreased grip strength • Decreased range of motion • Loss of function	• Numbness • Tingling • Pain • Burning • Stiffness • Cramping

What MSDs does this standard cover? The proposed rule does not cover all MSDs, and thus a report of an MSD would not automatically require the employer to set up an ergonomics program or to provide MSD management. The proposed rule only covers those MSDs that meet all of the following requirements:

- They are ''OSHA recordable'' MSDs, and
- They are reported after the effective date of the standard, and
- They meet the screening criteria in § 1910.902 (*i.e.,* physical work activities and/or conditions are reasonably likely to cause the type of MSD reported and are a core element of the job and/or make up a significant amount of the employee's worktime).

OSHA recordable MSDs are those that meet the recording criteria of the OSHA recordkeeping rule, 29 CFR Part 1904. These MSDs must be recorded on the OSHA injury and illness logs, or are MSDs that would have to be recorded if the employer were obligated to keep such logs.

The OSHA recordkeeping rule does not require that every MSD be recorded.

The OSHA Meatpacking Guidelines explain what MSDs employers must record under the recordkeeping rule. A recordable MSD is a work-related MSD that results in one or more of the following:

- A diagnosis of an MSD by a HCP; or
- At least one positive physical finding, or
- An MSD symptom plus:
  - Medical treatment,
  - Restricted duty,
  - One or more lost work days, or
  - Transfer/rotation to another job.

Positive physical finding. A positive physical finding is a report of any of the MSD signs listed above that is observable by the employer and/or HCP. It is also a positive result on a medical test (*i.e.*, Finkelstein's, Phalen's or Tinel's test) conducted by an HCP. Because a positive physical finding is able to be observed by others, unlike a symptom, OSHA considers positive physical findings to be a recordable MSD, even if the employee has not missed work, been placed on work restrictions, or received medical treatment for the problem.

MSD symptom plus other action. Under OSHA's recordkeeping rule, MSD symptoms are recordable if they have resulted in medical treatment beyond first aid, restricted duty, one or more days away from work or transfer/rotation to another job. For example, where an employer responds to an employee report of symptoms (*e.g.*, numbness in the fingers or pain in the wrist) by putting the employee in a light duty job or by directing the employee to stay at home to rest the injured area, the event must be recorded.

When an employee requires medical treatment to obtain relief from and resolve MSD signs or symptoms, the condition is a recordable MSD. Conservative medical treatment of MSDs, for example, may include prescription anti-inflammatories, splints or braces to immobilize movement of the injured area while at rest or sleeping, and/or physical therapy.

There are several reasons why OSHA is proposing to use an OSHA recordable MSD as an initial trigger, rather than other incident triggers (*e.g.*, MSD rates, any report of MSD signs or symptoms, accepted workers' compensation claims) to determine coverage. First, using an OSHA recordable should not be difficult or burdensome for most employers because they are familiar with this definition from their OSHA injury and illness logs. This is why many stakeholders said they supported using an OSHA recordable MSD in the ergonomics rule. Using the same definition for both rules (the recordkeeping and ergonomics rules) would reduce employer burdens in complying with the ergonomics rule because employers would not have to develop or learn a new recordkeeping system. In addition, it would reduce paperwork burdens because the OSHA logs would satisfy both the ergonomics rule and also the OSHA recordkeeping requirement.

Second, a number of stakeholders support using an OSHA recordable MSD because they believe it is a reasonable, objective definition. For example, a number of stakeholders oppose using any report of MSD symptoms because they are concerned that such reports may be subjective, and, unless the symptoms are persistent, may not really mean that an injury is present. These stakeholders also said that an OSHA recordable is more objective than other measures, such as the results of discomfort surveys.

Third, limiting coverage to jobs with a high incidence rate would have limited value. The typical job has between 1 to 10 employees, *i.e.*, between 1 and 10 employees in a given establishment perform the same job. Even if one of these employees has an MSD, the annual rate would be an unacceptably high incidence rate of 10%. For all except rare situations in which there are more than 100 employees with the same job, defining the trigger in terms of a rate is not fundamentally different from a one-incident trigger (see the discussion in Chapter VII of the Preliminary Economic Analysis, Ex. 28–1).

Defining coverage in terms of a job with a workers' compensation award would result in unequal treatment of employees and employers covered by the ergonomics standard. State workers' compensation laws vary significantly and the same MSD may not be compensable in all States. For example, some States compensate an injured employee only if MSD hazards are the predominant cause of the MSD or if there is clear and convincing evidence that the MSD hazard caused the MSD. In Virginia, a number of MSDs are not compensable (*e.g.*, rotator cuff syndrome). Moreover, defining an MSD in terms of workers' compensation claims puts employers who willingly acknowledge the work-relatedness of an MSD at a disadvantage compared to those employers who discourage claims and challenge compensation awards.

Finally, using an OSHA recordable MSD as the initial trigger would make the ergonomics rule more protective than using a number of the other MSD measures. Using an OSHA recordable MSD would require employers to respond to every MSD that is sufficiently important to warrant recording. In contrast, using multiple MSDs or incidence rates would mean that the ergonomics rule would not require some employers to provide protection or MSD management for the first employee who reports an MSD, even if the MSD is clearly work related or has resulted in severe permanent damage. (See OSHA's Initial Regulatory Flexibility Analysis in Chapter VII of the Preliminary Economic Analysis, Ex. 28–1, for an analysis of the potential impacts of alternative triggers.)

OSHA requests information and comment on its proposal to base coverage on the occurrence of an OSHA recordable MSD and an employer determination that the recordable also meets the screening criteria, as well as on alternative definitions of the term MSD that would be as protective as the proposed definition.

Reported after effective date. OSHA is also proposing to limit the MSDs that the standard would cover to those that are reported after the standard becomes effective, which is 60 days after the final Ergonomics Program Standard is published in the **Federal Register**. Coverage of the standard would not be triggered for MSDs that occurred before that date.

f. Screening criteria. The last requirement is that MSDs meet the criteria in § 1910.902. If the criteria are not met, the employer has no further obligation under the proposed rule.

Section 1910.902 Does this standard allow me to rule out some MSDs?

Yes. The standard only covers those OSHA recordable MSDs that also meet these screening criteria:

(a) The physical work activities and conditions in the job are reasonably likely to cause or contribute to the type of MSD reported; and

(b) These activities and conditions are a core element of the job and/or make up a significant amount of the employee's worktime.

The screening criteria limit coverage of the proposed standard to jobs where exposure to MSD hazards is reasonably likely to cause or contribute to the type of MSD reported, and the job activities are a core element of the job and/or make up a significant amount of the employee's worktime. Because MSD hazards are physical work activities or conditions that are reasonably likely to cause MSDs, normally the occurrence of a recordable MSD is a good indicator that an MSD hazard is present. However, there are occasions in which MSDs result from idiosyncratic or unusual work circumstances. While work-related, such an MSD may not evince underlying hazards of the type an ergonomics program is designed to address. For example, if an employee who routinely does heavy lifting incurs work-related low back pain, that is precisely the type of MSD the work activities of the job are reasonably likely to have contributed to and would be the type of MSD hazard the ergonomics program is designed to control. If the same employee reports carpal tunnel syndrome, however, the situation is different. Of course, the condition may not be work-related. Even if it is, however, it is likely to be related to physical work circumstances or reactions that would not normally be taken into account in designing ergonomic controls. Because the occurrence of a recordable MSD is not a good proxy for an underlying hazard in this circumstance, the MSD would not be a covered MSD for purposes of this standard. For the reasons described in the explanation of manufacturing and manual handling jobs above, covered MSDs are limited to those that have a good nexus with the physical work activities and conditions of the job; that is, the physical work activities and conditions that are reasonably likely to result in the occurrence of an MSD are (1) a core element of the job, and/or (2) make up a significant amount of the employee's worktime.

2. Other Sections on Scope

Section 1910.903 Does this standard apply to the entire workplace or to other workplaces in the company?

No. This standard is job-based. It only applies to jobs specified in § 1910.901 not to your entire workplace or to other workplaces in your company.

Section 1910.903 specifies that the ergonomics rule would apply only to those jobs OSHA explicitly identified as covered jobs and ensures that the presence of a covered job does not bring the rest of the workplace under the ergonomics standard. This means that employers would not have to develop an ergonomics program that covers all jobs and employees in the workplace merely because one job in the workplace is covered by the ergonomics standard. Other jobs in the workplace would only be included under the standard if they meet the definition of a covered job or if they involve the same physical work activities and conditions as the job in which the employee experienced the covered MSD.

Some stakeholders recommended that if an ergonomics program is required in a workplace, it should cover the entire workplace. They said that a whole-workplace approach would be easier because it would eliminate the need to determine whether certain jobs are covered by the ergonomics rule or involve the same physical work activities and MSD hazards as the covered job (Ex. 26–1370). Some said that a facility-wide program achieves greater employee buy in and support for the ergonomics program. It would also create employee goodwill because all employees would be part of the program and would be provided protection, as opposed to a situation in which employees working side-by-side would not necessarily both be covered by the ergonomics program. Finally, stakeholders said they found that developing a facility-wide program was as a more efficient use of resources, because it eliminated duplication of efforts such as training. For these reasons, they said, many employers have taken this approach in their own workplaces.

OSHA agrees with stakeholders that there are advantages to facility-wide ergonomic programs and OSHA encourages employers to consider a facility-wide approach. However, OSHA is not proposing to require a workplace-wide approach because the risk factors are not present in every job to the extent that an MSD is reasonably likely to occur. The job-based coverage of the proposed rule ensures that employers focus first on the jobs where intervention is needed the most; that is, jobs in which the employees' exposure to the risk factors is significant enough that MSDs are occurring or reasonably likely to occur if exposure continues unabated. In any event, if other jobs in the workplace are or become problem jobs, those employees would also be included in the program required by the standard and would thus be provided protection from MSD hazards. Job-based coverage assures that employers are not required to expend resources on jobs in which there is little likelihood that MSD hazards are present.

The remaining half of section 1910.903 informs employers that their program for addressing problem jobs does not have to be applied corporate-wide. That is, the existence of a problem job in one workplace does not mean that employers have to set up an ergonomics program in every facility owned by the company in which that job is performed. OSHA is proposing to limit employer obligations to the facility in which the problem job is identified. At the same time, OSHA recognizes that a number of employers have developed corporate-wide ergonomics programs. OSHA notes that while the general program and protocols of such corporate programs are applied to all workplaces, job hazard analyses and determinations about whether and what actions are needed in specific jobs are usually made at the workplace level.

OSHA notes that, although the ergonomics rule would not apply corporate-wide, the employer will need to take action in other company-owned facilities if they have any of the problem jobs this standard covers (*e.g.*, if a covered MSD occurs there).

Section 1910.904 Are there areas this standard does not cover?

Yes. This standard does not apply to agriculture, construction or maritime operations.

OSHA is proposing to exclude firms engaged in agriculture, construction and maritime operations from the scope of the first phase of this ergonomics rulemaking. OSHA acknowledges that LWD MSD rates are also high in firms engaged in agriculture, construction and maritime operations. However, the unique problems (*e.g.*, jobs of very short duration, no fixed workstations) and the more limited information available on effective ergonomic controls in these workplaces have convinced OSHA that it must, for resource and priority-setting reasons, limit this first phase to general industry. OSHA has preliminarily decided to address the MSD hazards in firms engaged in these operations in a separate rulemaking. (OSHA's reasoning is discussed in detail in Part C below.)

OSHA intends to develop a separate ergonomics rule that can be tailored to the conditions that are unique to firms in these industries. In addition, OSHA believes that the experience it gains from the first phase will provide valuable assistance in developing an effective ergonomics rule for agriculture, construction and maritime.

OSHA requests comments and information about whether firms engaged in agriculture, construction and maritime operations should be included in this ergonomics standard at this time. In particular, OSHA requests comments and information about whether, for example, manual handling operations in agriculture, construction and maritime should be included in this first phase of the ergonomics rulemaking.

C. Authority and Reasons for Limiting Coverage of the Proposed Ergonomics Standard.

This section discusses OSHA's authority under the OSH Act to promulgate the ergonomics standard sequentially, and its reasons for limiting the proposed ergonomics standard at this time to the three types of jobs discussed above. This discussion focuses on the following questions:

- What authority and reasons support promulgating the Ergonomics Program Standard sequentially, and limiting the first phase to manufacturing jobs, manual handling jobs, and other jobs where an OSHA recordable MSD is reported?
- What authority and reasons support exclusion of the agriculture, construction and maritime industries from the proposed ergonomics standard?

1. Section 6(g)—OSHA Authority to Limit the Scope of Rulemakings

The OSH Act authorizes OSHA to use a phased approach to rulemaking, including focusing first on areas where the problem is severe and solutions are well-known. Section 6(g) of the OSH Act, 29 U.S.C. 655, permits OSHA to set priorities in establishing standards, including limiting the scope of particular standards and promulgating standards in phases. Section 6(g) provides:

> In determining the priority for establishing standards under this section, the Secretary shall give due regard to the urgency of the need for mandatory safety and health standards for particular industries, trades, crafts, occupations, businesses, workplaces or work environments. The Secretary shall also give due regard to the recommendations of the Secretary of Health, Education, and Welfare regarding the need for mandatory standards in determining the priority for establishing such standards.

In proposing the addition of section 6(g) to the OSH Act, Senator Jacob Javits explained that its purpose was ''to relieve the Secretary of the necessity of waiting to promulgate whatever standards he wishes across the board [by] allowing him to yield to more urgent demands before he tries to meet others. * * *'' Legislative History, 505.

The courts have broadly interpreted section 6(g) as ''clearly permit[ting] the Secretary to set priorities for the use of the agency's resources.'' *United Steelworkers of America* v. *Auchter (Hazard Communication),* 763 F.2d 728, 738 (3rd Cir. 1985); *Forging Industry Association v. OSHA (Noise),* 773 F.2d 1436, 1455 (4th Cir. 1985); *United States Steelworkers* v. *Marshall (Lead),* 647 F.2d 1189, 1309–1310 (D.C. Cir. 1980), cert. denied, 453 U.S. 913 (1981); *National Congress of Hispanic American Citizens* v. *Usery (Hispanic II),* 626 F.2d 882 (D.C. Cir. 1979); *National Congress of Hispanic American Citizens* v. Usery (Hispanic I), 554 F.2d 1196, 1199 (D.C. Cir. 1977). Section 6(g) authorizes OSHA to ''alter priorities and defer action due to legitimate statutory considerations,'' *Hispanic II,* 626 F.2d at 888 n. 30. In the PELs rulemaking, for example, the court upheld OSHA's decision to exclude exposure monitoring and medical surveillance provisions from the rule as being ''purely a matter of regulatory priority.'' *AFL–CIO* v. *OSHA (PELs),* 965 F.2d 962, 985 (11th Cir. 1992).

Section 6(g) also permits OSHA ''to promulgate standards sequentially.'' Hazard Communication, 763 F.2d at 738. See, *PELs,* 965 F.2d at 985 . For example, the courts have upheld OSHA's decisions to issue standards for general industry first and thereafter to develop separate rules for those other industries that may have unique problems requiring special consideration (*e.g.,* mobile jobs of very short duration in the construction industry). *Lead,* 647 F.2d at 1309–10. (See Confined Spaces standard, 29 CFR 1910.146.) Section 6(g) also authorizes OSHA to ''act in its legislative capacity 'to focus on only *one aspect of a larger problem.*' '' *Lead,* 647 F.2d at 1310 (citing Chief Justice Burger concurring in Benzene, 448 U.S. at 663 (1980)) (emphasis added). In the PELs rulemaking, OSHA limited the standard solely to revising exposure limits and excluded ancillary provisions designed to provide further protection even though most other health standards included such provisions. See, *PELs,* 965 F.2d at 985.

Although OSHA's discretionary authority under section 6(g) is quite broad, it is not absolute:

> The scope of an agency's discretion is bounded by law; an agency cannot justify a decision by reference to its discretionary authority, if the decision lies beyond the scope of agency's discretion. (citations omitted) A statute may define as off-limits to an agency a particular basis for a decision, just as it may foreclose a particular result altogether. *Farmworkers Justice Fund, Inc.* v. *Brock (Field Sanitation),* 811 F.2d 613, 620 (D.C. Cir.), vacated as moot, 811 F.2d 890 (1987).

The Supreme Court has made clear that an agency's decision will be set aside if it relied on factors which the Congress did not intend it to consider. *Motor Vehicle Manufacturers Assn.* v State Farm Mutual Automobile Insurance Co., 463 U.S. 29, 43 (1983). In section 6(g), Congress established factors OSHA must consider in setting its priorities: OSHA must give ''due regard to the urgency of the need'' for a standard in, among others, particular industries, occupations, workplaces, or work environments.[1] The court in Hazard Communication said that this language suggests a statutory standard by which to measure the exercise of OSHA's discretion. Hazard Communication, 763 F.2d at 738. Authorizing rulemaking priority for the most severe hazards also comports with the criteria of section 6(c), which authorizes OSHA to pursue expedited rulemaking (*i.e.,* emergency temporary standard) but only where employees are exposed to ''grave dangers.'' *Hispanic II,* 626 F.2d at 889 n.36.

The Third Circuit has held that there is another limit on OSHA's 6(g) authority depending on where OSHA is in the rulemaking process. Hazard Communication, 763 F.2d at 738. The court said that, in situations where OSHA is setting priorities for future rulemaking, the agency has great latitude under section 6(g) to address greater hazards first. *Id.* However, the court held that where OSHA has decided to promulgate a standard to address an issue it is not enough for the agency to declare that it has selected certain industries or jobs for coverage because they present greater hazards. *Id.* Where significant risk exists in other industries and a standard is feasible there as well, OSHA may exclude those industries only if covering them would ''seriously impede the rulemaking process.'' *Id.*

The standard in question, Hazard Communication (29 CFR 1910.1200), only required employers to provide employees with information and training about hazardous chemicals in the workplace, based on analyses generally conducted by the chemical manufacturer or importer. The standard did not require employers to analyze jobs, implement controls, or provide medical management. The court apparently believed that there was no substantial question about the feasibility of the rule, and therefore no question about whether the rule could be expanded without impeding the rulemaking process. It is not clear the court would have reached the same result or announced the same principle if the standard

[1] See also, *Hispanic I,* 554 F.2d at 1199 (''The Act has built in flexibilities that the Secretary may use, such as * * * the priorities between the various occupations that require standards. * * *'').

in question had posed more complex scientific and feasibility issues. In any event, OSHA's decision to limit the proposed standard is consistent with the Hazard Communication decision because, as discussed below, expansion of the rule at this time to include construction, maritime and agriculture would seriously impede the rulemaking process.

2. Focus on Jobs Where Problems Are Severe and Solutions Are Well-Understood

OSHA has developed a general principle, based on the underlying legislative intent and the case law interpreting section 6(g), that it proposes to follow in determining what jobs should be covered in the first phase of this rulemaking. As mentioned above, that principle is: Focus on areas where problems are severe and solutions are well-understood. OSHA's decision, based on this guiding principle, to cover manufacturing, manual handling and general industry jobs where there are MSDs is consistent with the language and legislative intent of section 6(g).

3. Reasons for Excluding Agriculture, Construction and Maritime Industries From the Proposed Standard

Some stakeholders recommended that the proposed rule be expanded to include all industries. They said that the number and rates of MSDs in the construction industry are very high. They added that incidence rates for some construction industries are higher than for some manufacturing industries that are to be covered in the first phase. However, for the reasons set forth below, OSHA is not proposing that the first phase of the Ergonomics Program Standard cover these other industries.

a. Unique problems. OSHA acknowledges that employees in the agriculture, construction and maritime industries face significant risk of harm due to exposure to MSD hazards. In 1996, for example, almost 65,000 employees in these industries reported MSDs that were serious enough to result in days away from work, according to OSHA's analysis of BLS data (Ex. 1413). This means that 10% of all reported lost-workday MSDs occurred in just three industry sectors. Nonetheless, consistent with its discretion under section 6(g), OSHA proposes to exclude these industries from this proposal and to give them special consideration in subsequent rulemaking. *Lead,* 647 F.2d at 1310.

First, work conditions and factors present in agricultural, construction and maritime activities often are quite different from those of general industry. To illustrate, much of construction work involves or is affected by an interaction among several factors. These factors include the following aspects or conditions of work:

• Consisting primarily of jobs of short duration;

• Under a variety of adverse environmental and workplace conditions (*e.g.,* cold, heat, confined spaces, heights);

• At non-fixed workstations or non-fixed work sites;

• On multi-employer work sites;

• Involving the use of ''day laborers'' and other short-term ''temporary workers,'';

• Involving situations in which employees provide their own tools and equipment; and

• Involving employees who may be trained by unions or other outside certifying organizations.

While some of these factors may be present at times in other industries, they are continuously present in construction. OSHA may need to develop an ergonomics standard that takes this range of special conditions into account. For example, OSHA may also need to revise job hazard analysis and hazard control provisions in the current proposal so they are effective for industries where jobs are of such short duration that they may be completed before analysis and control can be implemented. These and other unique work conditions also are present in agricultural and maritime activities. For example, in longshoring, quite often workers are obtained from union hiring halls where they have been trained and certified in the use of certain machinery.

In addition, as compared to the very large body of evidence that exists for general industry, OSHA's experience with and information about ergonomic solutions in the agriculture, construction and maritime industries are relatively limited. OSHA believes that the information it does have will support the promulgation of an ergonomics standard in these industries in the second phase of this rulemaking. However, the Agency needs more time to gather and analyze this evidence to develop an effective ergonomics standard for agriculture, construction and maritime. For example, OSHA must gather and examine information on the types of ergonomic controls that would work in an industry with a high number of non-fixed workstations.

Because of the unique problems in these industries, it could take considerably more time to gather the needed information. And after waiting until an equivalent body of evidence is gathered and analyzed for these industries, the evidence might still show that separate ergonomics rules are warranted for construction, agriculture and maritime in any event.

b. Substantially impede the rulemaking. Implicit in setting rulemaking priorities based on the urgency of the need for action is whether a standard can be issued in a time frame that is responsive to the urgent need. Another reason OSHA is proposing to limit the ergonomics rule to general industry is that OSHA believes that expanding the rule to cover agriculture, construction and maritime would seriously delay addressing the urgent need for protection in the covered jobs. This is because information and experience on ergonomics in these industries is more limited than is the case in general industry. Expanding the scope could place substantial additional burdens on an already complex rulemaking. For example, if OSHA must first gather and analyze evidence for every industry before it may propose an ergonomics standard, 90% of the employees who already have been injured and for whom a standard can be promulgated now may be forced to wait for their urgently needed protection until OSHA is also able to provide it to the remaining employees exposed to MSD hazards. Also, expanding the scope of this proposed standard could strain OSHA's limited resources to the detriment not only of the ergonomics rulemaking but to other OSHA priorities as well, including other priorities for the construction, maritime and agricultural industries.

On the other hand, focusing on areas where a large body of evidence of effective ergonomics programs and control interventions exists should help OSHA to respond quickly to urgent situations where worker protection is needed now. Limiting the scope of the proposed rule at this time is thus fully consistent with OSHA's obligations under section 6(g).

By contrast, in agriculture, construction and maritime, the information on ergonomics programs and interventions is more limited. Only now is NIOSH conducting a study on ergonomic problems and interventions in the shipyard industry, and the results of that study are not expected for more than a year.

How Does This Standard Apply to Me? (§§ 1910.905–1910.910)

OSHA's proposed ergonomics program standard has several unique features. First, it is a job-based standard. As the preamble sections for 1910.901 through 1910.904 of the proposed standard make clear, the standard applies to general industry employers whose employees: (1) Work in manual handling jobs; (2) work in manufacturing jobs; and (3) work in other general industry jobs and experience a musculoskeletal disorder (MSD) that is covered by this standard. Second, employers within the scope of the standard are required only to implement the ergonomics program required by the standard for those jobs specifically listed above; they are not required to have a program for all of the jobs in their workplace. Third, the requirements of the standard apply differently to different general industry employers, because the standard is also risk based. That is, for employers whose employees perform manual handling or manufacturing jobs—jobs which together account for a disproportionate share (60%) of all reported work-related MSDs—employers are required to implement only those elements of the proposed standard that will prepare them to deal with a covered MSD should one occur. Thus, employers whose employees work in these high-risk jobs must put several of the required program elements in place even *before* their employees experience a covered MSD, because the likelihood that they will do so is great. If an employee in a manual handling or manufacturing job subsequently experiences a covered MSD, the employer would then be required to implement the remaining elements of the ergonomics program required by the standard, including job hazard analysis and control, MSD management, training, and program evaluation.

For general industry employers without manual handling or manufacturing jobs in their workplace, however, the proposed standard would not require action until an employee actually experiences such an MSD. In other words, for general industry employers with other types of jobs, the event that ''triggers'' coverage by the standard is the occurrence of an MSD that the employer determines to be covered. As explained above in the summary and explanation for sections 1910.901 through 1910.904, such an MSD could occur in any general industry job, *e.g.*, grocery store cashier, newspaper reporter, secretary, cafeteria worker, restaurant server, computer programmer, mail sorter, janitor, etc. Relying on the occurrence of a covered MSD to trigger the standard's coverage for non-manual handling, non-manufacturing jobs is consistent with the risk-based design of the standard: The occurrence of an MSD that is determined by the employer to be, first, an OSHA-recordable MSD, second, an MSD that has occurred in a job in which the physical work activities are reasonably likely to cause or contribute to the type of MSDs reported, and third, an MSD that has occurred in a job where the physical work activities and conditions are a core element of the job and/or make up a significant amount of the employee's worktime. The scope provisions of the standard (sections 1910.901 through 1910.904) also indicate that employers whose employees engage in construction, agricultural, or maritime operations are not covered by the scope of the rule.

Sections 1910.905 through 1910.910 of the proposed standard, titled ''How does this standard apply to me?,'' determine how various elements of the proposal would apply to these three different groups of general industry employers, depending on the jobs their employees perform and/or whether their employees experience a musculoskeletal disorder that is covered by the standard. These sections of the proposal thus contain the internal ''action levels'' or ''triggers'' that OSHA has built into the standard to tailor its requirements to the extent of the ergonomics problem present in a given workplace.

Specifically, these sections of the proposal contain the following requirements:

- Section 1910.905 describes the elements of a complete ergonomics program;
- Section 1910.906 establishes the requirements of the program that apply to all general industry employers that have manual handling or manufacturing production jobs in their workplaces;
- Section 1910.907 sets forth the requirements of the rule applying to general industry employers whose employees experience a covered MSD in jobs other than manual handling or manufacturing;
- Section 1910.908 establishes the criteria general industry employers wishing to avail themselves of the proposed standard's ''grandfather'' clause must meet in order to qualify for grandfather status;
- Section 1910.909 provides general industry employers with a Quick Fix option, which would allow them to avoid setting up an ergonomics program for any problem job that they can fix completely within a short period of time, provided that they also meet the other requirements delineated in this section; and
- Section 1910.910 specifies the requirements applying to employers whose Quick Fix controls have not eliminated MSD hazards in the problem jobs they tried to address through the Quick Fix option.

The following paragraphs explain OSHA's rationale for each of these sections of the proposed rule.

Section 1910.905 What are the elements of a complete ergonomics program?

In this standard, a full ergonomics program consists of these six program elements:

- Management Leadership and Employee Participation;
- Hazard Information and Reporting;
- Job Hazard Analysis and Control;
- Training;
- MSD Management; and
- Program Evaluation.

OSHA is proposing in this standard that employers implement an ergonomics program that contains well-recognized program elements. OSHA is not alone in believing that all of these core elements are essential to the effective functioning of ergonomics programs. Many private sector companies, OSHA stakeholders, insurers, employee and employer associations, safety and health professionals, and other Federal agencies (*e.g.*, NIOSH, GAO) have endorsed these elements as key to ergonomic program effectiveness. Evidence of the widespread acceptance of these program elements and their effectiveness is reflected in the following documents, regulatory actions, and sources of expert opinion: [1]

[1] There is no provision for WRP in the OSHA safety and health program guidelines, state safety and health programs, nor the ASSE program; of these, the OSHA guidelines and ASSE program are voluntary.

• They track OSHA's 1989 voluntary *Safety and Health Program Management Guidelines* (54 FR 3904), which were well received and widely adopted by employers and other stakeholders;

• State safety and health program regulations, most of which address ergonomic issues. Of the 32 states that encourage or mandate workplace safety and health programs, 21 have provisions corresponding to the core elements in this proposal;

• OSHA's Ergonomics Program Management Guidelines for Meatpacking Plants (Ex. 2–13), which includes all of these core elements. Facilities that have developed programs based on the meatpacking guidelines have experienced dramatic reductions in the severity and number of MSDs (Ex. 26–1420);

• Consensus among occupational safety and health professionals that these are the elements needed in an effective safety and health program. (see, *e.g.,* the American Society of Safety Engineers Safety and Health Program Manual). The core elements in this proposal are also similar to the components in the approach used by the Accredited Standards Committee in developing the draft consensus standard, ''Control of Cumulative Trauma Disorders'' for the American National Standards Institute (Z–365);

• A study by the General Accounting Office of ergonomics programs, which found that effective programs include the same set of core elements as OSHA has proposed; and

• The 1997 NIOSH document titled ''Element of Ergonomics Programs,'' which outlines the ''approach most commonly recommended for identifying and correcting ergonomic problems.'' Thus, OSHA finds that these elements are the ones needed for an effective ergonomics program and represent the tried and true mainstream approach to ergonomic programs.

The core elements in this proposal will allow employers to manage all aspects of the process of protecting workers from MSDs and are a way of organizing that process into parts that can be meaningfully understood and implemented. All of the elements are important, although many safety and health professionals believe that management leadership and employee participation are the keystone of an effective ergonomics program (OSHA/NIOSH conference 1997). OSHA believes that all of the elements are necessary to achieve the overall goal of managing MSDs and ensuring that MSD hazards are systematically and routinely prevented, eliminated, or controlled.

Many OSHA stakeholders and respondents to the ergonomics ANPR published in 1992 (57 FR 34192) have endorsed the program approach. For example, the M & M Protection Center (Ex. 3–51) stated: ''Generic components described in the ANPR and in the Meat Packing Guidelines are feasible and necessary elements of an ergonomic hazards control strategy. These form a practical foundation from which to build a more industry-specific program.''

Another commenter, Arvin Industries, Inc. (Ex. 3–46) emphasized the value of the program approach to companies engaged in different businesses:

> The use of the * * * [program] approach has been shown to provide effective solutions and a significant reduction in ergonomics hazards in jobs in many different industries.

Employees, represented by the AFL–CIO (Ex. 3–184), urged OSHA to include all of the program elements in the Meatpacking Guidelines in any future ergonomics standard:

> The AFL–CIO strongly supports the inclusion of the listed elements in OSHA's proposed ergonomics standard.

OSHA has been responsive to these commenters by including the six core elements listed above in the ergonomics program required by the proposed standard for jobs where the hazards present are such as to pose a reasonable likelihood of lending to a covered MSD, or have already caused or contributed to such an MSD.

The summary and explanation sections of the preamble for each program element describe OSHA's reasoning for including each element in the proposed program.

Section 1910.906 How does this standard apply to manufacturing and manual handling jobs?

You must:

a. Implement the first two elements of the ergonomics program (Management Leadership and Employee Participation, and Hazard Information and Reporting) even if no MSD has occurred in those jobs.

b. Implement the other program elements when either of the following occurs in those jobs (unless you eliminate MSD hazards using the Quick Fix option in section 1910.909):

1. A covered MSD is reported; or

2. Persistent MSD symptoms are reported plus:

i. You have knowledge that an MSD hazard exists in the job;

ii. Physical work activities and conditions in the job are reasonably likely to cause or contribute to the type of MSD symptoms reported; and

iii. These activities and conditions are a core element of the job and/or make up a significant amount of the employer's worktime.

Note To § 1910.906: ''Covered MSD'' refers to MSDs that meet the criteria in § 1910.901(c). As it applies to manufacturing and manual handling jobs, ''covered MSDs'' also refers to persistent symptoms that meet the criteria of this section.

This section of the rule sets out the requirements applying to general industry employers whose employees perform the high-risk jobs of manual handling or product manufacturing. As discussed in the Risk Assessment and Benefits chapter of the preamble and Preliminary Economic Analysis, respectively, these two jobs account for 60% of all reported general industry MSDs but employ only 28% of all general industry employees. Section 1910.901(a) defines manufacturing jobs as production jobs in which employees perform the physical work activities of producing a product and in which these activities make up a significant amount of their worktime, and section 1910.902(b) defines manual handling jobs as those in which employees perform forceful lifting/lowering, pushing/pulling, or carrying and in which such forceful manual handling is a core element of the employee's job.

Examples of jobs that are typically manufacturing jobs include assembly line jobs, product inspection jobs, and jobs involving machine operation, meat packing, and tire building, among others. Examples of manual handling jobs are those involving patient handling, baggage handling, grocery store stocking, garbage collecting, and janitorial work, among others. Examples of other jobs that would typically be considered manual handling or manufacturing jobs, and examples of those that would not be so classified, can be found in proposed section 1910.945, Definitions.

Paragraphs (a) and (b) of section 1910.906 mandate that employers whose operations involve manual handling or manufacturing jobs, as defined by the proposed standard, implement the first two elements of the ergonomics program required by the standard in these jobs. These elements are:

(1) Management leadership and employee participation, and (2) hazard information and reporting. Each general industry employer whose operations involve either or both of these types of jobs would be required to implement these two program elements in these jobs within one year of the standard's effective date (see proposed section 1910.942). Compliance with these two elements is required even if no employee in these jobs has experienced a covered MSD. As discussed above, OSHA is requiring that these basic elements of an ergonomics program be in place in these jobs because of the high-risk nature of the physical work activities associated with these jobs. Having these elements in place ensures that employers and employees are informed and aware of MSD hazards and the signs and symptoms of MSDs and have established the management structure and employee participation mechanisms necessary to respond quickly if the need arises.

This section of the proposal also requires employers with manual handling or manufacturing jobs to comply with the other elements of an ergonomics program, including MSD management, job hazard analysis and control, training, and program evaluation, if an employee in a manual handling or manufacturing job experiences an MSD that the employer determines, in accordance with proposed sections 1910.901 (c) and 1910.902, to be covered by the proposed standard. As explained in the summary and explanation for those sections, a covered MSD, as defined by this standard, is one that occurs after the effective date of the standard, is an OSHA-recordable MSD (as defined by OSHA's recordkeeping rule, 29 CFR part 1904), and is determined by the employer to have occurred in a job in which the physical work activities and conditions are reasonably likely to have caused or contributed to the type of MSD reported, or to have aggravated a pre-existing MSD. For manufacturing or manual handling jobs, it is important to note that covered MSDs also include: (1) Reports by employees of persistent symptoms of MSDs (persistent is defined as lasting for 7 consecutive days), (2) where the employer has knowledge that such jobs pose MSD hazards to employees, (3) where the job is one in which the physical work activities and conditions of the job are reasonably likely to cause or contribute to the type of MSD reported, and (4) where the activities and conditions are a core element of the job and/or make up a significant amount of the employee's worktime. By ''have knowledge,'' OSHA means that the employer has been provided with information that MSD hazards exist in that job by personnel from an insurance company, or by a consultant, a health care professional, or a person working for the employer who has the requisite training to identify and analyze MSD hazards. Inclusion of this action trigger in the proposed standard is consistent with OSHA's risk-based approach, because the occurrence of persistent symptoms, such as constant pain, tingling, or numbness, coupled with information from a knowledgeable source that the employee's job is one that poses an ergonomic hazard, is strong evidence that the job is one that is reasonably likely to cause or contribute to a covered MSD. OSHA believes that employers generally accept and rely on information from these sources because they are perceived of as unbiased, knowledgeable, and aware of conditions in the employer's specific workplace.

Section 1910.906 of the proposal would allow employers whose work involves manufacturing or manual handling operations to limit their ergonomics program for those jobs to two elements, management commitment/employee participation, and hazard information and reporting, until a problem job (*i.e.*, one held by an employee who has experienced a covered MSD, or a job in the workplace that has the same physical activities and conditions as the job held by such an employee) has been identified. If no covered MSD occurs in the manufacturing or manual handling job, the employer is not required to implement the other elements of the program.

By requiring employers whose employees work in manual handling or manufacturing jobs to implement the first two elements of an ergonomics program even before a covered MSD occurs among the employees in that job, OSHA is requiring these employers to establish a basic surveillance system for MSDs. This basic system consists, under the management leadership element, of assigning responsibilities for the ergonomics program to managers, supervisors, and employees so that these individuals know what their role in the program is, providing these individuals with the information, resources, information and training they need to carry out these responsibilities effectively, and communicating with employers on a regular basis about the program and their concerns about ergonomics issues. In addition, the employer must, as part of management leadership, make sure that its existing policies and procedures do not discourage employee reporting of MSDs or participation in the program. By following these requirements, employers will have established the management process necessary to a functioning ergonomics program: management at the workplace will have a basic system in place to ensure that employee concerns about MSDs are being expressed and responded to, program responsibilities are understood, resources have been made available to the program, and no barriers stand in the way of early and full employee reporting.

The employee participation component of this first program element is the other side of the basic surveillance system the standard requires employers with these two kinds of high-risk jobs to implement. To comply with the employee participation provisions of the standard, employers must set up a way for employees and their designated representatives to report MSD signs and symptoms to the employer, receive prompt responses to these reports, have access to a copy of the ergonomics standard (either through posting or by providing hand copies to employees) and to information about the employer's ergonomics program, and ways to participate in the development, implementation, and evaluation of the ergonomics program.

By implementing these provisions, the second half of the first program element will be put in place: employees will know how to report MSDs and their signs and symptoms, they will expect to receive responses to those reports from management, they will understand their employers' ergonomics program, and they will know how they can participate effectively in making the program a success.

Section 1910.906 also requires, at paragraph (b), that employers with these jobs comply with all of the other elements of an ergonomics program—job hazard analysis and control, MSD management, training, and program evaluation—if a covered MSD occurs in a manual handling or manufacturing job. (As discussed above, for these jobs, persistent MSD symptoms are considered covered MSDs if they also meet the criteria specified in paragraph (b)(2) of this section.) There is one exception to compliance with paragraph (b) of this section: employers who choose the proposed rule's Quick Fix option (described below) do not have to implement the other program elements.

Section 1910.907 How does this standard apply to other jobs in general industry?

In other jobs in general industry, you must comply with all of the program elements in the standard when a covered MSD is reported (unless you eliminate the MSD hazards using the Quick Fix option).

As discussed earlier in this section of the preamble, employers with other jobs (*i.e.,* jobs that do *not* involve either manufacturing or manual handling) are not required by the proposed rule to take any action until and unless a covered MSD occurs in such a job. Thus, for most employers in general industry in a given year, no action is required by the standard. However, if a covered MSD occurs in one of these ''other'' jobs, it becomes a ''problem job,'' as defined in the standard, and the full ergonomics program must be implemented for that job and all jobs in the workplace that involve the same physical work activities.

OSHA has included section 1910.907 in the proposed standard to provide employees who have experienced a covered MSD in these other jobs with the same program protections afforded to manual handling and manufacturing employees who have suffered a covered MSD.

Section 1910.908 How does this standard apply if I already have an ergonomics program?

If you already have an ergonomics program for the jobs this standard covers, you may continue that program, even if it differs from the one this standard requires, provided you show that:

a. Your program satisfies the basic obligation section of each program element in this standard, and you are in compliance with the recordkeeping requirements of this standard (§§ 1910.939 and 1910.940);

b. You have implemented and evaluated your program and controls before [the effective date]; and

c. The evaluation indicates that the elements are functioning properly and that you are in compliance with the control requirements in § 1910.921.

This section of the proposed standard is a limited grandfather clause that is designed to permit employers who have already implemented and evaluated an ergonomics program in those jobs covered by the standard to continue their program, if: it has been shown to eliminate or materially reduce MSD hazards according to § 1910.921, it has the core elements of the program OSHA is requiring, and it meets the basic obligation of each of the core elements in the proposed rule.

By requiring that grandfathered programs meet the conditions set out in paragraphs (a) through (c) of section 1910.908, OSHA is affirming the importance of each of the core elements, as well as recordkeeping, to the proper functioning of an effective ergonomics program. OSHA is also emphasizing the importance the Agency places on the basic obligation sections of the proposed standard (sections 1910.911, 1910.914, 1910.917, 1910.923, 1910.929, and 1910.936). These sections establish the basic requirements employers must follow to implement each core element but do so in less detail than the implementing requirements that follow the basic obligation section for each core element. OSHA believes that the requirements identified in the basic obligations sections of the proposal are the minimum requirements needed to effectively implement the core element to which they pertain. In other words, although OSHA is proposing to grant grandfather status to effective ergonomics programs, it believes that the requirements set forth in each basic obligation section must be present in an ergonomics program for that element to be effective. Thus, employers whose existing programs meet the conditions of the limited grandfather clause in section 1910.908 are free not to implement the more detailed provisions that follow the basic obligation section, provided that they comply fully with the basic obligation section's provisions.

OSHA has several reasons for including the standard's core elements in any ergonomics program that is grandfathered in under the standard. OSHA's reasoning is discussed below.

First, except for WRP, the core elements (management leadership and employee participation, hazard identification and assessment, hazard prevention and control, MSD management, training, and evaluation) are included in the safety and health programs recommended or used by many different organizations (the ergonomics standard uses slightly different terminology for some of these elements):

• OSHA's VPP, SHARP, and consultation programs;

• The safety and health programs mandated by 18 states;

• The safety and health programs recommended by insurance companies for their insureds (many of which give premium discounts for companies that implement these programs or impose surcharges on those that do not);

• The safety and health programs recommended by the National Federation of Independent Business, the Synthetic Organic Chemical Manufacturers Association, the Chemical Manufacturers Association, the American Society of Safety Engineers, and many others;

• The strong recommendations of OSHA's Advisory Committees (NACOSH, ACCSH, and MACOSH), which consider these program elements essential to effective worker protection programs.

Second, OSHA believes, and most stakeholders agree, that enforcement of the standard will be more consistent and more equitable, as well as less time-consuming, for employers and compliance officers alike, if the test of an employer's program is whether the program contains the core elements, rather than whether it is effective. The term effectiveness is subject to many different interpretations. Effectiveness can be measured in many different ways (*e.g.,* decreases in the number of MSDs, decreases in the severity of MSDs, increases in product quality, decreases in insurance premiums, decreases in the number of claims, decreases in turnover, decreases in absenteeism, increases in productivity, increases in the number of MSDs reported early, etc.), several of which have built-in incentives to discourage reporting of MSDs (as discussed in the Significance of Risk (Section VII) section of the preamble, underreporting of MSDs is already extensive. In addition, there are no data that would allow OSHA to evaluate or to choose among these various effectiveness measures. OSHA solicits comments on measures of program effectiveness that are not susceptible to underreporting and that can be used reliably and simply by establishments of all sizes. For example, are there measures of effectiveness that OSHA could use as a measure of effectiveness when determining whether to allow a program to be grandfathered in?

In addition, evaluating programs using the core elements test is administratively simpler, both for OSHA personnel and employers. The Agency is in the process of validating a measurement tool for compliance officers and employers to use in assessing the effectiveness of ergonomics programs. This tool, which is based on the consultation program's Form 33, has been tested for face validity and is being tested for construct validity at the present time; OSHA intends to disseminate it to employers, so that both OSHA personnel and employers will be operating from the same ''sheet of music.'' OSHA believes that use of a tool based on the core elements rather than on unproven measures of effectiveness will thus benefit OSHA, workers, and their employers.

OSHA is including WRP, or equivalent protections against wage loss, as a requirement for all programs because, without it, OSHA believes that there will be increased pressure on employees not to report once an enforceable standard is in place. There is strong evidence that such underreporting is currently taking place (see the table summarizing the many articles on this topic in Section VII of the preamble), as well as evidence that protecting workers from wage loss increases reporting (the Krueger studies). OSHA's purpose in proposing a WRP provision in this standard is to ensure employee participation and free and full reporting of MSDs and MSD hazards. The ergonomics standard depends, more heavily than any OSHA health standard promulgated to date, on employee reporting for its effectiveness. Absent such reporting, the standard will not achieve its worker protection goals. The success of the standard, like that of the many effective ergonomics programs our stakeholders have told us about, depends on it.

The proposed grandfather clause is also limited in its applicability to programs that are in place and have been evaluated and found to be working properly by the effective date of the standard. OSHA believes that this provision is appropriate because it will encourage employers to be proactive and establish programs to protect their employees before the effective date. It will require these programs to have been evaluated before they qualify for grandfather status, which will avoid a last minute rush to implement programs before the effective date and ensure that those programs allowed under the grandfather clause are mature, fully functioning programs. It will also avoid the administrative and compliance problems that would arise if OSHA permitted employers to establish ergonomics programs that differ from the one in the standard even after the effective date.

OSHA seeks comment on all aspects of the grandfather clause provisions, particularly on the protectiveness and appropriateness of including such a provision in a final standard.

Section 1910.909 May I do a Quick Fix instead of setting up a full ergonomics program?

Yes. A Quick Fix is a way to fix a problem job quickly and completely. If you eliminate MSD hazards using a Quick Fix, you do not have to set up the full ergonomics program this standard requires. You must do the following when you Quick Fix a problem job:

(a) Promptly make available the MSD management this standard requires;

(b) Consult with employee(s) in the problem job about the physical work activities or conditions of the job they associate with the difficulties, observe the employee(s) performing the job to identify whether any risk factors are present, and ask employee(s) for recommendations for eliminating the MSD hazard;

(c) Put in Quick Fix controls within 90 days after the covered MSD is identified, and check the job within the next 30 days to determine whether the controls have eliminated the hazard;

(d) Keep a record of the Quick Fix controls; and

(e) Provide the hazard information this standard requires to employee(s) in the problem job within the 90-day period.

Note to § 1910.909: If you show that the MSD hazards only pose a risk to the employee with the covered MSD, you may limit the Quick Fix to that individual employee's job.

OSHA is permitting employers who meet all the requirements of this section to refrain from setting up the full ergonomics program otherwise required. For example, employers can avoid the training and program requirements of the standard if they can eliminate the MSD hazard in the problem job (including other jobs meeting the ''same job'' definition in the standard) quickly.

The Quick Fix option is designed for those problem jobs where the hazard can be readily identified, the solution is obvious, and the solution can be implemented within 90 days after the covered MSD is identified. OSHA has heard repeatedly from stakeholders and others that a large number of jobs will fall into this category. The proposed Quick Fix process differs from the job hazard analysis and control process described in sections 1910.917 through 1910.922, which is appropriate for MSD hazards and jobs requiring iterative changes or extensive analysis to resolve.

The proposed rule requires that employees in problem jobs receive MSD management, including work restriction protection, for their injuries without regard to whether the job is controlled using the Quick Fix option or the full job hazard analysis and control approach. In addition, employee(s) in problem jobs that are fixed through the Quick Fix process must be involved in the Quick Fix process, just as they are involved in the full job hazard analysis and control process. In other words, employers choosing the Quick Fix option must demonstrate management leadership and implement employee participation for the problem job, but would not have to continue these elements after the job is fixed (unless they are employers with manual handling or manufacturing jobs).

The Quick Fix controls must be implemented within 90 days to qualify for this option. OSHA believes that this period is sufficient for employers to identify appropriate engineering controls, to eliminate the MSD hazards entirely, and to order and implement those controls. Again, this time period is consistent with the principal concept behind Quick Fix: that the problem job be fixed quickly, simply and completely. Examples of Quick Fixes include purchasing an adjustable VDT workstation, placing a box under the work surface of an employee who must bend down to see the work, and tilting the work surface toward the employee to prevent long reaches.

As stated in paragraph (b) of this section, if the employer can demonstrate that the MSD hazard that caused or contributed to the MSD only poses a risk to the particular employee with the MSD, the employer may limit the Quick Fix to that individual employee's job. In other words, in this limited case, the employer would not be required to fix the jobs of others in the problem job, because the hazard is one unique to the employee rather than the job. For example, a very tall employee might only need to have the work surface raised, and a very small employee might only need to have the work surface repositioned closer to his or her body.

Paragraph (c) of section 1910.109 requires employers using the Quick Fix option to evaluate the controls within 30 days to be sure that they have eliminated the hazard. One of the best ways to determine whether the Quick Fix has worked is to ask the injured employee. Employers typically can tell almost immediately that the MSD hazard has been eliminated; however, it may take a week or two for the symptoms to resolve.

NIOSH recommends that employers wait a minimum of two weeks before evaluating control effectiveness, because employees need time to acclimate to the changes. NIOSH also recommends, and the proposed standard would require, that employers not wait longer than 30 days to evaluate controls, to enable changes to be made if they are not working.

Paragraph (d) of section 1910.909 requires employers who avail themselves of this option to keep records of the Quick Fix controls they implement. This means that employers must document the controls they have implemented, when they are implemented, and the results of the 30-day evaluation. These records are essential to document the employer's choice of this option and to support the employer's decision not to implement the other components of the ergonomics program.

Section 1910.910 What must I do if the Quick Fix does not work?

You must set up the complete ergonomics program if either of these occurs:

(a) The Quick Fix controls do not eliminate the MSD hazards within the Quick Fix deadline (within 120 days after the covered MSD is identified); or

(b) Another covered MSD is reported in that job within 36 months.

Exception: If a second covered MSD occurs in that job resulting from different physical work activities and conditions, you may use the Quick Fix a second time.

This section requires employers who have chosen the Quick Fix option but have not been successful in eliminating the MSD hazards in the job to implement the full ergonomics program. The employer must implement the full ergonomics program for a job either where the Quick Fix fails to eliminate MSD hazards within 120 days, or if another covered MSD occurs in that job within 36 months after implementing the Quick Fix.

This paragraph of the proposed standard contains an exception: where an employer has implemented a Quick Fix in a job and another covered MSD occurs in that job, the employer may may use the Quick Fix approach a second time if the second covered MSD is one caused or contributed to by work activities that are different from those that caused or contributed to the first covered MSD in that job. The exception to section 1910.910 would apply when, for example, a particular job requires the employee to perform a manufacturing assembly or data entry job for a significant amount of their worktime and also to perform forceful lifting as a core element of the job. In such a situation, an employee in that job could experience a case of carpal tunnel syndrome, and the employer could use a Quick Fix to control the MSD hazard. If any employee in the same job subsequently (*e.g.*, 2 years later) develops a lower back injury, the exception to section 1910.910 would permit the employer to use a Quick Fix to address the manual handling hazard. However, the proposed standard would only permit the Quick Fix option to be used twice in the same job because, if covered MSDs continue to occur in the same job, job hazard analysis and control, as well as the other provisions of the full program, must be implemented.

Evidence of the failure of the Quick Fix approach could take two forms: the evaluation performed within 30 days of the implementation of the Quick Fix reveals that the control has not eliminated the hazard (*e.g.*, the employee reports that his/her signs or symptoms have worsened) or an employee in that job suffers a covered MSD to which the exception does not apply. Where the Quick Fix option has failed, the employer would be required to move into the full program, *i.e.*, job hazard analysis and control, training, and program evaluation.

Management Leadership and Employee Participation (§§ 1910.911–1910.913)

Sections 1910.911–913 of the proposed standard describe and explain the proposed requirements for the management leadership and employee participation element of the Ergonomics Program standard. These two program components are critical to the successful implementation of an ergonomics program in any workplace. The importance of management leadership is well-recognized (Exs. 26-17; 26–10; 26–27; 26–22; 26–18; 26–13; 26–14). Likewise, the importance of employee participation in ergonomics program success is also well-documented (Exs. 26–30; 26–17; 26–4; 26–21; 26–19; 26–10; 26–15; 26–16; 26–20; 26–27; 26–22; 26–11; 26–12; 26-18; 26–13; 26–14).

Management leadership and employee participation are complementary (Exs. 2–12; 2–13). Management leadership and commitment provides the motivating force and the resources for organizing and controlling activities within an organization (Ex. 2–12). In effective ergonomics programs, management regards the protection of employee health and safety as a fundamental value of the organization, and incorporates objectives for the success of this program into its broader company goals (Ex. 2–12). Employee participation provides the means through which workers develop and express their own commitment to safe and healthful work, as well as sharing in the overall success of the company (Ex. 2–12).

OSHA has decided to include a management leadership component in its proposed Ergonomics Program standard because the importance of management leadership has been emphasized throughout the literature on ergonomics programs (Exs. 2–13; 26–2; 26–5; 26–9; 26–17; 26–10; 26–27; 26–22; 26–18; 26–13; 26–14). For example, OSHA's Ergonomics Program Management Guidelines for Meatpacking Plants (''Meatpacking Guidelines'') states that an ''effective ergonomics program includes a commitment by the employer to provide the visible involvement of top management, so that all employees, from management to line workers, fully understand that management has a serious commitment to the program'' (Ex. 2–13, p. 2). NIOSH also emphasizes management commitment in its primer, Elements of Ergonomics Programs (Ex. 26–2). According to NIOSH, the ''occupational safety and health literature stresses management commitment as a key and perhaps controlling factor in determining whether any worksite hazard control effort will be successful'' (Ex. 26–2, p. 6). Adams (Ex. 26–9, p. 182) states simply that ''to launch an ergonomics process, management support is key.'' In its report titled, ''Worker Protection: Private Sector Ergonomics Programs Yield Positive Results,'' the Government Accounting Office (GAO) also found management commitment to be a key component for program success (Ex. 26–5). The GAO found that ''management commitment demonstrates the employer's belief that ergonomic efforts are essential to a safe and healthy work environment for all employees' (Ex. 26–5, letter:3.1).

In response to questions raised in OSHA's Advance Notice of Proposed Rulemaking (ANPR) (Ex. 1), a number of comments were received that addressed the issue of management commitment for a successful ergonomics program (Exs. 3-136; 3–173; 3–124; 3–27). For example, the American Automobile Manufacturers Association stated that an ergonomics program should incorporate ''employer commitment in writing to health and safety,'' and that management commitment is an ''essential part of any successful program'' (Ex. 3–173, p. 2). Ms. Anne Tramposh, Vice President of Advantage Health Systems, Inc., also wrote of the importance of management commitment (Ex. 3–124, p. 5). She stated:

At the risk of over-generalizing this issue, we have found that companies lacking management commitment will not truly implement the comprehensive multi-disciplinary program approach that is needed to address the ''Ergonomic Disorders'' problem. These companies tend to look for band-aids, not solutions.

On the other hand, companies with strong top management commitment, that literally cringe at [the] thought that they may be injuring their employees, will seek the root causes of the problem. They will dedicate financial and personnel resources to the program. They will not quit when the ''going gets tough'' and more employees are reporting injuries (at the beginning of a program).

Any standard or regulation for this problem must ensure top management commitment. The Ergonomic Disorder problem will not go away without it.

Another statement of support for management commitment was provided by Mr. Stephen Rohrer, Section Head, EG&G Energy Measurements, Inc. (Ex. 3–27). In explaining the ergonomics program at his company, Mr. Rohrer stated, ''[O]ne of the key components of the program was obtaining upper management support for ergonomics. This was accomplished by a policy statement placing ergonomics at the same level of importance as the company's production processes' (Ex. 3–27, p. 2).

OSHA believes that employee participation is as important for program success as management leadership. OSHA's Meatpacking Guidelines (Ex. 2–13) recommend employee involvement as essential to the identification of existing and potential hazards and the development and implementation of effective hazard abatement. NIOSH found that promoting employee participation to improve workplace conditions has several benefits, including: enhanced worker motivation and job satisfaction; added problem-solving capabilities; greater acceptance of change; and greater knowledge of the work and organization (Exs. 26–2; 26–4). Employee participation also helps to secure employee buy-in to the ergonomics program.

Section 8 of the OSH Act also recognizes the value of employee involvement in workplace safety and health. For example, this section of the Act spells out specific requirements for employee involvement in the observation of employee monitoring to identify employee exposure to workplace hazards, obtaining and reviewing records, receiving information, and reporting hazards.

Active employee participation is especially important in the proposed Ergonomics Program standard because this standard, more than most OSHA standards, depends for its effectiveness on the voluntary reporting of MSD signs and symptoms by employees. To ensure that employees voluntarily participate when the signs and symptoms of MSDs first arise, OSHA believes they must be active participants in program development, implementation, and evaluation, and must be sure that they will not be discriminated against for such participation (see the discussion of proposed section 1910.911 below). Also, when it came to the issue of employee participation, many of OSHA's stakeholders said that this element is essential to program success (Exs. 26–23; 26–24).

Additionally, OSHA received many comments in response to its ANPR that support the idea of employee participation in ergonomics programs (Exs. 3–27; 3–66; 3–94; 3–96; 3–98; 3–124; 3–136; 3–155; 3–173). For example, Mr. James Torgerson, Director-Corporate Safety, Sara Lee Corporation, stated (Ex. 3–66, p. 4):

Further, it is our belief that employee involvement in the development and implementation of a company's ergonomic program is desirable for both the company and for the employees. We believe that employers should be encouraged to consider where employee involvement can best be utilized in their individual program. For example, employees can be used as a resource to assist in identifying and resolving ergonomic problems. Mandatory joint labor/management committees, however, should not be part of the standard.

Dr. Tom Leamon, Vice President, Liberty Mutual Insurance Company, also commented on the need for an employee participation requirement (Ex. 3–96). He stated, ''[t]he effectiveness of regulations would be enhanced by a provision for worker participation, in particular the identification of potential problems and solutions and providing this information to the management decision process within the unit'' (Ex. 3–96, p. 2).

Additionally, Mr. Steve Trawick, Director, Health and Safety, United Paperworkers International Union and Mr. Daniel Kass, Director of the Hunter College Center for Occupational and Environmental Health, clearly stated their support of employee participation in ergonomics programs. In response to the ANPR, they wrote ''[e]mployee involvement is crucial to the success of the ergonomic program. Workers know jobs in the plant better than anyone and can offer invaluable input in the analysis and decision making process'' (Ex. 3–136, p. 4).

However, OSHA is aware that there is opposition to the inclusion of the management commitment and employee participation provisions in the proposed Ergonomics Program standard. For example, several stakeholders have expressed concern about the implementation and enforceability of the management leadership requirements, asserting that they amount to micro-management of their business. Clearly, OSHA does not intend this proposed program element to be a form of micro-management. Precisely to avoid this unwanted outcome, the requirements for management leadership and employee participation have been proposed in performance oriented language. Thus, employers covered by this standard may manage their leadership of the ergonomics program in whatever ways work best for their workplaces, as long as the basic requirements are satisfied.

Additional opposition to this proposed provision was expressed in a stakeholder meeting held in Washington, DC, when one participant stated that legislation of employer commitment and employee participation is problematic because it is not clear what these provisions require (Ex. 26–23). Other stakeholders have stated that, in their opinion, employee participation is not needed in successful programs (Ex. 26–23). Still others have argued that employee participation, as proposed by OSHA, is in violation of the National Labor Relations Act (NLRA) (Ex. 26–23).

Regarding conflicts with the NLRA, testimony presented by Henry L. Solano, Solicitor of Labor, Department of Labor, before the Subcommittee on Workforce Protections Committee on Education and the Workforce in the House of Representatives on May 13, 1999 (Ex. 26–29), clearly states that ''the interplay of the OSH Act and the National Labor Relations Act (NLRA) does not present an obstacle to progress in this area [of employee participation in promoting a safe and healthful workplace].'' Mr. Solano identified many ways in which employers can involve their employees in safety and health matters without raising any concern that they may be violating Section 8(a)(2) of the NLRA. OSHA is proposing to require employee participation but not to specify the form that participation is to take. There are several lawful forms of employee participation that have been upheld or described with approval by the National Labor Relations Board (NLRB) in the course of deciding cases under Section 8(a)(2).

According to Mr. Solano (Ex. 26–29, pp. 11–12), brainstorming groups are one such example. A group of employees that brainstorms about MSD hazards, for example, presents management with a list of ideas or suggestions. Management independently considers the ideas and suggestions and may or may not act on them. An information-gathering committee that gathers and presents information to the employer, who may or may not take action based on the information, is also a lawful form of employee participation (Ex. 26–29, p. 12). Granting rights to individual employees, such as rights to report problems and make recommendations is consistent with Section 8(a)(2). Additionally, employers have the option to assign safety-related duties to employees as part of their job description (Ex. 26–29, pp. 12–13, 14). Other forms of employee participation that have been approved by the NLRB include safety conferences and all-employee committees in which all employees participate (Ex. 26–29, pp. 13–14). Although in his testimony Mr. Solano was specifically addressing safety and health programs in general, his discussion of lawful forms of employee participation applies equally to ergonomics programs. Another mechanism is a joint labor-management committee established in compliance with the NLRA by bargaining between the employer and the union representing the employees. Thus, employers complying with the proposed standard's employee participation provisions have many lawful ways of doing so.

OSHA notes that the proposed management leadership provisions of the rule have been written in performance language to allow individual employers to implement them as appropriate to conditions in their workplace. This approach avoids the over specification that some stakeholders were concerned about. On the second point, the importance of employee involvement to program effectiveness, the discussion below makes clear that OSHA, and many stakeholders, safety and health professionals, and ergonomists agree that this element is the key to program success. OSHA has also been careful to structure the proposed rule's employee participation requirements so that they are entirely consonant with the case law based on the NLRA. The proposed rule does not, for example, mandate any particular method—such as employee committees—for ensuring employee participation. This leaves employers free to involve employees in the program in ways that do not violate the NLRA but will further meaningful employee participation.

Section 1910.911 What is my basic obligation?

You must demonstrate management leadership of your ergonomics program. Employees (and their designated representatives) must have ways to report ''MSD signs'' and ''MSD symptoms;'' get responses to reports; and be involved in developing, implementing and evaluating each element of your program. You must not have policies or practices that discourage employees from participating in the program or from reporting MSD signs or symptoms.

Section 1910.911 of the proposed Ergonomics Program standard provides employers with an answer to the question ''What is my basic obligation?'' First, employers would be required to demonstrate management leadership of their ergonomics program. Management leadership is demonstrated through personal concern for employee health and safety, as evidenced by the priority placed on the ergonomics program. OSHA believes that, to be effective, the demonstration of management leadership must be active rather than passive. Leadership that is limited to a ''paper program,'' such as having written policies and procedures neatly packaged in a three-ring binder that sits on a shelf, would not be viewed by OSHA as meeting the intention of this provision. On the other hand, management leadership that is known throughout the organization via active engagement in the ergonomics process, with appropriate follow-through on commitments, would meet OSHA's intention. Employers who comply with the requirements of Section 1910.911 would certainly be fulfilling the leadership portion of the standard. Employers may further demonstrate leadership, if they so choose, by participating in plant walkarounds, holding meetings with employees on ergonomic issues, and monitoring reports on program effectiveness.

Second, proposed section 1910.911 would also obligate employers to create ways for employees, and their designated representatives, to report MSD signs and symptoms, get responses to reports, and be involved in the program. OSHA has vigorously advocated employee participation in workplace safety and health issues for many years and is pleased by the growing recognition of the importance of employee participation by private-sector companies, trade associations, safety and health professionals, and employees themselves. OSHA supports employee participation because employees have the most direct interest in their safety and health on the job, they have an in-depth knowledge of the operations and tasks they conduct at the worksite, they often have excellent ideas on how to solve health and safety problems, and their interest in the program is vital to its success. If employees do not report their injuries and illnesses or recognized job-related hazards, any workplace program intended to promote safety and health will fail.

Congress also recognized the importance of employee participation in safety and health activities when it enacted the Occupational Safety and Health Act in 1970. In section 2 of the Act, titled ''Congressional Findings and Purpose,'' Congress declared that its goal of assuring safe and healthful workplaces was to be achieved by joint employer-employee efforts to reduce hazards and implement effective programs for providing safe and healthful working conditions. Additionally, Congress acknowledged that employers and employees have separate roles and rights connected with the achievement of safe and healthful working conditions. Thus, the Act offers employees opportunities to become involved in setting standards, variance processes, enforcement, and training. To assist employees in exercising these rights, Congress gave employees access to a wide variety of information. Employees were also given rights to file complaints and to participate actively in OSHA inspections, hazard abatement verification, citation contests, and the observation of the monitoring of toxic substances.

The value of employee participation in ergonomics programs has been recognized by other federal agencies. The GAO concluded in 1997 that effective ergonomics programs must include both management commitment and employee involvement as two of the core elements necessary to ensure that ergonomics hazards are identified and controlled to protect workers (Ex. 26–5). According to the GAO (Ex. 26–5), some of the ways in which employee participation can be demonstrated include:

• Creating committees or teams to receive information on ergonomic problem areas, analyze the problems, and make recommendations for corrective action;

• Establishing a procedure to encourage prompt and accurate reporting of signs and symptoms of MSDs by employees so that these symptoms can be evaluated and, if warranted, treated;

• Undertaking campaigns to solicit employee reports of potential problems and suggestions for improving job operations or conditions; and

• Administering periodic surveys to obtain employee reactions to workplace conditions so that employees may point out or confirm problems.

NIOSH also recognizes the benefits of employee involvement in the publication Elements of Ergonomics Programs (Ex. 26–2). According to NIOSH (Ex. 26–2, p. 8) these benefits include:

• Enhanced worker motivation and job satisfaction;

• Added problem-solving capabilities;

• Greater acceptance of change; and

• Greater knowledge of the work and organization.

Further, NIOSH recommends that employees be encouraged to provide input on defining job hazards, controlling job hazards, and how best to implement controls (Ex. 26–2). Forms of employee involvement described by NIOSH (Ex. 26–2, pp. 8–9) include:

• Joint labor-management safety and health committees;

• Department or area work groups; and

• Direct individual employee input.

However, NIOSH clearly states that ''[n]o single form or level of worker involvement fits all situations or meets all needs. Much depends on the nature of the problems to be addressed, the skills and abilities of those involved, and the company's prevailing practices for participative approaches in resolving workplace issues'' (Ex. 26–2, p. 9).

Employee involvement, along with management commitment, is also one of the major elements included in OSHA's Safety and Health Program Management Guidelines, published in January 1989 (54 FR 3904–3916). Issued with strong public support, the guidelines state, ''[e]mployee involvement provides the means through which workers develop and/or express their own commitment to safety and health protection, for themselves and for their fellow workers'' (54 FR 3909). At that time, OSHA stated that ''* * * employee involvement in decisions affecting their safety and health results in better management decisions and more effective protection'' (54 FR 3907). OSHA continues to believe that employee participation plays a crucial role in protecting the safety and health of employees and must be an integral part of any ergonomics program.

A recommendation for employee involvement was included in OSHA's ''Meatpacking Guidelines'' as the complement to management commitment (Ex. 2–13, pp. 2–3). The Guidelines recommended:

> An effective program includes a commitment by the employer to provide for and encourage employee involvement in the ergonomics program and in decisions that affect worker safety and health, including the following:
>
> 1. An employee complaint or suggestion procedure that allows workers to bring their concerns to management and provide feedback without fear of reprisal.
>
> 2. A procedure that encourages prompt and accurate reporting of signs and symptoms of [MSDs] by employees so that they can be evaluated and, if warranted, treated.
>
> 3. Safety and health committees that receive information on ergonomic problem areas, analyze them, and make recommendations for corrective action.
>
> 4. Ergonomic teams or monitors with the required skills to identify and analyze jobs for ergonomic stress and recommend solutions.

Third, section 1910.911 of the proposed standard informs employers that policies or practices that discourage employees from reporting MSD signs or symptoms or from participating in the program would not be allowed. Such actions on the part of the employer would undermine the intention of § 1910.911. As discussed above, OSHA believes that meaningful employee participation in the ergonomics program is essential both to identify existing and potential MSD hazards, and to develop and implement an effective solution to abate these hazards.

In the ANPR, OSHA requested comments related to early reporting of MSD signs or symptoms (question D2), the developing and implementing of ergonomics programs including involvement on the ergonomics team (question A6), and the benefits of an ergonomics program (question A7). In response to this request, OSHA received information that supports the proposed requirements in Section 1910.911. For example, Mr. Rohrer of EG&G Energy Measurements, Inc. commented (Ex. 3–27, p. 3):

> The main benefits of this [ergonomics] program are educating employees and empowering employees to recognized ergonomic problems in their work environment while helping to provide solutions to those problems. The program invites employees to make known work problems without fear of retribution from management, even in a period of size restructuring. One of the program philosophies is quite simple—a problem can't be solved unless it's identified.

Additionally, Mr. John Clark, International Representative, International Union, UAW provided this comment (Ex. 3–155, p. 3):

> The structured participation of workers is needed for several reasons. Complaints of symptoms will not be freely given if workers fear reprisal by management. Workers know their job best and must be brought into the process of redesign. The close relationship of this activity to work standards and productivity issues requires prior understandings and continuing oversight. The program must maintain an emphasis on the prevention of pain and suffering, not a cost benefit calculation, and that requires worker involvement.

Section 1910.912 What must I do to provide management leadership?

> You must:
>
> (a) Assign and communicate responsibilities for setting up and managing the ergonomics program so managers, supervisors and employees know what you expect of them and how you will hold them accountable for meeting those responsibilities;
>
> (b) Provide those persons with the authority, ''resources,'' information and training necessary to meet their responsibilities;
>
> (c) Examine your existing policies and practices to ensure they encourage and do not discourage reporting and participation in the ergonomics program; and (d) Communicate ''periodically'' with employees about the program and their concerns about MSDs.

Proposed section 1910.912 provides employers with answers to the following question: ''What must I do to provide management leadership?'' This section explains four management leadership responsibilities that employers would have under the proposed ergonomics standard. First, as stated in paragraph (a), employers must assign and communicate responsibilities for setting up and managing the ergonomics program so that managers, supervisors and employees know what is expected of them and how they will be held accountable for meeting those responsibilities. Although proposed paragraph (a) would require that ergonomics program responsibilities be assigned, it does not specify who should be assigned to carry out what responsibility. OSHA believes that the employer is in the best position to decide who should have responsibility for the various parts of the process of implementing an ergonomics program, and the proposal gives the employer great leeway in making these decisions.

The proposed rule also does not describe how safety and health responsibility is to be allocated. In larger workplaces, where responsibilities are described in writing, the allocation might be accomplished through official statements, such as job descriptions or individual annual objectives. In very small worksites, oral instruction would suffice as long as everyone knows who has been assigned what responsibilities. In fact, in all cases, the key factor is that those to whom responsibility has been assigned understand that responsibility and take it seriously.

Individuals with responsibility for the ergonomics program must understand how they will be held accountable for meeting these responsibilities. OSHA has not specified how employers should accomplish this proposed requirement. Again, OSHA believes that employers are in the best position to decide how accountability should be determined and evaluated. Some employers may chose to incorporate accountability measures into performance appraisals. For example, one study reports that supervisor performance evaluations had been modified to include an assessment of whether or not ergonomic problems had been addressed (Ex. 26–28).

Second, as stated in proposed paragraph (b), employers must provide individuals assigned responsibilities in the ergonomics program with the authority, resources, information and training necessary to meet their responsibilities. Providing adequate authority, resources, information and training necessary to carry out program responsibilities demonstrates management leadership. If, for example, an employee is assigned responsibility for evaluating a potential MSD hazard, that employee would need access to relevant information about the job creating the potential hazard, adequate knowledge to competently evaluate the job, sufficient time to evaluate the job, and the authority to recommend changes to the job if it is found to present MSD hazards.

Authority, as used in this provision of the proposed standard, means the delegated ability to take action. Such delegated authority is essential if decisions are to be made in a timely manner and progress is to be made in accomplishing ergonomic program goals. Individuals assigned a particular responsibility under the ergonomics program must have the authority they need to discharge those responsibilities.

Resources, as defined in this proposed standard (see § 1910.945, which contains definitions of key terms), are the provisions necessary to develop, implement and maintain an effective ergonomics program. Resources include money (such as the funds needed to purchase equipment to perform job hazard analysis, develop training materials, and implement controls), personnel and the work time to conduct program responsibilities, such as job hazard analysis or training. The resources needed to meet program responsibilities under this standard will vary with circumstances.

The proposed standard would also require employers to provide individuals with assigned responsibility for the ergonomics program with the information and training they need to meet their responsibilities. For individuals involved in ergonomics program implementation and management, employers would be required to provide information and training so that these individuals understand and know, at a minimum:

- The ergonomics program and their role in it.
- How to identify and analyze MSD hazards.
- How to identify, evaluate, and implement measures to control MSD hazards.
- How to evaluate the effectiveness of ergonomics programs.

Sections 1910.923–928 of the proposed rule provides additional information about proposed requirements for ergonomics program training.

Proposed paragraph (b) is written to allow broad discretion for employers to decide just what authority, resources, information, and training are needed for the specific responsibilities assigned. The employer is, however, required by this paragraph to provide the authority, resources, information and training necessary to discharge the responsibility the employer has assigned.

Problems in fulfilling program responsibilities are often caused by lack of the necessary authority or resources to accomplish those responsibilities. For example, an employee may be assigned the responsibility for evaluating MSD hazards and getting those hazards corrected. However, if the same hazards are found on repeat inspections, it may be that the employee lacked the authority to require correction or that no training or inadequate training in the evaluation of MSD hazards has been provided. In both of these examples, the employer has not provided the authority, resources, information and training necessary for the employee to meet his or her assigned responsibilities.

Third, as stated in proposed paragraph (c), employers would be required to examine their existing policies and practices to ensure that they encourage the reporting of MSD signs and symptoms and do not discourage reporting and participation in the ergonomics program. The intent of this proposed provision is to inform employers that they are prohibited by the proposed rule from taking actions that might undermine or otherwise interfere with the reporting of MSD signs and symptoms or ergonomics program participation by their employees.

OSHA has included this provision in the proposed standard because the Agency believes that such protection is needed to encourage early reporting of the symptoms and signs of MSDs and meaningful employee participation in the ergonomics program. OSHA believes that employees in all workplaces should be encouraged by their employers to report injuries, illnesses, and hazards of all kinds—not just those related to ergonomic issues—because only full and frank reporting allows employers to identify hazards and do something about them. In workplaces where employees are discouraged, either implicitly or explicitly, from participating fully in all aspects of safety and health in the workplace, deaths, injuries, and illnesses will continue to occur, employers will continue to pay high workers' compensation premiums, worker morale will suffer, and product quality will be below par. Encouraging employee participation, and particularly the reporting of MSD signs and symptoms, is especially important under the proposed ergonomics rule because the success of the program depends on such reporting. That is, the standard is structured so that employee reports of MSD signs and symptoms trigger employer actions.

OSHA is aware that some employers discourage reporting unintentionally, and that this can happen even in workplaces where an ergonomics program has been implemented in good faith. For example, employers may be discouraging full and early reporting if they have:

• A policy that every employee who reports MSD signs or symptoms must rest at home without pay.

• A policy that requires drug testing of every employee who reports an injury.

• A supervisory practice of withholding overtime work for anyone who reports MSD signs or symptoms.

• A policy that prohibits the use of sick leave if an employee is off work because of a work-related injury.

It should be noted that OSHA does not consider that having a drug testing policy is, in and of itself, a violation of the standard. However, if the drug testing policy was applied in a discriminatory way, or had a chilling effect on employees' willingness to report, the Agency would evaluate the situation on a case-by-case basis.

Because the underreporting of occupational illnesses and injuries is a widely recognized problem, and is especially serious in the case of ergonomic injuries and illnesses (see discussion of underreporting in the Significance of Risk section (Section VII of this preamble), the purpose of this proposed provision is to ensure that employees in jobs covered by the standard will not be discouraged from reporting problems to their employers. For example, the use of incentive or award programs that focus on achieving low numbers or rates of reported MSDs may discourage early reporting. Such programs, although sometimes intended to improve employee safety and health, may inadvertently lead to the underreporting of MSD cases and thus actually increase unsafe working conditions. Programs that offer financial rewards, such as individual or group performance bonuses, management promotions, or safety game awards (''safety bingo''), or provide personal recognition of individual employees (''safe employee of the month'') to employees, groups, or supervisors if they achieve a zero or low incidence of reportable injuries or illnesses may put considerable pressure on workers not to report and thus discourage reporting, whether intentionally or unintentionally.

OSHA's objective is that employees feel free to report MSD signs and symptoms as early as possible, because doing so prevents pain and suffering, averts disability, and reduces employer costs. To achieve this objective, all MSDs must be reported so that they can be assessed to determine whether they are covered by the standard. Thus, the Agency's concern is with the proper reporting of MSD injuries and illnesses, not on the design of the employer's incentive program. If such programs have the effect of discouraging reporting or employee participation, however, employers would not be in compliance with this section of the standard. Thus, because these programs have the potential to discourage reporting, employers should take special care to ensure that they do not do so.

In comments submitted to OSHA in response to requests made in the ANPR, Martin Marietta Energy Systems, Inc., among others, stated that incentive programs may pose possible barriers to early reporting (Ex. 3–151). The International Union of Electrical, Salaried, Machine and Furniture Workers urged OSHA to discourage practices that inhibit early reporting, and specifically pointed to the use of safety contests (Ex. 3–183).

OSHA is not prohibiting the use of safety incentive or award programs, and nothing in the proposed rule would do so. However, OSHA is encouraging employers who wish to use such programs to design them to reward safe work practices, such as active participation in the ergonomics program, the identification of MSD hazards in the workplace, and the reporting of the early signs and symptoms of MSDs, rather than to reward employees for having fewer MSDs or lower rates of MSDs. The differences in these two kinds of programs—those that focus on safe work practices and those that stress fewer reported MSDs—is that the former, when coupled with appropriate supervisory feedback to employees, may actually reinforce and encourage the kinds of safe practices and participation that employers need to enhance safety and health, while the latter too often encourage employees not to report.

OSHA would not consider incentive programs to be ''illegal'' under this rule except where they are applied in a discriminatory way or have a chilling effect on employees' willingness to report. OSHA's practice is to evaluate the recordkeeping system, and the accuracy and completeness of reporting, when it inspects facilities. If no underreporting is apparent, OSHA does not inquire about any incentive programs that may be in place at the facility. However, if there does appear to be underreporting, OSHA evaluates the situation further to determine what is contributing to the underreporting. OSHA would not cite the employer under this standard for having an incentive program unless it was discouraging reporting or participation in the program (§ 1910.912 (c)). OSHA would cite employers for failure to record OSHA recordable injuries and illnesses, but such a citation would be for a violation of the recordkeeping rule, not the ergonomics rule.

It is OSHA's experience that incentive or award programs are not needed to motivate employees who are active participants in workplace safety and health programs, such as the ergonomics program proposed by this standard. Employees involved in effective workplace programs already receive feedback from their co-workers, supervisors, and managers on safe work practices, regularly provide such feedback to others, and are ''rewarded'' by being full participants in achieving a safe and healthful workplace.

Likewise, only informed employees can truly participate effectively in a workplace ergonomics program. Employees who have received adequate information and training on ergonomic hazards in their workplace can act as ''another pair of eyes and ears'' for their employers. Informed and trained employees can contribute to a workplace culture that values safety and health.

Fourth, proposed paragraph (d) would require that employers ''communicate 'periodically' with employees about the program and their concerns about MSDs.'' Periodic communication between an employer and his or her employees means a regular, two-way exchange of information in which employees receive information about the employer's ergonomics program and its progress, and the employer receives information about MSDs that is of concern to the employees. Although OSHA does not specify a time period for these communications, the frequency of this exchange of information should accurately reflect the needs of a given workplace. For example, OSHA would expect more frequent communication during the start-up phase of an ergonomics program, when MSD signs or symptoms are reported, and prior to the implementation of workplace changes. At a minimum, communications must be often and timely enough to ensure that employees have the information necessary to protect themselves from MSDs, and have effective input into the operation of the ergonomics program.

Employers will be able to demonstrate this communication by periodically checking to see whether their employees have accurate information about the process for reporting MSD signs or symptoms. Employees should be able to state the various steps of this process, or at a minimum, the first step in the reporting process. Additionally, employers will be able to inspect the reports themselves (if they are in writing) to determine whether employees are actually reporting MSD signs or symptoms and if they are reporting them early.

Section 1910.913 What ways must employees have to participate in the ergonomics program?

Employees (and their designated representatives) must have:

(a) A way to report MSD signs and symptoms;

(b) Prompt responses to their reports;

(c) Access to this standard and to information about the ergonomics program; and

(d) Ways to be involved in developing, implementing and evaluating each element of the ergonomics program.

Proposed section 1910.913 of the ergonomics program standard informs employers of OSHA's specific requirements for employee participation. It provides an answer to the question, ''What ways must employees have to participate in the ergonomics program?'' Proposed paragraph (a) contains the requirement that employees, and their designated representatives, if the employees are represented by a union or unions, must have a way to report MSD signs and symptoms. This proposed provision requires employers to establish a clear process for reporting MSD signs and symptoms and to make that process known to his or her employees, so that reports are received in a timely and systematized manner. For example, employees must know whom to make reports to. These reporting systems may be either formal or informal, depending on the nature and size of the affected employee population. The intention of this provision is for a means of communication to be available and for employees to know how to have access to the system.

Prompt answers to employee reports are necessary so that employees know that their reports have been received and considered. Paragraph (b) of section 1910.913 of the proposed ergonomics program standard requires that employees and their designated representative(s), where applicable, receive prompt responses to their reports. OSHA believes that a timely and good faith response is essential to reinforce the reporting and information exchange process. Quick responses to employee reports are a way to demonstrate management leadership of the ergonomics program. The requirements in proposed paragraphs (a) and (b) of section 1910.913 are the complements to proposed section 1910.916, which requires employers to identify at least one person to receive and respond promptly to employee reports of MSD signs or symptoms, and to take the action this standard requires.

Proposed paragraph (c) of section 1910.913 states that employees, and their designated representative(s), if applicable, must have ''access to this standard and to information about the ergonomics program.'' Such information includes: the assignment of responsibilities under the program; job hazard analysis results; hazard control plans; and records of reports related to the occurrence of covered MSDs and the identification of MSD hazards; ergonomic program evaluation results; and lists of alternative duty jobs. Additionally, employees must be provided with access to a copy of this Ergonomics Program standard. Employers can comply with this provision by posting a copy of the standard on the bulletin board. OSHA believes that employees must have this information to meaningfully participate in the ergonomics program. However, employee access to information does not include access to confidential or private information the employer may have that is of a personal nature, such as medical records.

Assuring employee access to information related to their safety and health on the job is not unique to this proposed standard. Employers are already obligated to provide employees with access to their exposure and medical records by the requirements set forth in OSHA's standard ''Access to Employee Exposure and Medical Records'' (29 CFR 1910.1020). Additionally, OSHA requires employers covered by the Process Safety Management standard (29 CFR 1910.119) to provide employee access to process hazard analyses and all other information required to be developed under that standard.

Paragraph (d) of section 1910.913 proposes that employees and their designated representatives, if applicable, must have ''ways to be involved in developing, implementing and evaluating each element of the ergonomics program.'' Element of ergonomics program refers to elements that are required by this standard, as listed in proposed section 1910.905. OSHA believes that employees must be involved in these important elements of an ergonomics program in order for the program to be effective. For example, when it comes to job hazard analysis and control, no one knows the job better than the employee(s) who does the job on a regular basis. Employees are also most likely to have valuable input regarding the most effective and inexpensive solutions to MSD hazards related to their jobs.

For example, employees must have input in the development, implementation, and evaluation of ergonomic training programs, where training is required under this standard. Employees themselves are the best advisors regarding effective training program content and level of understanding for sometimes complex training material. Obviously, in workplaces where the primary language of some of the employees to be trained is not English, employees must play a critical role in assuring that the training material is presented in language that is understood by the employees. In many cases, that language will be English, because many workers will have acquired a good understanding of English. The standard intends, however, that the training program content be understood by all employees who are required to receive training.

Employees must also be involved in evaluating the effectiveness of the ergonomics program and the control measures that are implemented. OSHA believes that the employees who perform jobs that have MSD hazards are in the best position to know whether or not the ergonomics program and control measures are effective as implemented or if they need to be modified. To effectively eliminate MSD hazards, employers and employees must form a partnership, with each contributing his or her unique expertise to achieve the goals of the ergonomics program.

The nature, form, and extent of how employers must provide employees with opportunities to participate will vary among workplaces. Each workplace and workforce is different, and what will be effective will vary, depending on such factors as:

- The nature of the MSD hazards;
- The number and type of problem jobs in the workplace;
- Past experience with employee participation programs;
- The presence or absence of a union;
- The general safety and health culture of the workplace;
- Relevant state or local laws; and
- The employer's financial resources.

OSHA proposes to provide great latitude to each employer, in consultation with employees, to find the optimal means for achieving the participation required by this proposed standard in their workplace.

Hazard Information and Reporting (§§ 1910.914–1910.916)

Proposed sections 1910.914–1910.916 would require employers whose employees work in manufacturing or manual handling operations, or in jobs in which a covered MSD has occurred, to provide employees in those jobs with basic information about musculoskeletal disorders (MSDs), including their signs and symptoms and how to recognize them. Some signs and symptoms of MSD problems are obvious, such as trigger finger, while others, such as the early stages of tendinitis, may be more subtle. However, explaining the nature of the problem, the characteristic signs and symptoms, and the importance of early reporting is a necessary component of any ergonomics program.

The proposed requirements in these sections are designed to ensure that employers with high-risk employees, such as those in manual handling and manufacturing jobs, have a system in place that will respond appropriately if a covered MSD is reported. In order for employees to report the first signs or symptoms of an MSD, they must recognize those signs and symptoms and understand the urgency of reporting them to the employer promptly. To achieve this end, the proposed rule requires employers to establish a system that includes an MSD reporting system. These sections also require that employers provide pertinent information to employees in problem jobs; this information must address the signs and symptoms of MSDs and common MSD hazards.

These sections stress the importance of early reporting to ensure that employees with MSD signs or symptoms receive help before serious damage occurs. Additionally, the early reporting of MSDs helps to avoid the development of MSD signs or symptoms in other employees in the workplace in the same job. Receiving reports from employees and reviewing available information is an easy and straightforward way to identify problem jobs. For example, employers who follow up on employee reports of MSD signs or symptoms, such as undue strain, localized fatigue, discomfort, or pain that does not go away after overnight rest will be able to take preventive action at the earliest stages.

OSHA's proposed reporting system is a tool for secondary prevention of MSDs. Its purpose is to identify employees with covered MSDs before they would otherwise seek health care for their signs or symptoms. Thus, by design, the reporting system should be highly sensitive, *i.e.*, identify both those employees who definitely have a covered MSD as well as those who, upon further evaluation, are found not to have a covered MSD. OSHA believes this approach is appropriate because certain requirements of this proposed rule are triggered by the occurrence of a covered MSD. Reporting all signs or symptoms of MSDs will help to ensure that covered MSDs are properly identified.

It is important to note that reporting of all signs or symptoms of MSDs through this system does not mean that all of these cases will turn out, on further investigation, to be OSHA recordable cases. Once an employee reports signs or symptoms of an MSD, his or her case would need to be evaluated for OSHA recordability. If the case is determined to be an OSHA recordable MSD and in addition meets the screening criteria (see § 1910.902), it is a covered MSD as defined by the proposed standard.

The information that employers would be required to provide to employees under these sections is general information about MSDs and common MSD hazards. This information, for example, would not have to be specific about the precise conditions or MSD hazards of a particular job. Job-specific training that results from a job hazard analysis is only required if the requirements in the sections that address training (§§ 1910.9 23–928) are triggered by the occurrence of a covered MSD. Examples of the ''big picture'' information that would be required by section 1910.915 include: general hazards associated with MSDs; what musculoskeletal disorders are and the signs and symptoms they cause; the importance of early reporting of MSD signs and symptoms to full recovery; and information about the systems in place to handle employee reporting of MSD signs and symptoms. The intent of this section is to make employees aware of MSDs and common MSD hazards.

In debates over the OSH Act before its passage, Senator Williams stressed that the hidden nature of harmful physical agents made employee awareness of these hazards critically important to providing them with adequate protection from excessive exposure (Legislative History, at 415). MSD hazards are an example of harmful physical agents. This observation continues to be true today, and is particularly apparent in the case of MSDs, which are widely underreported, in part because neither employers nor employees make the link between workplace risk factors and the signs and symptoms of MSDs.

Section 1910.914 What is my basic obligation?

You must set up a way for employees to report MSD signs and symptoms and to get prompt responses. You must evaluate employee reports of MSD signs and symptoms to determine whether a covered MSD has occurred. You must periodically provide information to employees that explains how to identify and report MSD signs and symptoms.

Proposed section 1910.914 informs employers of what they are required to do to facilitate employee reporting of MSD signs and symptoms. There are three proposed obligations under this section. First, employers would be required to: ''set up a way for employees to report MSD signs and symptoms and to get prompt responses.'' By using the word ''way,'' OSHA has created flexibility for employers to use either formal or informal approaches to establishing a reporting system. Large employers may decide that a formal system of reporting that includes written documentation is appropriate to ensure that nothing falls through the cracks. Employers with fewer than 10 employees, on the other hand, may find that oral reporting systems are adequate. Many employers may already have reporting systems in place that can be adapted to accommodate the requirements of the proposed Ergonomics Program standard. However, regardless of how methods are tailored to meet the needs of a specific workplace and workforce, the process must be systematic and accessible to all employees.

The MSD signs and symptoms to be reported are defined in the section of this standard that covers key terms (§ 1910.945). Signs of MSDs are defined as ''objective physical findings that an employee may be developing an MSD.'' Examples of signs of MSDs include:

- Decreased range of motion;
- Decreased grip strength;
- Loss of function; and
- Deformity.

Symptoms of MSDs are more subjective physical experiences that an employee may report that indicate he or she may be developing an MSD. Examples of MSD symptoms in the affected body part include:

- Numbness;
- Burning;
- Pain;
- Cramping;
- Tingling; and
- Stiffness.

Symptoms can vary in their severity, depending on the amount of exposure an employee has had. Often symptoms may appear gradually and be evidenced as muscle fatigue or pain at work that disappears during rest. Usually symptoms become more severe as exposure continues. For example, at first tingling may continue during rest, then numbness or pain may make it difficult to perform the job, and finally pain may be so severe that the employee is unable to perform physical work activities.

There are several reasons why OSHA believes the proposed reporting system is important for a successful ergonomics program. First, an important trigger in this proposed standard is the occurrence of an MSD. In order for an employer to be made aware of MSDs in his or her workplace, employees must have a mechanism for reporting this information. Second, if an accessible reporting system is not made available to employees, they will be discouraged from reporting MSD signs and symptoms and the ergonomics program will fail. A reporting system that is well-known to employees is one way to ensure employee participation in the ergonomics program.

Section 1910.914 further proposes that ''you must evaluate employee reports of MSD signs and symptoms to determine whether a covered MSD has occurred.'' This requirement has been written to allow maximum flexibility for employers. In order to determine whether an employee who has experienced MSD signs or symptoms actually has a covered MSD, many employers will choose to have employees who report MSD signs or symptoms evaluated by an ergonomist or health care professional. Other employers will use ergonomics committee members or other staff with appropriate training. Some employers may have a health care professional available on-site for employee evaluations, and others may use a contract provider to whom employees are referred. Regardless of who does this evaluation, employers would be required to take reports of MSD signs or symptoms seriously and to provide employees, when appropriate, with early assessment and access to prompt and effective evaluation at no cost to the employees. When the occurrence of a covered MSD is confirmed, employers would be responsible for providing MSD management of that MSD to the affected employee. Proposed employer obligations for MSD management are found in sections 1910.929–1910.935 and are discussed below in connection with those sections of the proposed standard.

As part of their basic obligation, employers would also be required to ''periodically provide information to employees that explains how to identify and report MSD signs and symptoms.'' The information that would be required to be communicated to fulfill the basic obligation under this section (§ 1910.914) differs from the information to be provided through the training provisions contained in sections 1910.923–1910.928 of the proposed rule. The information to be shared with employees under this section is general information related to MSDs, MSD hazards, and the ergonomics program. Employees need access to this information in order to be alert to the onset of MSD signs or symptoms and to effectively participate in the ergonomics program, as well as to protect themselves while at work.

In order to provide employers with maximum flexibility, the time intervals for these activities have not been specified in the proposed rule. However, in the section on key terms in this standard (§ 1910.945), OSHA states that ''periodically means that a process or activity, such as records review or training, is performed on a regular basis that is appropriate for the conditions in the workplace.'' By using the term ''regular basis,'' OSHA provides employers with a flexible definition that is adaptable to an employer's specific situation. OSHA proposes that information for employees be provided periodically because retention of information diminishes over time.

The section on key terms in this standard, § 1910.945, further defines ''periodically'' to mean ''that the process or activity is conducted as often as needed, such as when significant changes are made in the workplace that may result in increased exposure to MSD hazards.'' Examples of significant changes in the workplace include the introduction of new equipment, new processes, or new production demands that may increase the likelihood that employees will be exposed to MSD hazards.

Section 1910.915 What information must I provide to employees?

You must provide this information to current and new employees:

(a) Common MSD hazards;

(b) The signs and symptoms of MSDs, and the importance of reporting them early;

(c) How to report MSD signs and symptoms; and

(d) A summary of the requirements of this standard.

Proposed section 1910.915 informs employers of the specific information they must provide to current and new employees in manufacturing operations, manual handling operations and other jobs with covered MSDs. The provision of this information to employees is necessary to facilitate their active participation in the ergonomics program. Additionally, since the identification of problem jobs is triggered by employee reporting of a covered MSD, informed employees are critical to assure the accuracy of the reporting system, regardless of whether the system is written or oral.

OSHA considers ''current'' employees to be those in either manufacturing operations, manual handling operations, or other problem jobs at the time this standard becomes effective. ''New'' employees include newly hired employees, as well as those who are new to manufacturing and manual handling operations or other jobs with covered MSDs, but not necessarily new to the company.

At a minimum, OSHA would require that employers provide their employees with information that covers four topics. First, proposed paragraph (a) would require that employers provide information to current and new employees in manufacturing operations, manual handling operations, and other jobs with covered MSDs so they know about the ''common MSD hazards.'' By using the word ''common'' OSHA means general, as opposed to job specific, MSD hazards.

Second, as stated in paragraph (b), employees must know ''the signs and symptoms of MSDs, and the importance of reporting them early.'' A discussion of MSD signs and symptoms and the importance of early reporting can be found in the summary and explanation of section 1910.914.

The ultimate goal of early reporting of signs and symptoms is to identify MSDs while they are still reversible in order to prevent pain, suffering, and disability due to MSD hazards. Such a goal creates a win-win environment for both employers and employees. Employees are assured that their health and safety will be protected, and employers will benefit from the decreased occurrence and costs of covered MSDs in their workforce.

Third, proposed paragraph (c) would require employers to provide information to their employees in manufacturing operations, manual handling operations and other jobs with covered MSDs so they know how to report MSD signs and symptoms. OSHA does not specify how this information must be shared. It can be communicated either in writing or orally, depending on the nature of the work environment. However, employers must be sure that their affected employees understand how to access this reporting system. This requirement complements the obligation set forth in section 1910.914, which states that employers must set up a way for employees to report MSD signs and symptoms.

Fourth, proposed paragraph (d) would require employers to provide ''a summary of the requirements of this standard'' to their employees in manufacturing operations, manual handling operations, and other jobs with covered MSDs. OSHA believes that employees are entitled to information about the ergonomic program elements and specific requirements contained in this standard. Moreover, employees must have this information to meaningfully participate in the ergonomics program.

OSHA believes that there are many practical ways that employers would be able to accomplish these proposed requirements. One method that aids the understanding of somewhat technical information is to allow employees an opportunity to ask questions about information presented to them and receive answers to their questions. There are many ways that question and answer sessions can be incorporated into the work schedule. Examples include question and answer sessions that are: organized classroom style; part of regularly scheduled meetings with employees and their supervisors; an outgrowth of informal talks with employees; and incorporated into safety meetings. OSHA believes that merely arranging for employees to view a videotape on common MSD hazards, without an opportunity for discussion or questions and answers, is unlikely to ensure that the necessary information has been effectively communicated.

Another method critical to employee understanding of information related to common MSD hazards and the signs and symptoms of MSDs is to provide the information in the language and at levels the employees comprehend. Commercially available information related to common MSD hazards and MSD signs and symptoms is often available in languages other than English and at various comprehension levels. When purchasing prepared informational materials, employers must consider language and comprehension when making their selections. For employers with predominantly non-English speaking workers, an effective alternative to commercially prepared informational material may be selecting and training a worker who speaks both English and the predominant language of the workforce to deliver MSD hazard information. For employers with workers who cannot read, employers would be required to provide information orally or through visual displays or graphics.

OSHA recognizes that retention periods for information, especially technical information, can sometimes be short, and that it often takes multiple presentations of information before it is effectively understood, processed, and applied. Therefore, OSHA would expect employers to be creative in meeting these proposed obligations. Some additional ideas that employers may consider include: posting information in conspicuous locations as a continuous reminder; frequently changing the message conveyed in the posted information so that it doesn't become stale and invisible; using plain language and terms to communicate the information; incorporating visually appealing pictures or displays; and setting up interactive displays of model work stations so employees can experiment with equipment while they are not engaged in production or service provision.

Section 1910.916 What must I do to set up a reporting system?

You must:

(a) Identify at least one person to receive and respond to employee reports, and to take the action this standard requires.

(b) Promptly respond to employee reports of MSD signs or symptoms in accordance with this standard.

Proposed section 1910.916 advises employers of what they must ''do to set up a reporting system.'' This section contains two requirements that employers must meet. First, proposed paragraph (a) would require that employers ''identify at least one person to receive and respond to employee reports, and to take the action this standard requires.'' These proposed requirements provide additional support and encouragement for employees to report MSD signs and symptoms. If employees are expected to report MSD signs and symptoms, there must be at least one person assigned the responsibility to receive and respond to the reports and act upon them.

The employer may decide who the person or persons to receive such reports should be and how many persons are needed. In many places of employment, all front-line supervisors have the responsibility to receive and respond to reports of work-related injuries and illness. In other workplaces, a safety officer or safety committee has the responsibility to receive and respond to such reports. In still other companies an occupational health nurse may be available to receive and respond to reports of MSD signs and symptoms.

Small employers, on the other hand, may choose to carry out these responsibilities themselves instead of delegating them to others. For example, a small employer could simply make sure that all employees are encouraged to report MSD signs and symptoms directly to him or her. In response to those reports, that same small employer would then also be the designated individual to ensure that the appropriate action, as required by this standard, is initiated when the employee has a covered MSD. In the proposed standard the choice of designee is left to the employer, because OSHA recognizes that various employers may elect to implement this provision differently.

Second, proposed paragraph (b) of this section would require employers to '' promptly respond to employee reports of MSD signs or symptoms in accordance with this standard.'' The summary and explanation for most of this requirement has been previously discussed in section 1910.914, which covers the employer's basic obligation. Any employee reports of MSD signs or symptoms must be taken seriously by the employer; if a covered MSD has occurred, the employee's job is a problem job, and the employer must then comply with the job hazard analysis and control provisions of sections 1910.917 through 1910.922. Such reports may also indicate that an element(s) of the ergonomics program is not properly functioning. Thus, employers must critically evaluate employee reports of MSD signs or symptoms and determine what actions must be taken to comply with the requirements of this proposed Ergonomics Program standard.

Job Hazard Analysis and Control (§§ 1910.917–1910.922)

This part of the Summary and Explanation discusses the proposed requirements for Job Hazard Analysis and Control (§§ 1910.917–1910.922). It describes the proposed requirements, provides information on the process of job hazard analysis and control, and presents examples of controls that have been used effectively by employers to eliminate or materially reduce MSD hazards.

Job hazard analysis and control is the heart of any ergonomics program because it is the first step in eliminating or materially reducing MSD hazards. Through job hazard analysis, employers identify and assess where and how employees' physical capabilities have been exceeded in a given job. It does this by identifying what aspects of the physical work activities and conditions of the job and what ergonomics risk factors may be causing or contributing to the MSD hazards.

Once MSD hazards have been identified, the next step is to eliminate or control them. An effective hazard control process involves identifying and implementing control measures to obtain an adequate balance between worker capabilities and work requirements so that MSDs are not reasonably likely to occur (Karwowski and Salvendy, *Ergonomics in Manufacturing,* 1998, Ex. 26–1419).

OSHA is proposing a flexible approach to the analysis and control of MSD hazards. A flexible approach helps to ensure that the required job hazard analysis and control process is appropriate for a diverse range of employers and is applicable to a variety of different jobs. For example, OSHA believes that both small and large employers will be able to use the job hazard analysis and control provisions of the standard and will be able to comply with them.

Section 1910.917 What is my basic obligation?

You must analyze the problem job to identify the ''ergonomic risk factors'' that result in MSD hazards. You must eliminate the MSD hazards, reduce them to the extent feasible, or materially reduce them using the incremental abatement process in this standard. If you show that the MSD hazards only pose a risk to the employee with the covered MSD, you may limit the job hazard analysis and control to that individual employee's job.

OSHA is proposing that employers analyze jobs in which a covered MSD is reported. (In the proposed rule these jobs are called ''problem jobs.'') If employers determine, through the job hazard analysis, that there are physical work activities and work conditions in the problem job that are reasonably likely to be causing or contributing to the covered MSD, they would be required to implement controls to achieve one of these control endpoints: eliminate MSD hazards, reduce hazards to the extent feasible, or materially reduce the hazard (following the incremental abatement process in § 1910.922). (The control endpoints in this basic obligation section would also apply to those ergonomics programs that might be grandfathered in under § 1910.908.)

1. Covered MSDs

OSHA is proposing to limit employers' obligation to analyze and control MSD hazard requirements to jobs in which covered MSDs have been reported after the date the Ergonomics Program Standard becomes effective. This means that the only employers who would have to analyze and control jobs are those who have determined that a covered MSD has occurred in their workplace.

Many stakeholders support limiting job hazard analysis and control to jobs in which there is an identified MSD hazard, such as an injury (Exs. 3–56, 3–99, 3–114, 3–133, 3–161, 26–1370). Other stakeholders suggested that an ergonomics rule should require employers to analyze and control any job in which employees are exposed to MSD hazards (Exs. 3–141, 3–183, 3–184). OSHA requests comment on whether job hazard analysis and control should be limited to jobs with covered MSDs or expanded to include jobs in which employees are exposed to MSD hazards, even if no injuries have been reported.

2. Problem Jobs

OSHA is proposing that employers must do hazard analysis and control in problem jobs. The requirement that employers analyze jobs with covered MSDs is not limited to the injured employee's job or workstation. It also includes the workstations of others in that job in the establishment who are exposed to the same physical work activities and conditions and thus the same MSD hazards. If the job is performed on more than one work shift in the establishment, the analysis must include employees from the other shifts who are to exposed the same physical work activities and conditions and thus the same MSD hazards. Including in the analysis other employees who perform the same physical work activities is an important proactive measure for preventing other employees from developing the type of MSD that has already occurred at least once among employees who are doing the same type of tasks. (However, the employer would not be required to analyze the same job performed at other establishments of the company.)

OSHA is proposing that the analysis must include all jobs involving the same physical work activities and conditions as those where a covered MSD has occurred, regardless of whether those jobs have the same job title. Using job titles/classifications to determine which jobs are analyzed is not necessarily relevant in terms of safety and health concerns. First, jobs involving the same physical work activities and conditions may have different titles if there are working supervisors/managers, a seniority system, or different work shifts. For example, ''Fabricator II'' on the overnight shift may be performing the same physical work activities as ''Junior Fabricator'' or ''Apprentice Fabricator'' on the day shift. If so, they all may be at increased risk of developing an MSD.

Second, relying on job titles may group together employees who have the same title but whose jobs are quite different. For example, all ''assembler'' jobs on an auto assembly line may not involve the same physical work activities or conditions. One assembler may bolt on a door, another puts on the bumper, while the third one installs the dashboard. Analyzing these jobs as one group may not be helpful because the physical work activities may be so different that the employees are not exposed to the same risk factors and, as a result, the same controls will not work.

Although employees in jobs in the workplace must be included in job hazard analysis if their jobs involve the same physical work activities and conditions, OSHA recognizes that jobs may not have the same activities and conditions just because employees use the same equipment or are working on the same product. For example, employees do not have to be included if their physical work activities differ in terms of activities and conditions. For example, VDT users may not be considered to be in the same job where one user does inputting for more than 4 hours a day at a modular VDT workstation and the other uses the VDT on the desk only to read and send e-mail messages. These two employees have significantly different levels of exposure to ergonomic risk factors. The fact that employees are working on the same motorcycle assembly line does not necessarily mean they are performing the same assembly job. One employee on that line may be screwing on the shock absorbers, where he is exposed to awkward postures and force, while another employee is exposed to forceful lifting and lowering while putting on the wheels.

On the other side of the same job issue, where employers show that the problem is limited to the employee who reported the MSD, they may limit job hazard analysis and control to addressing the MSD hazards that are affecting that individual employee. They also may limit the remaining elements of their program, such as training, to that individual employee.

Evidence in the record suggests that there are likely to be situations in which the physical work activities or conditions only pose a risk to the reporting employee. For example, an employee in a commercial bakery may report a back or shoulder MSD related to extended reaches involved in sorting rolls. However, other employees who have performed the job for several years do not have (and never have had) difficulties performing the physical work activities of the job. In this case, an employer might conclude that the problem is limited to the injured employee. In this situation, the employer could limit the response (*e.g.,* analysis, control, training) to physical work activities and conditions confronting that injured employee.

Another example might involve manufacturing assembly line job where an employee is much shorter than other employees. The employee reports persistent shoulder and elbow pain, which the employer observes is caused by having to reach higher than the other employees to perform the job tasks. This may also be an appropriate case for the employer to focus the analysis and control efforts on the employee who reported the problem.

Section 1910.918 What must I do to analyze a problem job?

You must:

(a) Include in the job hazard analysis all of the employees in the problem job or those who represent the range of physical capabilities of employees in the job;

(b) Ask the employees whether performing the job poses physical difficulties, and, if so, which physical work activities or conditions of the job they associate with the difficulties;

* * * * *

An ergonomics job hazard analysis is the employer's process for pinpointing the work-related causes of MSDs. It involves examining the workplace conditions and individual elements or tasks of a job to identify and assess the ergonomic risk factors that are reasonably likely to be causing or contributing to the reported MSDs (Ex. 26–2). Job hazard analysis can also be a preventive measure. That is, it is used to identify jobs and job tasks where MSDs and MSD hazards are reasonably likely to develop in the future.

Job hazard analysis is an essential element in the effective control of MSD hazards. In many situations, the causes of MSD hazards are apparent after discussions with the employee and observation of the job, but in other jobs the causes may not be readily apparent. In part, this is because most MSD hazards involve exposure to a combination of risk factors (*i.e.,* multifactoral hazard). For example, it may not be clear in a repetitive motion job whether exposure to repetition, force or awkward postures is the risk factor that is causing the problem.

The job hazard analysis is also important to pinpoint where the risk of harm exists and to rule out aspects of the job that do not put employees at risk. In this sense, a job hazard analysis is an efficient way to help employers focus their resources on the most likely causes of the problem so that the control strategy they select has a reasonable expectation of eliminating or materially reducing the MSD hazards. It also provides employers with the information they need to target their efforts to those jobs or tasks that may pose the most severe problems.

In this proposed standard, the job hazard analysis also serves another purpose. It is a systematic method for confirming whether the employer's initial determination that the MSD is work-related was correct. This is an important step for those employers whose ergonomics programs include early intervention when employees report MSDs. For example, a number of employers said that they provide MSD management first (*i.e.,* immediate restricted work activity whenever an employee reports MSD signs or symptoms), and afterward look to see whether they need to take action to fix the job. For these employers, the job hazard analysis includes two parts: first, after careful examination the employee is determined by the analysis to be exposed to ergonomic risk factors to the extent that a covered MSD is reasonably likely to occur; and second, the employers has determined that no job fix is needed. The job hazard analysis steps in such a case help employers who have an effective reporting and MSD management system and who have relied on a preliminary determination to trigger medical intervention not to go further than is necessary to address the hazard.

The proposed rule does not require that employers use a particular method for identifying and analyzing MSD hazards. Employers are free to select the method or process that best fits the conditions of their workplaces, and there are many different approaches currently in use (see, for example, Exs. 26–2, 26–5). Some employers use simple and fairly informal procedures to analyze their problem jobs. This is especially true for employers who have only limited or isolated problems. For example, the United States General Accounting Office reported that the job hazard analysis process for the ergonomics programs they reviewed often focused only on the particular job element that was thought to be the problem (Ex. 26–5). For other employers, the process may be very detailed or more formalized. For example, their process may include job-task breakdown, videotaping or photographing the job, job or hazard checklists, employee questionnaires, use of measuring tools, or biomechanical calculations (Ex. 26–2). For example, checklists, together with other screening methods such as walk-through observational surveys, and worker and supervisory interviews, employee symptom or discomfort surveys, are recognized ergonomic evaluation methods (Exs. 26–2, 26–3, ANSI Z–365 Draft, 1997, Ex. 26–1264). A few of these methods are described in this section. Information on other methods of job hazard analysis are included in the public docket of this rulemaking. (Exs. 26–2, 26–5). According to this information and stakeholder comments, the job hazard analysis methods employers use have the following steps or activities in common. OSHA has designed the proposed job hazard analysis requirements around these steps:

- Obtaining information about the specific tasks or actions the job involves;
- Obtaining information about the job and problems in it from employees who perform the job;
- Observing the job;
- Identifying specific job factors; and
- Evaluating those factors (*e.g.*, duration, frequency and magnitude) to determine whether they are causing or contributing to the problem (Ex. 26–2, 26–5, 26–1370).

The proposed rule requires that the hazard analysis and control of problem jobs be conducted by person(s) who have received training in the process of analyzing and controlling MSD hazards (See § 1910.925).

1. Paragraph (a)

Paragraph (a) of proposed § 1910.918 would require that, if the employer does not show that the MSD hazards only pose a risk to the employee who has the covered MSD, the employer must do a job hazard analysis for other employees in the problem job as well as for the injured employee. Doing a job hazard analysis for all employees in a problem job ensures that employers have available the most complete information about the causes of the problem when they are identifying and assessing ways to control MSD hazards. Having this information also helps to ensure that the controls employers select will eliminate or materially reduce MSD hazards for all employees in the job.

At the same time, OSHA is aware that conducting a job hazard analysis that covers all employees in a problem job may be burdensome for some employers. For example, some employers may have large numbers of employees who perform the same job at one workplace (*e.g.*, telephone operators, customer service representatives, catalog sales representatives, data processors, nurses aides, package handlers, sorting and delivery persons). Conducting a job hazard analysis for each one of these employees could be time and resource intensive. In addition, if the controls are likely to be the same for all of the employees in a particular job, continuing to conduct job hazard analyses after a certain point may have diminishing returns.

Doing job hazard analysis for all employees also may be difficult in jobs that do not have fixed workstations (*e.g.*, beverage delivery, package delivery, furniture moving, appliance delivery, home repair, visiting nurse, home health aide). Some of these jobs may have constantly changing work conditions, all of which it may not be possible to analyze.

Therefore, OSHA is proposing in paragraph (a) that employers not be required to conduct a job hazard analysis for each employee in a problem job. Under the Ergonomics Program Standard, employers would be allowed to limit the number of employees' jobs that they analyze, provided that the jobs they do analyze represent the range of physical capabilities of all of the employees who currently are in the job. The intention of this provision is to reduce the job hazard analysis burdens on employers, who would otherwise have to do many individual hazard analyses, while at the same time ensuring that the process accurately identifies and does not underestimate the exposure of employees to the MSD hazards in the problem job.

To ensure that the job hazard analysis is an accurate estimate of exposure, employers would be required to do a job hazard analysis for a sufficient number of employees in the job (from all work shifts) for the analysis to be representative of all of the employees in the problem job in terms of their physical work activities. To illustrate, to get an accurate estimate of exposure to MSD hazards of all employees in an assembly line job, an employer may have to include the following employees in the hazard analysis group:

- Shortest employees in the job because they are likely to have to make the longest reaches or to have a working surface that is too high,
- Tallest employees because they may have to maintain the most excessive awkward postures (*e.g.*, leaning over the assembly line, reaching down with the arms) while performing tasks,
- Employees with the smallest hands because they may have to exert considerably more force to grip and operate hand and power tools,
- Employees who work in the coldest areas of the workplace because they may have to exert more force to perform repetitive motions, and
- Employees who wear bifocals because they may be exposed to awkward postures (*e.g.*, bending neck back to see).

2. Paragraph (b)—''Ask employees''

Paragraph (b) of this section would require employers to consult with employees as part of the job hazard analysis process. Talking or consulting with employees in a problem job helps to ensure that the employer has the complete picture about the problems in a job, especially if the job hazard analysis includes only a limited number of employees. Where the job hazard analysis is limited, consulting with all employees during the hazard analysis and control process is an effective way to gain employee acceptance and minimize resistance to change when implementing controls and job modifications become necessary. Nonetheless, for the reasons discussed in paragraph (a) of this section, OSHA is not proposing to require that employers consult with every employee during the job hazard analysis process, provided that employers consult with at least those employees whose jobs are being analyzed.

Many employers have told OSHA that talking with employees is a quick and easy way to find out what kind of problems are in the job (Ex. 26–1370). They said that talking with employees is often the best way to identify the causes of the problem and to identify the most cost-effective solutions to it (Ex. 26–1370).

Many stakeholders have said that employee input at the job hazard analysis stage is essential (Ex. 26–1370). A comment from Johnson & Johnson sums up this opinion:

> Hazards cannot be addressed efficiently without an accurate evaluation of the situation. The line employee is one of the best sources of this information * * * [they are] local process experts (Ex. 3–232).

Discussions with employers who have set up ergonomics programs, pursuant to corporate settlement agreements with OSHA, also confirm the necessity of employee input in the job hazard analysis (Ex. 26–1420). A number of these employers said that employees need to be involved in the analysis and control process because ''no one knows the job better than the person who does it'' (Ex. 26–1420). Other stakeholders echo this belief, saying that employees have the best understanding of what it takes to perform each task in a job, and thus, what parts of the job are the hardest to perform or pose the biggest difficulties:

''Job analysis should include input from the workers themselves. The employees can best tell what conditions cause them pain, discomfort, and injuries. They often have easy and practical suggestions on how such problems can be alleviated.'' American Federation of State, County and Municipal Employees (Ex. 3–164).

Involving employees, in addition to helping to ensure that the job hazard analysis is correct, can make the job hazard analysis and control process more efficient. Employees can help employers pinpoint the causes of problems more quickly and, according to a number of stakeholders, employees often come up with some of the best practical, no-cost or cost-effective, solutions (Ex. 26–1370). The American Health Care Association agrees:

Employers and employees alike who work in the industry are in the best possible position to identify risk factors in their workplace and to develop prevention methods that concentrate on the significant problems unique to their particular industry's environment (Ex. 3–112).

There are many different ways in which employers can comply with the requirement to ask employees about the problem job, and OSHA does not intend to require employers to use a certain method. Employers are free to use any method to get information from employees about the problems in the job. Employers may do something as simple as informally talking with employees while observing the job being performed. Consulting with employees in the problem job can be made part of a regular staff or production meeting or ''toolbox chat.'' Employers may ask employees through surveys/questionnaires and more formal employee interviews. Many employers have developed very effective tools for gathering important job information from employees who do the job.

AMP Inc., a manufacturer of electronic components, with 300 employees, uses a one-page ''Ergonomic Evaluation Form'' that asks employees to answer simple ''yes/no'' questions about the employee's ease and comfort when performing certain job tasks. After the company's ergonomics team (comprised of line employees) reviews the form, a member of the team interviews the employee. (Ex. 26–5).

Paragraph (b) would require that employers ask employees whether performing the job poses physical difficulties. This language should not be interpreted as requiring employers to conduct symptom or discomfort surveys. Rather, the intention of this provision is for employers to ask employees to help identify the physical work activities, job conditions and ergonomic risk factors that may be making the job difficult to perform.

Section 1910.918 What must I do to analyze a problem job?

You must:

* * * * *

(c) Observe the employees performing the job to identify which of the following physical work activities, workplace conditions and ergonomic risk factors are present:

PHYSICAL WORK ACTIVITIES AND CONDITIONS	ERGONOMIC RISK FACTORS THAT MAY BE PRESENT
(1) Exerting considerable physical effort to complete a motion	(i) Force (ii) Awkward postures (iii) Contact stress
(2) Doing same motion over and over again	(i) Repetition (ii) Force (iii) Awkward postures (iv) Cold temperatures
(3) Performing motions constantly without short pauses or breaks in between	(i) Repetition (ii) Force (iii) Awkward postures (iv) Static postures (v) Contact stress (vi) Vibration
(4) Performing tasks that involve long reaches	(i) Awkward postures (ii) Static postures (iii) Force
(5) Working surfaces are too high or too low	(i) Awkward postures (ii) Static postures (iii) Force (iv) Contact stress
(6) Maintaining same position or posture while performing tasks	(i) Awkward posture (ii) Static postures (iii) Force (iv) Cold temperatures
(7) Sitting for a long time	(i) Awkward posture (ii) Static postures (iii) Contact stress
(8) Using hand and power tools	(i) Force (ii) Awkward postures (iii) Static postures (iv) Contact stress (v) Vibration (vi) Cold temperatures
(9) Vibrating working surfaces, machinery or vehicles	(i) Vibration (ii) Force (iii) Cold temperatures
(10) Workstation edges or objects press hard into muscles or tendons	(i) Contact stress
(11) Using hand as a hammer	(i) Contact stress (ii) Force
(12) Using hands or body as a clamp to hold object while performing tasks	(i) Force (ii) Static postures (iii) Awkward postures (iv) Contact stress
(13) Gloves are bulky, too large or too small	(i) Force (ii) Contact stress

PHYSICAL WORK ACTIVITIES AND CONDITIONS	ERGONOMIC RISK FACTORS THAT MAY BE PRESENT
MANUAL HANDLING (Lifting/lowering, pushing/pulling, and carrying)	
(14) Objects or people moved are heavy	(i) Force (ii) Repetition (iii) Awkward postures (iv) Static postures (v) Contact stress
(15) Horizontal reach is long (Distance of hands from body to grasp object to be handled)	(i) Force (ii) Repetition (iii) Awkward postures (iv) Static postures (v) Contact stress
(16) Vertical reach is below knees or above the shoulders (Distance of hands above the ground when object is grasped or released)	(i) Force (ii) Repetition (iii) Awkward postures (iv) Static postures (v) Contact stress
(17) Objects or people are moved significant distance	(i) Force (ii) Repetition (iii) Awkward postures (iv) Static postures (v) Contact stress
(18) Bending or twisting during manual handling	(i) Force (ii) Repetition (iii) Awkward postures (iv) Static postures
(19) Object is slippery or has no handles	(i) Force (ii) Repetition (iii) Awkward postures (iv) Static postures
(20) Floor surfaces are uneven, slippery or sloped	(i) Force (ii) Repetition (iii) Awkward postures (iv) Static postures

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1. Paragraph (c)

Paragraph (c) of proposed § 1910.918 requires employers to do the following:

- Observe the employee performing the job,
- Identify whether any of the physical work activities or conditions listed in the section are present, and
- Identify whether any of the relevant ergonomic risk factors listed in the section are involved in the particular work activity or condition.

a. ''Observe'' employees performing the job. The proposed rule requires employers to watch employees perform the physical work activities of the job and look at the conditions under which the job is performed. Job observation allows the employer to see how the employee does the job and provides information about the workstation layout, tools, equipment and general environmental conditions in the workplace.

There are several ways employers may comply with the observation requirement of the proposed standard. Employers may simply watch employees perform the job tasks. Often, all it takes to identify the problem and how to solve it is to watch the employee do the job. For example, watching a data processor reaching to use the mouse because the keyboard tray is not long enough to accommodate it may be all it takes to identify the likely cause of the employee's shoulder pain.

Videotaping the job is a common practice for ''observing'' jobs. A number of employers, especially in situations where the work activities are complex or the causes of the problem may not be easily identifiable, say that they videotape or photograph the job. These employers find it helpful to be able to refer to a record of the job while evaluating the ergonomic risk factors or identifying and assessing possible control measures (Ex. 26–1370).

''Job task analysis'' is another job hazard analysis process that is widely used. This process involves breaking the job down into its various discrete elements or actions and then identifying and evaluating or measuring the extent to which the risk factors that are present in the physical work activities and conditions are reasonably likely to be contributing to the MSD hazard (Exs. 26–2, 26–1247). To do a job task breakdown, a number of employers look at the job as a series of individual, distinct tasks or steps (Exs. 26–2, 26–5, 26–1247, 26–1370). Focusing on each task allows for easier identification of the physical activities required to complete the job. While observing the job employers record a description of each task for use in later risk factor analysis as well as other information that is helpful in completing the analysis:

- Tools or equipment used to perform task,
- Materials used in task,
- Amount of time spent doing each task,
- Workstation dimensions and layout,
- Weight of items handled,
- Environmental conditions (cold, glare, blowing air),
- Vibration and its source,
- Personal protective equipment worn (Ex. 26–2).

Many employers use hazard identification and analysis checklists to help focus the job observation process. OSHA agrees that well designed checklists, when used in the context for which they are intended, do provide a range of employers, especially small business owners, with effective alternatives to hiring a consultant. There are many ways in which checklists may be useful: identifying physical work activities and conditions, identifying ergonomic risk factors, evaluating jobs, prioritizing jobs for further analysis, and providing a systematic review of risk factors.

b. Identify physical work activities, workplace conditions and ergonomic risk factors. Paragraph (c) would require that, as part of the job observation, employers identify the physical work activities, workplace conditions, and ergonomic risk factors present in the problem job that may be causing or contributing to the MSD hazard. Identifying the presence of physical work activities and conditions is the starting point for pinpointing the hazards the job may involve. Once the applicable activities and conditions are identified, employers would have to determine whether any of the ergonomic risk factors that OSHA has listed as being potentially relevant to those activities and conditions are present.

c. Ergonomic risk factors. Ergonomic risk factors are the aspects of a job or task that impose a biomechanical stress on the worker. Ergonomic risk factors are the synergistic elements of MSD hazards. In the Health Effects section of this preamble (section V), OSHA discusses the large body of evidence supporting the finding that exposure to ergonomic risk factors in the workplace can cause or contribute to the risk of developing an MSD. This evidence, which includes thousands of epidemiologic studies, laboratory studies, and extensive reviews of the existing scientific evidence by NIOSH and the National Academy of Science, shows that the following ergonomic risk factors are most likely to cause or contribute to an MSD:

- Force
- Repetition
- Awkward postures
- Static postures
- Vibration
- Contact stress
- Cold temperatures

These risk factors are described briefly below (a more detailed discussion of ergonomic risk factors is included in the Health Effects section):

Force. Force refers to the amount of physical effort that is required to accomplish a task or motion. Tasks or motions that require application of higher force place higher mechanical loads on muscles, tendons, ligaments, and joints (Ex. 26–2). Tasks involving high forces may cause muscles to fatigue more quickly. High forces also may lead to irritation, inflammation, strains and tears of muscles, tendons and other tissues.

The force required to complete a movement increases when other risk factors are also involved. For example, more physical effort may be needed to perform tasks when the speed or acceleration of motions increases, when vibration is present, or when the task also requires awkward postures.

Force can be internal, such as when tension develops within the muscles, ligaments and tendons during movement. Force can also be external, as when a force is applied to the body, either voluntarily or involuntarily. Forceful exertion is most often associated with the movement of heavy loads, such as lifting heavy objects on and off a conveyor, delivering heavy packages, pushing a heavy cart, or moving a pallet. Hand tools that involve pinch grips require more forceful exertions than those that allow other grips, such as power grips.

Repetition. Repetition refers to performing a task or series of motions over and over again with little variation. When motions are repeated frequently (*e.g.*, every few seconds) for prolonged periods (*e.g.*, several hours, a work shift), fatigue and strain of the muscle and tendons can occur because there may be inadequate time for recovery. Repetition often involves the use of only a few muscles and body parts, which can become extremely fatigued while the rest of the body is little used.

Awkward postures. Awkward postures refer to positions of the body (*e.g.*, limbs, joints, back) that deviate significantly from the neutral position [1] while job tasks are being performed. For example, when a person's arm is hanging straight down (*i.e.*, perpendicular to the ground) with the elbow close to the body, the shoulder is said to be in a neutral position. However, when employees are performing overhead work (*e.g.*, installing or repairing equipment, grasping objects from a high shelf) their shoulders are far from the neutral position. Other examples include wrists bent while typing, bending over to grasp or lift an object, twisting the back and torso while moving heavy objects, and squatting. Awkward postures often are significant contributors to MSDs because they increase the work and the muscle force that is required.

Static postures. Static postures (or ''static loading'') refer to physical exertion in which the same posture or position is held throughout the exertion. These types of exertions put increased loads or forces on the muscles and tendons, which contributes to fatigue. This occurs because not moving impedes the flow of blood that is needed to bring nutrients to the muscles and to carry away the waste products of muscle metabolism. Examples of static postures include gripping tools that cannot be put down, holding the arms out or up to perform tasks, or standing in one place for prolonged periods.

Vibration. Vibration is the oscillatory motion of a physical body. Localized vibration, such as vibration of the hand and arm, occurs when a specific part of the body comes into contact with vibrating objects such as powered hand tools (*e.g.*, chain saw, electric drill, chipping hammer) or equipment (*e.g.*, wood planer, punch press, packaging machine). Whole-body vibration occurs when standing or sitting in vibrating environments (*e.g.*, driving a truck over bumpy roads) or when using heavy vibrating equipment that requires whole-body involvement (*e.g.*, jackhammers).

Contact stress. Contact stress results from occasional, repeated or continuous contact between sensitive body tissue and a hard or sharp object. Contact stress commonly affects the soft tissue on the fingers, palms, forearms, thighs, shins and feet. This contact may create pressure over a small area of the body (*e.g.*, wrist, forearm) that can inhibit blood flow, tendon and muscle movement and nerve function. Examples of contact stress include resting wrists on the sharp edge of a desk or workstation while performing tasks, pressing of tool handles into the palms, especially when they cannot be put down, tasks that require hand hammering, and sitting without adequate space for the knees.

Cold temperatures. Cold temperatures refer to exposure to excessive cold while performing work tasks. Cold temperatures can reduce the dexterity and sensitivity of the hand. Cold temperatures, for example, cause the worker to apply more grip force to hold hand tools and objects. Also, prolonged contact with cold surfaces (*e.g.*, handling cold meat) can impair dexterity and induce numbness. Cold is a problem when it is present with other risk factors and is especially problematic when it is present with vibration exposure.

Of these risk factors, evidence in the Health Effects chapter shows that force (*i.e.*, forceful exertions), repetition, and awkward postures, especially when occurring at high levels or in combination, are most often associated with the occurrence of MSDs. Exposure to one ergonomic risk factor may be enough to cause or contribute to a covered MSD. For example, a job task may require exertion of so much physical force that, even though the task does not involve additional risk factors such as awkward postures or repetition, an MSD is likely to occur. For example, using the hand or knee as a hammer (*e.g.*, operating a punch press or using the knee to stretch carpet during installation) alone may expose the employee to such a degree of physical stress that the employee has a significant risk of being harmed.

[1] Neutral posture is the position of a body joint has requires the least amount of muscle activity to maintain. For example, the wrist is neutral in a handshake position, the shoulder is neutral when the elbow is near the waist, the back is neutral when standing up straight.

However, most often ergonomic risk factors act in combination to create a hazard. The evidence in the Health Effects section shows that jobs that have multiple risk factors have a greater likelihood of causing an MSD, depending on the duration, frequency and/or magnitude of exposure to each. Thus, it is important that ergonomic risk factors be considered in light of their combined effect in causing or contributing to an MSD. This can only be achieved if the job hazard analysis and control process includes identification of all the ergonomic risk factors that may be present in a job. If they are not identified, employers will not have all the information that is needed to determine the cause of the covered MSD or understand what risk factors need to be reduced to eliminate or materially reduce the MSD hazards.

Although certain of the risk factors described above are easy to identify and it is not difficult to understand why they may be likely to create hazardous exposures, others are not as apparent or observable. Employers who already have ergonomics programs and persons who manage ergonomics programs should not have difficulty identifying risk factors in the workplace. Because these persons have training and experience, ergonomic risk factors are likely to be familiar concepts for them. Through the process of developing and implementing their ergonomics programs these persons have gained a good working knowledge of the ergonomic risk factors that are most likely to be present in their workplaces.

For those employers who are just beginning their programs and have little or no training and experience dealing with ergonomic risk factors, OSHA has tried to make the process of identifying them as workable as possible. Therefore, in the proposed rule OSHA has taken the ergonomic risk factors and the combination of risk factors most associated with the occurrence of MSDs and tried to present them in ways that those with more limited knowledge about ergonomics can readily identify. In this way, the ergonomic risk factors the proposed rule covers are presented in terms of specific and physically observable work activities and conditions. If any of these activities or conditions are present, the table in § 1910.918(c) tells employers which risk factors are likely to be relevant.

OSHA is proposing that employers use this list of physical work activities or conditions as a starting point for hazard evaluation, for several reasons. First, the list of activities and conditions is easy for employers to understand because they will be able to translate them to their own workplaces more readily than would be the case for ergonomic to risk factors. For example, ''hand used as a hammer'' is more easily understood than the term ''contact stress,'' and ''long reaches'' graphically explains an ''awkward posture'' that may be a problem.

Second, the list helps employers quickly focus on the aspects of a job that are most likely to be associated with covered MSDs. At the same time, the list also identifies the risk factors that are most likely to be associated with the activities and/or conditions, which should help employers further focus their analysis. In this way the list serves as a bridge to the combinations of risk factors that studies have shown to be associated with an increased risk of developing work-related MSDs.

Third, having employers start the MSD identification and evaluation process with this list ensures that the analysis will be comprehensive. This is because the list includes the major components of work that have been associated with MSDs.

c. Physical work activities and conditions. The physical work activities and conditions OSHA has included in the proposed rule cover the basic physical aspects of jobs and workstations. These aspects include:

- Physical demands of work;
- Workplace and workstation conditions and layout;
- Characteristics of object(s) that are handled or used; and
- Environmental conditions.

The following table shows the physical work activities and workplace conditions that are associated with those physical aspects:

PHYSICAL ASPECTS OF JOBS AND WORKSTATIONS	EXAMPLES OF PHYSICAL WORK ACTIVITIES AND CONDITIONS ASSOCIATED WITH THE PHYSICAL ASPECT
Physical demands of work	• Exerting considerable physical effort to complete a motion • Doing the same motion over and over again • Performing motions constantly without short pauses or breaks in between • Maintaining same position or posture while performing tasks • Sitting for a long time • Using hand as a hammer • Using hands or body as a clamp to hold object while performing tasks • Objects or people are moved significant distances
Layout and condition of the workplace or workstation	• Performing tasks that involve long reaches • Working surfaces too high or too low • Vibrating working surfaces, machinery or vehicles • Workstation edges or objects press hard into muscles or tendons • Horizontal reach is long • Vertical reach is below knees or above the shoulders • Floor surfaces are uneven, slippery or sloped
Characteristics of the object(s) handled	• Using hand and power tools • Gloves bulky, too large or too small • Objects or people moved are heavy • Object is slippery or has no handles

PHYSICAL ASPECTS OF JOBS AND WORKSTATIONS	EXAMPLES OF PHYSICAL WORK ACTIVITIES AND CONDITIONS ASSOCIATED WITH THE PHYSICAL ASPECT
Environmental Conditions	• Cold temperatures

Employers who examine the job in which a covered MSD occurred to identify the physical work activities and workplace conditions in paragraph (c) and then evaluate the risk factors that OSHA has identified as potentially relevant, will be considered to be in compliance with the hazard analysis requirements of the proposed rule.

Exerting considerable force to complete a motion (*i.e.*, forceful exertions). It is not difficult to understand why jobs that require employees to apply a lot of physical effort may involve significant exposure to ergonomic risk factors and pose an increased risk of injury. For example, it is easy to see how much biomechanical stress employees are under when you see them grimace while trying to loosen lug nuts on an old tire, shift body weight and stance to wrench open stuck valves, or stiffen the body in order to lift a heavy or bulky object from the floor of a truck. Simply put, forceful exertions like these take more out of a person than tasks that do not require much physical effort. An easy way to confirm whether a task involves forceful exertions is to ask workers who are doing the task, or to try to do it yourself.

Performing forceful exertions requires an application of considerable contraction forces by the muscles, which causes them to fatigue rapidly. The more force that must be applied in the exertion, the more quickly the muscles will fatigue or become strained. Excessive or prolonged exposure to forceful exertions also leads to overuse of muscles and may result in muscle strain, soreness and damage. Performing forceful exertions can also irritate tendons, joints and discs, which leads to inflammation, fluid build up, and constriction of blood vessels and nerves in the area. Increased compression of nerves from the pressure imposed by inflamed tendons or muscle contractions may cause disorders of the nervous system (*e.g.*, carpal tunnel syndrome and other nerve entrapment disorders).

Injuries related to forceful exertions can occur in any tissue or joint. As mentioned above, back injuries from overexertion are a leading cause of workplace injuries and workers' compensation cases. A number of studies also show that repeated forceful exertions of the hands and arms are associated with work-related MSDs (*e.g.*, using tools, pinching or pushing with the fingers).

Lifting and carrying heavy objects are usually the tasks that come to mind as examples of forceful lifting tasks, but high forces are also involved in other types of jobs. These include jobs that require employees to apply pinch forces with their fingers (*e.g.*, picking up or placing small items on an assembly line with the fingers), static forces (*e.g.*, applying a lot of physical effort to put the last turn on a screw, pulling hard on a 30-inch wrench to loosen a bolt), and dynamic forces (*e.g.*, tossing objects into containers). (Forceful lifting/lowering, pushing/pulling and carrying are discussed under ''Manual Handling'' activities and conditions below.)

Force. Performing forceful exertions may place excessive mechanical loads on the tissues (*e.g.*, muscles, tendons, other tissues) that are used to exert or transfer force from the skeletal system to the work. Heavy loading of tissues causes the body to fatigue more quickly, and increases the amount of time tissues need to recover from the effects of such exertions. Tasks involving prolonged forceful exertions or excessive force alone can result in harm, including muscle strain or tears. However, where other risk factors are present, especially frequent repetition of exertions, awkward postures, or static postures they add to the force required to accomplish the exertion. In such cases, even tasks involving moderate levels of force may lead to injury and tissue damage because there may not be adequate recovery time. Forceful exertions can also cause or contribute to nerve disorders. Application of high levels of muscle and tendon tension and the contraction necessary to perform forceful exertions may increase pressure on entrapped/confined nerves and other tissues. For example, many employees who perform cutting and trimming tasks on poultry production lines have developed carpal tunnel syndrome (*e.g.*, a nerve entrapment disorder) from repeated forceful exertions of the hands and wrists to cut through the skin, meat, or bone. The continuous application of muscle-tendon movements in the hand and wrist inflames the tendons and puts pressure on the median nerve running through the carpal tunnel in the wrist to the hand. In addition, if the tendons and other soft tissue in the wrist or hand do not have adequate recovery time from the forceful exertions, they can become inflamed enough to put pressure on the median nerve.

Examples:
Pulling meat off a bone on a meat cutting assembly line,
Pulling hard to tighten bolts or screws in assembly line work,
Squeezing hard on a pair of pliers, or
Pulling hard on a long wrench to tighten or loosen a bolt

Awkward postures. Working in awkward postures increases the amount of force needed to accomplish an exertion. Awkward postures create conditions where the transfer of power from the muscles to the skeletal system is inefficient. To demonstrate this, hold a dry marker in your hand with your wrist straight and then let someone try to pull it out of your hand. Now hold the marker with your wrist bent toward the inside of your forearm as far as you can and hold the marker while someone tries to pull it out of your hand. To overcome muscle inefficiency, employees must apply more force both to initiate and complete the motion or exertion. In general, the more extreme the postures (*i.e.*, the greater the postures deviate from neutral positions), the more inefficiently the muscles operate and, in turn, the more force is needed to complete the task. Thus, awkward postures make forceful exertions even more forceful, from the standpoint of the muscle, and increase the amount of recovery time that is needed.

Examples:
- Throwing 20-pound bundles of printed material to overhead conveyors.
- Bolting or screwing a new part into an auto that is on a lift.

Contact stress. Mechanical friction (*i.e.*, pressure of a hard object on soft tissues and tendons) causes contact stress, which is increased when tasks require forceful exertion. The addition of force adds to the friction created by the repeated or continuous contact between the soft tissues and a hard object. It also adds to the irritation of tissues and/or to the pressures on parts of the body, which can further inhibit blood flow and nerve conduction.

Examples:
- Using the hand as a hammer is an example of force plus contact stress.
- Operating a carpet kicker with the knees

Doing the same motions over and over again (*i.e.*, repetitive motions). Many jobs that involve repetition of the same job again and again are apparent even upon cursory observation: assembly line jobs where motions are repeated every few seconds, data processing jobs, directory assistant operators, court reporting, letter and package sorting. Repetitive motion jobs include performance of identical motions again and again, but also include repeating multiple tasks where the motions of each task are very similar and involve the same muscles and tissues.

Evidence in the Health Effects section shows a strong association between the occurrence of MSDs and jobs involving exposure to repetitive motions. The joints are most susceptible to repetitive motion injuries, especially the wrists, fingers, shoulders, and elbows. Repetitive work that is done with the foot (*e.g.*, operating foot activated controls) or knees (*e.g.*, climbing ladders or using a carpet kicker) may also result in an MSD.

Repetition. Motions that are repeated again and again with little variation may cause fatigue and overuse of the muscles, tendons, and joints that are involved in the exertion (Ex. 26–2). Overuse leads to muscle strain, inflammation of joints and tendons, and increased pressure on nerves. As exposure continues or intensifies (*e.g.*, pace increases) tears in muscle fibers occur. The more frequently repetitive motions are performed (*i.e.*, fast pace), the longer they are performed (*i.e.*, long sessions without a break or more than 8 hours a day), and/or the more risk factors that are involved, the greater the risk of injury due to overuse and lack of adequate recovery time.

Exposure to repetition alone can cause MSDs. This is especially true where the same motions or tasks are performed for an extended period and/or where the task cycle is short (*e.g.*, the task cycle lasts only a few seconds). The risk of injury is significantly increased when other risk factors are also present.

Examples:
- Packing bags of potato chips into shipping boxes.
- Intensive keying of information into computer.

Force. The effects of repetitive motions on the body are increased when high forces are involved. Repetition of forceful exertions requires employees to exert more muscle tension and contraction, which leads to muscle fatigue. When repetitive motions involve high forces, even more recovery time is required for muscles than repetitive motions that do not contain high forces.

Prolonged repetition of forceful exertions also may result in inflammation in tendons and joints. In addition, the added muscle tension from forceful repetitive motions also puts more pressure on surrounding nerves and other confined tissues. This may cause damage to entrapped nerves and tissues.

Examples:
- Filleting fish in a processing plant, or
- Constantly using screwdriver to drive screws into wood.

Awkward postures. Performing repetitive motions in awkward postures (*e.g.*, bent wrists, extended arms) adds significantly to the muscular effort required to perform each motion. The added force hastens the onset of fatigue and increases the likelihood of injury from overuse.

In some cases, awkward postures may be so extreme that they can turn a low risk repetitive motion job into a high risk job. For example, an assembly job involving tightening bolts may not pose any problem where objects being assembled are at mid-torso level. However, the same job at the same pace may be hazardous if tightening the bolts involves overhead work.

Examples:
- Sorting parts or letters into bins of different heights and locations (*e.g.*, behind the employee), or
- Working with bent wrists to assemble small circuit breakers.

Cold temperatures. Cold temperature adds to the amount of force necessary to perform repetitive motions and increases the perception of stiffness of the joints and tissues in the body. Exposure to cold temperatures triggers the body to redirect blood flow from the extremities (hands, feet, and ears) in order to conserve body heat. When the blood supply to the hands is diminished, the manual dexterity and tactile sensitivity of the fingers are reduced. Employees compensate by applying more force to the muscles in the hands and fingers in order to complete the motions.

Exposure to cold temperatures also reduces the ability of tissues to recover from repetitive exertions. The reduction in blood flow reduces the delivery of oxygen and energy to tissues, and the removal of heat and waste products. This reduction in blood flow can also lead to pain and injury.

Example:
- Trimming chicken or turkey breasts in a processing plant, or
- Working in an operating room of a hospital.

Performing motions constantly without short pauses or breaks in between (*i.e.*, inadequate recovery time). Jobs that do not provide short pauses or breaks between motions or task cycles are often a problem because there may not be adequate time for muscles to recover from the effects of the exertion before the motion must be repeated. If there are no pauses between motions or the pauses are too short, the muscles cannot recover to the rested condition. Thus, the effects of the forces on the muscles accumulates and the muscles become fatigued and strained. The lack of adequate recovery time often occurs in jobs involving highly repetitive tasks. This happens when task cycle lengths are very short, which also means that the job involves a high number of cycle repetitions per minute. For example, some research shows that tendons and muscles in the wrists may not be able to recover where repeated task cycles are less than 5 seconds in length, that is, they are repeated more than 12 times per minute (Ex. 26–2).

Jobs involving constant muscle activity (static contractions) also may not provide adequate recovery time. These types of jobs may involve continuously holding hand tools (*e.g.*, knife, paint brush, staple gun), which means that employees have constant exposure to static postures and low contraction forces.

The longer motions or job tasks are performed, the less likely that there will be adequate recovery time. The accumulation of exposure leads to muscle fatigue or overuse. In addition, where the intensity of exposure is greater, for example, in repetitive motion jobs that involve exposure to additional risk factors (*e.g.*, force, awkward postures, or static postures), the increased forces required for the exertion also increase the amount of recovery time that is needed. Any part of the musculoskeletal system involved in moving the body is subject to injury where there is inadequate recovery time, and the recovery times needed vary by body part. For example, although employees may not be at high risk for forearm injury if task cycles are 25 seconds long or not repeated more than 3 times per minute, they may be at high risk of shoulder injury under this regimen.

Repetition. As task cycles in repetitive motion jobs get shorter (and the number of repetitions per minute increases) employees are at greater risk of injury. Where task cycles are short, the same muscles are in constant use and the muscles get no rest from the force required to perform the task cycle. In addition, where task cycles are short, there is little variation in the physical demands of the tasks, which would allow some muscles to rest while others are in use. Thus, muscle fatigue continues to accumulate and may lead to muscle-tendon strain.

The following table shows the frequency of repetition and length of tasks cycles that are associated with increased risk of injury in repetitive motion jobs:

BODY AREA	FREQUENCY REPETITION PER MINUTE	LEVEL OF RISK	VERY HIGH RISK IF MODIFIED BY EITHER:
Shoulder	More than 2.5	High	High external force, speed, high static load, extreme posture,
Upper arm/elbow	More than 10	High	Lack of training, high output demands, lack of control,
Forearm/wrist	More than 10	High	Long duration of repetitive work
Finger	More than 200	High	

(Kilbom, 1994)

Examples:
- Deboning operation in a poultry plant where the cycle time is short and the birds are conveyed at a fast rate,
- Inserting coils to build an inner-spring mattress at a rate of one per second, or
- Letter sorting.

Force. Motions involving high forces, like highly repetitive motions, put a lot of mechanical stress on the body because muscles must apply considerably more contraction forces to accomplish the task. Thus, these tasks require significantly more muscle recovery time as compared to tasks that do not involve high force. If recovery time is not adequate, these employees are at greater risk of injury due to fatigue and overexertion.

Examples:
- The chuck boner job in a beef processing plant, or
- Shaking crab meat from Alaskan king crab legs.

Awkward postures, static postures, contact stress, vibration. The presence of any or all of these risk factors in a job, particularly jobs involving repetitive motion or forceful exertion, increases the force already required to perform job tasks and, therefore, increases the amount of time muscles need to recover from the exertions the task requires. If the recovery time is not adequate, the presence of these risk factors hastens the onset of fatigue and the effects associated with overuse of muscles, joints and tendons.

Examples:
- Attaching doors on the bathroom vanity assembly line, or
- Capping and cupping cookies on an assembly line.

Performing tasks that involve long reaches. Many job tasks involve long reaches: working overhead, putting items on a high shelf, reaching across a conveyor to put in a part or grasp an object, or bending over to reach a part in the bottom of a big supply box. These tasks expose employees to extreme awkward postures. Where long reaches are momentary and/or infrequent and the forces are low, these tasks are not a problem because there is likely to be adequate time for the body to recover between reaches. However, when long reaches are done frequently, force is involved and/or a long reach lasts more than a few seconds, the risk of harm increases.

Long reaches usually have the greatest impact on the shoulders and lower back. The shoulder is unique in its wide range of motion when compared with other joints in the body. The bony restraints are minimal, but soft tissue constrains the motion. Thus, injuries usually occur when the soft tissue is used to maintain an awkward posture and/or forceful exertion.

The back is flexed forward or extended back to extend reaches beyond the limit of the arm length. In addition, workers in repetitive jobs will often bend their back so that they can reduce the awkward shoulder posture. Bending the back forward adds the weight of the upper body to the force exerted by the back muscles and supported by the spine. Bending to the side, backwards or twisting puts the spine and back muscles in awkward postures.

Awkward postures. When employees are performing tasks that involve long reaches they are exposed to extreme awkward postures; that is, the positions of their shoulders, elbows and/or back deviate significantly from more neutral positions. Repeatedly performing tasks in such positions poses increased stress on the joints and/or spinal discs. As mentioned before, muscles do not work as efficiently in awkward postures, and the muscles must exert more physical effort to accomplish the task. This increased force contributes to muscle-tendon fatigue and strain. For example, the shoulder may deviate at least 90° from its neutral position when reaching across a conveyor to grasp an object. If the employee continues doing such reaches, the stress on the muscles and tendons in the shoulder can cause irritation and inflammation of the tendons and shoulder joint. This, in turn, may place increased pressure on nerves and blood vessels, reducing the supply of blood to the affected muscles and tendons.

Examples:
- Reaching above the head to activate a press or other machine,
- Reaching frequently for small parts in a bin that is at or close to the limit of the arm's reach,
- Reaching down and behind the back to pick up parts to feed to a press or place on a conveyor,
- Reaching across a conveyor to pick up items.

- Reaching to pick up items on the other side of the scanner on a grocery checkout conveyor.

Static postures. The effects on the body from doing tasks that require long reaches are exacerbated where the reaches must be maintained for more than a very few seconds. Holding extreme postures places very high static loads on the body, resulting in rapid fatigue. Not only do the static postures add to the muscular effort required to do the task, but the lack of motion impedes the blood flow that is necessary for tissue recovery.

The constricted blood flow reduces the supply of nutrients to the muscles and the removal of acids and other waste products away from the tissues. Reduced blood flow also slows down delivery of oxygen to the muscles.

The longer or more frequently static loading occurs, the greater the risk of injury due to overuse of muscles, joints and other tissues.

Examples:
- Doing extensive repair work when the automobile is overhead on a vehicle lift.
- Holding out the arm to use a mouse that is on a surface more than 15 inches from the body because the keyboard tray is not big enough to hold the mouse.

Force. Because of exposure to extreme postures, tasks that involve long reaches require considerably more force to accomplish than tasks that can be performed close to the body. For example, it requires much more physical effort to hold and operate a 10-pound rivet gun 2 feet in front or above the body than close to the body. First, the employee must apply more muscle force to simply hold a 10-pound gun when the arms are extended and the back is bent. The longer the gun must be held in that position, the more effort the muscles must exert. Second, the employee must apply more force in order to operate the gun in such an extreme position. Thus, long reaches can turn a low or moderate force task into a high force task that places employees at greater risk of harm. The addition of static postures to the extreme awkward postures further increases the force necessary to perform the task. Muscle-tendon fatigue and strain may occur very rapidly where these tasks are performed frequently because of lack of time to recover from such forceful exertions.

Long reaches can also increase the dynamic forces of the exertion. For example, long reaches to get a bag of flour from a shopping cart and bring it to the scanner can result in high acceleration forces of the back and wrist.

Finally, employees may be exposed to forceful exertions, even if long reaches do not involve lifting heavy objects. When employees bend over to perform long reaches, the muscles in the back must exert a lot of force to lift and lower the weight of the upper body. This causes the back muscles to fatigue more rapidly and puts pressure on the discs in the lower back. Where employees have to maintain long reaches for more than a few seconds, a large amount of static force is applied by the back muscles to the discs.

Examples:
- Throwing items into an overhead container,
- Reaching over the bagging area to place bags of groceries into shopping carts.

Working surfaces are too high or too low. Working surfaces that are too high or too low are another way in which employees are exposed to awkward postures. Where employees must work on such surfaces for a long period, the risk of tissue damage and other MSD problems increases.

Working surfaces can be too high or too low for many employees because most working surfaces are not adjustable. For example, 30 inches is a typical height for desks, tables and other working surfaces operated from a sitting position, and 36 to 40 inches is a typical height range for working surfaces operated from a standing position. Although employees of average height may be able to work comfortably at these working surfaces, the typical heights may not work for shorter or taller employees. An assembly-line employee who is 6′5″ may have to bend over significantly to assemble the parts on a conveyor that is 36 inches high, while a 5-foot employee working on a 42-inch conveyor may have to work with her elbows away from the body.

The height of working surfaces can also be too high or too low when employees must use work surfaces or workstations that were not designed for the tasks being performed. For example, typical desks (*i.e.,* 30 inches high) are not designed for computer use. Even persons of average height may have to raise their elbows and shoulders to use the keyboard on their desks. This is especially true where desk chairs cannot be raised high enough to correct the problem. Even when the employee can be raised to a good height, the feet are often left dangling above the floor.

Awkward postures. Awkward posture is the primary ergonomic risk factor to which employees are exposed when the height of working surfaces is not correct. Working at surfaces that are too high can affect several parts of the body. Employees may have to lift and/or bend their shoulders, elbows and arms (including hands and wrists) into uncomfortable positions to perform the job tasks on higher surfaces. For example, employees may have to raise their shoulders or move their elbows out from the side of their body to do a task on a high working surface. Also, they may have to bend their heads and necks to see the work they are doing.

Working surfaces that are too high usually affect the shoulders. The muscles must apply considerably more contraction force to raise and hold the shoulders and elbows out to the side, particularly if that position also must be maintained for more than a couple of seconds. The shoulder muscles fatigue quickly in this position.

On the other hand, when surfaces are too low, employees may have to bend their backs and necks to perform their tasks while hunched over the working surface. They may also have to reach down with their arms and shoulders to do the tasks. Where working surfaces are very low, employees may have to kneel or squat, which places very high forces on the knees to maintain the position and the weight of the body. Working surfaces that are too low usually affect the lower back and occasionally the neck.

As mentioned above, since muscles operate less efficiently in awkward positions, more force must be expended to do the task. Where employees work on high or low surfaces only occasionally (*e.g.,* once a week, only a short time each day), it does not pose a problem. However, where employees' primary working surface is too high or low, there is greater risk of injury due to exposure to awkward postures.

Examples:
- Threading extruded fiber onto a spool that is 15 inches above the floor, or
- Activating palm switches that are 60 inches above the floor.

Static postures. When awkward working positions must be maintained (*i.e.,* without support), it also increases the static loading of muscles and tendons. This causes the body to fatigue even more quickly.

Examples:
- Working on a vertical drafting table, or
- Sitting at grinding bench where the grinding wheel is 24 inches above the floor.

Contact stress. There are two ways in which contact stress can occur when working surfaces are too high or low. The incorrect height can create contact points that would not exist if the surface was at the correct height. In addition, contact stress can occur when employees, whose arms and shoulders are fatigued from prolonged awkward and static postures, end up resting their forearms, wrists or hands on hard or sharp edges in order to rest their arms and shoulders.

Examples:
- Working at a computer placed on a folding table, or
- Holding an injection molded part at eye level by resting the elbows on the work surface.

Maintaining same work positions or posture for a long period. The chief complaint people usually make when they have worked for a long time in the same position is that they feel ''stiff, sore and tired.'' These are some of the effects that result when tasks involve static postures (*e.g.,* driving for several hours without a break).

Static postures increase the amount of force required to do a task because, in addition to the force required to perform the task, contraction forces must be applied to hold the body in position throughout the work shift. Maintaining the same position or posture includes a variety of things. It includes holding the arms and shoulders in a non-neutral posture without moving.

The effects of maintaining the same work positions can occur in almost any joint of the body and vary depending on body location. For example, the effect on the knees and back from squatting or kneeling for 2 hours is likely to be greater than the effect on the neck and shoulders from looking up at a monitor for the same period.

Static postures. Tasks requiring employees to maintain the same position for an extended period increase the static loads/forces on muscles and other tissues. The longer postures must be maintained, the greater the loading of muscles and other tissues. This increased force contributes to fatigue and muscle-tendon strain.

Exposure to contact stress may be a by-product of prolonged static loading. When muscles become fatigued, employees look for ways to rest the affected areas. Sometimes employees may rest their arms or wrists on the hard surface and edges of the workstation. For example, computer operators may relieve static loading on their forearms and wrists by resting their wrists on the edge of the computer table. However, the blood flow and movement of their wrists may continue to be reduced because of the contact stress.

Examples:
- Watching a computer monitor that is above eye level, or
- Holding a mouse that is located in front of the keyboard.

Awkward postures. The effects of static loading on the body are made worse where it is an awkward posture that must be maintained. Awkward postures add to the strain that muscles and tendons are already feeling because of static postures.

In addition, the fatigue that results from static loads may cause employees to assume awkward positions in order to rest fatigued areas. For example, employees assembling microchips and computer circuits may rest their elbows on the work surface in order to relieve static loading on arms, wrists and hands. However, leaning on the elbows to continue working may result in static loading of the back, shoulders, neck and contact stress on the cubital tunnel.

Examples:
- Cradling a phone on the shoulder, or
- Holding the arms on the top half of a steering wheel.

Cold temperatures. Exposure to cold temperatures exacerbates the effects of static postures because it too reduces blood flow to muscles and other tissues. This may interfere with the ability of muscles and other tissues to recover from the effects of static loading. Exposure to cold temperatures also causes reduction in manual dexterity and feeling.

Examples:
- A butcher working in the plant's cooler for several hours, or
- Standing to direct traffic on a busy road in the winter.

Sitting for a long time. Sitting for long periods without the opportunity to stand up and move around is another way in which employees are exposed to static loading of tissues, primarily in the lumbar area of the back. It can also affect the upper back, neck and legs. The problem is exacerbated where awkward postures are also present.

Static postures. Employees may be exposed to static postures when they must sit for a prolonged period on chairs, stools or benches that do not provide adequate lumbar support, that is, either the back rest of the seat does not provide good lumbar support or there is no back rest at all. When there is no lumbar support and the back is bent forward, the muscles of the back are trying to force the lumbar region out of it natural curve (*i.e.,* proper alignment of the vertebrae), which places pressure on the discs and reduces blood supply to the spinal tissue. The constant exertion of the contraction forces leads to muscle fatigue.

When the back muscles become sore, people tend to slouch. In this posture more force is being placed on the back and the discs. As the static loading continues, pressure continues to be applied to the membranes of the discs and they may become stressed. Stressed discs, in turn, may put pressure on blood vessels and may pinch a nerve (*e.g.,* sciatic nerve), which results in pain.

Even where the chair has a back rest with lumbar support to help maintain the back in a neutral position, employees still may continue to be exposed to static loading because they cannot take advantage of the back rest. This may occur when the seat pan is too big or the seat is too high for the employee. Many employees respond by sitting forward, instead of against the back rest, so that their feet can be on the ground, thus pressing the spine out of the natural curve and placing pressure on the discs.

Awkward postures. Employees are also exposed to awkward back postures when they are working in a seated position and the back is not in a neutral position. The awkward postures may be caused by the physical work activities employees perform while sitting, the level of fatigue, the characteristics of the seat, and/or the height of the working surface (and objects on the working surface).

The back is in an awkward position if the employee is leaning forward, slouching or slumping in their seats to work. Employees may lean forward because they are fatigued, because they must reach or lift an object, because the work surface is too low or not tilted, or because they must move closer to see what they are working on. The awkward postures add to the static forces being applied to the discs and the muscles in the back. In addition, employees may be exposed to awkward neck postures when they look to see the work.

Examples:
- Working at a computer workstation where the operator must lean forward to see the screen,
- Working in a chair on an uneven floor.

Contact stress. Although contact stress that occurs from prolonged sitting is not directly related to the occurrence of MSDs, contact stress can increase discomfort and awkward postures. For example, where the seat pan is not padded at the edge, is too big or too high, it can create contact stress on the back of the thighs, which may result in constriction of blood flow to the legs. If employees sit forward to relieve this stress, the back is not supported and the employee may have a hard time maintaining the back in a neutral position.

Examples:
- Working in a chair where the seat pan is too long, or
- Working in chair with arm rests that are too close to the body.

Using hand and power tools. ''Using hand and power tools'' to perform physical work activities does not in itself mean that employees are exposed to ergonomic risk factors that put them at risk of injury. Rather, it is a shorthand way of alerting employers that there are aspects of tool design and use that need to be checked out to see whether ergonomic risk factors may be present. These include:

- Weight and size of tool,
- Tool handles and/or grips,
- Tool activation (repetitively, one finger),
- Tool kickback, vibration and maintenance.

Force. There are many ways in which operating hand and power tools can expose employees to high forces. First, when hand or power tools are heavy (*e.g.,* more than 10 pounds), employees may be exposed to high levels of force just to hold and control the tool. This is over and above the muscle force that must be applied to operate the tool and may cause the muscles to fatigue quickly.

Second, power tools that do not have good weight distribution can increase the force needed to operate the tools. This occurs when employees cannot hold tools at the ''center of gravity,'' and the tool rotates or spins around when it is in use. Employees must exert considerable muscle force and maintain the contraction forces to prevent such rotation.

Third, when tool handles or grips are too small or too big, employees must exert greater force to operate the tools because such handles/grips reduce grip capacity. Where handles are too narrow, employees may have to exert high muscle contraction forces to hold and operate the tool. For example, operating certain dental tools may require the exertion of considerable force and result in high pressure on the fingers and hand because they have very small handles (*i.e.,* narrower than a pen or pencil). And if the handles are too wide, there is less ability to generate the force (*i.e.,* muscle contraction) necessary to operate the tools, and employees are more likely to be exposed to awkward postures when they must bend or flex their wrists to maintain a grip on the tool handle.

Fourth, the way in which tools are activated can add considerably to the amount of force needed to operate the tool. Tools that have squeeze triggers may require employees to apply a lot of muscle contraction in the hands and fingers. Some triggers are so small that there is only room for them to be activated with one finger, that is, all the force to squeeze the trigger must be generated by one finger, which places excessive forces on the muscles and tendons of the finger. Because the fingers may not have enough strength to operate the squeeze trigger, the muscles may fatigue quickly. In addition, tendons may become so inflamed that fluid builds up in the area and it may be difficult to continue bending the fingers to squeeze the trigger. This is especially true for the use of manual hand tools, where exertion of a lot of force may be necessary to overcome the trigger's activation resistance.

Finally, application of high forces may be necessary to stop kickbacks and to resist the weight and power of some tools. For example, a logger or arborist may have to apply a lot force when cutting felled trees in order to prevent the kickback that could occur if the saw hits a very hard spot (*e.g.,* a knot in the tree). Employees using powered floor-buffers have to apply a lot of physical exertion to keep the buffers on a flat and centered plane and to keep them from spinning out.

Examples:
- Using powered driver to run and tighten nuts on bolts and opposing force when the driver reaches the end of the tightening process, or
- Constantly pressing the trigger to activate a drill with the index finger.

Awkward postures. There are several reasons why employees may be exposed to awkward postures when they are using hand and power tools. Awkward postures may be the result of bad tool design or workstation layout. Others may be poorly designed for the task so that the posture (awkward posture) requires more force and leads to overexertion of the fingers, hand, wrist, elbow, or shoulder (such as the use of a 90° screwdriver when an in-line screwdriver is more appropriate). A pistol grip electric drill may be fine on a vertical surface but on a horizontal surface the operator must turn the drill 90° to use it. Any force that must be maintained on the tool requires much more contraction of the muscles, which leads, in turn, to more rapid fatigue.

Examples:
- Reaching over a barrier to operate a rivet gun, or
- Squatting to tighten 20 bolts on a pipe flange.

Static postures. In many jobs the work situation requires that the worker constantly hold the tool and does not allow the worker to put the tool down. As a result, the grasp muscles and other support muscles are constantly active or statically loaded. Tools that require the worker to maintain some level of exertion to achieve a steady flow or activity such as a glue gun or a frosting bag require the muscles to be constantly in tension/contraction and applying some level of force. When workers have to hold a tool without putting it down, they must maintain the muscles in contraction. Mouse users who grip a mouse constantly because their work requires so much click and drag also experience these low but constant forces. Over time, fatigue of muscles and inflammation of tendons occurs.

Examples:
- Constantly holding knife used to trim chicken breasts in poultry plant,
- Holding a wire wrap gun.

Contact stress. Poor tool design is often the cause of contact stress in the use of operating tools. For example, gripping handles that are small may press the handle or handle edge into the skin, resulting in contact stress. Knurls (indentations in handles) may result in contact stress if they push into the fingers because they do not fit the operator's hand.

Examples:
- Using a screwdriver with edges on the handle to tighten bolts on an assembly line,
- Using a small wire clippers (handles press into the palm) to remove component lead after wave solder.

Vibration. Although using powered hand tools (*e.g.,* electric, hydraulic, pneumatic) may help to reduce risk factors such as force and repetition, they can expose employees to vibration. Vibrating hand tools transmit vibrations to the operator and, depending on the level of the vibration and duration, may contribute to the occurrence of Raynaud's phenomenon (*i.e.* vibration-induced white-finger MSDs) (Ex. 26–2). Vibration inhibits the blood supply to the hand and fingers, which leads to numbness and tingling in the fingers. These vibration-induced MSDs show a progression of symptoms beginning with occasional or intermittent numbness or loss of color (*i.e.,* blanching) in the tips of a few fingers. Continued exposure leads to more persistent attacks, affecting greater parts of most fingers and reducing feeling (*i.e.,* tactile discrimination) and manual dexterity (Ex. 26–2) (see the Health Effects section for a more-detailed discussion of specific MSDs).

The level of vibration can be the result of bad design, poor maintenance, and age of the powered hand tool. For example, even new powered hand tools can expose employees to excessive vibration if it they do not include any devices to dampen the vibration or in other ways shield the operator from it. Using vibrating hand tools can also contribute to muscle-tendon stress and fatigue. Operators may have to use increased grip force to steady such hand tools.

Examples:
- Cutting trees with chain saw, or
- Using grinding tools to form dentures.

Cold temperatures. The effects of any or all of the risk factors discussed can be exacerbated if the employee is exposed to cold while operating the tool. The cold temperatures can be due to the workplace environment (*e.g.,* deboning meat when temperatures must be maintained below certain levels, using a chain saw in the winter) or due to air blowing from the power tool across the operator's hand. When cold air blows across the hands, the fingers get cold and they are less dextrous. The reduction in dexterity occurs because blood flow is reduced in the cold fingers, blood flow becomes constricted, and the tissue becomes stiff.

Examples:
- Using a knife to process catfish fillets,
- Using a socket wrench to change out equipment on the roof in the winter.

Vibrating working surfaces, machinery or vehicles. Most jobs that involve contact with vibrating surfaces, machines and vehicles are easy to see, hear or feel. Since many products and processes are disturbed by vibration, employers often isolate and dampen vibration to levels below the threshold of effect on workers. However, there are some processes for which vibrating surfaces are unavoidable. An employee who comes into contact with such a surface may absorb enough vibration energy to create a health concern. Exposure to vibration energy usually results in one of two types of exposure—whole body vibration and hand/arm vibration. The exposures can result in an increase in forceful exertions, fatigue, numbness, tingling, and a loss of dexterity. These results are exacerbated by the presence of a cold environment.

Work conditions that involve sitting, standing or lying on a vibrating surface produce whole-body vibration. Excessive levels of whole-body vibration or exposure to it for prolonged periods can make it difficult to perform job tasks due to numbness and tingling and a loss of dexterity. Vibration energy can disrupt blood flow and affect the nervous system. Body parts that absorb the vibration (like the back and knees) are particularly vulnerable. Workers who stand on vibrating surfaces absorb most of the vibration energy in their legs, particularly the knees. Whole body vibration forces on the spinal discs can cause microfractures in the disc structure, which may lead to herniated or ruptured discs. Vibration can also disrupt the blood supply to the tissue around the spine, resulting in fatigue and inflammation. When the feet or buttocks are in contact with a vibrating surface, injury is usually to the spine.

Examples:
- Working near a 100-ton press,
- Working near a vibratory bowl, or
- Operating a fork truck over rough dock plates or gravel.

When the hands are in contact with a vibrating surface, the energy is primarily absorbed in the hands and arms and may lead to hand-arm vibration illnesses. The most common sources of hand-arm vibration syndrome are vibrating hand tools (*e.g.,* chainsaws, rivet guns, back pack leaf blowers). Some more subtle sources are holding pressurized hoses with nozzles, using a striking device such as a hammer, resting the hand on a vibrating machine, and holding a handle such as a steering wheel attached to a larger piece of equipment. In addition to the damage that is caused by the vibration energy, the muscles can become fatigued and strained due to the additional forces needed to compensate for the lack of tactile feedback and dexterity caused by the vibration. These losses are a result of the disruption of the peripheral sensory nerves caused by vibration. When the hands are in contact with a vibrating surface, injury is usually to the hands and arms.

Examples:
- Leaning against a grinding machine while it is operating,
- Holding a wheel while operating a sewing machine, or
- Manually aligning sections of a newspaper using a vibrating table.

Cold temperatures. Vibration reduces blood flow to the affected tissues. Vibration has a synergistic effect on the loss of blood flow in the presence of cold temperatures. The effect is present in the extremities because the body reacts to cold temperatures by shunting blood away from the extremities to preserve body heat.

Examples:
- Driving a fork truck over rough surfaces in a frozen food warehouse, or
- Using vibrating etching tools in a clean room

Workstation edges or objects press hard into tissues or joints. In some workplaces there are sharp edges or corners that press into the workers' skin during the course of their job. Workers who, because of the job and workstation design, must rest their arms or lean against a table with a hard, squared edge, exemplify this situation. Contact stress generally causes musculoskeletal disorders when the compression occurs against tendons that are being used or against nerves or blood vessels in vulnerable locations. Contact stress can restrict the movement of the tendon (more resistance), which requires more force and leads to inflammation of the tendon and surrounding tissues. Contact stress that pushes sharply into deeper tissues may reduce blood flow and result in early muscle fatigue. Tissue that is compressed for prolonged periods of time may be damaged. Nerves that are exposed to contact stress in multiple locations are especially vulnerable. The problem becomes worse with extended or repeated exposure.

Examples:
- Extensive use of shears or scissors,
- Using a tool with a small, thin handle that digs into the palm,
- Using tools with grooved handles that press against the side of fingers,
- Leaning against a metal work bench with a square edge,
- Using a keyboard on a standard table or desk with unrounded edges, or
- Sitting in a bench or chair that does not have a padded seat.

Using hand as a hammer (*i.e.*, contact stress). When the hand is used to strike something, extreme contact stress may be created. This is sometimes done to avoid damage to the product, but the result of using the hand as a hammer is damage to the worker. Striking a hard object with the base of the palm to align, seat, release or move a part is the type of job where the hand is most likely to be used as a hammer. Even occasional hammering with the hand can cause problems, but repeated activity of this sort will result in serious damage to the tissues of the hand.

When the palm is used to deliver a blow to an object, the force from the blow passes into the soft tissues and then deeper into the tendons, nerves and muscles. The force from the hit can cause acute trauma to the palm, but over time the palm becomes calloused and acute trauma is no longer protective of the deep tissue, and consequently the tendons and muscles can be subjected to frequent disruption of blood supply, irritation, and trauma due to the reaction force from the hit. The more force that is required to hammer the part, the more residual force that will pass into the tendons, nerves and muscles. The forces from the hit may cause bruising of muscles and add to swelling and inflammation of tendons.

Examples:
- Pounding on a two part mold to get it to seat or come together properly,
- Hitting a palm button to activate a machine,
- Striking two parts to separate them, or
- Striking the handle of a vice to loosen it.

Using hands or body as a clamp to hold objects while performing tasks. Sometimes this is referred to as having the worker act as a ‘‘human clamp’’ or ‘‘human vise.’’ In these situations the worker usually holds the object being worked on with one hand (often in an awkward, forceful posture) while force is applied by the other hand. The hand being used as a clamp has to hold the object while resisting the forces being applied by the other hand. Using the hand as a clamp leads to muscle fatigue and inflammation of the muscles and tendons.

The strain on the muscles and tendons in the clamping hand is especially high when the task involves static postures or contact stress. Although the hand and arms are most often used as a clamp, some larger jobs require the feet, legs, hips or torso (lateral bending of the back) to support a part while work is performed.

Examples:
- Holding the head of a cow on a slippery surface while attempting to remove meat,
- Holding a small part while assembling it,
- Drilling a hole in a part that the worker has to hold, or
- Using the hips or thighs to hold a part in place while working on the part.

Force. Higher force requirements on the clamping hand results in more strain on the muscles and tendons. Sometimes the clamping hand is used in an inefficient pinch grip. When high forces are required throughout the shift day after day, the muscles and tendons may not have time to recover, leading to muscle fatigue and inflammation of the tendons. Higher clamp forces are required when the part is heavy or the forces applied to the part are high.

Examples:
- Holding an extrusion nozzle while checking each hole (50 holes) to ensure it is the appropriate size,
- Holding a jar in one hand while attempting to remove the lid with the other hand.

Static postures. Often when the body is used to position and hold an object, the clamping part of the body maintains the same posture (static posture). Static loading reduces blood flow because the muscles are not moving (*i.e.*, contracting and relaxing). The constant muscle tension can lead to swelling and pressure on nearby nerves. Static loading and high forces can lead to tears in the muscle tissue. Static loading of the tendons can also lead to inflammation and swelling to the point where motion is restricted and the swelling may put pressure on (*i.e.*, pinch) the nerves.

Examples:
- Holding a pipe overhead while preparing a fitting, or
- Holding an uncooperative animal on the exam table.

Awkward postures. More force is required when clamping the object requires maintaining an awkward posture, because the muscles do not operate efficiently in an awkward posture. Since the muscles must work harder, fatigue sets in sooner, leading to fatigue and inflammation. An awkward posture also puts additional strain on the tendons, which can cause inflammation, swelling, restricted movement and pressure on nearby nerves.

Examples:
- Using the hands to wring out a mop,
- Bending sideways using the shoulder to hold a door panel in place while fastening the hinges, or
- Holding a part in place overhead while inserting fasteners.

Contact stress. If the object being held has a sharp edge or knurls (that force the fingers into slots), then the object may dig into the skin and can restrict the motion of the tendons and bruise or reduce blood flow to the muscles.

Examples:
- Holding a pane of glass while attaching hardware,
- Using the knee to position a pump while making the electrical connection, or
- Holding onto a nut while turning the bolt.

Gloves are too large, too small or too bulky. For many jobs it is necessary or appropriate for workers to wear gloves while doing their jobs. Gloves can make grasping an object more difficult by changing the friction, decreasing dexterity, and interfering with sensory feedback. This often leads to using more muscle force than would be required without gloves. Additionally, gloves can fold, wrinkle, and bunch so that pressure points are created that result in contact stress. Gloves that fit or are less bulky may help to relieve these problems. An even better solution is to eliminate the need to wear gloves.

Examples of glove use that may rise to the level of a hazard are providing inappropriate gloves for the work, or failing to consider the worker's needs when gloves are purchased, providing thick gloves for a task that requires dexterity beyond that allowed by the gloves, or providing vibration dampening gloves and expecting levels of dexterity or force exertion that are beyond the level possible with the gloves.

Force. Large, bulky, or loose gloves can interfere with tactile feedback so much that the worker must apply considerably more force than would be required to do the same task with more appropriate gloves or no gloves. Some gloves, such as those used for cut and puncture protection, are heavy and may cause additional fatigue.

Examples:
- Working on a hot pack used in extruding plastic with heat resistant gloves, or
- Holding a chicken leg while wearing cut resistant gloves.

Contact stress. Many bulky gloves bunch and cause pressure to small areas of the hands. Gloves that are supposed to provide protection from vibration and those with thick leather on the palm side are examples of gloves that may cause pressure points. When gloves are too small, they may impede the movement of the fingers and may reduce the blood supply.

Examples:
- Wearing latex gloves that are too tight, or
- Selecting cases in a frozen foods warehouse while wearing knit gloves under thermal gloves.

Manual handling (lifting/lowering, pushing/pulling and carrying). Forceful manual handling activities are a leading cause of workplace injury and illness. Lower back MSDs from lifting account for a large percentage of all workers' compensation cases. Studies discussed in the Health Effects section indicate that employees performing manual handling tasks have a significantly higher risk of back injury where they are exposed to force, repetition and/or awkward postures in the job.

The physical work activities and conditions included on the manual handling list in the proposal are ones that are likely to be a significant problem because they are ones in which the major ergonomic risk factors associated with manual handling tasks are present: force and awkward postures/static postures. This discussion about physical work activities and conditions in manual handling tasks is organized by task (*e.g.*, lifting, pulling). Manual handling tasks are discussed only where the physical work activities and conditions and ergonomic risk factors are likely to be a significant problem.

Objects or people are heavy (lifting, lowering, pushing, pulling, carrying). Workers lift, lower and move items every day. The heavier the weight that has to be lifted, lowered and/or moved, the more force the worker will have to exert. The heavier the weight, the closer the contraction required of the muscles will be to their maximum capability. When muscles contract at or near their maximum, they fatigue more rapidly and the likelihood of damage to the muscle and other tissues involved in the activity increases. In most situations involving lifting, lowering and moving heavy objects or people, the predominant risk factor is force. Manual handling of heavy objects exposes employees to high forces and will usually have the greatest impact on the back. Another aspect of weight that should be considered is a sudden shift in weight. Workers are more often able to accomplish a manual handling task without injury when they are prepared. When a patient's legs suddenly buckle while they are being transferred or a load within a package or container shifts, the worker may not be physically or mentally prepared for the weight.

Lifting and Lowering. In lifting and lowering, force is the risk factor that most often needs to be addressed. Although there may be a perception that lifting is more problematic than lowering, they both require the worker to exert the forces commensurate with the weight of the object. The actual forces exerted by the worker are determined by the weight of the object. It is obvious that lifting containers weighing 25 pounds is considerably easier than those weighing 50 pounds and that more people are capable of lifting the smaller amount. Posture can play a major role in the force required when moving an object. If that object can be held or lifted closer to the body, the muscle forces required in the back are less. Bulky containers present more of a problem when being lifted than do those with the same characteristics, including weight, that are compact. Finally, the frequency with which an object is lifted or lowered and the times it must be supported may be important in determining the risk presented by the job.

Examples:
- Lifting a resident, who has little ability to assist, from the toilet to a wheelchair,
- Lifting a 150 pound package from a loading dock into a van.

Pushing and Pulling. When pushing and pulling objects, the weight of the object or conveyance, including its contents, affects the force required of the worker. Often workers have to slide objects on a table or flat surface. In these cases the weight and the friction characteristics of the object and the surface are the prime determinants of the force required. Secondarily, the posture or reach may affect the degree of risk presented by the job. Where conveyances such as carts are used, the force required is generally determined by the characteristics and weight of the cart and contents. For very heavy carts, stopping and controlling the cart can sometimes be as difficult and important as pushing or pulling it to the desired location.

Examples:
- Pushing a 300 pound pump away from the paper machine, or
- Pushing a heavy cart up a sloped ramp.

Carrying. For carrying the weight, distance and object characteristics affect the forces required. Often the forces are exerted statically for some period of time when carrying. Additionally, the worker's body is in motion and the stability and biomechanics of the activity may be much worse than in a simple lifting or lowering situation. Examples might be carrying heavy parts from one work area to another, carrying containers from production to a pallet or storage area, or carrying packages when delivering them to a customer.

Examples:
- Carrying several 50-pound bags of feedstock material to the basement, or
- Carrying a resident of a nursing home to the bath tub.

Horizontal reach is long (Distance of hands from body to grasp object to be handled). Workers who are lifting/lowering, pushing/pulling or carrying are greatly affected by the distance that the hands are from the body during the activity. The forces required to manually move an object by the muscles in the back and shoulder are increased significantly as the load is moved away from the body. The resulting compression on bone and cushioning tissues is also significantly increased. The impact on the musculoskeletal system increases dramatically as the object or weight (center of gravity for bulky objects) is farther from the body. When moving objects or people, the distance away from the worker's body affects the forces for a lift or carry. Two characteristics of a lift requiring a long horizontal reach make it harder on the worker. The first is that the worker's own body weight must be supported and lifted in addition to the weight of the object. The second is that the torque required puts the muscles at a greater mechanical disadvantage when the objects being lifted are at a greater distance from the body joint involved. Because of the mechanical disadvantage, the predominant risk factor in these situations is force, which is increased because of the risk factor of awkward posture (long reach) present. The awkward posture involved in long reaches requires higher muscle forces to lift or move the same weight as would be necessary if the reach were shorter. The problem becomes worse when either greater weight or greater distance is required. Lifting, lowering and/or carrying items when a long horizontal reach is required will usually have the greatest impact on the shoulders, arms and back.

Lifting and Lowering. For lifting and lowering where the horizontal reach is long, force is the factor that needs to be addressed. This is usually accomplished by reducing the reaches or the weight. Examples would include reaching for a product on the far side of a conveyor, reaching to a parts supply bin that is on the far edge of the work surface, lifting a large box with a center of gravity at some distance from the body, lifting or lowering something on the far side of a barrier, placing packages on the far side of a pallet, or assisting a patient in sitting.

Pushing and Pulling. For pushing and pulling tasks, there may be reaches that are long; however, these are not usually a problem unless there is simultaneous lifting or unless the pushing and pulling direction is side to side rather than in and out. Moving objects from side to side is much less efficient than toward and away from the body.

Examples:
- Pushing a heavy box on a non-powered conveyor

Carrying. There are times when workers carry an object that cannot be rested against the body, so the arms are in a position that is similar to that of a long reach. This also happens when carrying a large box or container. When this happens the force risk factor is probably the most important, followed by the awkward and static posture risk factors.

Examples:
- Carrying a hot pack used in extruding plastic to the repair cart, or
- Carrying a carboy of nitric acid.

Vertical reach is below knees or above the shoulders (Distance of hands above the ground when the object is grasped or released). Workers who are lifting/lowering, pushing/pulling or carrying must exert more effort if the vertical position of the hands (when the object is started in motion) is above or below 30″ (Snook 1978, Ex. 2–26; Ayoub *et al.* 1978, Ex. 26–1416; Snook and Ciriello 1991, Ex. 26–1008). The forces required by the muscles in the back and shoulder are increased significantly as the hands near the floor or move above the shoulders. The NIOSH lift equation reduces the recommended lift by 22.5% if the lift occurs at or above shoulder level.

In addition to the force, the resulting compression on bone and cushioning tissues increases the likelihood of an injury. Ideally the hands are at (or slightly below) waist level when manual handling begins. Manual handling tasks that require the hands to be lower than the knees or higher than mid-torso put the worker at a biomechanical disadvantage, which requires the muscles to exert more force than if the starting point is near waist height. Low starting points require bending or squatting, which adds stress to the back and knees, respectively, due to the awkward posture. When the lifted object is below the worker's knees, he or she must bend forward, thus stretching the muscles in the back into an awkward and less efficient lifting posture. In addition, from a stooped posture the worker must lift the weight of the torso up as the object is lifted.

When an object is lifted above mid-torso heights, the thrust of the lifting force shifts from the larger/stronger muscles of the back to the smaller muscles of the shoulder. As the load is raised higher, the muscles of the shoulder become the primary movers. When material is lifted overhead, control of the lift becomes important. If the weight of the load were to suddenly shift while being lifted overhead, the resulting awkward posture, combined with the weight and distance of the load from the lower spine, could tear tendons, ligaments and muscles.

Lifting and Lowering. In lifting and lowering from or to low or high positions, awkward posture is a risk factor that often needs to be addressed. The awkward posture makes the muscles less efficient, and results in higher muscle forces than would be required if the lifting or lowering took place with the load within 10 inches of the waist.

Examples:
- Picking up a 35 pound spool of yarn from a peg above shoulder height,
- Picking a 40 pound item from a 60″ high shelf in a grocery warehouse, or
- Lifting a 50 pound motor off a pallet

Pushing and Pulling. When pushing or pulling objects, the height of hands affects the amount of force needed. When the hands are slightly above waist height, the worker gets the most from the muscles. As the hands are moved lower or higher, the worker's posture becomes more awkward and requires more force from the muscles.

Examples:
- Pushing a cart with the hands above mid chest height, or
- Pulling a wooden pallet across the floor.

Carrying. Carrying an object combines the static loading of the muscles with the loading caused by the awkward vertical position of the load. The combination of static and awkward postures greatly increases the fatigue on the muscles. Maintaining a stooped posture to carry a load places strain on the muscles of the back and shoulder as well as the spinal discs. Not only is the back supporting the weight of the object, but also the weight of the upper body. Carrying loads above shoulder height cannot be maintained for prolonged periods of time because the shoulder muscles will fatigue. The exception is when the weight of the load is rested on the skeletal system and the arms merely balance the weight (*e.g.,* carrying objects on the head, carrying trays of food on the shoulder).

Examples:
- Carrying large, bulky boxes of machine parts where the worker is unable to carry the box with a horizontal hold, or

- Carrying a large piece of furniture down steps.

Objects or people are moved significant distance (*i.e.*, pushing, pulling, carrying). In producing products or even services it is often necessary to move objects or people. This may be done by a worker pushing, pulling or carrying the item. Almost invariably this involves forceful exertions. The method of movement, the force required, and the distance to be moved are the important aspects of the job that will determine the presence of MSD hazards. The higher the force required and the longer the distance to be moved, the more likely it is that the job will present a problem. Force is the predominant risk factor when objects are moved, and it can be mitigated by using carts or other conveyances. This type of job is most likely to have adverse effects on the back, shoulders and arms.

Lifting and Lowering. Lifting and lowering is usually involved in a job of this type when the object is to be carried. For the lifting and lowering part of the job, the discussion of ‘‘objects or people moved are heavy,’’ above, should be consulted. The carry part of the task involves force and static postures. The weight of the object and the distance affect the force required and the time spent in static and forceful postures, respectively. Carrying puts the body in a dynamic activity where the stability is less than when the body is stationary. Examples of movement distances that might rise to the level of a hazard are moving a patient from the bed to the bath, lifting a tire from the floor to above the head, or carrying a heavy part from a pallet to a workstation.

Pushing and Pulling. When pushing or pulling an object for a significant distance, the forces required and the distance moved are the important aspects of the job. If a cart or conveyance is used, the force to push or pull it is almost always the risk factor of concern. Sometimes large or heavy objects are moved by sliding them across the floor. This usually involves high forces and is better done in other ways such as using a cart or powered mover.

Examples:
- Pushing a cart of restaurant supplies from the delivery truck to the restaurant, or
- Pushing a patient on a gurney to physical therapy.

Carrying. Once again, the weight of the object and the distance it must be carried are the important factors. The effect of these on the worker can be reduced by providing some form of conveyance.

Examples:
- Carrying trash cans to the garbage truck, or
- Carrying water bottles to the cooler.

Bending or twisting during manual handling. Bending or twisting while manual handling creates an awkward posture and changes the way forces are distributed in the spine. When the spine is in its natural position, forces are directed along the bony structure and distributed into the tissue as the spine curves. However, bending and twisting redirects the forces, placing more compressive and shear forces on the discs. Psychophysical studies have reported that there is a decrease in the maximum acceptable weight of lift (MAWL) in the range of 8% to 22% where twisting of the torso is involved (Garg and Badger 1986, Ex. 26–121; Mital and Fard 1986, Ex. 26–182; Garg and Banaag 1988, Ex. 26–951). Experiments by Adams *et al.* (1980, Ex. 26–701) indicate that combined bending and twisting of the spine reduces the tissue tolerance of the intervertebral discs, predisposing them to rupture.

When an object to be lifted is below the worker's knees, he or she must bend forward, thus stretching the muscles in the back into an awkward and less efficient lifting posture. In addition, from a stooped posture the worker must lift the weight of the torso up as the object is lifted. Lifting from a stooped posture also creates a situation where the worker can accelerate the torso as they lift.

Marras and Granata (1995, Ex. 26–1383, and 1997b, Ex. 26–169) found that increased velocity and acceleration in trunk lateral bending and twisting result in measurable increases in both compressive and shear forces experienced by the intervertebral discs.

Lifting and Lowering. In lifting and lowering, awkward posture is the risk factor that most often needs to be addressed. The awkward posture makes the muscles less efficient and results in higher forces than would be required if the lift or lower were ±10 inches from the waist.

Examples:
- Moving 30 pound motors from a workstation to a conveyor perpendicular (90°) to the workstation,
- Moving a patient from the bed to a wheelchair, or
- Loading luggage into the cargo hold of an airplane.

Object is bulky, slippery or has no handles (lifting, lowering, carrying). Lack of good hand holds or good coupling between the hand and the object can result in higher grasp forces, higher other hand/arm forces, higher back forces, or the adoption of awkward postures to secure a stable relationship with the load. The predominant risk factors involved are force and awkward postures, which usually affect the back, hands, wrists and fingers.

Lifting and Lowering. When lifting and lowering an item in which the coupling is poor, the worker has to adapt. Sometimes this involves having the hands or center of gravity of the load at considerable distance from the body, which increases the forces required of the back in awkward postures. Sometimes the hands have to bend around the box corners, resulting in considerable force being exerted in an awkward posture. Bulky loads cause the worker to bend the back more. Open boxes with poor coupling may be picked up with pinch grips on the tops of the box sides, which results in high forces and an ineffective grip.

Examples:
- Lifting a 40 pound fuel pump out of a tank of mineral oil,
- Lifting wet watermelons out of a box (which requires the worker to use excessive grip force), or
- Lifting a patient with little ability to assist out of bed.

Pushing and Pulling. Hand forces will tend to be higher when pushing or pulling bulky items or those that have poor coupling.

Examples:
- Pushing a large box of potatoes in a produce warehouse.

Carrying. The problems of carrying an object with poor coupling or that is bulky are very similar to those involved in lifting and lowering. These problems are exacerbated by the static loading required when carrying any distance.

Examples:
- Carrying a keg of beer,
- Carrying machined parts to a degreaser, or
- Carrying a side of beef.

Floor surfaces are uneven, slippery, or sloped. Surfaces that are not level require the worker to compensate by placing the body in an awkward posture. When the spine is in its natural position, forces are directed along the bony structure and distributed into the tissue as the spine curves. However, awkward postures both redirect the forces, placing more compressive and shear forces on the discs and placing the muscle in a less efficient position. In addition, to move an object manually, the forces exerted by the feet need to be resisted by the forces that push back from the floor. When the floor is slippery or sloped, the worker must expend more energy resisting the natural tendency for the feet to slip. If the load should shift while the worker is on an uneven, slippery or sloped surface, an injury becomes more likely. Poor floor conditions can affect the footing and the ease of movement of carts. Force is the risk factor that is usually exacerbated by poor floor surfaces and the back is the usual location of MSDs that are brought on by problems of floor surfaces. Lack of good footing will result in added stress on the postural muscles and other tissues.

Lifting and Lowering. In lifting and lowering, awkward posture is the risk factor that most often needs to be addressed. The awkward posture makes the muscles less efficient and results in higher forces. The higher forces lead to fatigue and inflammation.

Examples:
- Shoveling grain, or
- Lifting bags of laundry from a wet floor.

Pushing and Pulling. Pushing or pulling on an uneven, slippery, or sloped surface can result in a sudden increase in the force needed to move or stop an object. The increase in force alone can tear muscles or strain tendons enough to cause an injury. When the increase in force occurs when the body is in an awkward posture due to the surface, then a muscle or tendon strain is more likely, due to the inefficient position of the muscles.

Examples:
- Pushing a laundry hamper across a wet floor,
- Pushing a file cabinet on a carpeted floor,
- Pushing a wheelchair through gravel, or
- Pushing a cart on a cracked concrete floor.

Carrying. Carrying an object while walking on uneven, slippery or sloped surfaces causes the body to continually shift to accommodate the changing working surface.

Example:
- Carrying boxes of metal scraps down steps, or
- Carrying boxes of paper up a ramp into the computer room.

Section 1910.918 What must I do to analyze a problem job?

You must:

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(b) Evaluate the ergonomic risk factors in the job to determine the MSD hazards associated with the covered MSD. As necessary, evaluate the duration, frequency and magnitude of employee exposure to the risk factors.

4. Paragraph (d)—''Evaluate''

Paragraph (d) of this section would require employers to evaluate the identified ergonomic risk factors to determine whether the employee exposure to them is such that a covered MSD would be reasonably likely to occur. To make this determination, employers need to look at the duration, frequency and magnitude (*i.e.*, modifying factors) of the employee's exposure to the ergonomic risk factors.

OSHA is proposing this evaluation provision because, although many jobs have ergonomic risk factors, these risk factors do not always rise to the level that poses a significant risk of injury. This may be because the exposure does not last long enough, is not repeated frequently enough, or is not intensive enough to pose a risk. For example, an employee bending to pick up a paper clip off the floor is exposed to awkward postures; however, this activity is not likely to result in a covered MSD because it is done infrequently. Also, an employee who picks up a box of copier paper is certainly exposed to high forces, but a covered MSD is not likely to occur where the employee does this only, for example, once a week. On the other hand, a job that requires bending from a neutral posture for most of the day would be likely to cause a covered MSD. The following is a brief description of the modifying factors:

a. Duration. Duration refers to the length of time an employee is continually exposed to risk factors. The duration of job tasks can have a substantial effect on the likelihood of both localized and general fatigue. In general, the longer the period of continuous work (*i.e.*, the longer the tasks require sustained muscle contraction), the longer the recovery or rest time required (Ex. 26–2). Duration can be mitigated by changing the sequence of activities or recovery time and pattern of exposure. Breaks or short pauses in the work routine help to reduce the effects of the duration of exposure.

b. Frequency. The response of the muscles and tendons to work is dependent on the number of times the tissue is required to respond and the recovery time between activity. The frequency can be viewed at the micro level, such as grasps per minute or lifts per hour. However, often a macro view will be sufficient, such as time in a job per shift, or days per week in a job.

2c. Magnitude. Magnitude (or intensity) is a measure of the strength of the risk factor, for example: how much force, how deviated the posture, how great the velocity or acceleration of motion, how much pressure due to compression. Magnitude can be measured either in absolute terms or relative to an individual's capabilities. There are studies on how much force should be required under some circumstances, but as an initial estimate, employees can be asked to classify the force requirements of the job on a scale (*e.g.*, low, moderate or high). Often this is all that is needed to focus the analysis on the part of the job that needs to be changed.

There are many qualitative and quantitative ways to determine the magnitude of exposure. Often all it takes is the employer asking employees to describe the most difficult part of the job, and the answer will indicate the magnitude of the risk factor. A common practice for assessing forceful exertion is to ask the employee to rate the force required to do the task. When magnitude is assessed qualitatively, the employer is making a relative rating, that is, the perceived magnitude of the risk factor relative to the capabilities of the worker. Relative ratings are very useful in understanding whether the job fits the employees currently doing the job.

There are a number of ways to quantitatively measure magnitude of exposure. For example, the NIOSH Lifting Equation is widely used to determine recommended weight limits for safe lifting and carrying (Ex. 26–521). The Snook Push-Pull Tables are used by many stakeholders to evaluate and design pushing, pulling and carrying tasks (Ex. 26–1008). For work-related upper extremity MSDs, the RULA survey method is often used to investigate and evaluate jobs (McAtamney, Lynn, Corlet, E. Nigel, 24(2) Applied Ergonomics 91–99, 1993, Ex. 26–1421).

The following is an example of an evaluation (qualitative and quantitative) of the duration, frequency and magnitude of exposure to ergonomic risk factors in a computer-work job:

OBSERVATION	RISK FACTORS	FREQUENCY	DURATION	MAGNITUDE	CAUSE
Same posture maintained as the head bends down to look at the paper and screen	Repetition, awkward postures	Constant	6 hours per day	Head movement is about 45 degrees down from straight up	Monitor and sheet of paper are low.
High work surfaces causes the elbows to be above mid torso	Awkward postures, static postures	Constant	6 hours per day	Upper arm is about half way between resting at the side and straight out from the shoulder	Keyboard at mid-chest height.
Same posture maintained with the fingers on the keyboard	Awkward postures, static postures	Constant while typing	Typing time is about 6 hours per day	Hands do not move from the keyboard	Keyboard use.
Repetition of the same motion by the fingers	Repetition	900/min	Typing time is about 6 hours per day	Moderate level of typing	Keying.
Workstation objects press hard against the body	Contact stress	Constant while typing	Typing time is about 6 hours per day	Worker has red lines on the wrist	Edge of the desk pressing into the wrist.
Long reaches for the mouse	Awkward postures, static postures	Constant while using the mouse	Uses the mouse less than one hour per day	The arm is fully extended	The mouse is about 1.5 feet from the worker.
Prolonged sitting	Static posture	Constant	About 6 hours per day		Constant keying, sitting too long.
Workstation chair presses hard into the back of the thigh	Contact stress	Constant	About 6 hours per day		Chair seat pan too high, and the feet dangle above the floor or rest on the base of the chair.

As mentioned above, ergonomic risk factors are synergistic elements of MSD hazards. Simply put, the total effect of these risk factors is greater than the sum of their parts. As such, employers need to be especially watchful for situations where risk factors occur simultaneously. Levels of risk factors that may pose little risk when found alone are much more likely to cause MSDs when they occur with other risk factors.

Controls that reduce a risk factor focus on reductions in the risk modifiers (frequency, duration or magnitude). By limiting exposure to the modifiers, the risk of an injury is reduced. Thus in any job the combination of the task, environment and the worker create a continuum of opportunity to reduce the risk by reducing the modifying factors. The closer the control approach comes to eliminating the frequency, duration or magnitude, the more likely it is that the MSD hazard has been controlled. Conversely, if the control does little to change the frequency, duration or magnitude, it is unlikely that the MSD hazard has been controlled.

Section 1910.919 What hazard control steps must I follow?

You must:

(a) Ask employees in the problem job for recommendations about eliminating or materially reducing the MSD hazards;

(b) Identify, assess and implement feasible controls (interim and/or permanent) to eliminate or materially reduce the MSD hazards. This includes prioritizing the control of hazards, where necessary;

(c) Track your progress in eliminating or materially reducing the MSD hazards. This includes consulting with employees in problem jobs about whether the implemented controls have eliminated or materially reduced the hazards; and

(d) Identify and evaluate MSD hazards when you change, design or purchase equipment or processes in problem jobs.

Section § 1910.919 of the proposed rule outlines the basic process employers must use in controlling MSD hazards. These provisions are well-recognized as the basic problem-solving steps of hazard control (Ex. 26–2).

1. Paragraph (a) —''Ask employees for recommendations''

Proposed paragraph (a) requires that employers ask employees for recommendations on controls. Many stakeholders have said that employees who are doing a job are usually the best resource for finding both the problems or difficulties in that job and for identifying appropriate solutions that will control the hazards (Exs. 3–112, 3–164, 3–112, 26–5). In addition, employee input and participation in the problem solving process can minimize the resistance to change when job changes become necessary. Many stakeholders have testified to the value of employee participation in ergonomics:

Employers and employees alike who work in the industry are in the best possible position to identify risk factors in their workplace and to develop prevention methods that concentrate on the significant problems unique to their particular industry's environment. America Health Care Association (Ex. 3–112).

Job analysis should include input from the workers themselves. The employees can best tell what conditions have caused them pain, discomfort, and injuries. They often have easy and practical suggestions on how such problems can be alleviated. American Federation of State, County and Municipal Employees, AFL–CIO (Ex. 3–164).

2. Paragraph (b)—''Identify, assess and implement controls''

OSHA is proposing a requirement that employers identify, assess and implement feasible controls (interim and permanent) to eliminate or materially reduce the MSD hazards identified. Controls are considered feasible if they are presently in use for the application in question, can be adapted for such use from technologies that are being used in other applications, can be developed by improving existing technologies, or is on the horizon of technological development. For many MSD hazards, the identification and assessment of controls will be brief because the MSD hazards are obvious or not complex and can easily be implemented. Many MSD hazards can be addressed with off-the-shelf controls. Often controls can be identified during the job hazard analysis and even be put in as they are identified, such as these examples:

- Eliminating awkward postures (leaning over workstation) by putting blocks under a work bench to raise the work surface height.
- Eliminating awkward postures of the neck and reducing stress on the back by putting a telephone book under a VDT monitor.
- Reducing awkward postures of the neck by removing light bulbs that were causing glare on the VDT monitor screen.
- Reducing force by cleaning thread from the wheels of a cart that had been hard to push.

Where controls are not obvious or off-the-shelf, the identification and assessment of controls may require more effort.

Identify controls

There are many different methods employers can use and places employers can go to identify controls. Many employers rely on their internal resources to identify possible controls. These in-house experts may include:

- Employees who perform the job and their supervisors,
- Engineering personnel,
- Workplace safety and health personnel or committee,
- Maintenance personnel,
- On-site health care professionals,
- Procurement staff, and
- Human resource personnel.

A number of stakeholders said they bring their in-house experts together for brainstorming sessions to identify as many solutions as possible for the problem job (Ex. 26–1370). Some of those stakeholders have told OSHA that brainstorming is often a good technique for addressing complex problems (Ex. 26–1370). Looking at the original design and equipment specifications is another in-house method for identifying solutions. Reviewing the original design specifications or even operation manuals can help determine whether the job, equipment, tools or raw materials have changed substantially. If changes are identified, a return to the original condition via equipment maintenance and repair may be enough to correct the problem.

Another common method of identifying controls is to look at similar operations. Stakeholders have said that they review similar operations at sister worksites to identify changes that have worked there over time.

Possible controls can also be identified from sources outside the workplace, such as:

- Equipment Catalogs. Review of equipment catalogues, especially those dealing with the types of problems present. For example, if the problem deals with handling drummed materials, there are equipment catalogues that offer a number of pieces of equipment that aid with the handling of drums.
- Vendors. Talk to vendors who work within a particular industry. They may be able to share ideas from other operations. It may be useful to develop a partnership with a vendor and work collaboratively to resolve the problem.
- Trade Associations or Labor Unions. Discuss the problem with a trade association or a labor union. They may serve as a focal point for efforts to initiate changes within the industry.
- Conferences and Trade Shows.
- Insurance companies. Insurance companies can provide information about what other clients with similar operations are doing to solve problems.
- OSHA Consultation Services. OSHA provides free on-site assistance in identifying, analyzing and controlling problems. The first priority of OSHA's consultation services is small businesses in high hazard industries.
- Specialists. Specialists in materials handling, layout, work methods, occupational safety and health, or ergonomics may be able to provide solutions based on their experience. Many large organizations have such specialists on staff or at corporate headquarters.

Through in-house experts and other sources of expertise, employers need to generate solutions that eliminate or materially reduce ergonomic risk factors. To assist employers in identifying solutions, the following table provides a list of solutions and control measures that have been identified and used to eliminate or materially reduce ergonomic risk factors in the physical work activities and conditions identified in § 1910.918(c):

PHYSICAL WORK ACTIVITIES AND CONDITIONS	ERGONOMIC RISK FACTORS THAT MAY BE PRESENT	EXAMPLES OF CONTROLS
(1) Exerting considerable physical effort to complete a motion	(i) Force	Use powered tools Change pinch to power grip Use longer handle Use powered lift assist Use lift tables
	(ii) Awkward postures	Provide better mechanical advantage such as a longer handle Move the items closer to the worker Design task for smooth movements
	(iii) Contact stress	Attach a handle Wrap or coat the handle with cushioning and non slip material Wear gloves that improve the grip
(2) Doing same motion over and over again	(i) Repetition (ii) Force	Use power tools Use job enlargement Use job rotation Reallocate tasks
	(iii) Awkward postures	Provide wrist rest Allow short breaks
	(iv) Cold temperatures	Take break in a warm area Provide heat where the hands are located
(3) Performing motions constantly without short pauses or breaks in between	(i) Repetition (ii) Force (iii) Awkward postures (iv) Static postures (v) Contact stress (vi) Vibration	Use job enlargement Allow breaks as needed
(4) Performing tasks that involve long reaches	(i) Awkward postures	Redesign the workplace layout Reposition object Provide better access to machinery Rotate pallet or work surface Keep work in front of the worker Use a tool to extend the reach
	(ii) Static postures	Provide adjustability Allow short breaks Use job enlargement Allow tools and items to be set aside periodically
	(iii) Force	Use lift tables or pallet jacks
(5) Working surfaces are too high or too low	(i) Awkward postures	Provide adjustability Raise/lower the worker Use a tool to extend the reach
	(ii) Static postures (iii) Force	Use job enlargement Reorient work Allow short breaks Use lift tables
	(iv) Contact stress	Ensure round edges Pad surfaces
(6) Maintaining same position or posture while performing tasks	(i) Awkward postures	Use job enlargement Reposition object

PHYSICAL WORK ACTIVITIES AND CONDITIONS	ERGONOMIC RISK FACTORS THAT MAY BE PRESENT	EXAMPLES OF CONTROLS
	(ii) Static postures	Reduce weight of object Use job rotation Use job enlargement Allow short breaks Use sit/stand workstation Use anti-fatigue mats Provide foot rest Provide cushioned insoles
	(iii) Force	Use balanced powered hand tools Provide lift assist
	(iv) Cold temperatures	Wear thermal clothing Take break in a warm area Provide localized heating
(7) Sitting for a long time	(i) Awkward postures (ii) Static postures (iii) Contact stress	Stand occasionally Provide lumbar support Allow short breaks Provide chairs with padding on the seat Make seat height adjustment
(8) Using hand and power tools	(i) Force (ii) Awkward postures (iii) Static postures (iv) Contact stress	Support weight of the tool mechanically Ensure tool has good balance Use appropriate size handles Avoid sharp edges and finger slots on the handle
	(v) Vibration (vi) Cold temperatures	Use low vibration tools Isolate source of vibration from the worker Maintain tools Reduce vibration Insulate hands Eliminate of reduce draft or blow back on the hands
(9) Vibrating working surfaces, machinery or vehicles	(i) Vibration (ii) Force (iii) Cold temperatures	Isolate source of vibration Use job rotation Use adsorbing material to reduce the magnitude of the vibration Provide insulation from the cold Allow breaks in a warm area
(10) Workstation edges or objects press hard into muscles or tendons	(i) Contact stress	Provide round edges Enlarge handles Pad surfaces and handles
(11) Using the hand as a hammer	(i) Contact stress (ii) Force	Review design specifications Use soft mallet Provide frequent maintenance
(12) Using hands or body as a clamp to hold object while performing tasks	(i) Force (ii) Static posture (iii) Awkward posture (iv) Contact stress	Use a fixture, clamp or jig Use job rotation Provide round edges Pad surfaces
(13) Gloves are bulky, too large or too small	(i) Force (ii) Contact stress	Provide several sizes and weights of gloves

PHYSICAL WORK ACTIVITIES AND CONDITIONS	ERGONOMIC RISK FACTORS THAT MAY BE PRESENT	EXAMPLES OF CONTROLS
MANUAL HANDLING (Lifting/lowering, pushing/pulling, and carrying)		
(14) Objects or people moved are heavy	(i) Force (ii) Repetition (iii) Awkward postures (iv) Static posture (v) Contact stress	Lighten load Use lift assist Use lift table Place package in larger containers that have to be mechanically handled Use two people lift team Rely on gravity to move the object Reduce friction
(15) Horizontal reach is long	(i) Force (ii) Repetition (iii) Awkward postures (iv) Static posture (v) Contact stress	Redesign the workplace layout Reposition object closer to the employee Provide pallet, table that can be rotated Provide space so that the employee can walk around to the object Reduce the size of the object Slide the object closer before lifting Eliminate unnecessary barriers
(16) Vertical reach is below knees or above the shoulders	(i) Force (ii) Repetition (iii) Awkward postures (iv) Static posture (v) Contact stress	Do not place objects to be lifted on the floor Use adjustable height tables Put employee on a platform Store heavy objects stored at waist height Put handles on the object Change the work place layout
(17) Objects or people are moved significant distances	(i) Force (ii) Repetition (iii) Awkward posture (iv) Static postures (v) Contact stress	Modify the process to eliminate or reduce moves over a significant distance Convey the object (*e.g.,* conveyor, ball casters, air) Use fork lifts, hand dollies, carts, or chairs (for people) Use appropriate wheels on carts (and maintain the wheels) Provide handles for pushing, pulling or carrying
(18) Bending or twisting during manual handling	(i) Force (ii) Repetition (ii) Awkward postures (iv) Static postures	Raise work to the appropriate height Lower the employee Arrange workstation so that work is done in front of the worker Use conveyors, chutes, slides, or turntables to change direction of the object
(19) Object is slippery or has no handles	(i) Force (ii) Repetition (iii) Awkward posture (iv) Static posture	Provide good handles Provide belt with handholds to assist in moving patients Provide gloves that assist in holding slippery objects
(20) Floor surfaces are uneven, slippery or sloped	(i) Force (ii) Repetition (iii) Awkward postures (iv) Static posture	Redesign the handling job to avoid movement over poor surfaces Use surface with treatments or anti-skid strips Provide footwear that improves friction

Assess controls. The assessment of controls is an effort by employers, with input from employees, to select controls that are reasonably anticipated to eliminate or materially reduce the MSD hazards. The employer may find that there are several controls that would be reasonably likely to reduce the hazard. Multiple control alternatives are often available, especially when several risk factors contribute to the MSD hazard. The employer needs to assess which of the possible controls should be tried. Clearly, a control that significantly reduces several risk factors is preferred over a control that only reduces one of the risk factors.

Selection of the risk factor(s) to control and/or control measures to try can be based on numerous criteria. An example of one method involves ranking all of the ergonomic risk factors and/or possible controls according to how well they meet these four criteria:

• Effectiveness—Greatest reduction in exposure to the MSD hazards.

• Acceptability—Employees most likely to accept and use this control.

• Timeliness—Takes least amount of time to implement, train and achieve material reduction in exposure to MSD hazards.

• Cost—Elimination or material reduction of exposure to MSD hazards at the lowest cost.

Where there are several jobs that need to be controlled, the employer may need to consider prioritizing the implementation of controls as part of the assessment process. Although many employers tend to select the most severe problems to control first, the criteria above are another way to prioritize the control of jobs.

Implement Controls. Because of the multifactoral nature of MSD hazards, it is not always clear whether the selected controls will achieve the intended reduction in exposure to the hazards. As a result, the control of MSD hazards often requires testing selected controls and modifying them appropriately before implementing them throughout the job. Testing controls verifies that the proposed solution actually works and what additional changes or enhancements are needed.

There are a number of ways in which employers may test out controls. Many employers modify a single workstation first to ensure that all necessary revisions have been identified and completed. Only then are the modifications applied to other workstations. Some employers with manufacturing operations test out new work methods on training lines or training workstations, which typically have slower line speeds. In addition, employers may have employees test out several different models of new tools, furniture, and equipment to identify the best fit for each employee.

Stakeholders have told OSHA that sometimes it can take a long time to develop, purchase and/or install effective permanent controls (Ex. 26–1370). To ensure that employers have adequate time to identify, assess and test out possible control measures, OSHA is proposing that employers have up to 3 years to implement permanent controls (or 1 year after the compliance start-up times have passed). However, so that employees do not go unprotected for that period of time, OSHA is proposing to require that employers implement interim controls more quickly. Often simple engineering or administrative controls may be implemented quickly, while a better solution is being designed. A number of stakeholders have said that they used administrative controls to reduce exposures during the interim time it took them to design and implement new engineering controls (Ex. 26–1370).

3. Paragraph (c)—''Track progress''

Paragraph (c) would require employers to track their progress (*i.e.*, evaluate their progress and success) in eliminating or materially reducing the MSD hazards. OSHA believes this provision is important for several reasons. First, evaluating the effectiveness of controls is the *sine qua non* of an incremental abatement process. Unless they follow up on their control efforts, employers will not know whether the hazards have been adequately controlled or whether the abatement process needs to continue. Simply put, if the job is not controlled, the problem-solving is not complete.

Second, tracking progress is also essential in those cases where employers need to prioritize the control of hazards. It tells employers whether they are on schedule with their abatement plans. Third, tracking the progress of control efforts is a good way of determining whether the elements of the program are functioning properly. For example, evaluating controls, especially work practice controls, is one way to determine whether the ergonomics training has been effective.

Many employers evaluate controls within 30 to 60 days after implementation. This gives employees enough time to get accustomed to the controls and to see whether the controls have introduced other problems into the job (Ex. 26–2).

Once again, there are many ways that employers may track their progress in addressing MSD hazards, and OSHA does not intend to require employers to use one particular method. NIOSH says that the evaluation should use the same tool that was used to analyze the problem, or another method that allows employers to compare the before-and-after results (Ex. 26–2). One of the easiest approaches is to follow up with employees in the problem job and ask them whether the controls have reduced the physical difficulties of performing the job, whether the job is more comfortable, or whether the tools and equipment seem to fit them better. Many employers take baseline measurements before the ergonomics program is implemented so they have a way of quantifying their success. Some of the measures they use include:

• Reductions in severity rates, especially at the very start of the program,
• Reduction in incidence rates,
• Reduction in total lost-workdays and lost-workdays per case,
• Reduction in job turnover or absenteeism,
• Reduction in workers' compensation costs/medical costs,
• Increases in productivity or quality,
• Reduction in reject rates,
• Number of jobs analyzed and controlled,
• Number of problems solved.

OSHA is not proposing to require that employers use one of these methods listed to assess the effectiveness of controls. Employers are free to choose their own criteria. The proposed rule would require, however, that whatever measure employers do select, their evaluation of controls must include consulting employees in the problem job.

4. Paragraph (d)—Proactive ergonomics

Paragraph (d) would require employers to identify and evaluate MSD hazards when they make process and equipment changes. Sometimes this concept is referred to as ''proactive ergonomics'' or ''safety through design.'' The concept encompasses facilities, hardware, equipment, tooling, materials, layout and configuration, energy controls, environmental concerns and products. Designing or purchasing to eliminate or materially reduce MSD hazards in the design process helps to avoid costly retrofitting. It also results in easier and less costly implementation of occupational safety and health needs (Ex. 26–2, Ex. 26–1418).

OSHA is proposing this requirement, in part, because many stakeholders have said that the best and most cost-effective way to control MSD hazards is to prevent them from being introduced into the workplace in the first place (Ex. 26–1370):

> Ergonomic principles are most effectively applied to workstations and new designs on a preventive basis, before injuries or illnesses occur. Good design with ergonomics provides the greatest economic benefit for industry. American Industrial Hygiene Association (Ex. 3–197).

Design strategies should emphasize fitting job demands to the capabilities and limitations of employees. To achieve this, decision-makers must have appropriate information and knowledge about ergonomic risk factors and ways to control them. They need to know about the problems in jobs and the causes. Designers of in-house equipment, machine and processes also need to have an understanding of ergonomic risk factors and how to control them. For example, they may need anthropometric data to be able to design to the range of capabilities and limitations of employees.

It is also important that persons involved in procurement have basic knowledge about the causes of problems and ergonomic solutions. For example, they need to know that adjustable chairs can reduce awkward postures and that narrow tool handles can considerably increase the amount of force required to perform a task. In addition, to prevent the introduction of new hazards into the workplace, procurement personnel need information about equipment needs.

Several employers in the meat processing industry have told OSHA that they were able to communicate their common concerns to equipment suppliers and that, as a result, several suppliers are now providing tools and equipment that reduce the likelihood of an MSD. OSHA encourages employers to contact individuals and other companies any time information about the cause of a workplace musculoskeletal disorder could be used to prevent similar incidents. Owens and Garg (Ex. 26–1415) found that manufacturers are often receptive and responsive to recommendations for design changes made by users of their products in the design phase.

Section 1910.920 What kinds of controls must I use?

(a) In this standard, you may use any combination of engineering, administrative and/or work practice controls to eliminate or materially reduce MSD hazards. Engineering controls, where feasible, are the preferred method for eliminating or materially reducing MSD hazards. However, administrative and work practice controls also may be important in addressing MSD hazards.

(b) Personal protective equipment (PPE) may be used to supplement engineering, work practice and administrative controls, but may only be used alone where other controls are not feasible. Where PPE is used, you must provide it at no cost to employees.

Note to § 1910.920: Back belts/braces and wrist braces/splints are not considered PPE for purposes of this standard.

Section 1910.920 permits the employer to use any combination of engineering, administrative, or work practice controls to address the MSD hazards identified in problem jobs. OSHA is proposing to allow employers this flexibility in choice of controls because OSHA's experience and reports from stakeholders both indicate that all of these control approaches have contributed to reductions in the number and severity of workplace MSDs. In addition, the broad range of jobs to which the standard will apply, and the great variation in workplace conditions covered, make compliance flexibility essential.

Paragraph (a) of § 1910.920 does, however, state that engineering controls are the preferred method of eliminating or substantially reducing MSD hazards in cases where these controls are feasible. The proposal defines engineering controls as controls that physically change the job in a way that eliminates or materially reduces the MSD hazard or hazards present. Examples of engineering controls that are used to address ergonomic hazards are workstation modifications, changes to the tools or equipment used to do the job, facility redesigns, altering production processes, and/or changing or modifying the materials used.

Engineering controls range from very simple to complex: from putting blocks under a desk to raise the work surface for a taller-than-average worker to providing a lumbar support pillow or rolled-up towel to a video display unit (VDU) operator to redesigning an entire facility to enhance productivity, reduce product defects, and reduce workplace MSDs.

When choosing an engineering control to address a particular ergonomic problem, employers often have many choices, depending on how much they wish to spend, how permanent a solution they seek, how extensive a production process change they need, and employee acceptance and preference. For example, as MacLeod (Ex. 26–1425) points out, an employer whose VDU operators are experiencing neck and shoulder problems has many options available, including the following:

- Raising the height of the monitor by putting it on phone books, building a monitor stand, buying an adjustable monitor stand, buying an adjustable wall-mounted monitor stand, or buying an adjustable desk-mounted monitor stand;
- Putting the desk on blocks; or
- Providing an adjustable-height desk or workstation.

The ergonomics proposal reflects the preference of ergonomists and safety and health professionals for engineering controls, which is based on the ability of engineering controls to eliminate the MSD hazards posed by the job. The standard ergonomics textbooks and guidance documents emphasize the superiority of engineering controls over other classes of controls, *i.e.*, administrative controls, work practices, or personal protective equipment (PPE) (see, for example, Ex. 26–1487, Ex. 26–1428, Ex. 26–1424, Ex. 26–2; Ex. 26–1426, Ex. 26–1425, Ex. 26–1408; and Ex. 26–3). According to NIOSH's recent publication, ''Elements of Ergonomics Programs'':

> A three tier hierarchy of controls is widely accepted as an intervention strategy for controlling workplace hazards, including ergonomic hazards. (Ex. 26–2)

A recent ergonomics text states, ''Ergonomic hazards can be effectively eliminated by introducing engineering controls and applying ergonomic principles when developing workstations, tools, or jobs * * * only engineering controls eliminate the workplace hazards. Other strategies [work practices, administrative controls] only minimize the risk of injury'' (Ex. 26–1408).

Ergonomists endorse the hierarchy of controls, which accords first place to engineering controls, because they believe that control technologies should be selected based on their reliability and efficacy in eliminating or reducing the workplace hazard (risk factors) giving rise to the MSD. Engineering controls are preferred because these controls and their effectiveness are:

- Reliable;
- Consistent;
- Effective;
- Measurable;
- Not dependent on human behavior (that of managers, supervisors, or workers) for their effectiveness;
- Do not introduce new hazards into the process.

In contrast to administrative and work practice controls or personal protective equipment, which occupy the second and third tiers of the hierarchy, respectively, engineering controls fix the problem once and for all. However, because there is such variability in the workplace conditions covered by the proposed standard, OSHA is permitting employers to use any combination of engineering, work practice, or administrative controls as methods of control for MSD hazards.

Work practice controls involve changes in the way an employee does the job. They are defined by the standard as changes in the way an employee performs the physical work activities of a job that reduce exposure to MSD hazards. Work practice controls involve procedures and methods for performing work safely. Examples of work practices that reduce the potential for exposure to ergonomic risk factors are training workers to use a new or modified tool properly, training workers to vary the tasks they perform throughout the day to minimize muscle fatigue, and training workers to work in positions that reduce risk factors as much as possible (*e.g.*, to hold a tool with their wrists straight, to avoid awkward postures, etc.). In the context of ergonomic programs, work practice controls are essential, both because they reduce ergonomic stressors in their own right and because they are critical if engineering controls are to work effectively. For example, workers need to be trained to use a power grip rather than a trigger grip if a new tool is to be successful, and they need to be trained to adjust an ergonomically designed chair properly if it is to substantially reduce the risk of neck disorders, shoulder tendinitis, or another type of MSD. Work practices, like learning to vary job activities during the day (*e.g.*, moving from filing to sorting mail to using the computer and back again) can often reduce the magnitude and duration of exposure to the risk factor sufficiently to make MSDs unlikely. To be effective, the culture at the workplace and supervisory support and reinforcement are necessary to ensure that safe work practices are routinely observed.

Administrative controls are management-controlled work practices and policies designed to reduce exposures to MSD hazards by changing the way work is assigned or scheduled. Administrative controls reduce the frequency, magnitude, and/or duration of exposure and thus reduce the cumulative dose to any one worker. Examples of administrative controls that are used in the ergonomics context are employee rotation, job enlargement, and employer-authorized changes in the pace of work.

Administrative controls have been effective in addressing MSD hazards in some cases. For example, one case study cited in the Benefits chapter (Chapter IV of the Preliminary Economic Analysis) describes a lift team approach that has been quite effective in reducing work-related back injuries among nursing personnel in a long-term care facility for the elderly (Ex. 26–1091). However, many ergonomists note that these controls should be used with caution. For example, a recent book (Ex. 26–1408) states ''* * * the biggest disadvantage with administrative controls is that they treat the symptoms and not the cause of biomechanical stress.''

Another well-known ergonomics book, MacLeod's ''The Ergonomic Edge,'' cautions:

> * * * job rotation is only beneficial if the tasks involve different muscle-tendon groups or if the workers are rotated to a rest cycle * * * Poorly structured job rotation programs, may, in fact, *increase* the risk of CTDs. If employees are not properly trained or accustomed to the tasks they are to do, they can increase their exposure to risk factors * * * Furthermore, job rotation alone does not change the risk factors present in a facility. It only distributes the risk factors more evenly across a larger group of people. Thus, the risk for some individuals can be reduced, while the risk for others is increased. * * * When employees rotate between two jobs the risk of exposure can be thought of as being ''averaged.'' Job rotation may drop the average to within a safe level, or raise the whole group in excess of safe limits * * * Finally, although job rotation may have beneficial effects, engineering changes should remain the goal of the ergonomics program.'' [Ex. 26–1425]

The proposed standard permits employers to use personal protective equipment (PPE) to supplement engineering, work practice, and administrative controls. However, personal protective equipment may not be used alone, *i.e.*, as the sole means of employee protection unless no other controls are feasible. Any PPE that is provided must be made available to employees at no cost.

PPE is equipment that is worn by the employee and provides an effective barrier between the employee and the MSD hazards in the job. Examples are palm pads and knee pads to reduce contact stress, vibration-attenuation gloves, and gloves worn to protect against cold temperatures.

The hierarchy of controls, which is widely endorsed by ergonomists, occupational safety and health specialists, and health care professionals, accords last place to PPE because:

- Its efficacy in practice depends on human behavior (the manager's, supervisor's and worker's),
- Studies have shown that the effectiveness of PPE is highly variable and inconsistent from one worker to the next,
- The protection provided cannot be measured reliably,
- PPE must be maintained and replaced frequently to maintain its effectiveness,
- It is burdensome for employees to wear, because it decreases mobility and is often uncomfortable,
- It may pose hazards of its own (*e.g.*, the use of vibration-reduction gloves may also force workers to increase their grip strength).

One author (Ex. 26–1408) notes that: ''* * * in most cases, the use of PPE focuses attention upon worker responses and not the causes of ergonomic hazards * * * PPE does not eliminate ergonomic hazards * * * [and] must be considered as the last line of defense against ergonomic hazard exposure.'' Thus, although the proposed standard permits PPE to be used as a supplemental control, it cannot be relied on as a permanent solution to the presence of MSD hazards unless other feasible controls are not available.

A note to proposed section 1910.920 states:

Back belts/braces and wrist braces/splints are not considered PPE.

The proposal includes this note to alert employers to the fact that back belts and wrist braces, which are widely used in U.S. workplaces, are not considered a control to reduce ergonomic hazards under the standard. These devices are being marketed as equipment that can prevent MSDs, although the evidence to support these claims is not available.

The AIHA ''White Book'' (Ex. 26–1424) cautions: ''Back belts have become ubiquitous in the American workplaces. Some employers now require their use by employees. But there is little scientific evaluation available regarding their use in primary prevention.'' Recently, a NIOSH working group reviewed the available scientific literature on the use of back belts and published a 1994 report evaluating them. NIOSH expressed concern that wearing a belt may alter workers' perceptions of their capacity to lift heavy workloads (*i.e.*, belt wearing may foster an increased sense of security, which may not be warranted or substantiated (Ex. 15–16). NIOSH does not recommend the use of back belts as PPE, and neither do a number of professional societies (Ex. 15–15, Ex. 15–17, Ex. 15–33). NIOSH is currently studying the effect of back belt use on employees engaged in manual handling jobs in WalMart stores.

Wrist splints and braces present even more serious problems:

''Wrist splints or braces used to keep the wrist straight during work are not recommended, unless prescribed by a physician for rehabilitation. * * * using a splint to achieve the same end may cause more harm than good since the work orientation may require workers to bend their wrists. If workers are wearing wrist splints, they may have to use more force to work against the brace. This is not only inefficient, it may actually increase the pressure in the carpal tunnel area, causing more damage to the hand and wrist'' (Ex. 26–1424).

OSHA thus believe that the proposed Note to section 1910.920 will alert employers and employees to the lack of evidence demonstrating the effectiveness of these devices.

Section 1910.921 How far must I go in eliminating or materially reducing MSD hazards when a covered MSD occurs?

The occurrence of a covered MSD in a problem job is not itself a violation of this standard. You must comply with one of the following:

(a) You implement controls that materially reduce the MSD hazards using the incremental abatement process in § 1910.922; or

Note to § 1910.921(a): ''Materially reduce MSD hazards'' means to reduce the duration, frequency and/or magnitude of exposure to one or more ergonomic risk factors in a way that is reasonably anticipated to significantly reduce the likelihood that covered MSDs will occur.

(b) You implement controls that reduce the MSD hazards to the extent feasible. Then, you periodically look to see whether additional controls are now feasible and, if so, you implement them promptly; or

(c) You implement controls that eliminate the MSD hazards in the problem job.

Note to § 1910.921(c): ''Eliminate MSD hazards'' means that you eliminate employee exposure to ergonomic risk factors associated with the covered MSD, or you reduce employee exposure to the risk factors to such degree that a covered MSD is no longer reasonably likely to occur.

Section 1910.921 of the proposed rule tells employers how far they must go to reduce exposure to MSD hazards to be in compliance with the Ergonomics Program Standard. This section sets forth the control endpoint that employers must achieve. Proposed § 1910.921 includes three control endpoints. Employers are in compliance with this section when they have implemented controls that satisfy one of the following:

- The controls eliminate MSD hazards;
- The controls reduce MSD hazards to the extent feasible; or
- The controls materially reduce MSD hazards.

Many case studies demonstrate that employers have successfully either eliminated the risk factors in problem jobs or materially reduced the risk factors to a level where an MSD is reasonably unlikely to occur. (See Applied Ergonomics Case Studies Volume 2, Alexander, D.C., ed., 1999; Preliminary Risk Assessment (Chapter V); Preliminary Economic Analysis (Section VIII).)

Section 1910.921 of the proposed rule would not require employers to eliminate the occurrence of all MSDs. OSHA recognizes that, in a number of jobs, workplaces, and physical work activities it may not be possible to eliminate MSDs. OSHA is also aware that employers who have an effective ergonomics program may still receive reports of MSDs. The goal of the proposed rule is to have employers put a good working system into place so that they can take quick and effective action when MSDs do occur. And section 1910.921 tells employers how far they must go in implementing controls after that MSD does occur.

1. Materially Reduce (Paragraph (a))

Paragraph (a) of the proposed rule provides that employers are in compliance if they implement controls that materially reduce MSD hazards in the job using the incremental abatement process in § 1910.922. Materially reduce MSD hazards should not be interpreted to mean that the employer may simply make any change, even one for which there is only a nominal expectation that the control will reduce the likelihood that an MSD will occur. The note to paragraph (a) emphasizes that materially reduce requires more. Materially reduce means that the overall effect anticipated to result from implementing controls to reduce risk factor exposure is a significant reduction in the probability that another MSD will occur in that job. For example, if the likely cause of an MSD hazard is regular unassisted manual lifting of 100-pound rolls of roofing material, reducing the weight of the roll to 90 pounds would not significantly change the likelihood that an MSD will occur and would not be considered a material reduction.

To further illustrate, a covered MSD of the lower back occurs in a manual handling job that requires employees to fill and seal a 50-pound bag of lead chromate pigment every 2 minutes, lift the bag and twist to put it on a pallet, and pile the bags as high as 4-feet off the ground. When the pallet is fully loaded, employees push it to the loading area at the far end of the facility. Reducing the risk factors by moving the loading area next to the fill lines cuts out more than 75% of the distance pallets had been moved. This change does materially reduce exposure to pushing and pulling the pallet. However, the hazards caused by pushing and pulling the pallets are not nearly as likely to cause or contribute to the type of MSD reported as the force and repetition risk factors in the job, and therefore the change has done little to address the ergonomic risk factors. Thus, there does not appear to be a reasonable likelihood that the implemented change will achieve a material reduction in the likelihood of injury. On the other hand, changes such as halving the fill weight of the job and/or adding additional employees to the fill line would be reasonably anticipated to materially reduce the probability of injury, because they address the primary risk factors in the manual handling job.

At the same time OSHA recognizes that a number of MSD hazards are complex and it may not always be clear what control(s) will achieve a material reduction in the probability that MSDs will occur. OSHA is aware that it may be necessary in many situations for employers to test a solution to know if it will work. As a result, OSHA is proposing that employers be considered in compliance with the requirement to materially reduce MSD hazards if they select and implement the controls that a reasonable person would anticipate would achieve a material reduction in the likelihood of injury.

The fact that an employer hired a qualified ergonomics consultant to analyze a problem job and then implemented the controls that the consultant said should significantly reduce MSD hazards is good evidence that the employer has taken action reasonably anticipated to materially reduce the likelihood of injury. Examples of other evidence that employers have taken action that could reasonably be expected to significantly reduce the MSD hazards are that the implemented controls have been shown to reduce MSD hazards in other workplaces in the industry; that the controls were identified, evaluated and implemented by a trained ergonomics committee; or that both the MSD hazard and solution were obvious. There are also many other ways of demonstrating that the controls selected could reasonably be anticipated to achieve a material reduction in risk factors.

Employers may materially reduce MSD hazards by reducing the frequency (*i.e.,* how often), duration (*i.e.,* how long) and/or magnitude (*i.e.,* quantity) of exposure to the risk factors. For example, a manufacturing employer may be able to achieve a significant reduction in MSD hazards in an assembly line job by reducing or eliminating awkward postures, even without changing the frequency with which tasks are performed. The employer may also achieve the equivalent level of protection by reducing the length of time employees must perform repetitive tasks without a break, or by adding more workers to the assembly line so that task cycles are not repeated as often. Employers are free to proceed as they wish (*e.g.,* eliminating one risk factor, reducing the frequency and duration but not the magnitude of exposure, or trying a combination of eliminating and reducing risk factors) so long as the overall effect of their actions is to achieve a material reduction in the hazard.

OSHA is also proposing in paragraph (a) that employers use the incremental abatement process in § 1910.922 to materially reduce MSD hazards. As the term indicates, an incremental hazard abatement process relieves employers from having to implement, all at once, the combination of controls that may ultimately prove necessary to control the hazard. Instead, this process allows employers to implement controls in smaller increments, *e.g.,* one at a time, and then to observe whether the control(s) have been successful in materially reducing the hazard before moving on to other controls. If the control(s) is successful, as measured by the resolution of the injured employee's MSD, reports from employees that the job is no longer physically stressful, or by the absence of additional MSDs, the employer would be allowed to stop adding controls and to wait and see whether additional controls will be needed. The proposed rule provides that as long as no MSDs occur (*i.e.,* the injured employee's condition improves and no other MSDs are reported), employers may continue in the wait and see mode. If covered MSDs occur, employers would be required to identify and try out additional controls.

OSHA believes that it is appropriate and reasonable to allow employers to reduce MSD hazards using an incremental process. First, as mentioned above, MSD hazards are complex and there may be a number of situations where employers may not know what will fix the job. Because of this, OSHA believes that employers should be allowed to try out controls in smaller increments so they are more clear about what solutions will work before they have to move on to put in all the necessary controls.

Second, OSHA believes that the incremental abatement process is a cost effective approach for materially reducing MSD hazards. The proposed rule would not require employers to implement more controls than are necessary to achieve a substantial reduction in the MSD hazards. OSHA believes that an incremental test and evaluate approach will help assure that employers will not have to spend $1,000 in controls if $100 will fix the problem. In fact, a number of stakeholders who have ergonomics programs have said that many controls cost less than $100 (Ex. 26–1370) (see OSHA Web). Given this, OSHA believes it is reasonable to allow employers to test the less-costly solutions that other employers may have identified to see whether those solutions will adequately address the hazards in their workplaces.

Third, OSHA is proposing an incremental abatement process because it is the process that employers with good ergonomics program are using. Many stakeholders have told OSHA that their programs use an incremental abatement process (Ex. 26–1370). In addition, there is strong support for this approach among stakeholders representing a broad range of industries, employers and employees.

Fourth, the Occupational Safety and Health Review Commission has upheld OSHA's authority under a section 5(a)(1) ergonomics enforcement action to require employers:

> [T]o engage in an abatement process, the goal of which is to determine what action or combination of actions will eliminate or materially reduce the hazard. *Secretary of Labor* v. *Pepperidge Farm*, 17 OSHC 1993, 2034 (April 26, 1997).

Finally, OSHA believes that an incremental abatement process provides the best fit with the rapidly changing area of ergonomics control technology. New controls and ergonomics equipment come onto the market almost daily. By allowing employers to implement controls incrementally rather than requiring them to implement all feasible controls immediately, employers will have an opportunity and incentive to select the newest and best solutions. As a result, many more MSD hazards are likely to be identified and addressed in the design phase and eliminated before they enter the workplace. It is a well-accepted principle that the best way to address ergonomic hazards is in the design phase. For example, one stakeholder commented that ''With ergonomics programs you are never done. The workplace is constantly changing.'' (Hank Lick, Ford Motor Company, at February 1998 ergonomics stakeholder meeting, Ex. 26–1370)

The concept of incremental hazard abatement may suggest to some that ergonomics is a never-ending process or continuous loop. However, OSHA is proposing a stopping point. In § 1910.944, OSHA is proposing that employers be permitted to suspend large parts of their ergonomics program, including the incremental abatement process, if they have materially reduced the MSD hazards and no covered MSD has been reported for 3 years. Where a 3-year wait and see period has passed without the occurrence of any covered MSDs, the incremental control(s) the employer anticipated would significantly reduce the likelihood that covered MSDs would occur will have been proven in fact to do so. Therefore, there is no need to continue all the elements of the ergonomics program at that time.

2. Reduce to the Extent Feasible (Paragraph (b))

Paragraph (b) of the proposed standard states that employers have implemented all necessary controls, if they have implemented all the controls that are feasible. This control endpoint is statutorily driven. OSHA has no authority to require employers to do what is not feasible or ''capable of being done.'' *American Textile Mfrs. Institute* v. *Donovan (Cotton Dust)*, 452 U.S. 490, 509, 513 n. 31, 540 (1981). When employers have reached this level, they are not required to be involved in the incremental abatement process since they have already implemented the existing feasible control technology. (As discussed above, controls are considered feasible if they are presently in use for the application in question, can be adapted for such use from technologies that are being used in other applications, can be developed by improving existing technologies, or are on the horizon of technological development.)

However, OSHA is proposing that these employers periodically check to see whether new technology has been developed and is available if they continue to have MSDs in their covered jobs. In addition, these employers must periodically review whether controls that previously may not have been feasible are now capable of being implemented in the problem job. OSHA is not proposing to impose a time period for the periodic review. Rather, as periodically is defined in the proposed rule, employers must establish a regular time period for checking out whether the control situation has changed. The time basis for review must be appropriate for the conditions in the workplace, such as the nature and extent of the MSD hazards. A review of conditions may be necessary where there are significant changes in the workplace that may result in increased exposure to MSD hazards.

When additional feasible controls are identified, the proposed rule requires that employers must implement them promptly. The compliance timetable in § 1910.943 is not applicable to paragraph (b). That schedule incorporates time for identifying and analyzing controls before control implementation deadlines come due. In paragraph (b), on the other hand, the hazards are known and the analysis has been completed. Given this, OSHA does not believe it is necessary or appropriate to give employers a year to implement additional controls after they become available.

3. Eliminate MSD Hazards (Paragraph (c))

Of course, employers are also finished implementing controls when they have eliminated MSD hazards. This control endpoint is also statutorily based. Cotton Dust, 452 U.S. at 505–06; *Industrial Union Dep't, AFL–CIO* v. *American Petroleum Inst. et al.* (Benzene), 448 U.S. 607, 642 (1980) .

The phrase ''eliminate MSD hazards'' incorporates two concepts. First, employers are finished when they have eliminated exposure to the hazard. For example, use of a mechanical lift eliminates forceful exertions, and a voice-activated computer eliminates highly repetitive motions. Second, it means that controls have been implemented that have reduced exposure to ergonomic risk factors to the extent that employees in the job are no longer exposed to a reasonable likelihood of developing a covered MSD. MSDs are no longer reasonably likely to occur in a parts assembly job where the awkward reaches behind the back for parts has been eliminated and parts are now delivered on a conveyor to employees.

Where employers have eliminated the reasonable likelihood of the occurrence of a covered MSD, they are in compliance with the proposed control endpoint. And even if MSDs are reported in the job, employers who have eliminated MSD hazards have no obligation to take control action because the physical work activities and conditions of the job are no longer reasonably likely to cause or contribute to an MSD. In addition, if no covered MSD is reported for a period of at least 3 years after the employer has eliminated MSD hazards, the employer may stop parts of the ergonomics program in accordance with § 1910.944.

Section 1910.922 What is the ''incremental abatement process'' for materially reducing MSD hazards?

You may materially reduce MSD hazards using the following incremental abatement process:

(a) When a covered MSD occurs, you implement one or more controls that materially reduce the MSD hazards; and

(b) If continued exposure to MSD hazards in the job prevents the injured employee's condition from improving or another covered MSD occurs in that job, you implement additional feasible controls to materially reduce the hazard further; and

(c) You do not have to put in further controls if the injured employee's condition improves and no additional covered MSD occurs in the job. However, if the employee's condition does not improve or another covered MSD occurs, you must continue this incremental abatement process if other feasible controls are available.

Section 1910.922 of the proposed rule explains the steps of the incremental abatement process that employers are to use if they want to materially reduce hazards incrementally. The proposed incremental abatement process allows employers to test solutions in a problem job, and wait and see whether the action does significantly reduce the hazards before trying out additional controls. In Pepperidge Farm, the Commission discussed the meaning of an incremental abatement process in upholding OSHA's authority under section 5(a)(1) of the OSH Act to require that an employer engage in this process to control ergonomic hazards:

Incrementalism implies a premium on evaluation of the consequences of initial actions which have been undertaken. Incrementalism also suggests (but does not require) that some steps may await the completion of others, and admits that actions may not have the desired results. Pepperidge Farm, 17 OSHC at 2034 n. 114.

Many stakeholders as well as professionals in the field of workplace safety and health refer to the incremental abatement process as a continuous improvement process (Ex. 26–1370). A comment by the Electronic Industries Association (Ex. 3–230) best sums up the goal of the proposed incremental abatement process:

Ergonomics is a continuous improvement process. If an employer can show that they have made an organized effort to identify ergonomic stressors, to educate their affected employees on ergonomic principles, to implement solutions, and to have a system to identify when a solution is not working and needs to be readdressed, they have met the intent of the law.

1. Paragraph (a)

Paragraph (a) provides that employers may go about addressing MSD hazards by trying out a control(s) to see whether this will take care of the problem. But it also specifies that whatever control(s) the employer wants to start with must be one(s) that a reasonable person would anticipate to be likely to achieve a material reduction in the hazard, or where the efficacy of individual control measures is unclear, it has the potential to significantly reduce the likelihood that covered MSDs would occur in the job.

Under this process, employers have great flexibility to choose the control or controls that would be reasonably likely to materially reduce the hazard. Employers may start where they wish in addressing the hazard so long as their initial action is reasonably anticipated to reduce the hazard. Thus, employers may start with the ergonomic risk factor they prefer to look into first and with the modifying factor (*i.e.*, duration, frequency, magnitude) they wish to address first.

For example, in a manual handling job that requires the worker to quickly lift heavy containers off a low flatbed cart all day and then to turn to put them on a conveyor, an employer is likely to have several options about which risk factor(s) to start with: size or weight of load, vertical height of the lift, turning/twisting motion, or the container design. The employer is also likely to have several ways to modify (or reduce) any of the risk factors: reduce the percentage of the work day spent doing this task, reduce how quickly each load must be moved, reduce the weight of load, reduce the vertical height (*e.g.*, raise height of flatbed), reduce the amount of twisting, add handles to containers, or install mechanical lift or lifting assist devices.

Paragraph (a) provides that if reducing the vertical height that the employee must lift the container does materially reduce the likelihood of injury, the employer is not required at the outset, for example, to purchase and install mechanical lifts. However, if the load weighs more than 100 pounds, for example, it is not reasonable to expect that changing the vertical distance alone would significantly reduce the likelihood that employees performing these physical work activities would develop a back injury (unless the vertical travel distance was reduced to 0 because the requirement to lift was eliminated).

2. Paragraph (b)

Paragraph (b) specifies that if the problem does not resolve or gets worse, employers must try additional feasible controls to achieve a material reduction in the hazard. A problem is not considered resolved if the injured employee's condition does not improve because the employee continues to be exposed to ergonomic risk factors that are reasonably likely to cause, contribute to, or aggravate an MSD of this type. Employers need to install additional controls if another employee in the job reports a covered MSD. The fact that another employee in the job has been injured is a good indication that additional controls are needed to reduce the hazard.

3. Paragraph (c)

Paragraph (c) proposes that, if after the employer implements the initial control(s) designed to materially reduce the hazard, the injured employee's condition gets better, then the employer would not be required to take further control action, provided that no one else in the job develops a covered MSD. This provision would allow the employer, at this point, to wait and see whether the initial action has been adequate. As long as no one in the problem job reports a covered MSD, the employer need not put in any additional controls.

When a covered MSD is reported in that job, however, the waiting process is over. The occurrence of another covered MSD indicates that the initial controls were not adequate. This means that employers must try other feasible controls to materially reduce the MSD hazards in the job. As long as covered MSDs continue to occur and feasible controls exist, employers must be following the steps of the incremental abatement process.

As with the control endpoints discussed in § 1910.921, there also are endpoints to the incremental abatement process. Obviously, employers may stop the incremental abatement process when they have eliminated the MSD hazards because there is nothing remaining in the physical work activities and conditions of the job that would be reasonably likely to cause or contribute to a covered MSD. Likewise, the obligation to continue the process would cease if employers have tried controls and have reduced the hazard to the extent feasible, *i.e.*, they have done everything at this time. The only remaining hazard analysis and control obligation required by the standard in such a situation is to periodically check to see whether a new control that is capable of materially reducing the hazard has become available.

Training (§§ 1910.923–1910.928)

Training is a critical component of an ergonomics program. Training is needed to equip employees in problem jobs, their supervisors, and persons involved in administering the ergonomics program with the knowledge and skills necessary to recognize and control MSDs and MSD hazards. Effectively addressing workplace MSD hazards requires that these individuals possess the ability to identify the physical work activities and job conditions that may increase a worker's risk of developing MSDs, recognize the signs and symptoms of these disorders, and participate in the development and execution of effective strategies to eliminate or materially reduce them.

As has already been discussed, the proposed standard requires that information regarding common MSD hazards, signs and symptoms of MSDs, reporting methods, and the requirements of the standard be provided to at-risk employees. Providing information serves to heighten awareness of employees with regard to MSDs that may occur and the workplace risk factors that can cause them, as well as indicating the means of communicating any relevant observations to the employer. The provision of information alone, however, does not constitute training, because it may not ensure the level of comprehension that is necessary for employees to take an active role in the ergonomics program. The requirements of the proposed standard for training are also broader in scope than the requirements for providing information, extending to methods of control as well as the recognition of MSD hazards.

Section 1910.923 What is my basic obligation?

You must provide training to employees so they know about MSD hazards and your ergonomics program and measures for eliminating or materially reducing the hazards. You must provide training initially, periodically, and at least every 3 years at no cost to employees.

Section 1910.923 proposes to require employers to provide training to employees about MSD hazards, the ergonomics program, and control measures in the workplace. Training would be required to be provided initially, periodically as needed, and at least every three years. Training would be required to be provided at no cost to employees.

Initial training is necessary to ensure that employees in problem jobs, their supervisors, and the individuals who set up and manage the ergonomics program are provided with the knowledge and skills necessary to recognize MSD hazards in their workplace and to effectively participate in the ergonomics program. Periodic training is necessary to address new developments in the workplace and to reinforce and retain the knowledge acquired in initial training. The length and frequency of training would be determined by the needs of the workplace. Individuals would need to be trained sufficiently to understand the subjects specified in § 1910.925. An interval of three years between training sessions is proposed as the minimum necessary to preserve the knowledge and understanding acquired in initial training. Employee participation in the ergonomics program, job hazard analysis, and program evaluation all depend on adequate employee training.

The proposed requirement that training be provided at no cost to employees means that the employer would bear any costs associated with training. For example, any training materials given to employees would have to be provided free of charge. Employees would have to be compensated at their regular rate of pay for time spent receiving training, and could not be required to forfeit regularly scheduled lunch or rest periods to attend training sessions. In addition, where training requires employees to travel, the employer would have to pay for the cost of travel, including travel time when the activities are not scheduled during the employee's normal work hours.

The proposed requirement that training be provided at no cost to employees reflects OSHA's strong belief and past regulatory policy that the costs of complying with safety and health requirements be borne by the employer. The Agency considers training to be essential to the effectiveness of other provisions of the proposed standard: work practice controls, for example, will not be effective if employees are not aware of their proper application, and MSD management cannot be effective if employees do not know when it is appropriate or how to obtain access to it. OSHA believes it is reasonable for employers to bear the cost of training, because, under the Occupational Safety and Health Act of 1970, employers bear the responsibility for providing a safe and healthful workplace. Having the costs borne by the employee would discourage participation in training activities, and would thus limit the effectiveness of the rule's training requirements.

Section 1910.924 Who must I train?

You must train:

(a) Employees in problem jobs;

(b) Supervisors of employees in problem jobs; and

(c) Persons involved in setting up and managing the ergonomics program, except for any outside consultant you may use.

Employees in problem jobs play a key role in the success of an ergonomics program. They are the individuals who have developed or are at risk of developing MSDs. By reporting MSDs and MSD hazards early, making recommendations, and following established control procedures, these workers can assist in protecting themselves.

Early reporting of the development of MSDs would allow the employer to provide appropriate MSD management to the affected employees. Notification of the existence of MSD hazards would alert the employer to the necessity of evaluating and implementing measures to eliminate or control the hazards. The effective control of MSD hazards also often requires the active participation of employees. For example, a work station that can be easily adjusted to accommodate the demands of different tasks or the height and reach limitations of different workers will not be constructively used if the workers are not aware of how to make the adjustments. If employees are not aware of MSD signs and symptoms, or cannot properly use control measures, the ergonomic protection process will not succeed. It is critical that employees have the training they need to perform these functions. The proposed standard therefore would require in § 1910.924(a) that training be provided to all employees in problem jobs.

Supervisors of employees in problem jobs are often in a position to observe MSD hazards and to recognize when MSDs develop in the workers they supervise. As supervisors, they are also in a position to ensure that employees in problem jobs understand and conform with procedures established to control MSD hazards. A supervisor, for example, may observe an employee operating a hand-held vibrating power tool without wearing appropriate vibration-resistant gloves. The supervisor, when prepared by training to understand the significance of this oversight, could take corrective action by ensuring that gloves are provided and used when necessary. If the supervisor was aware that this employee was experiencing numbness, tingling, and loss of sensation in the fingers, training would provide the knowledge necessary to recognize these symptoms as potential indications of an MSD. Training of supervisors would thus provide an additional avenue for the protection of employees who develop MSDs. MSDs and MSD hazards that may be overlooked by the employees who are directly affected may be recognized by their supervisors. Training is necessary for these supervisors to acquire the knowledge necessary for these tasks. For this reason, the proposed standard would require in § 1910.924 (b) that supervisors of employees in problem jobs be provided training.

The effectiveness of the ergonomics program is also dependent on the abilities of those individuals who establish and administer the program. These individuals must be able to identify MSDs and MSD hazards, undertake appropriate interventions to control the hazards, and evaluate the effectiveness of the ergonomics program and controls that have been adopted. The individuals who establish and administer the ergonomics program may be provided by the employer with the authority and resources necessary to accomplish these objectives, but without effective training it is unlikely that they would have sufficient knowledge to accomplish them successfully. For example, a program administrator assigned the task of evaluating the effectiveness of measures instituted to materially reduce MSD hazards in problem jobs would likely need training in order to understand how to assess effectiveness. Section 1910.924 (c) of the proposed standard would therefore require that training be provided to individuals who set up and manage the ergonomics program. Outside consultants do not need to be trained by the employer, because these individuals are responsible to preparing themselves to perform their professional duties.

Section 1910.925 What subjects must training cover?

This table specifies the subjects training must cover:

YOU MUST PROVIDE TRAINING FOR . . .	SO THAT THEY KNOW . . .
(a) Employees in problem jobs and their supervisors.	(1) How to recognize MSD signs and symptoms; (2) How to report MSD signs and symptoms, and the importance of early reporting; (3) MSD hazards in their jobs and the measures they must follow to protect themselves from exposure to MSD hazards; (4) Job-specific controls implemented in their jobs; (5) The ergonomics program and their role in it; and (6) The requirements of this standard.
(b) Persons involved in setting up and managing the ergonomics program.	(1) The subjects above; (2) How to set up and manage an ergonomics program; (3) How to identify and analyze MSD hazards and measures to eliminate or materially reduce the hazards; and

YOU MUST PROVIDE TRAINING FOR . . .	SO THAT THEY KNOW . . .
	(4) How to evaluate the effectiveness of ergonomics programs and controls.

Training must encompass certain elements in order to provide affected individuals with sufficient knowledge to recognize and control MSDs and MSD hazards in their workplace. The proposed standard presents a number of elements on which training would be required for all employees in problem jobs, their supervisors, and persons involved in setting up and managing the ergonomics program. For persons involved in setting up and managing the ergonomics program, several additional elements would be required to be covered.

Training would address recognition of MSD signs and symptoms, and the method and importance of early reporting when these signs and symptoms develop. This is an elaboration of the information provided to at-risk employees, and an opportunity for the employer to relate the general information provided to the operations at a specific workplace and to site-specific conditions. Training is not intended to prepare workers, supervisors, or managers to medically diagnose or treat MSDs. Rather, the purpose is to instill an understanding of what type of health problems may be work related so that these individuals will be able to recognize when MSD management is necessary.

Since the employees who would be trained are in problem jobs, they are exposed to factors that are associated with a risk of developing MSDs, and may already suffer from MSDs. It is thus particularly important that they be aware of the MSD signs and symptoms that are reasonably likely to occur. The supervisors of employees in problem jobs will often be in position to observe MSD hazards and the development of MSD signs and symptoms among the workers they supervise. In many instances, supervisors may perform the same job tasks as the workers they supervise. Early reporting would help the employer ensure that intervention in the disease process occurs before functional incapacity or permanent disability results, and would assist in identifying MSD hazards so that measures could be taken to eliminate or materially reduce those hazards. In many instances, the workers who perform tasks that involve MSD hazards and their supervisors are also the persons most familiar with the options for controlling those hazards. The recommendations of these individuals are thus an important means of identifying actions that would alleviate MSD hazards.

Employees in problem jobs, their supervisors, and persons involved in setting up and managing the ergonomics program would also be trained to recognize the MSD hazards in jobs and the measures that must be taken to control exposure to these hazards. This would include both general measures and those specific to the job. This training would provide these individuals with the knowledge and skills necessary to take actions to reduce the potential for developing MSDs. Proper understanding of control measures is particularly important because the effectiveness of these measures is dependent on their proper use by employees. All affected parties also need to know what their role in the ergonomics program is, in order to best facilitate the program's successful implementation. Employees, for example, must understand the provisions for MSD management in order to participate appropriately in this process.

The proposed standard includes a requirement that employees in problem jobs, their supervisors, and persons involved in setting up and managing the ergonomics program know the requirements of the standard. This would ensure that workers are aware that specific requirements have been established to protect them from MSDs. Program administrators would be able to ensure that the program meets its legal obligations.

Additionally, program administrators must know how to set up and manage an ergonomics program, recognize and appraise MSD hazards, and select and apply appropriate measures to eliminate or materially reduce MSD hazards in order for the ergonomics program to be effective. The proposed standard would require that training be provided to equip these individuals to perform these assigned functions. The administrators would further be trained to evaluate the effectiveness of ergonomics programs and controls, in order that they be able to identify and rectify any deficiencies that may occur in their workplace's program.

While employees in problem jobs may be able to take some limited actions individually to protect themselves from MSD hazards, the primary responsibility for providing a safe work environment rests with the employer. The individuals who set up and administer the ergonomics program act on behalf of the employer in controlling MSD hazards. Employees cannot be protected from MSD hazards unless these hazards are identified and effective measures are then taken to control them. Accordingly, the individuals who administer the ergonomics program must be properly trained to discern when interventions are needed, decide what intervention methods are appropriate, and examine the results of interventions to determine if further actions are necessary.

Section 1910.926 What must I do to ensure that employees understand the training?

You must provide training and information in language that employees understand. You also must give employees an opportunity to ask questions and receive answers.

The proposed standard would allow employers to use whatever training methodology they consider most useful or appropriate for that particular workplace, provided that the specified elements are addressed. Hands-on training, videotapes, slide presentations, classroom instruction, informal discussions during safety meetings, written materials, or any combination of these methods may be appropriate. The primary concern is that the training be effective.

In order for the training to be effective, the employer must ensure that the training is provided in a manner that the employee is able to understand. Employees have varying educational levels, literacy, and language skills, and training must be presented in a language and at a level of understanding that accounts for these differences in order to meet the proposed requirement that individuals being trained understand the specified training elements. This may mean, for example, providing materials, instruction, or assistance in Spanish rather than English if the workers being trained are Spanish-speaking and do not understand English. The employer would not be required to provide training in the employee's preferred language if the employee understood both languages; as long as the employee is able to understand the language used, the intent of the proposed standard would be met.

In order to ensure that employees comprehend the actions that they must take to protect themselves from exposure to MSD hazards, it is critical that trainees have the opportunity to ask questions and receive answers if they do not fully understand the material that is presented to them. When videotape presentations or computer-based programs are used, this requirement may be met by having a qualified trainer available to address questions after the presentation, or providing a telephone hotline so that trainees will have direct access to a qualified trainer.

Section 1910.927 When must I train employees?

This table specifies when you must train employees:

IF YOU HAVE . . .	THEN YOU MUST PROVIDE TRAINING AT THESE TIMES . . .
(a) Employees in problem jobs and their supervisors	(1) When a problem job is identified; (2) When initially assigned to a problem job; (3) Periodically as needed (*e.g.,* when new hazards are identified in a problem job or changes are made to a problem job that may increase exposure to MSD hazards); and (4) At least every 3 years.
(b) Persons involved in setting up and managing the ergonomics program	(1) When they are initially assigned to setting up and managing the ergonomics program; (2) Periodically as needed (*e.g.,* when evaluation reveals significant deficiencies in the program, when significant changes are made in the ergonomics program); and (3) At least every 3 years.

Section 1910.927 proposes establishing time frames for the provision of training. Employees in problem jobs and their supervisors would be required to be provided training when a problem job is identified, when they are initially assigned to a problem job, and periodically thereafter as needed, but at least every three years.

The need for initial training is self-evident: employees and their supervisors must be trained prior to the occurrence of covered MSDs in order to recognize the hazards, help to reduce them, and effectively participate in the ergonomics program. If an employee is assigned to a problem job prior to receiving proper training, that employee is not likely to be able to take advantage of protective measures that are available to alleviate MSD hazards.

Periodic training under the proposed standard would be required to be conducted on an as-needed basis. The frequency of routine training would be performance oriented; individuals would need to be trained sufficiently to understand the elements specified in § 1910.925. Periodic training is needed to refresh and reinforce the memories of individuals who have previously been trained, and to ensure that these individuals are informed of new developments in the ergonomics program. For example, training after new control measures are implemented would generally be necessary in order to ensure that employees are able to properly use the new controls as they are introduced. Employees would likely be unfamiliar with new work practices undertaken, with the operation of new engineering controls, or the use of new personal protective equipment; training would rectify this lack of understanding. This would ensure that employees are able to actively participate in protecting themselves under the conditions found in the workplace, even if those conditions change.

At a minimum, the periodic training would be required to take place every three years. This interval is considered by the Agency to represent the maximum reasonable interval for affected individuals to retain the knowledge and understanding initially acquired without some form of reinforcement. More frequent periodic training, such as annual training, has not been proposed because regular communication between employees and management would be ongoing as a result of the proposed requirements for management leadership and employee involvement in the ergonomics program. Employee involvement in developing, implementing, and evaluating each element of the ergonomics program, including training, is included in the requirements of the proposed standard in § 1910.912. Prompt reporting by employees of MSD signs and symptoms and MSD hazards, effective job hazard analysis, and evaluation of the ergonomics program will make employers aware of additional training needs. Periodic training more frequently than every three years is likely to be appropriate in many work situations, for example in a workplace with many problem jobs. A requirement for annual training has not been included in this proposal in order to avoid encumbering those employers whose operations involve more limited exposure to MSD hazards.

Persons involved in setting up and managing the ergonomics program would be required under the proposed standard to be trained upon initial assignment to these duties. Knowledge and understanding of the identification of MSDs and analysis of MSD hazards, measures to eliminate or materially reduce MSD hazards, and the ergonomics program and its evaluation are all needed for the development and operation of the program. Periodic training is needed to provide program administrators with the skills and abilities to adjust the program to account for changes in the workplace, and to correct any significant deficiencies that may be identified in the program. This would assure that the ergonomics program is applicable to current conditions in the workplace, and is optimally effective in protecting workers from MSD hazards. Periodic training would also allow those individuals setting up and managing the program to keep abreast of new developments in the evolving field of ergonomics.

In comments received in response to the ANPR, some concern was expressed by industry regarding the frequency of training. For example, the American Meat Institute wrote (Ex. 3–147):

> OSHA should not dictate specific training requirements. Specifically, training frequencies should not be included in a standard.

OSHA intends for the performance oriented approach adopted in the proposal to provide sufficient flexibility so that employees in problem jobs, their supervisors, and individuals involved in establishing and managing the ergonomics program receive sufficient training to effectively participate in the program, without compelling employers to provide training more often than the circumstances of the workplace dictate.

Section 1910.928 Must I retrain employees who have received training already?

No. You do not have to provide initial training to current employees, new employees and persons involved in setting up and managing the ergonomics program if they have received training in the subjects this standard requires within the last 3 years. However, you must provide initial training in the subjects in which they have not been trained.

Proposed § 1910.928 would allow training received within the previous three years to fulfill the requirements for initial training. Subsequent periodic training would still be required at least every three years, and more frequently if warranted by the circumstances of the workplace. For example, a baggage handler who has received training from one employer and then moves to another employer six months later to perform the same job may not need to receive initial training in all of the subjects prescribed in § 1910.925. Prior training in general topics, such as the recognition of MSD signs and symptoms, may remain relevant in the new workplace. However, site-specific training, for example training in how to perform work safely using the equipment at the new workplace, would generally be required. Allowing prior training in covered topics to be ''portable'' would apply to both current and newly hired employees, including those who set up and manage the ergonomics program.

The employer must be able to demonstrate that the employee has retained sufficient knowledge to meet the requirements for initial training in order for prior training to be considered sufficient to meet the requirements of § 1910.928. This could be determined through discussion of the required training subjects with the employee. Merely having received training during the previous three years would not be sufficient for an exemption from the initial training requirement. If the employer cannot demonstrate that the new employee has been trained and knows the required elements, the new employer would be obligated to train the employee in these elements. In cases where understanding of some elements is lacking or inadequate, the employer would be required to provide training only in those elements. This allowance for prior training is intended to ensure that employees receive sufficient training, without requiring unnecessary repetition of that training.

Evidence in the record clearly shows that training is an essential component of an effective ergonomics program and can help to reduce MSDs. In some instances, training in appropriate work practice controls may serve to reduce the incidence of MSDs. For example, the effectiveness of training in reducing the incidence of MSDs has been reported by Parenmark *et al.* (Ex. 26–6). Sixteen newly hired assembly workers at a Swedish chain saw plant were trained to perform their jobs using work practices that maintained the muscular load on the upper extremities at 10% or less of maximum voluntary contraction. The same training was also given to a group of assembly workers who had been on the job for one year. Training was not provided to a control group of new hires. After 48 weeks on the job, sick leave due to arm/neck/shoulder complaints was reduced by more than 50% among the new hires provided ergonomic work practice training when compared to the control group of new hires; the difference was statistically significant. For the assembly workers who had been on the job for one year, sick leave due to arm/neck/shoulder complaints was reduced by over 40% after training, although this result was not statistically significant.

Further evidence of the success of training in proper work practices in controlling MSD hazards in some instances is provided by Dortch and Trombly (Ex. 26–7), who examined the effectiveness of training in reducing the frequency of movements identified as traumatizing to the musculature and connective tissue of the hand, wrist, and forearm and known to be associated with MSDs. Eighteen electronic assembly workers were observed performing their jobs, and the number of MSD-associated movements was recorded for each individual. The workers were then divided into two groups. The first group received awareness training and a printed handout describing job-specific work practice controls. In addition to awareness training and the printed handout, members of the second group discussed the concepts in the handout individually with an instructor and received hands-on training. Each of the groups exhibited statistically significant reductions in the frequency of those movements associated with MSD development during observation one week after the training was administered. The group receiving more extensive training showed the greater reduction, although the difference between the two groups after training was not statistically significant.

Engels *et al.* (Ex. 26–8) studied the effectiveness of ergonomic work practice training for nurses. Twelve nurses attending an ergonomic education course were compared to a control group of twelve nurses. Participants were videotaped and their performance was assessed by scoring ergonomic errors on a checklist. Included among the activities monitored under standardized conditions were such tasks as transferring a patient from a bed to a wheelchair, washing a patient, and raising a patient from a lying position to sitting up. The nurses who had received training were found to be less likely to make ergonomic errors than the control group; this result was statistically significant. When the ergonomic work practice training was accompanied by other elements of an ergonomics program, the likelihood of making ergonomic errors was found to continue to decrease a year after the training had ended; this result was also statistically significant.

Training in work practices, however, represents only one of the subjects that would be covered in the proposed requirements for ergonomic training. Training in the recognition of MSD signs and symptoms, and methods of reporting development of these signs and symptoms, would allow appropriate medical management to take place. Ergonomics training can also provide employees in problem jobs, their supervisors, and ergonomics program managers with the knowledge necessary to actively participate in the development of appropriate methods of controlling MSD hazards in their workplace, providing a number of benefits for employers. The Joyce Institute, a provider of ergonomic training and consultation services, reported the results obtained by a number of companies when ergonomic improvements were made as a result of training (Ex. 3–122E–3). Among the outcomes:

- Textron-Davidson Interior Trim experienced a 42% reduction in OSHA recordable injuries, a savings of $440,000 in labor and materials, and a reduction in employee turnover;
- Spectra-Physics reduced CTDs from 558 to 150 in three years;
- A food processing company found 50% fewer CTDs in the plant where training had been performed and changes

made when compared to other plants doing similar work; and

• Milton Bradley experienced a 90% improvement in quality as measured by customer returns due to damaged packaging.

Responses to the ANPR indicate that the need for ergonomic safety and health training is widely recognized. For example, the National Solid Wastes Management Association (Ex. 3–248) stated:

The Association feels that the training and education of workers is the single most important element of any general industry standard, and is the element most within the resources of the majority of employers within our industry to provide an effective reduction in exposure to ergonomic hazards * * *

If employees are sufficiently educated to avoid or minimize ergonomic hazards within their personal control, to report symptoms early enough to avoid serious medical complications and to understand the need to communicate to their employer regarding a work station, equipment or job duty that presents an ergonomic hazard, then the employer should be in the best possible position to identify and rectify an inappropriate situation.

The Mount Sinai-Irving J. Selikoff Occupational Health Clinical Center (Ex. 3–162) also advocated training for employees:

We believe that training and education of workers about ergonomic hazards should be required under the standard. The training should emphasize the identification of potential ergonomic hazards as well as recognition of symptoms of common ergonomic disorders. Prevention should be strongly emphasized in such programs as part of an aggressive company-wide commitment to work to eliminate these problems as soon as possible.

The Telesector Resources Group (Ex. 3–215) expressed support for training all employees exposed to significant workplace risk factors, and indicated what should be included in this training, particularly job-specific training regarding work practices:

Employees exposed to significant occupationally-related CTD risk factors should be trained in the broad scope of applicable ergonomics principles and in the specific operations of their work tasks and workstations where such training is required to ensure that the task can be performed, and equipment operated as intended. These employees should understand the significant CTD risk factors to which they may be exposed and how to prevent or minimize exposure to them. Education and training in applicable ergonomics principles is especially important for new employees and those employees who are assuming new job tasks where significant CTD risk factors are known to exist.

Similarly, the AFL–CIO also endorsed training as part of an appropriate approach to addressing ergonomics in the workplace (Ex. 3–184):

In order for the standard to be most effective in preventing CTDs, workers must be trained in early identification of CTDs and risk factors for CTDs, proper ways to perform the job, and other information related to the standard.

However, not all stakeholders supported a training requirement. For example, the Society of American Florists (Ex. 3–55) commented:

Additional training and recordkeeping requirements would place yet another burden and layer of bureaucracy upon small businesses and compromise their ability to compete.

Some respondents to the ANPR expressed a desire that training requirements be adaptable to the specific circumstances of the affected employers. US WEST Business Resources, Inc. (Ex. 3–91), while endorsing training as part of the approach to ergonomics, stated that the requirements must be flexible:

US WEST recognizes that employee training is an essential cornerstone of any occupational health and safety program. As with other aspects of an ergonomics program, training needs are highly variable and OSHA must allow employers a high degree of flexibility in establishing training programs that best fit the needs of their employees and operations.

The Synthetic Organic Chemical Manufacturers Association, Inc. (Ex. 3–185) made the same point:

We agree that individuals participating in the CTD program should be trained. However, the level, frequency, and sophistication of the training effort should be performance-based so that the employer can best determine what is appropriate for its workplace.

In the proposed standard, OSHA seeks to provide employees, their supervisors, and those involved in administration of the ergonomics program sufficient training to actively participate in the protective process in their workplace, without creating any unnecessary or undue burden on employers. The Agency recognizes that workplaces vary greatly in the scope and magnitude of MSD hazards present, the number and complexity of control measures implemented, and the extent to which affected individuals must be involved in the control process. The standard, therefore, does not propose a specified format or length of time for training, allowing employers to adjust training to the needs of their workplace. It is anticipated that the training would vary in duration from facility to facility, depending on the extent of the MSD hazards, the type of operation, the controls required, and the involvement necessary on the part of the employee for the control measures to be effective.

MSD Management (§§ 1910.929 through 1910.935)

This discussion of MSD management is divided into three parts. Part A explains the proposed requirements in sections 1910.929 through 1910.935, all of which address aspects of the proposed MSD management process. Part B discusses OSHA's legal authority to require work restriction protection and the Agency's reasons for doing so. Part C deals with alternatives to the proposed work restriction protection requirements that OSHA has considered in developing the proposed rule's work protection provisions.

Part A—Proposed Requirements for Sections 1910.929 through 1910.935

This section of the proposed rule establishes the requirements for setting up a process to manage MSDs when they occur. MSD management is the employer's process for ensuring that injured employees are provided with:

• Prompt access to health care professionals (HCPs) or other safety and health professionals as appropriate;

• Effective evaluation, management, and follow-up; and

• Appropriate temporary work restrictions where needed during the recovery period.

MSD management emphasizes prevention of impairment and disability through early detection, prompt management and timely recovery from covered MSDs (Ex. 26–1264, Ex. 26–921). This early intervention process is important in helping to achieve the goals of the proposed standard—reducing the severity as well as the number of work-related MSDs.

The MSD management provisions in the proposed standard are built upon the processes that employers with ergonomics programs already are using to help employees who have work-related MSDs. Evidence in the record shows that these companies, through early intervention and management of MSDs, have achieved substantial reductions in areas such as lost-work time, lost-workdays, costs per case, and workers' compensation claims and costs (see, *e.g.*, Ex. 3–147, Ex. 26–1367, Ex. 26–1405).

The proposed MSD management provisions are consistent with and based on OSHA's other ergonomics efforts. MSD management provisions are included in OSHA's Ergonomics Program Management Guidelines for Meatpacking Plants (Ex. 26–3). The Guidelines emphasize that ''proper medical management is necessary both to eliminate or materially reduce the risk of development of CTD signs and symptoms through early identification and treatment and to prevent future problems'' (Ex. 26–3). In addition, MSD management provisions have been included in all of OSHA's corporate settlement agreements addressing MSD hazards. Finally, to become a member of OSHA's Voluntary Protection Program, employers must include an ''Occupational Heath Care Program'' in their safety and health programs. This would address MSDs, along with other health hazards.

1. Need for MSD Management

MSD management is recognized by, among others, employers, HCPs, and occupational safety and health professionals as an essential element of an effective ergonomics program (Ex. 26–1, Ex. 26–5, Ex. 26–1264). Among employers who told OSHA they have an ergonomics program, most reported that their programs include MSD management as a key element (Exs. 3–56; 3–59; 3–73; 3–95; 3–113; 3–118; 3–147; 3–175; 3–217; and 26–23 through 26–26). The draft American Standards Committee (ASC) consensus standard on the control of work-related MSDs states that a program to control MSDs ''shall'' include provisions for the evaluation and management of MSD cases (*i.e.*, MSD management), because such elements ''are either recognized and fundamental to injury prevention, or considered minimally essential to the control of [MSDs]'' (Ex. 26–1264). The draft ASC consensus standard was developed by a committee comprised of representatives from the medical, scientific, and academic communities, as well as those representing employers and employees.

There are many reasons why MSD management is essential to the success of an ergonomics program. MSD management helps to reduce the severity of MSDs that occur. As mentioned above, MSD management emphasizes the early detection of MSDs, followed by prompt and effective evaluation and management. Identifying and addressing MSD signs and symptoms at an early stage helps to slow or halt the progression of the disorder. When MSDs are caught early they are more likely to be reversible, to resolve quickly, and not to result in disability or permanent damage. The American Meat Institute is on record as saying that MSD management programs that promote early intervention result in a reduction in the number of serious MSDs, fewer surgeries, reduced lost-time from work, and a quicker return to full duty (Ex. 3–147). Two studies by Maurice Oxenburgh also support this. In one study, Oxenburgh found that for employees suffering from upper-extremity MSDs (UEMSDs), the earlier they reported signs and/or symptoms of the UEMSDs, the quicker they were able to return fully to work (Ex. 26–1367). Specifically, Oxenburgh found that UEMSDs resulted in 49 days away from work (or on restricted work) for employees who reported within 20 days of the onset of pain, 66 days for employees who reported within 21–50 days of the onset of pain, and 84 days for employees who reported after 51 days of the onset of pain. In another study, Oxenburgh observed two groups of video display unit (VDU) workers who were exposed to the same ergonomics risk factors. One group (''the MSD management group'') received medical screening, training, workstation redesign, treatment, and rehabilitation; the other group (''the control group'') received none of these interventions. Oxenburgh compared the two groups and found:

1. Twenty-two percent of the control group cases had second or third stage injuries, compared with 8% for the MSD management group;

2. The mean period of absence from work for the control group workers was 33.9 days, compared with 3.4 days for the MSD management group; and

3. The total amount of time the average worker in the control group lost, either to days away or alternate duty, was 124.9 days, compared to 34.9 days for the MSD management group (Ex. 26–1405).

These studies demonstrate the importance of early reporting and intervention as part of MSD management in reducing the severity of MSDs, as well as accelerating the recovery process for injured employees. In so doing, MSD management also reduces the costs of MSDs to employees and employers alike.

An MSD management process is also important to reduce the use of and need for surgery to repair MSDs (Ex. 26–5). Uniformly, stakeholders have told OSHA that intervention should be made at the earliest possible stage when conservative treatment, rather than surgery, is most likely to resolve MSDs (see Exs. 26–23 through 26–26). For example, the Denton Hand Rehabilitation Clinic stated:

> [E]arly intervention and nonsurgical intervention is the more appropriate approach to carpal tunnel syndrome. It is imperative that the high cost of health care be reduced and a program which offers early intervention and nonsurgical intervention with full employer participation, employee understanding, and the medical referral would certainly offer this (Ex. 3–33).

If MSD management is delayed or not provided at all, it may be more difficult to avoid surgery because conservative treatment may not be able to resolve the MSD.

MSD management also helps to reduce the number of MSDs by alerting employers early enough that they can take action before additional problems occur. To illustrate, many employers with ergonomics programs use the report of a single MSD as a trigger for conducting a job hazard analysis (Ex. 26–5). The purpose of analyzing and fixing the job at this stage is to prevent injury to other employees in the same job. An MSD management process that encourages early reporting and evaluation of that first MSD thus helps to ensure that the analysis and control of the job is done before a second employee develops an MSD.

MSD management also reduces MSDs through prevention. Specifically, MSD management helps to prevent future problems through development and communication of information about the occurrence of MSDs. For example, where engineering, design and procurement personnel are alerted to the occurrence of MSDs, they can help to implement the best kind of ergonomic controls: controlling MSD hazards in the design and purchase phase to prevent their introduction into the workplace.

OSHA is using the term ''MSD management'' in the proposed rule rather than ''medical management.'' ''Medical management'' is a term that OSHA has used in earlier ergonomics publications (*e.g.*, Ergonomics Program Management Guidelines for Meatpacking Plants (1990)) and stakeholders have become familiar with it. However, OSHA believes that ''MSD management'' is a more accurate term because it emphasizes that the successful resolution of MSDs may involve professionals from many disciplines. These individuals may include physicians, occupational health nurses, nurse practitioners, physician assistants, occupational therapists, physical therapists, industrial hygienists, ergonomists, safety engineers, or members of workplace safety and health committees. OSHA believes that all of these individuals, along with the employer and employees, may have a role to play in MSD management, depending on the size, organizational structure, or culture of the particular workplace.

In addition, OSHA believes that the term MSD management indicates that many approaches can be successful in resolving MSDs. For example, some employers have developed successful MSD management programs that are built on immediately providing restricted work activity at the first report of MSD signs or symptoms. These employers have said that quick intervention has resulted in dramatic reductions in lost workday injuries as well as reductions in medical treatment costs. Other companies utilize on-site HCPs to provide quick front-line health interventions. Although these approaches are quite different, they have both been shown to be successful. Still other organizations rely on the training and skill of ergonomics committee members to address problems. The MSD management provisions of the proposed rule have been written to recognize that many individuals may be trained and knowledgeable about MSDs and MSD hazards. The choice of approach to MSD management is left to the employer.

Section 1910.929 What is my basic obligation?

You must make MSD management available promptly whenever a covered MSD occurs. You must provide MSD management at no cost to employees. You must provide employees with the temporary ''work restrictions'' and ''work restriction protection (WRP)'' this standard requires.

The employer's basic obligation, as stated in section 1910.929, is to make MSD management available promptly to employees with covered MSDs. MSD management is a process that addresses MSDs promptly and appropriately. In other words, MSD management means that an employer has established a process for assuring that employees with covered MSDs receive timely attention for the reported MSD, including, if appropriate, work restrictions or job accommodation and follow-up. Where there is no on-site HCP, the employer may designate an individual to receive and respond promptly to reports of MSD signs, symptoms, and hazards. Where there is an on-site HCP, he or she would be the likely person to have responsibility for MSD management, including referral as appropriate.

An effective MSD management program has:

1. A method for identifying available appropriate work restrictions and promptly providing them when necessary;

2. A method for ensuring that an injured employee has received appropriate evaluation, management, and follow-up in the workplace;

3. A process for input from persons contributing to the successful resolution of an employee's covered MSD; and

4. A method for communicating with the safety and health professionals and HCPs involved in the process.

Many stakeholders stated that early reporting and intervention is absolutely essential for MSD management to be successful. To this end, the MSD management provisions are crafted to encourage employees to report MSDs early and to receive appropriate treatment promptly. In particular, OSHA's work restriction protection requirements (discussed in detail below) are included as part of the MSD management process to encourage employees to report MSDs early.

In its 1997 primer, Elements of Ergonomics Programs, NIOSH stated that, in general, the earlier symptoms are identified and treatment initiated, the less likely a more serious MSD is to develop (Ex. 26–2). Thus, employees need to receive prompt, appropriate help after reporting the signs or symptoms of MSDs that may be work-related. The importance of early reporting and intervention has also been documented in a number of studies (see Exs. 26–912, 26–913, 26–917, 26–914, 26–915, 26–910, 26–916, 26–911, 26–1367, 26–1405).

Commenters to OSHA's ANPR also stressed the importance of early reporting. Martin Marietta attributed a drop in the incidence rate of cumulative trauma disorders to early reporting and the education of their workers (Ex. 3–151). Perdue Farms noted a 15% decrease in cumulative trauma disorders, which they attributed to early reporting and intervention (Ex. 3–56). The Mount Sinai-Irving J. Selikoff Occupational Health Center stated: ''We cannot overemphasize the importance of the early reporting of symptoms. Based on evaluations of patients from a wide variety of work places, we believe it is essential to intervene medically, and by appropriate modification of the work station or job task, as soon as possible in order to reduce the potential for genesis of permanent impairment '' (Ex. 3–162). (See also Exs. 3–33; 3–147).

For MSD management to be effective, it must be provided ''promptly,'' as the proposed rule requires. By ''promptly,'' OSHA means that employers whose employees come forward with reports of MSDs or their signs or symptoms must as soon as possible assess the situation, determine whether temporary work restrictions or other measures are necessary, and/or refer the employee to the ergonomics committee, an ergonomics consultant, other qualified safety and health consultant or an HCP, as appropriate. These actions must be taken promptly to enable the MSD to resolve quickly, to prevent worsening due to further exposure to MSD hazards. For further guidance on what constitutes prompt MSD management, OSHA refers employers to § 1910.943. In that section, OSHA includes start-up deadlines for those employers who may not be covered by the ergonomics rule initially but whose employees subsequently, after the compliance deadlines for the rule have passed, develop MSDs that are covered by this standard. For those employers, OSHA requires that when an employee reports an MSD, MSD management must be provided within 5 days. OSHA believes that this time requirement is also appropriate for all cases of covered MSDs. This is not meant to imply, however, that employers should wait several calendar days after an employee reports experiencing symptoms before assessing the case, providing appropriate work restrictions, or referring the employee to the ergonomics committee, a safety and health professional, ergonomist, or an HCP. OSHA reiterates that prompt MSD management involves responding to employee reports of MSDs as soon as possible to prevent the MSDs from worsening.

MSD management must be provided at no cost to employees. The term ''at no cost to employees'' includes making MSD management available at a reasonable time and place, *i.e.*, during working hours. In order to increase the likelihood that employees will receive the full benefits provided by the standard, MSD evaluations must be provided in a manner that is reasonably convenient for employees. OSHA has defined ''at no cost'' the same way in its other health standards.

Employers must also provide employees with temporary work restrictions and work restriction protection as required by this proposed rule. Temporary work restrictions and work restriction protection are discussed in detail below.

The term MSD management in the proposed standard does not cover particular diagnostic tests, treatment protocols, or specific treatments but instead refers to the employer's process of ensuring that injured employees have access to appropriate help when they need it. It is not the purpose of this standard to dictate professional practice for HCPs. An employer is free to establish such protocols in consultation with an HCP, but this is not required by the standard. Many stakeholders urged OSHA to leave the establishment of treatment protocols and procedures for covered MSDs to the HCPs (see, *e.g.*, Ex. 3–154). Where HCP evaluation, treatment, and follow-up is necessary, OSHA believes that HCPs will prescribe treatment and specific therapeutics on the basis of the best available knowledge at the time that care is provided. In addition, OSHA believes HCPs will closely monitor the employee's progress to evaluate the effectiveness of the prescribed treatment. It has also generally not been OSHA's practice, in other health standards, to dictate specific diagnostic procedures or treatment protocols.

Section 1910.930 How must I make MSD management available?

You must:

(a) Respond promptly to employees with covered MSDs to prevent their condition from getting worse;

(b) Promptly determine whether temporary work restrictions or other measures are necessary;

(c) When necessary, provide employees with prompt access to a ''health care professional'' (HCP) for evaluation, management and ''follow-up'';

(d) Provide the HCP with the information necessary for conducting MSD management; and

(e) Obtain a written opinion from the HCP and ensure that the employee is also promptly provided with it.

Paragraph (a) requires employers to respond promptly to employees with covered MSDs. Whenever an employee reports an MSD, the key is to take action quickly to help ensure that the MSD does not worsen. As discussed above, stakeholders are in agreement that early reporting and response are the key to resolving MSD problems quickly and without permanent damage or disability. The term ''promptly,'' as used in this section, has the same meaning as in § 1910.929, discussed above. Employers must respond to employees with covered MSDs as soon as possible to determine what action is appropriate to prevent the employee's condition from becoming more severe.

Many employers with ergonomics programs respond to reports of MSDs by immediately placing the employee on restricted work activity, either in the same job or in an alternative assignment. Limiting further exposure to the MSD hazard or hazards associated with the employee's job ensures that the employee's condition does not worsen while the employer analyzes the problem job and, if necessary, makes arrangements for the employee to be evaluated by a safety and health professional, ergonomist, member of the ergonomics committee, or an HCP. Employers using this approach have discovered that the employee's condition will often resolve within a few days without further intervention. This is especially true if the symptom is associated with work hardening or conditioning for a new job, new tool, or new equipment. It could also be the case if a company has instituted a Quick Fix that completely eliminates the MSD hazard or hazards in the job, which ensures that the employee will experience no further exposure or aggravation of the condition.

For other employers, the first response may be to have the affected employee evaluated by an HCP. Where the employer has an on-site HCP, for example, the employee can usually be seen immediately. Immediate attention is particularly important where the employer does not have a policy of immediately limiting the work activities of employees who report MSDs. However, even when employers have on-site HCPs, the HCP may not be available when the employee reports an MSD.

In most cases, however, employers will not have an on-site HCP. In such cases, OSHA is aware that it may take a few days to arrange an appointment with an HCP. In order to assure a prompt response in these cases, employers must ensure that employees have access to the HCP as soon as possible. There are circumstances where immediate evaluation by an HCP is warranted. For example, an employee experiencing severe shoulder pain with numbness down her arm, an inability to sleep due to pain, and decreased range of motion of the arm and shoulder should immediately be referred to an HCP. An employee who describes symptoms that have been present continuously for three weeks should also be referred at the time of initial reporting.

Paragraph (b) requires employers to make an initial determination promptly of whether temporary work restrictions or other measures are necessary. In many workplaces, work restrictions are the first line of defense against progression of the disorder. Work restrictions include any limitation placed on the manner in which an injured employee performs a job during the recovery period, up to and including complete removal from work. Work restrictions are important to resolving most MSDs. The purpose of work restrictions is to facilitate recovery of the affected area by not exposing the injured tissues to the same risk factors. The employer, who must provide temporary work restrictions, where necessary, to employees with covered MSDs, and the employee whose work has been restricted need to understand (1) What jobs or tasks the employee can perform during the recovery period, (2) whether the employee can perform these jobs or tasks for the entire workshift, and/or (3) whether the employee needs to be removed from work entirely. Employees for whom restrictions have been assigned because of a covered MSD must be properly matched with those jobs that involve task and work activities that accommodate the requirements of the restriction and thus facilitate healing.

The employer must also determine whether other measures are necessary to protect the employee with a covered MSD. A company could institute a Quick Fix that completely eliminates the MSD hazard or hazards in the job, ensuring that the employee will experience no further exposure or aggravation of the condition. There are also circumstances where immediate evaluation by an HCP is warranted. In addition, an employer who was not able to provide immediate temporary work restrictions may be able to have an injured employee attend on-site training classes for a few days. The person(s) assigned responsibility for MSD management needs the relevant information to make the decision about what is appropriate for the affected employee.

Section 1910.930 gives employers flexibility to develop an appropriate process for responding to employees with covered MSDs. The proposed rule allows varied approaches because many factors can influence the process and procedures employers establish to deal with MSDs covered by this standard. Such factors may include the severity of the employee's condition and the interventions readily available. For example, some employers immediately place an employee on restricted duty. They take a ''wait and see approach'' and, if the MSD does not clear up in a few days, the employer moves on to the next level of intervention. Other employers have on-site HCPs. Some employers with on-site HCPs place employees who report signs or symptoms immediately on work restrictions while the HCP does the evaluation. Where necessary, the HCP then develops a treatment and/or return-to-work plan. Whatever the employer's response, it needs to be made promptly.

In paragraph (c) of the proposed rule, employers must provide injured employees with prompt access to an HCP, when necessary, for evaluation, management and follow-up. OSHA used the language ''when necessary'' in the proposed rule because the Agency recognizes that it is not always necessary for an employer to send the injured employee to an HCP. OSHA recognizes that there are situations in which providing work restrictions immediately and/or taking other measures immediately, such as fixing the job, may be an adequate response to the report. This is particularly true if the MSD is reported very early, that is, before the condition becomes severe. In other situations, however, it will be necessary to send the injured employee to an HCP. For example, employers who do not provide work restrictions and/or other measures at the time the MSD is reported will need to send injured employees to the HCP. In addition, there will be some cases where the reported MSD is so severe that it is essential the employee be evaluated by an HCP at the earliest possible time.

The proposed rule defines health care professional (HCP) as a physician or other licensed health care professional whose legally permitted scope of practice (*e.g.*, license, registration, or certification) allows them to independently provide or be delegated the responsibility to provide some or all of the MSD management requirements of this standard. The proposed rule is flexible enough to allow employers to use a broad range of HCPs, provided the HCP is capable and authorized to provide evaluation, management, and follow-up of MSDs. As defined by this proposal, HCPs are not limited to physicians or nurses. Different HCPs may be involved in the process at different points.

OSHA is proposing a flexible definition of HCP, for several reasons. First, this approach is responsive to the requests of stakeholders, particularly those with establishments in rural locations, who strongly urged that the rule provide maximum flexibility in the selection of HCPs. Specifically, these employers urged OSHA not to limit employers' choice of HCPs to specialists, who are often not available in reasonable proximity, which would delay prompt evaluation, management, and follow-up and make it much more costly. In general, most of the commenters made broad, generic statements on the qualifications of HCPs that were needed to perform MSD management. For example, the American College of Occupational and Environmental Medicine stated, ''[a] health care provider is considered to be a licensed/registered health care provider practicing within the scope of their license/registration'' (Ex. 3–105). Other commenters, such as Carol Stuart-Buttle, a well-known ergonomics consultant, concur with this opinion (Ex. 3–59). The American Feed Industry Association expressed concern that the medical profession in a rural area may not have the expertise to deal with work-related MSDs, and pointed out that compliance may be a problem if OSHA stipulates that the HCP have a specific background (Ex. 3–73).

Second, OSHA does not want to limit employers' options where the State has determined that an individual is authorized to provide care. The scope of practice for a particular HCP may vary from State to State. OSHA believes that issues of HCP qualifications and scope of practice are adequately addressed by State law and professional organizations, and thus it is appropriate to allow employers to rely on the system developed by the States. OSHA requests comments on these issues and specifically seeks information on the experience of employers in using HCPs with various qualifications in their ergonomics programs.

Some commenters said that the employer should be allowed to determine what HCPs would best be able to direct their occupational health services (Exs. 3–99; 3–104). For example, physician assistants, occupational therapists, and physical therapists said that the proposed ergonomics program rule should not limit the HCPs that are allowed to provide medical management and emphasized the role these professionals play in the management of work-related MSDs (Exs. 3–57; 3–47; 3–64).

Others, however, have urged OSHA to require employers to use only HCPs who have training in and experience with work-related MSDs and MSD hazards. These commenters stressed the need for knowledgeable HCPs. They said that HCPs should be required to have training and experience in occupational medicine, MSD hazards, and the disorders associated with these hazards (Exs. 3–181; 3–106). For example, one commenter stated that HCPs need a background in occupational health and in ergonomics (Ex. 3–59). Another pointed out that the skills of the HCP need to be updated periodically (Ex. 3–137).

To the extent possible, employers should use HCPs who are knowledgeable in the assessment and treatment of work-related MSDs to ensure appropriate evaluation, management, and follow-up of employees' MSDs. In any event, paragraph (d) of the proposed rule requires the employer to provide information to the HCPs conducting the assessment. If these individuals are already on site, they are likely to be familiar with the jobs in the workplace, the hazards identified in the hazard analysis, and what jobs or temporary alternative duty may be available. It is essential that HCPs charged with the responsibility for MSD management know or be provided this information if they are to successfully manage the cases of the injured workers.

OSHA rules state where an individual other than an HCP is responsible for determining whether temporary work restrictions or other measures are necessary under § 1910.930(b), that individual too must be provided the information necessary to discharge his or her responsibility. This is implicit in § 1910.930(b) and is in any event required by § 1910.912(b). With these materials, the safety and health professional or HCP will be better able to ensure that the employee is properly assessed and is placed in a job that will allow healing to occur during the recovery period.

Paragraph (e) requires the employer who has referred the employee to an HCP to obtain a written opinion from the HCP so it is clear to all parties what needs to be done to resolve the employee's MSD. This opinion must be written because oral communication is more susceptible of misinterpretation. Employers must keep a record, and the easiest way to do this is if the opinion is in writing. In addition, the HCP's opinion is valuable information for employers to have when identifying MSD hazards in jobs and evaluating the ergonomics program and controls.

This paragraph also requires an employer to ensure that the employee promptly receives a copy of the opinion, which is essential if the employee is to participate in his or her own protection. It is particularly important for the employee to be knowledgeable about what work restrictions, if any, he or she has been assigned and for how long they will apply.

Section 1910.931 What information must I provide to the health care professional?

You must provide:

(a) A description of the employee's job and information about the MSD hazards in it;

(b) A description of available work restrictions that are reasonably likely to fit the employee's capabilities during the recovery period;

(c) A copy of this MSD management section and a summary of the requirements of this standard; and

(d) Opportunities to conduct workplace walkthroughs.

Section 1910.931 requires that HCPs receive necessary information so the evaluation, management and follow-up of the injured employee is effective. It is important that employers provide information to HCPs, regardless of whether the HCP has special training or knowledge in dealing with occupational injuries and illnesses or in managing MSD cases. Requirements to provide information to HCPs are not new; they have been included in every medical surveillance provision in other OSHA health standards. In addition, a number of commenters recommended that OSHA's ergonomics rule ensure that HCPs receive the information they need to be familiar with the jobs in the employers' workplaces (Exs. 3–23–A; 3–56; 3–89). OSHA also notes that if employers provide the HCP with the information required in this section, they will have satisfied the requirement in § 1910.930(d) that they provide ''the HCP with the information necessary for conducting MSD management.''

Paragraph (a) requires employers to provide a description of the employee's job and information about the hazards in it. This information is needed to assist HCPs in providing both accurate assessment and effective management of MSDs. Without such information the HCP may not be able to make an accurate evaluation about the causes of the MSD or may not be able to prescribe appropriate restricted work activity. OSHA believes that providing HCPs with information about the results of any job hazard analysis that has been done in that job ensures that the HCP has the most complete and relevant information for evaluating and managing the recovery of the injured employee. Many stakeholders have told OSHA that they already provide this type of information to the treating HCP in order to familiarize the provider with the employee's job and associated workplace risk factors and ultimately to facilitate resolution of the MSD (Exs. 26–23 through 26–26).

Paragraph (b) requires employers to provide information on work restrictions that are available during the recovery period and that are reasonably likely to fit the employee's capabilities during the recovery period. Providing this information to HCPs helps to facilitate the appropriate matching of the employee's physical capabilities and limitations with a job that allows an employee to adequately rest the injured area while still remaining productive in other capacities. Employers with ergonomics programs have discovered that the more detailed information and communication provided to the HCP about available alternative duty jobs, the better the HCP understands the causes of the problem and knows what work capabilities remain. As a result, these employers have found that the HCP is more likely to recommend restricted work activity rather than removal from work during the recovery period. In addition, it is more likely that HCPs are able to recommend much shorter removal periods when removal is combined with restricted work activity as a means of facilitating recovery.

To achieve these kinds of MSD management results, the employer must establish a good communication process with the injured employee and the responsible HCPs, as well as with any other safety and health professionals involved in the MSD management process. In addition, for communication to be effective and helpful to the MSD management process, it needs to be clear, timely, and on-going. The person(s) the employer assigned to be responsible for working with the injured employee and communicating information to the HCP needs to have authority to coordinate appropriate placement of the affected employee in the workplace during the recovery period (Ex. 26–923, Ex. 26–924).

Paragraph (c) requires employers to give the HCP a copy of the MSD management section and a summary of the requirements of the standard. This summary must highlight how MSD management fits into the ergonomics program this standard requires. For example, it is especially important that the HCP understand that early reporting of MSD signs and symptoms is key to the success of the ergonomics program and that employers must encourage it. HCPs also need to know how quickly employers must provide employees with access to the HCP and that employers must analyze any job in which a covered MSD is reported. Moreover, HCPs need to understand that the effective resolution of MSDs may require the input of different persons, including those like safety and health professionals, ergonomists, and ergonomics committee members, who are in charge of analyzing and implementing measures that will eliminate or control the hazards that caused the MSD.

OSHA intends, in paragraph (d), that employers provide HCPs with opportunities to look at the problem job and the available alternative duty jobs. Not only is it important that the HCP become familiar with the physical work activities the injured employee performs, but also it is important that the HCP see the available alternative duty jobs to ensure that such jobs will allow the employee to rest the injured area during the recovery period. OSHA does not intend to require employers to provide HCPs walkthroughs throughout the entire facility.

Many stakeholders support this provision and have told OSHA that workplace walkthroughs are one of the best ways to obtain knowledge regarding the physical work activities and workplace conditions in the employee's job (Exs. 3–52; 3–107). They are also the best way for the HCP to understand whether the available alternative duty jobs will allow the injured employee to rest the affected area and not be exposed to other conditions that could aggravate rather than resolve the MSD.

Workplace walkthroughs can be either informal or formal. Several stakeholders said that they often invite community

HCPs for a tour of the facility. Others conduct the tours one on one. To remain knowledgeable about the specific workplace, jobs, job tasks, and any changes, employers should encourage HCPs to tour the workplace periodically. Finally, where workplace walkthroughs are not possible (*e.g.,* HCP located too far from the workplace), there are other ways HCPs can acquire more in-depth information about the employee's job and the MSD hazards in it. For example, employers can provide HCPs with the results of the job hazard analysis, photographs of the job, or videotapes of the job being performed.

Where possible, employers should use HCPs who have a basic knowledge of the importance of the early recognition, evaluation, treatment, and prevention of work-related MSDs. Since standards of care change over time, it is the responsibility of the treating health care professional to select treatments in accordance with current acceptable standards of practice (Kuorinka and Forcier, Eds. 1995, Ex. 26–638).

Section 1910.932 What must the HCP's written opinion contain?

The written opinion must contain:

(a) The HCP's opinion about the employee's medical conditions related to the MSD hazards in the employee's job.

(1) You must instruct the HCP that any other findings, diagnoses or information not related to workplace exposure to MSD hazards must remain confidential and must not be put in the written opinion or communicated to you.

(2) To the extent permitted and required by law, you must ensure employee privacy and confidentiality regarding medical conditions related to workplace exposure to MSD hazards that are identified during the MSD management process.

(b) Any recommended temporary work restrictions and follow-up;

(c) A statement that the HCP informed the employee about the results of the evaluation and any medical conditions resulting from exposure to MSD hazards that require further evaluation or treatment; and

(d) A statement that the HCP informed the employee about other physical activities that could aggravate the work-related MSD during the recovery period.

As mentioned above, the HCP must provide a copy of the written opinion to the employer and injured employee. The written opinion must contain the HCP's opinion about the employee's medical condition related to MSD hazards in the employee's job. The written opinion must explain what actions the HCP recommends to resolve an MSD. These recommendations may include temporary work restrictions or the work the employee may do during the recovery period as well as the medical treatment and follow-up necessary to ensure that the MSD resolves.

It is important that the HCP's opinion be provided in writing to the employer or the person(s) at the workplace who are responsible for carrying out the MSD management requirements of the standard. Employers need to know about the employee's medical condition to ensure that the restricted work activity they provide satisfies the HCP's recommendations. Employers also need to know whether the employee requires medical treatment that may necessitate his or her absence from work. The HCP's written opinion is especially important for the on-site person who is responsible for follow-up. That person needs to understand the HCP's plan for follow-up and how to assist in ensuring that follow-up is effective.

Paragraph (a) would require that the HCP's written opinion include information on any medical condition the employee has that is related to the MSD hazards in the employee's job. The HCP's opinion addresses issues such as whether the employee has a work-related MSD, whether work restrictions are needed and for how long, and what kind of follow-up is needed.

Note: Some HCPs may classify a medical condition under an International Disease Classification (ICD) code, while other HCPs may provide a more general diagnosis of the condition. The proposed rule is not limited to providing MSD management only for those MSDs that have an ICD–9 classification.

The HCP's opinion must be limited to medical conditions related to MSD hazards in the employee's job. This does not mean that the HCP must determine whether the MSD is work-related (recordable). Rather, this provision means that the written opinion must not contain medical information about the employee that is not related to work or to MSD hazards in the employee's job. This provision has been included to protect the privacy of the employee, who may not, for example, want the employer to know that he or she has been in treatment for a psychological condition.

As stated, the written opinion the HCP provides to the employer must not include medical information (*e.g.,* diagnoses, test results, medical history) that is not related to MSD hazards in the job. Paragraph (a) requires employers to instruct the HCP that any findings, diagnoses, recommendations on treatment or medical follow up, or information not related to workplace exposure to MSD hazards must remain confidential and must not be included in the written opinion or communicated in any way to the employer. This kind of prohibition is important in protecting the employee's privacy, and has been a routine feature of OSHA health standards. Moreover, HCPs have their own independent duty to protect the privacy of patients, even patients who work for the same employer as the HCP does. *Cf. Wilson* v. *IBP*, 558 N.W.2d 132, 138–39 (Iowa 1996). This confidentiality provision is necessary to ensure that employees will be willing to provide complete information about their medical condition and medical history. Employees will not divulge this type of personal information if they fear that employers will see it or use it to the employee's disadvantage. For example, employees may fear that their employment status could be jeopardized if employers know that they have certain kinds of medical conditions, which may be completely unrelated to work or exposure to MSD hazards, or if they are taking certain kinds of medication (*e.g.,* seizure medication, an anti-depressant). In this sense, the ergonomics rule is consistent with and is intended to be consistent with the confidentiality requirements of the Americans with Disabilities Act. Paragraph (a), however, recognizes that there may be times where information regarding medical conditions related to workplace exposure to MSD hazards are required to be revealed by some other State or Federal law. The proposed rule does not prohibit release of this confidential information where expressly required by those laws.

In paragraph (b), OSHA is proposing that the written opinion must contain any temporary work restrictions and follow-up that the employee needs during the recovery period. Work restrictions, defined in § 1910.945 of this proposed standard, are limitations placed on the manner in which an employee with a covered MSD performs a job during the recovery period. The proposed rule defines work restrictions to include modifications and restrictions to the employee's current job, such as limiting the intensity or duration of exposure, reassignment to temporary alternative duty jobs, and/or complete removal from the workplace.

The written opinion should specifically spell out recommended temporary work restrictions, what kind of follow-up is required, and the specific time frame for the follow-up. For example, restrictions on lifting during the recovery period should be as specific as possible: ''No lifting of more than 10 pounds above shoulder level.'' The more specific the temporary restrictions are, the more likely that the employer will be able to identify an alternative duty job that fits the employee's capabilities while still ensuring that the injured area is rested. Specific recommendations give employers needed information about whether employees can remain in their current job, with restrictions on certain of their regular job duties, during the recovery period. Finally, specific recommendations make it possible for on-site safety and health personnel to identify alternative jobs or job changes that will satisfy the temporary work restriction recommendations.

Paragraph (c) would require that injured employees be informed by the HCP about the results of the evaluation and medical conditions resulting from exposure to MSD hazards that may necessitate further evaluation or treatment. This provision ensures that employees know the information that is the basis for the written opinion the HCP provides to the employer. For example, it may include the test results, or physical examination results, that support the recommendations regarding treatment and/or work restrictions.

This provision would also ensure that there is full disclosure to the employee about medical conditions that require the employee's further attention. The written opinion must include a statement that the employee has been informed about the results of the evaluation.

Paragraph (d) is similar to the previous provision. It requires that employees be informed about other activities, including non-work activities, that could aggravate the covered MSD and could delay or prevent recovery. OSHA is proposing this provision because it is important for employees to know how they can facilitate and participate in their own recovery. Although the employer is responsible for ensuring that the employee is not exposed during the recovery period to workplace conditions and physical work activities that are reasonably likely to cause MSDs, the employee should be aware of the actions he or she should take away from work to reduce exposure to ergonomic risk factors. This may include reducing or stopping certain personal work or recreational activities that might be associated with MSDs. It also might include recommendations to wear immobilization devices, such as a wrist brace, during rest periods or while asleep. As discussed above, paragraph 1910.932(a) would require that employers ensure HCPs not include any of these recommendations in the written opinion.

This provision is intended for informational purposes only and does not require employees to refrain from non-work activities that could aggravate the MSD or delay recovery. OSHA's authority is ''limited to ameliorating conditions that exist in the workplace.'' *Forging Indus. Ass'n* v. *Secretary of Labor,* 773 F.2d 1436, 1442 (4th Cir. 1985).

Section 1910.933 What must I do if temporary work restrictions are needed?

You must:

(a) *Work Restrictions.* Provide temporary work restrictions, where necessary, to employees with covered MSDs. Where you have referred the employee to a HCP, you must follow the temporary work restriction recommendations in the HCP's written opinion;

(b) *Follow-up.* Ensure that appropriate follow-up is provided during the recovery period; and

(c) *Work Restriction Protection (WRP).* Maintain the employee's WRP while temporary work restrictions are provided. You may condition the provision of WRP on the employee's participation in the MSD management this standard requires.

Section 1910.933 outlines the requirements employers must follow when it is determined that an employee has a covered MSD that is serious enough to require some kind of work restriction.

Paragraph (a) would require that employers provide temporary work restrictions, where necessary, to employees with covered MSDs. As discussed above, work restrictions are restrictions on the way in which a job is performed or on the activities that the injured employee performs during the recovery period. Work restrictions include changes to the employee's existing job, such as limiting the tasks the employee may perform. Restrictions also include temporary transfer to a restricted duty job or removal from the workplace during the recovery period or a portion of it.

If a HCP has recommended restricted work, employers should consider such restrictions necessary to prevent the employee's condition from worsening and to allow the employee's injured tissues to recover. In those instances where the employer has referred the employee to a HCP, the employer must follow the temporary work restriction recommendations, if any, included in the HCP's written opinion.

The provision of work restrictions to injured employees is a vital component of MSD management. Work restrictions provide the necessary time for the injured tissues to recover. They are often considered the single most effective means of resolving MSDs, especially if they are provided at the earliest possible stage. If work restrictions are not provided, it may not be possible for the employee to recover, and permanent damage or disability may result.

For work restrictions to be effective, employers must ensure that they fit the physiologic needs of the injured employee. For example, work restrictions will only be effective if they reduce or prevent the employee's exposure to workplace risk factors that caused or contributed to the MSD or aggravated a pre-existing MSD. To find the right fit, employers may need to examine potential alternative duty jobs to ensure that the employee will still be able to rest the affected area while performing the alternative job. Identifying appropriate work restrictions may require the collaboration of different persons such as HCPs, safety and health personnel, persons involved in managing the ergonomics program, and the injured employee.

Although some covered MSDs are at such an advanced stage that complete removal from the work environment is the appropriate treatment, it usually should be the recommendation of last resort. Where appropriate, work restrictions that allow the employee to continue working (*e.g.,* in an alternative job, or by modifying certain tasks in the employee's job to enable the employee to remain in that job) are preferable during the recovery period. These types of restrictions allow employees to remain within the work environment. Studies indicate that the longer employees are off work, the less likely they are to return (Exs. 26–685, Ex. 26–919, 26–923, 26–924). If employers provide accurate and detailed information about the job and alternative jobs, it is more likely that the safety and health professional, ergonomist, or HCP will recommend restricted activity at work rather than complete removal. Employers should communicate with safety and health professionals, HCPs, and others to coordinate the provision of work restrictions.

Under this provision, employers are not required to provide particular alternative jobs or work restrictions that an employee requests. Therefore, if a safety and health professional, ergonomist, or HCP recommends that the employee not perform lifting tasks or engage in repetitive motions during the recovery period, the employer is free to provide any form of work restriction that effectuates that work restriction recommendation. For example, if the recommended work restriction requires fewer repetitive motions, the employer may move the employee to an alternative duty job as a way of achieving this restriction. Or the employer could reduce the number of repetitions expected to be performed in the employee's current job in a number of ways: by reducing the amount of time the employee performs repetitive motions, by reducing the speed at which the employer performs the tasks, or by eliminating certain repetitive tasks during recovery. In the case of lifting jobs, the work restriction may be as simple as limiting the types or weights of objects the employee must move or lift.

Paragraph (b) requires that the employee receive appropriate follow-up during the recovery period. Follow-up is the process or protocol the employer, safety and health professional, and/or HCP uses to check up on the condition of employees with covered MSDs when they are given temporary work restrictions during the recovery period. Follow-up of injured employees is essential to ensure that MSDs are resolving and, if they are not, that other actions are taken promptly. This process helps to ensure that injured employees do not ''slip through the cracks,'' for example, by being left in alternative duty jobs long after they have recovered, or by being given work restrictions without finding out if the restrictions are helping. If follow-up is not provided, neither the employer nor the safety and health professional or HCP will know that an employee's MSD symptoms are not abating or are becoming worse. Where follow-up is not provided or the healing process is not properly monitored, injured employees, in the end, may never be able to return to their jobs.

To be effective, follow-up may require the efforts of both an HCP and on-site personnel, such as the person(s) responsible for receiving and responding to employee reports. Some employers may use HCPs who already have a follow-up process in place. For example, some occupational medicine clinics have employees contact the clinic almost daily, or, alternatively, the clinic may contact the employee. In many situations, effective follow-up involves a team approach. This is especially true where the ergonomist, HCP or safety and health professional is not on-site and cannot see the employee on a daily basis. In these cases an on-site person (*e.g.,* nurse, person(s) designated to receive and respond to reports, human resources person) regularly checks on the employee and reports the results back to the HCP, ergonomist, or safety and health professional. This approach may be very effective because the HCP can be provided with almost daily reports on the injured employee's condition and respond quickly if the condition becomes worse.

Many stakeholders also recognize the need for effective follow-up and have made the process a standard company practice. Coors Brewing Company, for example, stated that it provides follow-up for injured employees as often as is necessary until the employee is released from care (Ex. 3–95).

Paragraph (c) requires employers to provide work restriction protection (WRP) to employees on temporary work restrictions. WRP is defined in § 1910.945 of the proposed rule as the maintenance of earnings and other employment rights and benefits of employees who are on temporary work restrictions as though the employees had not been placed on temporary work restrictions. For employees placed on temporary work restrictions short of complete removal from work (*e.g.,* an alternative duty job), WRP includes maintaining 100% of the after-tax earnings the employees were receiving at the time they were placed on work restrictions. For employees removed entirely from the workplace, WRP includes maintaining 90% of their after-tax earnings; the value of 90 percent is considered by OSHA to be a reasonable estimate of the percentage of take-home pay received by workers when awarded a worker's compensation claim. Thus, if an employee needs to be removed from work entirely, either because the employer, an ergonomist, a safety and health professional or the ergonomics committee has initiated it or the employer referred the employee to an HCP who recommended it, the employer must pay the removed employee 90% of the employee's after-tax earnings and maintain the employee's full benefits. If an employee is placed into an alternative duty job, however, that pays less than the employee was earning at the time the MSD occurred, the employer must maintain 100% of the employee's after-tax earnings, with full benefits. The benefits referred to in § 1910.945 include, for example, accrual of vacation time; employer contributions to health insurance; employer contributions to other workplace programs such as profit-sharing, life insurance, and pension; and seniority or ''bidding'' rights. Paragraph (c) also permits employers to condition the provision of WRP benefits upon an employee's participation in the MSD management required by the proposed standard.

By requiring employers to provide WRP, OSHA intends that employees have some economic protection when they are placed on temporary work restrictions. OSHA believes that this economic protection will encourage employees to come forward to report MSDs early; such reporting helps to ensure that the injured employees, as well as employees in the same ''problem'' job, are provided with protection from MSD hazards. Because early reporting is so critical to the proposed rule, OSHA has crafted WRP to encourage employees to report as early as possible. By requiring employers to maintain 100% of an employees' after-tax earnings when they are placed on temporary work restrictions short of complete removal from work, OSHA believes employees will have an incentive to report the onset of MSDs early, before their MSDs become so severe that complete removal from work is necessary. OSHA predicts that very few employees with covered MSDs will need to be removed entirely from the workplace during their recovery period. OSHA anticipates that restricted work activity will be sufficient for a large percentage of employees, particularly because the proposed standard requires employers to establish systems for the early reporting of MSDs and to provide prompt MSD management.

In the proposed standard OSHA is referring to this economic protection during temporary work restrictions as ''work restriction protection (WRP).'' In other OSHA health standards, similar provisions have been called ''medical removal protection.'' OSHA is using the term ''work restriction protection (WRP)'' because it more accurately describes the typical recovery process for most employees with MSDs and the practical effect this provision will have on employers and employees. Moreover, the term ''medical removal protection'' implies that removal is necessitated by a diagnosis or recommendation by an HCP. In the proposed rule, some restricted work activity (*i.e.*, immediate placement in alternative duty when an employee reports an MSD) need not be triggered by an HCP's opinion. OSHA does not believe it is appropriate to imply that restricted work activity can only be triggered by an HCP's opinion. OSHA intends that employees who are given restricted work activity even before seeing an HCP have WRP.

Note: When ''medical removal protection'' provisions in other health standards are discussed in this section, the term ''WRP'' is also used.

Section 1910.934 How long must I maintain the employee's work restriction protection when an employee is on temporary work restrictions?

You must maintain the employee's WRP until the FIRST of these occurs:

(a) The employee is determined to be able to return to the job,

(b) You implement measures that eliminate the MSD hazards or materially reduce them to the extent that the job does not pose a risk of harm to the injured employee during the recovery period; or

(c) 6 months have passed.

As mentioned above, the proposed rule would only require employers to provide work restrictions that are temporary, meaning that the work restrictions are for MSDs that are temporary and reversible. In this section, OSHA is proposing a time frame for the length of time employers would be required to maintain WRP, and identifies the points at which the employer's obligation to do so would end.

To ensure that WRP is provided only for temporary medical conditions, OSHA is proposing three cutoffs that limit the employer's obligation to provide WRP. The employer's obligation to provide WRP would cease when the first of the cutoffs occurs:

- The employee is able to return fully to the regular job,
- The job is fixed so the employee will not continue to get hurt, and
- WRP has been provided for 6 months

Although the proposed rule would require the employer to maintain WRP for as long as 6 months, evidence shows that the need to provide protection for 6 months is relatively rare. Although the median number of lost workdays for certain MSDs is quite high, as discussed in Chapter IV of the Preliminary Economic Analysis (Ex. 28–1) and Section VII of this preamble, data show that many MSD cases involve only a few days of work restriction before employees are able to return fully to work. In fact, according to the BLS, 50% of all MSD cases that involve days away from work result in less than 7 days away from work (Ex. 26–1413). Assuming no change in these lost workday trends, this evidence indicates that the first WRP cutoff that is likely to occur is that the employee is able to return fully to the regular job.

The second cutoff would occur when the employer fixes the job, either by eliminating or materially reducing the MSD hazards to the extent that the job does not pose a risk of harm to the injured employee during the recovery period. The second cutoff would occur even if the injured employee's MSD has not completely recovered. This cutoff is also likely to occur early in the process because so many ergonomic controls are quick and inexpensive. According to David Alexander, an ergonomist who has provided consultative services for employers in a broad range of industries, most jobs can be fixed for less than $500 (Alexander, D. and Orr, G. 1999, Ex. 26–1407). In addition, a number of controls involve making simple, low-cost changes in how the job is performed. For example, if a person is not tall enough to perform the task without reaching excessively, the employer could change the height at which the employee stands to perform the task. Or, if the reach for the product is too great, the employer can extend the length of the handle of the tool used to grab the product. If an employee's arm, leg or hand has contact with a hard work surface, the employer can wrap the surface with foam. In a warehousing area, employees can stack smaller amounts of product on each pallet, instead of stacking a large amount of product on one pallet. If an employer installs a fixture or device (a ''jig'') so that it maintains the correct relationship between a piece of work and the tool used during assembly, the employee does not have to use force or awkward posture to hold the part. Because controls for many jobs are inexpensive and cost less than WRP, this cutoff should create an incentive for employers to implement controls quickly.

The proposed rule itself facilitates the implementation of effective controls. Where a covered MSD occurs, the employer may either set up an ergonomics program for the employee in that job or do a Quick Fix. The Quick Fix provision of the proposed rule (see § 1910.909) essentially allows employers to bypass most of the requirements of the program if they can quickly implement controls that eliminate the hazard.

The final cutoff for WRP is 6 months. OSHA believes that few employers will be required to provide WRP for this length of time, because the overwhelming majority of MSDs resolve well before 6 months have passed. As mentioned above, the median number of days away from work for lost workday MSDs is 7. The 1998 Liberty Mutual data are consistent with the BLS data: only 11% of all UEMSD claims were associated with a length of disability of more than 6 months (Ex. 26–54). With implementation of the early reporting requirements in the proposed rule, that percentage should decrease.

Even though most MSDs involve substantially less than 6 months of recovery time, OSHA is proposing a maximum WRP duration of 6 months for several reasons. First, OSHA believes this is a ''fallback'' cutoff. Some employees with reversible MSDs may require longer recovery time. This is especially true where employees require surgery or where the employer has not established an aggressive early reporting policy and the MSD was not caught until signs or symptoms were more serious (see Oxenburgh 1984, Ex. 26–1367). Longer recovery time may also be necessary for employees who already have had an MSD or surgery, have a disability, or have other susceptibilities. OSHA wants to cover those cases that may require more time but nonetheless may still have good expectation of recovery.

At the end of the 6 month WRP period, employers should evaluate the employee's condition to determine whether work restrictions are still necessary and/or whether the employee can return to the job. OSHA seeks comment from interested parties on what protections should be provided to employees if their MSDs have not resolved at the end of the 6 month WRP period and they are not physically able to return to the job.

Section 1910.935 May I offset an employee's WRP if the employee receives workers' compensation or other income?

Yes. You may reduce the employee's WRP by the amount the employee receives during the work restriction period from:

(a) Workers' compensation payments for lost earnings;

(b) Payments for lost earnings from a compensation or insurance program that is publicly funded or funded by you; and

(c) Income from a job taken with another employer that was made possible because of the work restrictions.

Section 1910.935 specifies the offsets employers may make if an injured employee receives workers' compensation. This section serves two purposes. First, the provision helps to strike a balance by providing economic protection for employees who are placed on temporary work restrictions, while ensuring that employers need not provide WRP benefits that would result in the injured employee receiving more than current earnings. OSHA believes that an employer should not have to provide WRP benefits that duplicate the compensation the injured employee receives from other sources for earnings lost during the work restriction period. Although the most likely ''other'' source would most often be workers' compensation payments for lost earnings, the proposed rule also permits the employer to offset other earnings that would not have been possible but for the work restrictions, for example a job baby-sitting during the day because the injured worker is at home. (The employer would not be entitled to offset earnings the injured employee received from a second job held prior to the injury, except that the employer may offset any additional earnings from a previously held second job if such additional earnings were made possible by the work restrictions (*e.g.,* as a result of the work restrictions, the employee is able to work more hours at the previously held second job).)

Second, this section stresses that OSHA's intention in proposing WRP is not to supersede workers' compensation. If WRP were structured without regard to workers' compensation eligibility, it could be viewed as superseding workers' compensation. The offsets allowed in this paragraph are consistent with those in other OSHA health standards. The offsets for workers' compensation payments for lost earnings are permitted regardless of whether workers' compensation is publicly funded or employer-funded.

Part B—Work Restriction Protection

1. Legal Authority for WRP

The OSH Act authorizes WRP. WRP is authorized by the OSH Act as necessary to protect the health of employees suffering from MSDs. Section 6(b)(5) of the OSH Act directs OSHA to adopt the health standard that ''most adequately assures, to the extent feasible, on the basis of the best available evidence, that no employee will suffer material impairment of health or functional capacity'' if exposed to a hazard over a working lifetime. 29 U.S.C. 655(b)(5). Section 3(8) of the OSH Act explains that an ''occupational health and safety standard [requires] the adoption or use of one or more practices, means, methods, operations, or processes, reasonably necessary or appropriate to provide safe or healthful employment and places of employment.'' 29 U.S.C. 652(8). The statutory provisions give OSHA broad authority to require employers to implement practices that are reasonably necessary and appropriate to provide safe and healthful work environments. See *United Steelworkers of America* v. *Marshall (Lead),* 647 F.2d 1189, 1230 (D.C. Cir. 1980), *cert. denied,* 453 U.S. 913 (1981) (''A number of terms of the statute give OSHA almost unlimited discretion to devise means to achieve the congressionally mandated goal.''). As discussed in greater detail below, WRP furthers OSHA's statutory mandate to protect the health of workers. By providing employees with economic protection if they are placed on temporary work restrictions, WRP encourages employee participation in MSD management and increases early reporting of MSDs. This prevents injured employees from suffering more severe injury, including permanent disability. This also helps to protect other employees in the same jobs by ensuring that MSD hazards are identified and controlled before other employees become injured.

WRP also furthers the broad purposes of the OSH Act. In the OSH Act Congress sought ''to assure so far as possible every working man and woman in the Nation safe and healthful working conditions.'' 29 U.S.C. 651(b). To achieve this goal, Congress authorized OSHA to:

- ''[Develop] innovative methods, techniques, and approaches for dealing with occupational safety and health problems.'' 29 U.S.C. § 651(b)(5). WRP is such an innovative technique. WRP is designed to encourage early reporting of MSDs, and employee participation in MSD management and an employer's ergonomics program, thereby protecting the health of all employees.
- ''[Build] upon advances already made through employer and employee initiative for providing safe and healthful working conditions.'' 29 U.S.C. § 651(b)(4). WRP builds upon advances currently found in workplaces. Many employers with existing ergonomics programs provide for economic protection for employees when they are on restricted work activity. In addition, many collective bargaining agreements that already contain ergonomics programs include WRP provisions.
- ''[Provide] medical criteria which will assure insofar as practicable that no employee will suffer diminished health, functional capacity, or life expectancy as a result of his work experience.'' 29 U.S.C. § 651(b)(7). WRP is a critical component of MSD management which helps prevent workers from suffering from diminished health and functional capacity due to MSDs.

Courts uphold OSHA's authority to require WRP. Judicial decisions have upheld OSHA's authority under the OSH Act to require WRP. In *Lead,* the D.C. Circuit directly examined OSHA's authority to include WRP in the Lead standard and held (1) that the OSH Act gave OSHA broad authority to issue WRP, and (2) OSHA's inclusion of WRP in the Lead standard was necessary and appropriate to protect the health of workers. *Lead,* 647 F.2d at 1228–40.

In the *Lead* decision, the D.C. Circuit first held that OSHA's inclusion of WRP was within its statutory authority. The court found that the OSH Act and its legislative history ''demonstrate unmistakably that OSHA's statutory mandate is, as a general matter, broad enough to include such a regulation as [WRP].'' *Id.* at 1230. The court relied upon a number of provisions in the OSH Act in support of this finding, including 29 U.S.C. 651(b)(5) and the definition of an ''occupational safety and health standard'' discussed above. In short, the court held that OSHA has broad authority to fashion regulatory policies that further the goals of the OSH Act—enhancing worker safety and health and providing for safe and healthful working environments. See *Id.* at 1230 n. 64 (''[T]he breadth of agency discretion is, if anything, at [its] zenith when the action assailed related primarily * * * to the fashioning of policies * * * in order to arrive at maximum effectuation of Congressional objectives.'' (citation omitted)).

The court also concluded that the legislative history of the OSH Act supported reading the statute to authorize WRP. *Id.* at 1230–31. The court highlighted a statement by Senator Saxbe explaining how both the House and Senate versions of the OSH Act did not contain a ''list of specific 'do's and don'ts' for keeping workplaces safe and healthful''; rather, both versions tasked OSHA with developing regulations to address the various complexities of America's workplaces. *Id.* at 1230.

After concluding that OSHA had the statutory authority to promulgate WRP in general, the court held that OSHA's inclusion of WRP in the Lead standard was a reasonable exercise of that statutory authority. OSHA established that WRP was a preventive device necessary for the effectiveness of the standard. *Id.* at 1237. OSHA demonstrated that lead disease is highly reversible if caught in its early stages; however, OSHA provided evidence that employees ''would resist cooperating with the medical surveillance program'' absent assurances that they would have some economic protection if they were removed from their jobs due to high blood-lead levels. *Id.* at 1237. For example, employees fearing removal from their normal work without pay if they showed high blood-lead levels would tend to try to evade or cheat the blood test. The court held that WRP in the Lead standard was reasonably necessary and appropriate to protect the safety and health of workers.

Further supporting OSHA's authorization to include WRP in its standards, the D.C. Circuit in *International Union* v. *Pendergrass (Formaldehyde),* 878 F.2d 389, 400 (D.C. Cir. 1989)) criticized OSHA for not including any WRP in its Formaldehyde standard and remanded the standard to OSHA for reconsideration of the necessity of including WRP. OSHA had claimed that WRP was not appropriate in part because the ''nonspecificity of signs and symptoms [made] an accurate diagnosis of formaldehyde-induced irritation difficult,'' and the health effects from formaldehyde exposure for these employees quickly resolved. *Id.*

The court rejected OSHA's justifications and remanded the issue to OSHA for further examination. OSHA's failure to include WRP in the formaldehyde standard represented a dramatic ''swerve'' from prior health standards that required extensive explanation; OSHA's ''allusions to 'non-specificity' of symptoms [were] too vague and obscure either to show consistency with OSHA's prior stance or to justify a reversal of position.'' *Id.* at 400. The court also stated that WRP was particularly appropriate in situations where employees recover quickly from the signs and symptoms of disease. *Id.*

On remand, OSHA included a WRP provision in the formaldehyde standard, explaining:

> On reconsideration, the Agency has concluded that [WRP] provisions can contribute to the success of the medical surveillance programs prescribed in the formaldehyde standard. Unlike some other substance-specific standards, the formaldehyde standard does not provide for periodic medical examination for employees exposed at or above the action level. Instead, medical surveillance is accomplished in the final rule through the completion of annual medical questionnaires, coupled with affected employees' reports of signs and symptoms and medical examinations where necessary. This alternative depends on a high degree of employee participation and cooperation to determine if employee health is being impaired by formaldehyde exposure. OSHA believes these new [WRP] provisions will encourage employee participation in the standard's medical surveillance program and avoid the problems associated with nonspecificity and quick resolution of signs and symptoms that originally concerned the agency. 57 FR 22290, 22293, May 27, 1992.

Formaldehyde makes clear that OSHA may not decline to include WRP in a health standard absent specific findings justifying such a change in Agency practice.

Other health standards support OSHA's inclusion of WRP. OSHA has included some form of WRP in many other health standards based upon findings that WRP is necessary to encourage employee participation in medical surveillance. See 29 CFR 1910.1025 (Lead); 29 CFR 1910.1027 (Cadmium); 29 CFR 1910.1028 (Benzene); 29 CFR 1910.1048 (Formaldehyde); 29 CFR 1910.1050 (Methylenedianiline); 29 CFR 1910.1052 (Methylene Chloride). OSHA has tailored the WRP provisions in these health standards to address the particular hazards involved, as well as to effectuate the purposes of the standards. In some of these standards, for example, WRP is triggered by a specific finding. In the Lead standard, WRP must be provided when blood-lead levels exceed certain limits. In other standards, however, WRP is provided even though no medical ''triggering'' test is available. In these instances, WRP must be provided (1) when an employee exhibits signs or symptoms of disease (see, *e.g.,* 29 CFR 1910.1048 (l)(8)(I) (Formaldehyde) ''[WRP applies] when an employee reports significant irritation of the mucosa of the eyes or the upper airways, respiratory sensitization, dermal irritation, or dermal sensitization attributed to workplace formaldehyde exposure.''), or (2) there is a finding by a physician that an employee must be removed to avoid material impairment of health or functional capacity. Providing WRP based upon a finding by a physician (or HCP) is included in all other OSHA health standards with WRP. OSHA believes that this provision serves as a ''backstop'': it protects those employees who exhibit signs and/or symptoms of disease at particularly low exposures.

OSHA's inclusion of some form of WRP in other health standards based on findings that WRP is necessary to ensure employee participation in medical surveillance programs demonstrates an established policy that OSHA may not depart from without substantial justification. OSHA is aware of no such justification. To the contrary, OSHA's preliminary view is that WRP is necessary to encourage early and full employee reporting, which is critical if the standard is to reduce the number and severity of MSDs.

2. Necessity Of WRP

As discussed in more detail in the Risk Assessment and Significance of Risk sections of this preamble, many employees currently suffer from MSDs. OSHA believes that WRP is a critical component of the proposed rule for the following reasons:

1. WRP encourages employee participation in MSD management and the ergonomics program;

2. WRP encourages early reporting of MSDs, and/or signs and symptoms of MSDs;

3. The actions required of employers by the proposed rule are determined by reported MSDs; and

4. There is no justification to deviate from past OSHA practice and exclude WRP.

WRP encourages employee participation in MSD management and the ergonomics program.—There is evidence that many employees at present do not report MSDs, and/or signs and symptoms of MSDs, because they fear any or all of the following will happen to them if they report signs and/or symptoms of MSDs, and/or are diagnosed with an MSD:

1. They will be transferred to alternative ''light'' duty at reduced pay (see Exs. 3–184; 3–186);

2. They will be fired or suffer a great financial loss and lose their benefits (see Exs. 3–151; 3–183; 3–184; 3–186); or

3. They will suffer other forms of job discrimination or retaliation (see Ex. 3–121).

These comments are consistent with those comments OSHA received during other health standards rulemakings where similar WRP provisions were proposed. See, *e.g.*, 43 FR 54354, 54442, November 21, 1978. These fears are particularly acute for the many low-wage employees who live ''pay check-to-pay check.'' Evidence and data show that many of the jobs where ergonomic problems are severe are jobs that pay minimum wage or only slightly above minimum wage. For example, as detailed in the Preliminary Risk Assessment, some of the jobs with the highest incidence of MSDs are those held by nursing aides, orderlies, and attendants; laborers (not construction); stock handlers and baggers; and maids and housemen.

OSHA's concern about the pressure on workers not to come forward to report their MSD signs and symptoms early is heightened by two factors: the large number of employees who do not receive sick leave, and the difficulty employees have in receiving State workers' compensation benefits for work-related MSDs. The BLS reports that only 50% of workers are covered by sick leave benefits, *i.e.*, were paid for work absences due to illness or injury; 64% of blue collar workers are not provided this basic benefit (BLS 1995, Ex. 26–1406).

Each State has a statutory workers' compensation system that controls eligibility for and payment of benefits for State, municipal, and private sector employees. The Federal government operates a workers' compensation system covering Federal workers, and there are Federal statutes that create special compensation schemes for longshore and harbor workers and coal miners. The workers' compensation laws in each State are the result of legislative enactments and interpretations of courts and administrative tribunals, and the laws among States often vary sharply as to what injuries are covered and what benefits are paid.

All States compensate injured or ill workers with MSDs, at least to some degree. However, obtaining workers' compensation for MSDs is complicated by the difficulty of fitting an MSD into the State's definition of an injury caused by accident (an acute, traumatic injury traceable to a particular occurrence at a particular time and place) or an illness meeting the State's definition of occupational illness (often a specific list of diseases or a definition that includes only diseases associated with particular occupations); by the State-imposed statute of limitations on occupational illnesses; and by the high level of litigation associated with these claims.

State statutes have increasingly limited the compensability of MSD claims. In Virginia, for example, the only MSD that is covered is carpal tunnel syndrome (CTS); all other MSD claims are not accepted. Idaho requires the employee to have worked for a single employer for 60 days before a claim for a non-acute injury is considered. In Louisiana, if a claimant was on the job for less than 12 months, he or she needs an ''overwhelming preponderance of the evidence'' to receive compensation. In Texas, the claimant must prove the disease is inherent in that particular type of employment. The result of this trend can clearly be seen in the substantial underreporting of MSDs reported in a number of peer-reviewed articles (Cannon, *et al.* 1981, Ex. 26–1212; Mazlish, *et al.* 1995, Ex. 26–1186; Silverstein, *et al.* 1997, Ex. 26–28).

Those claims that are filed are often litigated and may drag on for years. For example, the California Workers Compensation Institute reported that 94% of the State's cumulative trauma claims were litigated and that employers in California pay $0.33 in litigation costs for every $1 paid in benefits for these cases. For other claims, this figure is $0.15 per $1 of benefits paid (Kohn 1997, Ex. 26–1408).

OSHA believes that both factors—the low level of sick leave benefits available to workers and the difficulty employees have in receiving workers' compensation benefits for work-related MSDs—underscore the importance of the proposed standard's WRP provisions. OSHA believes that by providing employees who must be placed on temporary work restrictions with some guaranteed economic protection, WRP will reduce employee anxiety about reporting signs and/or symptoms of MSDs. Thus, OSHA believes that employees will be more willing to participate actively in MSD management and the ergonomics program.

WRP encourages early reporting of MSDs, and/or signs and symptoms of MSDs. WRP also encourages employees to report MSDs, and/or signs and symptoms of MSDs, as early as possible, so that employers can determine whether the MSD is covered and/or whether temporary work restrictions are appropriate. Early reporting of MSDs leads to early detection and successful treatment of MSDs.OSHA has substantial evidence that most MSDs are reversible if treatment is provided early, before the disease becomes debilitating (see Exs. 3–56; 3–59; 3–179; 3–184). In addition, early detection and intervention reduces the severity of MSDs, as well as the treatment required to address the MSDs. An added benefit is that early detection, intervention, and treatment reduce the costs of MSDs for both employers and employees (see Exs. 3–23; 3–33; 3–50; 3–56; 3–59; 3–121; 3–124; 3–151; 3–162; 3–179; 3–184). Conversely, when employees do not report MSDs, and/or the signs or symptoms of MSDs early, they will likely continue working until their MSDs become (1) compensable under workers' compensation statutes, or (2) more severe and/or disabling. This results in more damage to the affected employee, higher costs for the employer, and reduced productivity.

Because early reporting is so important, the proposed WRP requirements are designed to maximize the incentives employees have to report signs and/or symptoms of MSDs early. As stated above, OSHA is requiring employers to maintain 100% of an employee's after-tax earnings if the employee is placed on work restrictions short of complete removal from work. OSHA believes that this will encourage employees to report signs and/or symptoms of MSDs at the earliest possible point, before their conditions become so severe that complete removal from work is necessary.

The early reporting that will result from WRP will not only provide protection for injured employees, it will provide protection to other employees as well. Early reporting allows employers to identify problem jobs early and to take the necessary steps to correct the identified hazards before other employees become hurt. In addition, early reporting may ensure that job fixes are provided more quickly. Since employers bear the costs of providing MSD management and WRP, they will have an incentive to reduce or avoid those costs by implementing effective and appropriate ergonomics programs in their workplaces. See 43 FR 54354, 54449, November 21, 1978 (''One beneficial side effect of [WRP] will be its role as an economic incentive for employers to comply with the inorganic lead standard.'').

OSHA has evidence that in current ergonomics programs where employees report signs and/or symptoms of MSDs early, the number of MSDs and the number of lost-time/lost-day injuries decreases (see Ranney 1993, Ex. 26–913; Day 1987, Ex. 26–914; see also Oxenburgh 1984, Ex. 26–1367). This evidence demonstrates that where employees report MSDs early: (1) the severity of the MSDs decreases, and (2) greater protection is provided to other employees in the workplace, so that they do not develop MSDs.

During OSHA's public outreach process, every stakeholder who commented on this subject agreed that early reporting of MSDs is critical to preventing disease and to protecting workers. They confirmed that early reporting also reduces the costs to the employee and employer (see Exs. 3–197; 3–118; 3–124; 3–151; 3–56; 3–68; 3–107). Moreover, many stakeholders that currently have ergonomics programs said that they achieved dramatic reductions in the number and severity of MSDs once they implemented an effective early reporting process (Exs. 26–23 through 26–26). This experience is consistent with the literature and studies conducted on ergonomics programs (see NIOSH 1997, Ex. 26–2; Oxenburgh 1985, Ex. 26–1405).

WRP is necessary where employer action is triggered by reports of MSDs. Whether the proposed rule covers certain jobs is determined, in part, by the reporting of an OSHA recordable MSD. This incident-based ''trigger'' is unique to OSHA health standards. In other OSHA health standards, employers are required to monitor their workplaces for hazards and control those hazards. In this proposed standard, however, employers will not have to implement certain aspects of an ergonomics program until a covered MSD is reported.

In order for an incident-based rule to be as effective as possible in providing protection for employees, employees must be willing to report MSDs, and/or signs and symptoms of MSDs. If employees are not willing to come forward and report MSDs, serious MSD hazards in that job will go uncontrolled, thus potentially placing every employee in that job at increased risk of harm. Moreover, some stakeholders fear that an incident-based ''trigger'' will create an incentive for employers to discourage employees from reporting MSDs. There is strong evidence that there currently is significant underreporting of MSDs (see Exs. 2–2; 2–4; 2–22; 3–159; 3–160; Fine *et al.* 1986, Ex. 26–920; Liss 1992, 26–918; Silverstein, *et al.* 1997, Ex. 26–28). OSHA believes that WRP in this proposed rule is thus particularly necessary to ensure that employees come forward and report MSDs early. OSHA believes the proposed WRP provision provides the necessary economic protection to ensure such employee reporting and participation.

No justification to deviate from past OSHA practice and exclude WRP. As mentioned above, many OSHA health standards include WRP. These standards are based on findings that workers are less likely to participate in needed medical management programs if they may suffer severe economic loss as a result. The court in Formaldehyde held that this principle evinced a clear policy that is to be followed unless OSHA gives a persuasive justification for deviating from it. Cf. Formaldehyde, 878 F.2d at 400. OSHA believes that it does not have justification for deviating from its past practice of including WRP in health standards where necessary and appropriate to encourage the participation of employees in programs designed to protect the safety and health of workers.

In particular, the fact that there are no unambiguous biological monitoring tests for diagnosing some MSDs is not a sufficient justification for such exclusion. Formaldehyde, 878 F.2d at 400. In addition, the fact that some MSDs resolve quickly is not sufficient to exclude WRP. *Id.* The court in Formaldehyde stated that if affected employees have quick recovery periods, they ''surely could benefit from receiving [WRP] during the recovery period.'' *Id*.

3. Stakeholder Comments on WRP

The issue of WRP has engendered much discussion. OSHA discussed different forms of WRP with its stakeholders, and OSHA has received many comments from industry, labor, and others on WRP generally, as well as on the specific elements of WRP. Many stakeholders, particularly those in the health care profession, support the inclusion of some WRP provision in the proposed rule (see, *e.g.*, Ex. 3–124). These professionals recognize the importance of encouraging employee participation in MSD management. Employees and their representatives also support some form of WRP as being necessary to the effectiveness of the proposed standard generally, and the effectiveness of MSD management specifically (see Exs. 3–184; 3–164). A large number of stakeholders, however, object to the inclusion of any form of WRP in the proposed standard. These stakeholders contend that WRP:

1. Is not necessary for the effective functioning of the standard;

2. Violates section 4(b)(4) of the OSH Act;

3. Poses a significant economic hardship for employers, especially small employers; and

4. Will be abused by employees.

Is WRP necessary? Some stakeholders argue that WRP is not necessary to get employees to report MSDs. They point to the fact that more than 600,000 MSDs are reported each year. MSDs, they state, account for approximately one of every three dollars paid out in workers' compensation claims. Given these numbers, these stakeholders state that the proposed rule does not need WRP to encourage employees to report MSDs and participate in MSD management. They say that the proposed requirements that employers encourage reporting, train employees in reporting, and refrain from retaliating against employees who do report, are sufficient measures to achieve the objective of early reporting of MSDs.

While OSHA agrees with stakeholders that many MSDs are reported each year, there is also strong evidence that MSDs are significantly underreported (see Exs. 2–2; 2–4; 2–22; 3–159; 3–160, 26–920, 26–918, 26–28). In the last 18 years, many peer-reviewed studies that document underreporting of MSDs in OSHA logs have been published in the scientific literature (Exs. 2–2, 26–1212, 26–1186, 26–28, 26–1258, 26–920, 26–922, 26–1259, 26–1261, 26–1260). These studies document extensive and widespread underreporting on the OSHA logs of occupational injuries and illnesses (Ex. 2–2) and of MSDs (Exs. 26–28, 26–1258, 26–920, 26–922, 26–1259, 26–1261, 26–1260). The studies also show that a large percentage of workers with MSDs that were identified as work-related by health care providers do not file workers' compensation claims (Exs. 26–1258, 26–1212, 26–920). In one early study, only 47 percent of workers with medically diagnosed cases of CTS filed claims (Ex. 26–1212). Fine and his co-authors found that, in two large automobile manufacturing plants, workers' compensation claims were filed in less than 1 percent of medically confirmed cumulative trauma cases in one plant and in only 14 percent of such cases in another (Ex. 26–920). A recent study of 30,000 Michigan workers who were identified by a health care provider as having a work-related injury showed that only 9 to 45 percent of workers filed a workers' compensation claim for their injuries (Ex. 26–1258). (For a more detailed discussion of these studies and a table summarizing them, please refer to Section VII of this preamble.) OSHA is including WRP in the standard to cure underreporting and to secure early reporting.

OSHA believes that existing State workers' compensation systems are not sufficient to encourage employees to report MSDs early and to cure this underreporting. As stated earlier, every State has a different workers' compensation system. In many States, obtaining workers' compensation for MSDs is difficult due to the different definitions of ''injuries'' or ''illnesses'' in the various States, the different State statutes of limitation, and the contentious litigation that is often associated with claims for compensation for MSDs. In addition, some States provide no compensation for some MSDs (see, *e.g.,* Virginia for rotator cuff tendinitis, epicondylitis, etc.). There is also another reason workers' compensation payments may not be adequate to ensure early employee reporting of MSDs. All States have waiting periods ranging from 1 to 7 days before an injury or illness is compensable under workers' compensation. Many employees cannot go even a few days without any pay. This is particularly true for many low-wage employees who live pay check-to-pay check. OSHA believes that existing workers' compensation systems are not adequate to ensure the effectiveness of MSD management.

Some stakeholders contend that WRP is not necessary because many employers do not currently reduce the pay or benefits of employees when they are placed on restricted work duty. OSHA agrees with these stakeholders that many employers with good ergonomics programs and generous benefits policies do not reduce injured employees' pay and benefits when they are given, for example, alternative duty jobs. Other stakeholders, however, have told OSHA that many employers do reduce pay in such cases. Some stakeholders have also said that to create an incentive to return to work quickly, employers may not allow employees to use sick leave if they develop a workplace injury or illness (see Ex. 23). Also, OSHA estimates that approximately 50% of businesses do not even have a sick leave policy (Ex. 26–1406). OSHA believes that these kinds of practices would significantly deter employee reporting and would persist if the ergonomics rule did not include WRP.

Does WRP violate section 4(b)(4) of the OSH Act? Several stakeholders contend that the WRP provision in the proposed rule violates section 4(b)(4) of the OSH Act because it would preempt, replace, and/or overwhelm State workers' compensation laws and systems.

Section 4(b)(4) of the OSH Act provides:

> Nothing in this Act shall be construed to supersede or in any manner affect any workmen's compensation law or to enlarge or diminish or affect in any other manner the common law or statutory rights, duties, or liabilities of employers and employees under any law with respect to injuries, diseases, or death of employees arising out of, or in the course of, employment. 29 U.S.C. § 653(b)(4).

Congress included section 4(b)(4) in the OSH Act for a number of reasons. First, the section is intended to bar ''workers from asserting a private cause of action against employers under OSHA standards.'' *Lead,* 647 F.2d at 1235. See also *Ben Robinson Co.* v. *Texas Workers' Compensation Comm'n.,* 934 S.W.2d 149, 156 (Tex. App. 1996) (''*Ben Robinson*'') (Section 4(b)(4) of the OSH Act sought ''to prevent injured workers from circumventing workers' compensation by claiming a private cause of action based on the OSH Act'' (citing *Pratico* v. *Portland Terminal Co.,* 783 F.2d 255, 265 (1st Cir. 1985))). Second, this section of the Act is intended to prevent any party in an employee's claim under workmen's compensation law or other State law from asserting that an OSHA regulation or the OSH Act itself preempts any element of State law. *Lead,* 647 F.2d at 1236. An employee thus cannot obtain relief under State law for a disablement that is not compensable under that law simply because an OSHA standard provides protection against that disablement. Similarly, when an employee is injured, the employer cannot escape liability under State law simply because OSHA has not regulated the hazard that caused the injury.

The D.C. Circuit has held that WRP does not violate the language or intended purposes of section 4(b)(4). See *Lead,* 647 F.2d at 1236; cf. Formaldehyde, 878 F.2d 400. In the *Lead* decision, the court squarely addressed the issue of whether a similar WRP provision violated section 4(b)(4). The WRP provision at issue in *Lead* required employers to maintain an employee's ''earnings and seniority rights during removal for a period of 18 months.'' *Lead,* 647 F.2d at 1230. In *Lead,* the opponents of WRP argued that WRP violated section 4(b)(4) because, in practical terms, WRP would ''wholly replac[e]'' workers' compensation (*i.e.,* federalize workers' compensation). *Id.* at 1234. Opponents claimed that WRP violated workers' compensation because it provided compensation before the point at which workers' compensation recognized the disability. *Id.* They also argued that WRP would render workers' compensation meaningless because disabled employees receiving full earnings under WRP would never seek workers' compensation. *Id.*

The court in *Lead* found these arguments unpersuasive. First, the court held that the section's prohibition against ''affecting'' or ''superseding'' workers'' compensation could not be read too broadly because all OSHA standards are meant in some way to ''affect'' workers'' compensation and ultimately to ''supersede'' it in the sense that they seek to ensure that employees are protected from injury and never have the need to seek such compensation. *Lead,* 647 F.2d at 1235. *Cf. Ben Robinson,* 934 S.W.2d at 156. The goal of this proposed rule is the same as the goal for the Lead standard: to ensure that employees are protected from developing MSDs and therefore have no need to seek workers' compensation.

Next, the court found that even if WRP were available, injured employees would have incentives to seek workers' compensation because: (1) Workers' compensation would reimburse them for the medical treatment expenses that WRP would not cover; and (2) WRP would only last for several months (*e.g.,* 18 months in the Lead standard; 6 months in the proposed rule), while workers' compensation would compensate them for longer periods of disability, and in certain cases indefinitely. *Lead,* 647 F.2d at 1235. The court's finding is particularly applicable to the proposed rule. Employees with MSDs would still have several incentives to seek workers' compensation. The only way employees with severe disorders could get reimbursement for medical expenses such as prescription medicines, physical therapy, and surgery, would be by filing a workers' compensation claim. (The proposed rule does not require that employers pay for the medical treatment costs, such as those for surgery or physical therapy, of employees who have covered MSDs.) In fact, employees with MSDs have an even greater incentive to file claims than employees covered by the Lead standard because the proposed rule limits WRP to 6 months (compared to 18 months for the Lead standard).

The court in *Lead* held that even if WRP has a ''great practical effect'' on workers'' compensation, it does not violate section 4(b)(4) as long as it ''leaves the state scheme wholly intact, as a legal matter.'' *Lead,* 647 F.2d at 1236. The proposed WRP provision does not touch the legal scheme of existing State workers' compensation laws, even though it may result in a reduction in workers' compensation claims and payments. The proposed WRP provision would not require States to cover MSDs that they have excluded from coverage. The proposed WRP provision would not require States to change the percentage of lost wages it will replace. The proposed WRP provision also would not change the legal tests for compensability; that is, it would not require that compensation be awarded when work ''contributed'' to the MSD if State workers'' compensation laws only allow it when work is the ''primary cause'' of the MSD.

The stakeholders who oppose WRP state that the *Lead* decision's reference to ''great practical effect'' is not applicable to the proposed WRP provision. They contend that the ''practical effect'' this provision would have is much greater than that anticipated by the *Lead* court. They argue that this standard, and thus the WRP provision, will cover a significantly greater number of employers and employees than previous OSHA standards. This means, they state, that a significantly larger number of employees will receive WRP. This degree of ''practical effect,'' they state, would either overwhelm workers'' compensation or render it meaningless or insignificant.

Although stakeholders are correct that the proposed rule is likely to cover more establishments than many other health standards, OSHA believes that these stakeholders overstate the ''practical effect'' that the proposed WRP provision would have on workers'' compensation as well as individual employers. While the median number of lost workdays for certain MSDs is quite high, as discussed in Sections IV and VII, the median number of lost workdays for all MSDs is 7 (Ex. 26–1413). Thus, in many cases the impact of WRP will be limited because a large percentage of MSDs resolve in a matter of days and many employers allow workers who must stay away from work or be on restricted work to use their sick leave for this purpose. By contrast, in other health standards, such as lead, it usually takes longer, for example, for blood lead levels to decline to acceptable levels. Once the ergonomics standard is final, the percentage of MSDs involving less than 6 days away from work should increase as employees are informed about the importance of early reporting, and employers implement better controls to reduce MSD hazards.

Second, as mentioned above, most MSDs resolve if employees are simply placed in alternative work duty during the recovery period. Where employers provide such work duty, only a very small number of cases ever require complete removal from work for any significant period of time. This suggests that the impact on workers' compensation will be much more limited than the stakeholders contend. Furthermore, as employers identify and fix problem jobs and employees are trained to report MSDs as early as possible, the numbers of injured employees requiring complete removal from work during the recovery period should decrease significantly. Companies that have implemented effective ergonomic programs report that lost-time/day injuries have decreased significantly or have been eliminated (Ex. 26–5; Ex. 3–147). In addition, the WRP provision itself is crafted to encourage employees to report signs and/or symptoms of MSDs as early as possible, thereby decreasing the number of employees with MSDs that will require complete removal from work.

Third, for many employers, WRP should have little impact. Many employers who have told OSHA that they already have an alternative duty program for employees with MSDs also said that they do not reduce employee pay when employees are placed on restricted work duty during the recovery period.

Finally, the type of ''practical effect'' many employers believe WRP will have on workers'' compensation systems is precisely the effect that the courts have said OSHA standards are intended to have. *Lead*, 647 F.2d at 1234–35. *Cf. Ben Robinson*, 934 S.W.2d at 156. The goal of WRP, as well as other provisions of the proposed rule, is to protect employees from suffering material impairment of health or functional capacity. Achieving that goal will result in reducing or eliminating the need to seek workers' compensation. This effect, however, does not violate section 4(b)(4) of the OSH Act. *Lead*, 647 F.2d at 1234–35.

Will WRP impose substantial economic hardship on employers? Some stakeholders argue that WRP will impose a substantial economic hardship on employers, especially small employers, because it will be so expensive to implement. Stakeholders argue that small employers will not be able to remain in business if they must provide employees with WRP.

OSHA is aware of the stakeholders' concerns, but the Preliminary Economic Analysis and Initial Regulatory Flexibility Analysis show that the proposed rule, which includes the WRP provision, is economically feasible for all of the industries that OSHA is proposing to cover, including small employers in those industries. Available data discussed above indicate that these stakeholders may be overstating the economic impact of the proposed rule. While the median number of lost workdays for certain MSDs is quite high, as discussed above, OSHA estimates that most MSDs do not result in any days away from work, and data on those that do indicate that half of all such reported MSDs (*i.e.*, lost workday MSDs) resulted in 7 or fewer days away from work (Ex. 26–1413). Once the proposed rule's provisions stressing the importance of early reporting become effective, the number of MSDs requiring more than 7 days away from work should decrease further. Thus, OSHA believes that the requirement to provide WRP will encourage employers to more quickly implement an effective ergonomics program (1) to detect MSDs, (2) to institute effective controls, and (3) to prevent other employees in the same job from developing a covered MSD. These actions will reduce the number and severity of MSDs, thus reducing WRP costs.

Will WRP be abused? Some stakeholders stated that WRP will be abused by employees. These stakeholders contend that MSDs are too difficult to reliably diagnose; thus, they contend that WRP will give employees an incentive to report injuries that occur ''off-the-job'' as injuries that are work-related. Certain stakeholders also fear that an employee could persuade an HCP to write a medical recommendation for six months of removal, even though the employee is not injured or not injured to the extent that such a period of removal is necessary.

OSHA has drafted the proposed standard to reduce any potential for employee abuse that may exist. First, OSHA is only requiring employers to maintain 90% of employees' after-tax earnings if they are removed form work entirely. If an employee is placed in work restrictions short of complete removal, the employer must maintain 100% of the employee's after-tax earnings. OSHA believes that this scheme provides little incentive for employees to persuade an HCP to write an unnecessary removal recommendation for six months or otherwise abuse WRP. To the contrary, OSHA believes that WRP will encourage employees to report signs and/or symptoms of MSDs as early as possible to avoid complete removal from work.

Second, OSHA emphasizes that employers have the ability to prevent abuse. Under the proposed rule, employers make the determination as to whether a reported MSD is covered by the standard, *i.e.*, whether the MSD is an OSHA recordable MSD and meets the screening criteria in § 1910.902. This gives employers the ability to prevent employees from receiving WRP benefits for injuries that are not work-related and covered by this standard. In addition, OSHA believes that implementation of an ergonomics program under this standard will decrease significantly any opportunity for abuse as MSD hazards are removed from the workplace.

Third, the proposed standard only requires that employers provide temporary work restrictions (and thus WRP) where necessary or when recommended by an HCP to whom the employee was referred by the employer. The employer need not remove the employee from work based only on a request made by the employee.

Fourth, when an employer refers an employee to an HCP and that HCP provides recommended temporary work restrictions, the proposed rule only requires the employer to provide the temporary work restrictions that the HCP actually recommends. This means that if the HCP recommends restricted duty, the employee is not entitled to time-off from work. Where employers provide the HCP with information and communicate with them about alternative duty jobs, OSHA believes that the HCP will be more likely to recommend restricted work activity than complete removal. Recent BLS statistics bear this out: since 1992, the percentage of restricted workdays for all occupational injuries and illnesses has increased by 50%, while the percentage of lost workdays has decreased by a substantial amount. This trend, which reflects the influence of return-to-work programs among other factors, shows no signs of abating.

Finally, the proposed standard does not require employers to provide WRP if they correct the hazards associated with the MSD such that there is no risk of harm to the employee during the recovery period. A workplace with hazard controls further reduces any potential for employee abuse associated with WRP.

For all of these reasons, OSHA believes that WRP will not provide employees with an incentive for abuse.

Part C—Alternatives

A number of stakeholders, including some who participated in the SBREFA process, and the SBREFA panel, have recommended that OSHA look at various alternatives to the proposed WRP provisions. OSHA has examined the following alternatives:

- Require employers to maintain 100% of an employee's after-tax earnings whenever the employee is placed on temporary work restrictions, including complete removal from work;
- Reduce the amount of time an employer would be required to provide WRP to an employee with an MSD;
- Propose a WRP provision that includes special provisions or an exemption for small businesses such as those included in the Methylene Chloride standard;
- Phase-in WRP over a period of time ranging from a number of months to as long as three years; and
- Require employers to provide employees with non-monetary incentives to report MSDs, instead of requiring WRP.

OSHA has carefully considered these alternatives. For the reasons that follow, OSHA has preliminarily decided not to include these provisions in the proposed ergonomics rule.

Require employers to maintain 100% of an employee's after-tax earnings whenever the employee is placed on temporary work restrictions, including complete removal from work. As stated, WRP requires employers to maintain 100% of an employee's after-tax earnings, plus full benefits, if the employee is placed on temporary work restrictions short of complete removal from work; however, if an employee is removed entirely from work, the employer must maintain 90% of the employee's after-tax earnings, plus full benefits. This differs from the WRP provisions in other health standards. In other health standards, OSHA requires that employers maintain an employee's full earnings, rights, and benefits when an employee is medically removed from work. See, *e.g.*, 29 CFR 1910.1025 (Lead); 29 CFR 1910.1027 (Cadmium). OSHA considered requiring employers to maintain an employee's full take-home pay and benefits whenever the employee is placed on any temporary work restrictions, including complete removal from work, but OSHA preliminarily has decided not to include this alternative in the proposed rule. As discussed in the Preliminary Economic Analysis (Ex. 28–1), this alternative would increase the costs of WRP by 36 percent.

OSHA believes that the proposed WRP provision provides the requisite economic protection to encourage employees to participate fully in the MSD management program. OSHA anticipates that few employees will require complete removal from work during the recovery period. For those few employees requiring complete removal, maintenance of 90% of their after-tax earnings (and full benefits), coupled with the cost savings from the elimination of such expenditures as commuting expenses, will provide them the requisite economic protection to effectuate the purposes of WRP: encouraging employee participation in MSD management. As stated, OSHA also believes that the proposed WRP design is uniquely suited to encourage employees to report MSDs as early as possible, a critical aspect of the proposed rule.

Reduce the length of time an employer would be required to provide WRP to an employee with an MSD. OSHA is proposing that employers may stop providing WRP benefits when the first of certain cutoff points occurs. The cutoff points are: the ability of the employee to return fully to the job; the successful control of the job; and, as a last resort, 6 months of WRP. OSHA considered reducing the length of time employers would have to provide WRP.

The vast majority of MSDs resolve in substantially less than six months. According to the Liberty Mutual Insurance Company, the largest workers' compensation insurer in the United States, 75% of all UEMSD claims in 1994 did not involve any days away from work and only about 11% of those involving lost workdays resulted in more than 6 months away from work (Ex. 26–54). This evidence indicates that most MSDs, if detected early, can be resolved very quickly. Even for CTS cases, the injury and illness with the highest number of median days away from work, the median number of days away from work in 1996 was 25 days, according to BLS (see Section VII). (The average number of lost workdays for CTS cases is likely to be higher since more than 42% of all CTS cases resulted in more than 30 days away from work.)

For claims for MSDs of the lower back, the most prevalent of all work-related MSDs, according to Liberty Mutual, the median number of days away from work was 7 days in 1996 (Ex. 26–54). Therefore, although the proposed rule provides 6 months of WRP protection, the evidence indicates that it is unlikely that 6 months would be the first cutoff event to occur.

However, there is also evidence that some employees may require an extended period to recover, and that a small percentage may require even more than 6 months. According to Liberty Mutual, for the one-quarter of the UEMSDs that did involve at least one day away from work, the average length of disability was 294 days and the median was 99 days (Ex. 26–54). One reason for the longer disability period may be that a high percentage of these cases involved surgeries, such as carpal tunnel release surgery, which would require a longer recovery period.

In other health standards that have WRP provisions, OSHA has set the length of WRP based primarily on its ''best estimate'' as to the rate (*i.e.*, time) at which employees will recover from the adverse health effect. In the Lead standard, the length of the WRP represented the rate at which employees with high blood-lead levels would naturally excrete lead if removed from lead exposure. See 43 FR 54354. 54469, November 21, 1978. Applying that principle, OSHA said in the preamble to the Lead standard that a maximum of 18 months was a reasonable and appropriate length of time, particularly since some workers had high blood lead levels: ''Very few workers should require longer than 18 months to decline to acceptable blood lead levels, and 18 months is not in excess of what some long-term lead workers may require.'' *Id.* at 54469.

The criterion OSHA applied in the Lead standard also supports OSHA's preliminary determination that employers should be required to provide up to 6 months of WRP for employees with MSDs, if necessary. According to BLS, 42% of all reported CTS cases involved more than 30 days away from work in 1992 (see Section VII). Data from Liberty Mutual confirm this. Liberty Mutual reported that for those UEMSDs involving lost-work time, the typical disability duration was more than 3 months (Ex. 26–54). Given these data, OSHA believes that the 6-month maximum time is reasonable because it would allow the majority of employees time to recover before losing WRP benefits. The six-month period is appropriate because this phase of the ergonomics rule is focusing on those jobs where employees have the highest numbers and rates of MSDs that are serious enough to result in days away from work.

In the Preliminary Economic Analysis, OSHA has provided preliminary cost estimates for three alternatives to the 6-month time period for WRP:

- A 3-month WRP provision;
- No WRP during the average workers' compensation waiting period (3 days);
- Providing WRP only for a limited number of days.

3-month WRP Provision. Cutting the WRP period in half to 3 months would reduce WRP costs somewhat. This alternative, however, would not cut the costs of WRP in half. This is because the vast majority of MSDs (75%) do not involve days away from work and the percentage of cases involving employees who are out of work for 3 months is not substantially less than the percentage out of work for 6 months. To illustrate, Liberty Mutual found that 89% of all workers' compensation indemnity cases for UEMSDs involved less than 6 months away from work, while 85% involved less than 3 months away from work—a difference of only 4% (Ex. 26–54).

If the WRP period were reduced to 3 months, however, many employees with UEMSDs that involve more than 3 months away from work would not receive WRP after the original 3 month period. According to Liberty Mutual, a majority of UEMSD workers' compensation claims resulted in more than 3 months away from work. In addition, the median number of lost workdays for these cases was 99 days and the mean was 294 days (Ex. 26–54). Thus, even looking only at UEMSDs, a 3-month WRP period would provide no WRP benefits after the first 3 months to more than 12% of all lost workday cases. This percentage of cases is hardly the equivalent to the ''very few'' cases of lead-poisoned workers who were estimated to need more than 18 months to recover. If the WRP period is significantly shortened, injured employees may have to return to their jobs before their condition resolves, which increases the likelihood of reinjury or aggravation of the MSD.

No WRP during the average workers' compensation waiting period (3 days). Under this option, WRP would not be provided until an employee has missed three days of work. All State workers' compensation systems have a waiting period. The waiting periods range from 1 to 7 days; most States have a waiting period of either 3 or 7 days. This alternative would not require employers to cover the expenses of an injured employee for the first 3 days, the average workers' compensation waiting period. While this alternative may reduce the costs of WRP somewhat, if adopted, it would reduce employee protection by 75%. Once again, this is because the vast majority of all reported MSDs involve no lost workdays or only a few lost workdays.

OSHA believes that, particularly for employees in low-wage jobs, this alternative would not achieve the goal of WRP: the early reporting of all MSDs. Stakeholders have told OSHA that workers in these low wage jobs are so fearful of the consequences of losing up to a few days of wages that they would not report MSDs or participate in MSD management if faced with the threat of this economic loss. Under this alternative, employers would not be prohibited from sending an employee with an MSD home after three days, even if an alternative duty job would be an effective way of managing the employee's recovery. While OSHA is aware that some employers currently pay employees during the State workers' compensation waiting period (see Exs. 26–23 through 26–26), stakeholders also said that a number of employers do not pay employees during this period, even if they are sent home (see Exs. 26–23 through 26–26). Some employers have policies to send any employee who reports an MSD home without pay for some number of days (see Exs. 26–23 through 26–26). Other employers told OSHA that they do not permit employees to use their sick leave to cover work-related injuries (see Ex. 23). These types of practices indicate that this alternative to the proposed WRP provision is unlikely to reduce employee fears of reporting MSDs early. Again, if employees do not report, it could result in increased harm to that employee and others in the same job. Indeed, this alternative would have the perverse effect of encouraging employees to wait until an MSD is serious enough to warrant more than three days away from work before reporting the MSD.

In only one standard has OSHA delayed the removal of injured employees and the application of WRP benefits. In the Formaldehyde standard, OSHA allows employers to wait two weeks before removing an employee from exposure. 29 CFR 1910.1048 (l)(8). In the preamble to that standard OSHA explained that the delay in removing employees was to give employers an opportunity to ascertain whether the signs or symptoms would subside without treatment or with the use of PPE and first aid (which imposes a barrier between the skin and the irritant). The two-week delay was based on evidence that the initial irritation exposure effects sometimes disappeared as employees became accustomed to working with compounds containing formaldehyde. The opposite exists in dealing with this hazard. WRP is particularly necessary at the onset of an MSD, because that is when the MSD is the least likely to result in permanent damage or disability. As exposure continues, MSD signs and symptoms get worse rather than abating (with the exception of initial work conditioning periods). As such, limiting WRP until after the employee has additional exposure to workplace risk factors could result in adverse health effects.

WRP only for a limited number of days. Under this option, WRP would only be provided for a limited number of days (*e.g.,* three, five, or seven days). This alternative is designed to provide protection for employees for the short period of time before workers' compensation payments begin.

As stated, the median number of lost-work days from MSDs is 7; thus, requiring employers to provide WRP benefits for three, five, or seven days may provide protection for some employees. At the same time, however, many MSDs are not resolved in those time periods. Even for those MSDs where the median number of days away from work is five, for example, statistically, 50 percent of those cases involve more than five days away from work. In addition, as indicated above, the median number of days away from work for CTS is 25 (see Section VII).

OSHA believes that this alternative would not provide the requisite protection to employees to encourage them to report MSDs early and to actively participate in MSD management. For those employees who have MSDs that do not resolve within the short time period called for by this alternative, this alternative leaves workers only with workers' compensation. In addition, many workers' compensation waiting periods extend beyond three or five days. For those employees in a state with a longer waiting period, if their MSDs do not resolve within the short time period covered by this alternative, they may be without any protection for several days (even though their injury may be covered by their State's workers' compensation system). The loss of even a few days pay is devastating to many employees. Furthermore, for those injured employees whose MSDs are not covered by their respective workers' compensation systems, this alternative would only provide protection for three, five or seven days. Because of this great financial strain, these employees may return to work too early, before their MSD is fully resolved, and reinjure themselves. OSHA believes that this alternative would have a chilling effect on early reporting of MSDs.

This alternative also reduces the employer's incentive to fix the job quickly. Under OSHA's proposal, one way an employer can avoid paying for WRP for 6 months is to fix the job so the injured employee can perform it. Under this alternative, however, the WRP payments would generally end before the employer is able to identify and fix the MSD hazards. Without that incentive, employers may opt for a longer timeline for controlling the job.

Apply Methylene Chloride WRP provision to small businesses covered by the ergonomics standard. The proposed WRP provision applies WRP universally to large and small employers. In this respect, WRP is similar to the WRP requirements in other health standards. See, *e.g.,* 29 CFR 1910.1025 (Lead); 29 CFR 1910.1027 (Cadmium); 29 CFR 1910.1028 (Benzene); 29 CFR 1910.1048 (Formaldehyde). To illustrate, the Lead standard applies the WRP requirements to all employers even though a substantial number of industries with lead exposures contain small businesses (*e.g.,* non-ferrous foundries, construction). In construction, for example, more than 75% of all establishments have fewer than 10 employees; however, the Lead standard (29 CFR 1926.62) applies to all employers, regardless of size. OSHA examined applying the feasibility limitations in the WRP provision in the Methylene Chloride standard to small businesses that would be covered by the ergonomics rule.

The Methylene Chloride standard allows small businesses to make a case-by-case analysis regarding the feasibility of WRP if one or more employees are already receiving WRP benefits and the employer is informed that removal is appropriate for a second employee. 63 FR 50712, 50717, September 22, 1998. If a second employee required removal while the first employee was being paid WRP benefits, the Methylene Chloride standard would not require the employer to remove the second injured employee from the job and pay WRP if:

> comparable work is not available and the employer is able to demonstrate that removal and the costs of extending [WRP] benefits to an additional employee, considering feasibility in relation to the size of the employer's business and the other requirements of the standard, make further reliance on [WRP] an inappropriate remedy * * *. *Id.* at 50730 (citing 29 CFR 1910.1052(j)(11)(I)(B)).

In each of the standards that have a WRP provision, the costs of the standards, including those of WRP, were found to be economically feasible for both large and small businesses in all affected industries. The same is true for the proposed ergonomics standard. The Preliminary Economic Analysis discussed below indicates that the proposed standard, including the 6-month WRP provision, is economically feasible for all industries. This is true even for very small businesses (those with fewer than 20 employees). OSHA's Preliminary Economic Analysis indicates that for very small businesses affected by the proposed standard, the impacts of the proposed rule are not likely to affect the viability of firms.

The WRP provision in the Methylene Chloride standard resulted from a settlement resolving several challenges to the final standard. OSHA and the parties to the settlement agreed that the WRP provision noted above was appropriate to the hazards posed by exposure to methylene chloride. The WRP provision agreed to in the settlement is limited to the unique characteristics of methylene chloride exposure. OSHA does not believe that a similar WRP provision would be appropriate here.

Delay or phase-in implementation of the WRP provision. OSHA also considered delaying or phasing-in implementation of WRP, perhaps by up to three years. The proposed standard does not delay or phase-in implementation of either MSD management or WRP. OSHA believes that, because so many workers already are experiencing MSDs every year, it is critical that both MSD management and WRP be implemented as soon as possible. Delaying WRP could result in serious damage or disability for employees who have MSD signs and symptoms but fear severe economic loss if they report an MSD. Moreover, if WRP were delayed for the recommended 3 years, as many as 1.8 million employees that are likely to have lost-workday MSDs over that time period would not have WRP protection. While OSHA acknowledges that some of these employees may be able to use sick leave pay during a recovery period, many employers either do not offer sick leave or prohibit employees from using sick leave for work-related MSDs. In fact, delaying the implementation of WRP could result in injured employees receiving less protection than they currently have. For example, employers who currently do not reduce the wages of employees on restricted duty would not be prohibited from changing their policies in the future, particularly since reports of MSDs will, after the standard's effective date, impose costs on employers for job analysis and control.

With regard to phasing-in WRP, some members of the SBREFA panel recommended that the phase-in be done according to establishment size, that is, phase-in large employers first and delay implementation of WRP for small businesses. However, such a phase-in would not be consistent with past OSHA practice (Ex. 23). The Lead standard is the only rule in which WRP has been phased-in. In that standard, OSHA determined that phase-in was necessary because seriously elevated blood levels were so persistent in the lead-using industries that removal presented feasibility problems:

The weight of the evidence in the lead record demonstrates that immediate imposition of the entire ultimate [WRP] program is not feasible. Put simply, existing worker blood lead levels are so high that major segments of the lead industry would have to immediately remove at least 25 percent to 40 percent of their productive work force from lead exposure. Sufficient transfer opportunities would not exist thus extensive layoffs would result with accompanying [WRP] costs.

* * * * *

OSHA is persuaded that several industry segments could not reasonably be expected to comply with an immediate imposition of the overall [WRP] program. 43 FR 54354, 54452, November 21, 1978.

Given this, OSHA decided to phase-in WRP based on the severity of employees' blood lead levels. By contrast, there is no evidence that immediate implementation of WRP in the ergonomics standard would present feasibility problems for employers, even for very small employers. The Preliminary Economic Analysis indicates that it would be feasible to apply the WRP provision to all covered employers. The Preliminary Economic Analysis shows that the proposed standard will neither affect the economic viability of any industry as a whole, nor of the small or very small establishments in those industries.

Delaying or phasing-in WRP would also render the proposed standard's hazard identification system ineffective. The hazard identification system in the proposed rule does not consist of assessing each job in the workplace to see if employees have excessive exposure to workplace risk factors. Instead, the hazard identification system is based on employees coming forward with reports of MSDs. In order for this hazard identification system to produce accurate results, it is essential that employees voluntarily come forward with their reports. However, if they fear severe economic loss for reporting, employees will not come forward. Phasing in WRP would have a chilling effect on employee's willingness to report MSDs and/or signs and symptoms of MSDs. This ''chilling effect'' will delay job hazard analysis and identification and the implementation of controls, subjecting employees to workplace risk factors and MSD hazards.

Finally, delaying or phasing-in WRP is not necessary to ease employers' transition because OSHA is already proposing to phase in all but the MSD management provisions of the standard. OSHA is proposing that employers be given a start-up time of up to 3 years to set up a full program and implement controls. These proposed start-up times are longer than the corresponding provisions in almost all other OSHA health standards. If job control is delayed while employers plan ergonomics changes and work those changes into their production cycle changes, it becomes even more important that employees not be without WRP protection in the interim.

Also, OSHA is proposing that general industry employers who are not brought under the scope of the standard until after all compliance deadlines have passed (*e.g.,* there are no covered MSDs among their employers until after compliance deadlines have passed) be given additional time to come into compliance. At that point, employers would have up to one year to put in controls and determine if their program is effective. This extension of compliance deadlines has not been included in other OSHA standards. In other standards, once the deadlines occur, employers must be in compliance from that point forward. For example, in many other OSHA standards, employers who build new facilities must be in compliance with OSHA standards from the very start (*e.g.,* the employer must be in compliance with the PEL when the facility first opens). This would not be the case under this proposed standard. Rather, employers in general industry are given additional time to come into compliance with the standard's requirements after an employee develops a covered MSD.

Use non-monetary incentives, instead of WRP, to increase employee reporting and participation in MSD management. OSHA also considered replacing WRP with non-monetary incentives for employees to report MSDs.

OSHA decided to propose a WRP provision because non-monetary incentives do not appear to be working. Section 11(c) of the OSH Act already includes a prohibition against employers retaliating against employees who report MSDs and MSD hazards:

No person shall discharge or in any manner discriminate against any employee because such employee has filed any complaint or instituted or caused to be instituted any proceeding under or related to this Act or has testified or is about to testify in any such proceeding or because of the exercise by such employee on behalf of himself or others of any right afforded by this Act. 29 U.S.C. 660(c).

However, despite this provision, several studies show that MSDs are significantly underreported. Although the reasons for such underreporting are believed to be many (including, for example, unintentional and intentional discouragement by employers, failure on the part of employers and employees to recognize the work-relatedness of many MSDs), OSHA believes the fear of severe economic loss is one of the primary reasons for the underreporting. The proposed rule includes a provision prohibiting employers from having practices that discriminate against employees who make a report. Nonetheless, there is evidence that non-monetary incentives can result in increased rather than decreased underreporting.

A number of stakeholders have said that employers use various non-monetary incentives to achieve a safer and more healthful workplace (see Exs. 26–23 through 26–26; Ex. 23). Some of these incentives include recognition and nominal rewards (company caps, plaques) for reporting hazards or presenting ideas to fix problem jobs or reduce severity rates. These types of incentives can increase employee reporting. There are also other incentives such as ''safety bingo'' and bonuses for supervisors and/or employees reporting low numbers of injuries or no injuries. According to stakeholders, incentives of this second type can have the unintended result of pressuring employees not to report injuries or other problems. For example, in *Wilson* v. *IBP,* 558 N.W.2d 132, 143–44 (Iowa 1996), the court found that the defendants had engaged in the following conduct which could discourage employee reporting and result in discrimination of employees who did report an MSD:

[The registered nurse who was the plant manger of occupational health services] had another reason for responding to workers' injuries as she did. IBP had a financial incentive program, somewhat disingenuously called 'the safety award system.' As part of the safety award system, IBP recorded the number and severity of injuries and the number of work days missed by employees due to work-related injuries. Employees of the division with the lowest injury statistics received gifts or extra year-end bonuses. Through its financial incentives, the safety award system provided strong motivation for management to reduce the number of lost time days.

* * * * *

From the evidence in this record, a reasonable juror could have found the following: [the plant nurse] lied to Dr. Hamsa to keep him from referring [the injured employee] to a neurosurgeon, that IBP and [the plant nurse] would profit financially by getting workers back to work quickly (via IBP's safety award system), and that [the plant nurse] maliciously manipulated [the injured employee's] medical treatment for personal profit, knowing that he had an unstable disc in his back * * *.

A reasonable juror could also have found as follows: IBP actively sought ultra-conservative physicians to avoid surgery costs; it hired a staff of investigators to spy on injured employees, one of whom looked into [the injured employee's] apartment windows; workers who were uncooperative in the company's planned medical treatment were assigned by [the plant nurse] to a light duty job, watching gauges in the rendering plant, where they were subjected to an atrocious smell while hog remains were boiled down into fertilizers and blood was drained into tanks.

This climate of suspicion toward the legitimacy of injuries to workers and their treatment, well known to [the plant nurse], could be found by a reasonable juror to corroborate a finding of willful and wanton disregard for the rights and safety of [the injured employee].

At this point, OSHA has not been able to identify non-monetary incentives that would be as effective as WRP in encouraging employees to report MSDs early and in protecting employees who do come forward voluntarily.

Requests for Comment

OSHA requests information and comments on the WRP provision in the proposed standard. Specifically, OSHA requests information and comments on the alternatives to WRP discussed in this section as well as other non-monetary alternatives that would achieve the same goals and be as protective as WRP. OSHA is particularly interested in whether commenters believe that for WRP to be effective in encouraging employee participation in MSD management and encouraging early reporting, employees must be guaranteed 100% of after-tax earnings and benefits if they are placed on any type of temporary work restriction, or whether a guarantee of 90 percent or less is sufficient to accomplish this goal.

Program Evaluation (§§ 1910.936–1910.938)

Sections 1910.936–1910.938 of the proposed Ergonomics Program standard would require that employers evaluate their ergonomics program to ensure that it is effective. Good management, as well as common sense, suggest that periodic review of a program's effectiveness is necessary to ensure that the resources being expended on the program are, in fact, achieving the desired results and that the program is achieving these results in an efficient way. Additionally, program evaluation is a tool that can be used to ensure that the program is appropriate for the specific MSD hazards in the employer's problem jobs.

OSHA has long considered program evaluation to be an integral component of programs implemented to address health and safety issues in the workplace. For example, the Ergonomics Program Management Guidelines for Meatpacking Plants (''Meatpacking Guidelines'') recommend regular program review and evaluation (Ex. 2–13). These guidelines suggest that procedures and mechanisms be developed to evaluate the implementation of the ergonomics program and to monitor progress accomplished. Program evaluation is included in the Meatpacking Guidelines as a program component that involves both management commitment and employee involvement. OSHA's 1989 voluntary Safety and Health Program Management Guidelines also recommend regular program evaluation as an integral program component (Ex. 2–12). Furthermore, OSHA's Voluntary Protection Programs (VPP) and its Consultation Program also require periodic evaluations of an employer's safety and health program. The following discussion presents OSHA's reasons for proposing the three program evaluation provisions described below.

Section 1910.936 What is my basic obligation?

You must evaluate your ergonomics program periodically, and at least every 3 years, to ensure that it is in compliance with this standard.

Proposed section 1910.936 informs employers of their basic obligation. This section would require employers to ''evaluate [their] ergonomics program periodically, and at least every 3 years, to ensure that it is in compliance with this standard.'' This means that employers would have to, at a minimum, analyze the functioning of the ergonomics program, compare it to the requirements of this standard, and identify any deficiencies in the program. Employers would be required to make sure that the ergonomics program they have implemented controls the MSD hazards in the problem jobs in their workplace. A program designed for a large site with many different problem jobs, for example, is likely to be more formal and extensive than one designed for a small site with one or two problem jobs. Similarly, an ergonomics program that fits a manufacturing facility may not be appropriate for a work environment in the service sector.

Program evaluation goes beyond a mere inspection or audit of problem jobs. It must ask questions to determine whether the required ergonomics program elements have been adequately implemented and whether they are integrated into a system that effectively addresses covered MSDs and MSD hazards. Such questions include:

- Has management effectively demonstrated its leadership?
- Are employees actively participating in the ergonomics program?
- Is there an effective system for the identification of MSDs and MSD hazards?
- Are identified hazards being controlled?
- Is the training program providing employees with the information they need to actively participate in the ergonomics program?
- Are employees using the reporting system?
- Are employees reluctant to report covered MSDs or MSD hazards because they receive mixed signals from their supervisors or managers about the importance of such reporting?
- Is prompt and effective MSD management available for employees with covered MSDs?

Program evaluation, in other words, involves a review of how various aspects of an employer's ergonomics program are working together to ensure that employees are protected from MSD hazards.

Program evaluations can be conducted by those responsible for carrying out the employer's program, but evaluations performed by persons who are not involved in the day-to-day operation of the program are often even more valuable because these individuals bring a fresh perspective to the task. They can often identify program weaknesses that those routinely involved in program implementation may fail to see. In any event, it is important that the ergonomics program be evaluated regularly for effectiveness and that program evaluation be routinely integrated into the program.

The extent of the evaluation that would be required by proposed section 1910.936 will vary from one workplace to another. However, the basic tools of evaluation are the same, even though their application may range from informal to formal. These tools include:

- Review of pertinent records, such as those related to covered MSDs and MSD hazards;
- Consultations with affected employees (including managers, supervisors, and employees) regarding the ergonomics program; and
- Reviews of MSD hazards and problem jobs.

The records to be reviewed would include all available documentation of covered MSDs and MSD hazards. These records might include:

- The OSHA 200 log;
- Reports of workers' compensation claims;
- Reports of job hazard analyses and identification of MSD hazards;
- Employee reports to management of covered MSDs or, for employers with manufacturing or manual handling jobs, persistent MSD symptoms;
- Insurance company reports and audits; and
- Reports from any ergonomic consultants engaged by the employer.

If the employer has a written ergonomics program, it should be included in the review of pertinent records.

Some employers may have very few of these records and will have to rely on other methods to assess effectiveness. For example, under § 1904.15 and § 1904.16 of OSHA's recordkeeping regulation (29 CFR part 1904), employers with fewer than 10 employees and employers in certain low-hazard Standard Industrial Classification (SIC) codes are exempt from the requirement to maintain an OSHA log. Therefore, these employers will have fewer records for review and will need to place more emphasis on employee interviews and surveys of MSD hazards and problem jobs when they perform ergonomics program evaluations.

Record review can also reveal valuable information on the effectiveness of an ergonomics program when comparisons are made from year to year and trends are identified. For example, if an employer compares the list of MSD hazards during consecutive program evaluations and finds that the number of identified hazards has decreased over time, then the employer may conclude that the program's job hazard analysis and control activities have been effective. Similarly, a reduction in the number of covered MSDs from year to year suggests that the program may be effective. However, program evaluation must include consideration of the accuracy and reliability of the records under review. It is essential to be sure that the identified trends are real and not the product of underreporting, loss of interest, or carelessness. For example, a downward trend in covered MSDs or MSD hazards may indicate that employees are being discouraged from reporting or that the employees performing job hazard analysis and control are not adequately trained to do so.

Another essential tool in any ergonomics program evaluation is interviews of employees doing, supervising, or managing problem jobs at all levels of the organization. Interviews of employees are designed to elicit information on how well the ergonomics program has been communicated to the people who rely on it the most. If employees cannot explain what MSD hazards they are exposed to in the course of their work, do not know what steps their employer is taking to eliminate or control these hazards, are unclear about the procedures they should follow to protect themselves from these hazards, or do not understand how to report covered MSDs or MSD hazards, the hazard information and reporting and training components of the program are not working. If a supervisor is unclear about how to reinforce proper work practices, the management leadership and training components of the program need improvement. Similarly, if managers are not aware of the covered MSDs and MSD hazards employees are reporting and what corrective actions are being taken, the management leadership and training components of the ergonomics program should be improved. Because interviews allow the program evaluator to assess how the program is actually working, there is no substitute for direct input from employees in the evaluation process.

Program evaluation must also include a review of MSD hazards and problem jobs at the worksite. This review goes beyond inspection and analysis of problem jobs because it is concerned not only with identifying hazards but with identifying the ergonomic program deficiencies that resulted in the continuation of these hazards. If the program evaluation identifies problem jobs that have not been evaluated for ergonomic hazards, the job hazard analysis component of the program needs to be improved. Further, if a previously identified MSD hazard remains uncorrected, the evaluator should conclude that the job hazard control component of the program is not effective. Likewise, if a MSD hazard is identified and controlled in one part of the facility but the same job has not been properly controlled in another part of the facility, two program components may need attention: the management leadership component, which failed to coordinate and disseminate MSD hazard information throughout the facility, and the training component, which failed to provide the employees performing the job hazard analyses with adequate training.

Proposed section 1910.936 also specifies the frequency of the program evaluations. It would require ergonomics program evaluations to be conducted periodically and at least every three years. Given the diversity of workplaces covered by this proposed rule, OSHA has chosen a flexible approach for the frequency of program evaluations. In § 1910.945 of this standard, the section that defines key terms, OSHA defines periodically as meaning a process or activity that is ''performed on a regular basis that is appropriate for the conditions in the workplace.'' The definition of periodically further clarifies that ''the process or activity is conducted as often as needed, such as when significant changes are made in the workplace that may result in increased exposure to MSD hazards.'' It is OSHA's intention to reduce unnecessary burden while ensuring that program evaluations, which are essential to program effectiveness, are conducted at some minimal frequency.

OSHA believes that the employer is in the best position to determine how often the ergonomics program at a particular worksite needs to be evaluated to ensure its effectiveness. A site undergoing process or production changes, or one experiencing high turnover, may need more frequent evaluations to ensure program effectiveness.

Similarly, an increase in covered MSDs in the workplace should suggest that a program evaluation is warranted. In work environments with a stable workforce and work operation, program evaluations conducted once every three years may be sufficient.

Guidance on the frequency of ergonomics program evaluations is also available from other sources. For example, the Meatpacking Guidelines (Ex. 2–13) recommends semi-annual reviews by top management to evaluate the success of the program in meeting its goals and objectives. The NIOSH publication, titled Elements of Ergonomics Programs (Ex. 26–2), distinguishes between short-term indicators and long-term indicators for evaluating the effectiveness of controls. According to NIOSH, subsequent to the implementation of controls to eliminate or reduce MSD hazards, a follow-up evaluation is necessary to ensure that the controls were effective and did not introduce new ergonomic risk factors. The follow-up evaluation should use the same measurement tools, for example MSD hazard checklists or MSD symptom surveys, that were used to document the original problem job. NIOSH recommends that this follow-up evaluation take place no sooner than one to two weeks after implementation, with one month being the most preferable time interval.

Section 1910.937 What must I do to evaluate my ergonomics program?

You must:

(a) Consult with employees in problem jobs to assess their views on the effectiveness of the program and to identify any significant deficiencies in the program;

(b) Evaluate the elements of your program to ensure they are functioning properly; and

(c) Evaluate the program to ensure it is eliminating or materially reducing MSD hazards.

Proposed section 1910.937 provides employers with the procedures that would be required to evaluate the effectiveness of the ergonomics program. It answers the question: ''What must I do to evaluate my ergonomics program?'' Through this proposed requirement, OSHA intends to inform employers of the minimal evaluation procedures necessary to assess whether or not their ergonomics program is working.

Proposed paragraph (a) would require employers to ''consult with employees in problem jobs to assess their views on the effectiveness of the program.'' Additionally, employers would be required to consult with employees ''to identify any significant deficiencies in the program.'' OSHA believes that employee participation in the ergonomics program is critical for success, and the involvement of employees in program evaluation is just one more way that employees can take an active role in the program. A requirement that employers consult with employees regarding program evaluation is not unique to the proposed Ergonomics Program standard. OSHA promulgated a similar provision in the Respiratory Protection final rule (29 CFR 1910.134).

Employees in jobs that have been identified as problem jobs are in the best position to judge whether or not job hazard analysis and control measures are effectively reducing or eliminating MSD hazards. Perhaps even more importantly, they will be most knowledgeable about whether the implemented controls have introduced new, unintended MSD hazards to the job. By consulting with employees, employers can also have direct feedback on the effectiveness of other ergonomics program elements, such as opportunities for employee participation, hazard information and reporting, and training. OSHA is aware that employers sometimes act in good faith to implement ergonomics program elements, but that the actual result experienced by employees can differ markedly from the intention. Thus, by checking directly with their employees, employers can be sure that their ergonomics program resources are being effectively invested.

Through collaboration with their employees, employers will also have the opportunity for input on major program shortcomings. If an ergonomics program is not successfully reducing the incidence of covered MSDs or MSD hazards, employees in problem jobs will most likely have valuable information to share on identifying and correcting the program weaknesses. OSHA believes that employers should have the opportunity to access this input from their employees and use it, together with their own independently collected information, to improve the effectiveness of their ergonomics program.

Proposed paragraph (b) would require employers to ''evaluate the elements of [their] program to ensure they are functioning properly.'' These elements, as identified in this proposed Ergonomics Program standard, include:

- Management leadership and employee participation;
- Hazard information and reporting;
- Job hazard analysis and control;
- Training; and
- MSD management.

OSHA believes that employers are best able to determine which evaluation criteria for these elements are most appropriate for their workplaces. Additionally, OSHA believes that employers should be able to define ''functioning properly'' according to the specific characteristics of their problem jobs, in particular, and their work environment in general. Thus, OSHA has not proposed specific evaluation criteria or goals for each ergonomics program element.

Proposed paragraph (c) would require employers to ''evaluate the program to ensure it is eliminating or materially reducing MSD hazards.'' The intention of this proposed paragraph is to require employers to evaluate the overall effectiveness of their ergonomics program, in addition to evaluating the individual program elements, as required in proposed paragraph (b). The primary purpose for implementation of an ergonomics program is the elimination or material reduction of MSD hazards. Thus, OSHA would expect employers to establish evaluation criteria to assess success in meeting this goal. There are a wide variety of methods available to employers that will facilitate the observation of trends that document program performance. OSHA believes that employers are best able to determine the specific evaluation criteria that will most effectively tell the story of their efforts to eliminate and materially reduce MSD hazards.

Section 1910.938 What must I do if the evaluation indicates my program has deficiencies?

If your evaluation indicates that your program has deficiencies, you must promptly take action to correct those deficiencies so that your program is in compliance with this standard.

Proposed section 1910.938 informs employers of what to do if their ergonomics program has deficiencies. This proposed section would require that employers ''promptly take action to correct those deficiencies so that [their] program is in compliance with this standard.'' Deficiencies are findings that indicate that the ergonomics program is not in compliance with the standard because, for example, it is not successfully controlling MSD hazards or is not providing needed MSD management. Employers would be required to respond to deficiencies in the ergonomics program by identifying appropriate corrective actions to be taken, assigning the responsibility for these corrective actions to an individual who will be held accountable for the results, setting a target date for completion of the corrective actions, and following up to make sure that the necessary actions were taken. This proposed requirement will help employers to improve their ergonomics program on an ongoing basis.

In anticipation of concerns that employers will be ''liable'' if their evaluations reveal deficiencies, OSHA emphasizes that the Agency's primary goal is to protect employees from MSD hazards, not to hold employers liable for ergonomics program deficiencies. In fact, OSHA expects that in the process of complying with the requirements of this standard, most employers will find deficiencies in their ergonomics program at one time or another. OSHA's concern will be whether or not employers act on the information obtained during the program evaluation. Employers who act in good faith to correct identified program deficiencies will satisfy this requirement. On the other hand, employers who identify ergonomics program deficiencies through the evaluation process and then do not act on this information may not be in compliance with this requirement.

In order to provide employers with maximum flexibility, OSHA has not specified a time frame in which identified program deficiencies must be corrected. OSHA recognizes that the time needed to correct a program deficiency will vary according to many factors. Such factors include:

- The nature of the MSD hazard;
- Previous attempts to correct the problem;
- The complexity of the needed controls;
- The expense of the needed controls;
- Whether the hazard is a higher or lower priority in the list of identified program deficiencies; and
- The expertise needed to control the hazard.

However, OSHA expects that employers will use good faith efforts to correct program deficiencies as quickly as possible.

What Records Must I Keep? (§§ 1910.939–1910.940)

Occupational injury and illness records are a vital part of any ergonomics program. These records provide employers, employees, and consultants with valuable information on conditions in the workplace and can be used to identify trends over time and to pinpoint problems. Nevertheless, OSHA recognizes the need to reduce paperwork burdens for all employers, especially small employers, to the extent that this can be done without reducing safety and health protection. The proposal accordingly limits the records this proposal requires employers to keep. Also, the proposed standard limits the applicability of the proposed recordkeeping requirements to employers with 10 or more employees, which is consistent with the Act's emphasis on minimizing paperwork burdens on small employers.

OSHA is exempting employers with fewer than 10 employees from the proposed standard's recordkeeping requirements because, in these very small workplaces, information can be communicated and retained informally. Larger employers must keep records of employee reports of MSDs and the employer's responses to them; the results of job hazard analysis; records of Quick Fix controls; records of controls implemented in problem jobs; program evaluations; and records of the MSD management process.

The following paragraphs discuss the specific requirements of the recordkeeping sections of the proposed standard.

Section 1910.939 Do I have to keep records of the ergonomics program?

The proposal states, ''You only have to keep records if you had 10 or more employees (including part-time employees and employees provided through personnel services) on any one day during the preceding calendar year.'' In section 1910.939, OSHA is thus proposing to exempt employers with fewer than 10 employees from having to keep any records for this proposed standard. Most of the small business representatives on the SBREFA panel said that they would choose to keep records even if they were not required to do so (Ex. 23). However, OSHA's experience indicates that, because of the absence of management layers and multishift work, informal communication is effective and formal recordkeeping systems are not necessary in very small companies. A small establishment may have a very simple ergonomics program that does not need written records.

This section indicates that part-time employees and employees provided through personnel services must be included in the count of employees for the purpose of this section. These workers are personnel retained and supervised on a daily basis by an employer for a limited time, and they include personnel under contract, written or oral, with the employer. OSHA believes that these employees should be included in the count of employees because many employers today have workforces composed largely of part-time or temporary employees. If these employees were not counted toward the size threshold for recordkeeping, large workplaces that operate with few permanent employees but many temporary employees would not be required to keep records even though the workplace had several levels of management and complex methods of communication.

By ''any one day during the preceding calendar year,'' OSHA means that so long as there are fewer than 10 employees, including employer-supervised part-time and temporary employees, at all times during preceding one-year period, the employer is not required to keep written records under this proposed standard.

Section 1910.940 What records must I keep and for how long?

This proposed section describes the records of the ergonomics program that employers would have to keep. It reflects OSHA's preliminary conclusion that recordkeeping is necessary for employers to measure their progress in establishing an effective program and in controlling MSD hazards.

The proposed standard requires employers to keep records of employee reports, employer responses, the results of job hazard analyses and controls, records of quick fix controls, and MSD management records for the purposes of musculoskeletal injury and illness prevention.

The following paragraphs discuss the specific requirements of the recordkeeping section of the proposed standard.

Section 1910.940 What records must I keep and for how long?

This table specifies the records you must keep and how long you must keep them:

YOU MUST KEEP THESE RECORDS . . .	FOR AT LEAST . . .
• Employee reports and your responses	3 years
• Job hazard analysis • Hazard control records • Quick Fix control records • Ergonomics program evaluation	3 years or until replaced by updated records, whichever comes first
• MSD management records	The duration of the injured employee's employment plus 3 years

Note to § 1910.939: The record retention period in this standard is shorter than that required by OSHA's rule on Access to Employee Exposure and Medical Records (29 CFR 1910.1020). However, you must comply with the other requirements of that rule.

The period the employer is required to keep exposure and medical records (*e.g.*, MSD management records) under this proposed standard is much shorter than is the case for other health standards. Health standards generally require exposure records to be kept for 30 years and medical surveillance records to be kept for the duration of employment plus 30 years, as required by 29 CFR 1910.1020, Access to employee exposure and medical records. These lengthy retention periods are appropriate for many toxic substances and harmful physical agent standards because of the long latency between exposure on the job and the onset of disease. However, for ergonomic disorders, there is a shorter latency period than for many of the chronic conditions and illnesses covered by these other rules. Also, changes in the workplace may make old ergonomics records irrelevant to current jobs and the present workplace environment. An employer's ergonomics program will continue to evolve, with the most recent aspects of that evolution being the most relevant for employee protection.

The three-year retention period in the proposed standard coincides with the required frequency of program evaluations mandated by the proposed standard. OSHA believes that employers will use these records to perform the required evaluations of the effectiveness of their program under this standard, and that records prior to the last evaluation would be of little use.

A note to section 1910.940 states that employers must continue to comply with the other requirements of the records access rule (29 CFR 1910.1020; Access to employee exposure and medical records), although the proposed ergonomics program rule permits a shorter records retention period than would otherwise be required by the records access rule.

When Must My Program be in Place? (§§ 1910.941–1910.944)

Sections 1910.941 through 1910.944 propose both compliance start-up deadlines and provide future compliance deadlines for certain situations, *i.e.*, for employers who are ''triggered'' into the scope of the standard after the compliance dates have passed.

OSHA is proposing certain variations in the approach to compliance deadlines that differ from the approach taken in other standards. First, OSHA is proposing a long start-up period so employers have time to get assistance before the compliance deadline comes due. Second, even after the compliance deadlines come due, OSHA is proposing to give employers newly covered by the standard additional time to set up a program and put in controls in certain situations. In other OSHA standards, once the compliance deadlines have occurred, employers must be in compliance with the standard continuously, even on the first day they open a new facility. Third, OSHA is proposing to allow employers to discontinue large portions of their program if no further MSDs are reported for a period of time.

Section 1910.941 When does this standard become effective?

This standard becomes effective 60 days after [publication date of final rule].

Proposed section 1910.941 establishes the effective date of the standard. The effective date is the date on or past which the standard is in effect and the date from which the compliance deadlines in this section are counted. In addition, only covered MSDs reported after the effective would be covered by the ergonomics standard.

Section 1910.942 When do I have to be in compliance with this standard?

This standard provides start-up time for setting up the ergonomics program and putting in controls in problem jobs. You must comply with the requirements of this standard, including recordkeeping, by the deadlines in this table:

YOU MUST COMPLY WITH THESE REQUIREMENTS AND RELATED RECORD-KEEPING . . .	NO LATER THAN . . .
• MSD management	Promptly when an MSD is reported
• Management leadership and employee participation • Hazard information and reporting	[1 year after the effective date]
• Job hazard analysis • Interim controls • Training	[2 years after the effective date]
• Permanent controls • Program evaluation	[3 years after the effective date]

Note to § 1910.942: The compliance deadlines in this section do not apply if you are using a Quick Fix.

In § 1910.942, OSHA is proposing to give long phased-in start-up times ranging from one to three years for meeting various requirements of the ergonomics program standard. OSHA believes that the long start-up period is appropriate for several reasons.

First, OSHA plans to provide extensive outreach and consultation as soon as the final ergonomics rule is published. OSHA believes that the 3-year start-up period will allow employers to take full advantages of these materials and services, as well as those developed by others, without concern that enforcement action would already be underway.

Second, OSHA also believes that giving employers additional time to comply with the rule will reduce the compliance burden for small employers and will facilitate compliance for all employers. OSHA recognizes that it takes time to put an ergonomics program in place and that small employers, in particular, need additional time to learn about the details of the rule and how to implement it in their workplace. Small employers, in particular, should take full advantage of OSHA's outreach, compliance assistance, and consultation services in meeting the standard's requirements.

At the same time, this section would require employers to begin setting up their ergonomics program step by step so they will have an effective process in place by the time compliance comes due. Without phased start-up, OSHA is concerned that some employers may wait until the last minute to take action. The phase-in of compliance is also important to ensure that those employees who report MSD signs and symptoms during the start-up period are provided with prompt intervention (both MSD management and work restrictions) in order to help the problem resolve quickly and without permanent damage. Finally, the longer start-up period would also allow employers to work needed job modifications into their regular production change schedules or processes. Because the best way to control MSD hazards is often in the design process, allowing additional compliance time will allow establishments of all sizes to make needed changes to their processes as part of regular production changes, and thus to make those changes at less cost.

Finally, the phase-in compliance deadlines fit the structure of the proposed rule. The rule itself envisions two levels of ergonomics programs: a basic program (for manual handling and manufacturing jobs) and the full program, and the compliance start-up deadlines track those phases. The basic program addresses management leadership and employee involvement and hazard information and reporting. Accordingly, the compliance deadlines for these preliminary requirements occur first. Later compliance deadlines correspond with elements of the full program, which requires job hazard analysis, job controls, training, and program evaluation if a covered MSD is reported. (The MSD management deadline is also consistent with this approach. The first start-up deadline for MSD management requires that MSD management be put into place ''promptly when an MSD is reported.'')

The proposed standard does not contain different compliance deadlines for small and larger employers, because OSHA believes that the proposed deadlines already build in enough time even for very small employers to get information about the rule and ways to implement an ergonomics program. OSHA also believes that the 3-year period is adequate for larger employers who may have more complex processes, more employees, more problem jobs, and more controls to implement.

Section 1910.943 What must I do if some or all of the compliance start-up deadlines have passed before a covered MSD is reported?

If the compliance start-up deadline has passed before you must comply with a particular element of this standard, you may take the following additional time to comply with that element and the related recordkeeping:

YOU MUST COMPLY WITH THESE REQUIREMENTS AND RELATED RECORD-KEEPING . . .	WITHIN . . .
• MSD management	5 days
• Management leadership and employee participation • Hazard information and reporting	30 days (In manufacturing and manual handling jobs, these requirements must be implemented by [1 year after the effective date])
• Job hazard analysis	60 days
• Interim controls • Training	90 days
• Permanent controls • Program evaluation	1 year

Note to § 1910.943: The compliance deadlines in this section do not apply if you are using a Quick Fix.

In section 1910.943, OSHA is proposing to give additional compliance time to those employers who do not have any problem jobs until after some or all of the compliance deadlines established in § 1910.942 have passed. This is because the first occurrence of an MSD in a job is unpredictable and may not occur until years after the standard is in effect.

The additional time OSHA is proposing is appropriate in those situations in which employers who do not have any covered MSDs reported until after certain deadlines have passed. The standard permits employers who do not have manufacturing or manual handling jobs to refrain from implementing an ergonomics program until after a covered MSD is reported. Even for employers who have manual handling or manufacturing jobs, extended dates are needed for the requirements that would not be triggered until after a covered MSD occurs.

OSHA believes that the additional time this section proposes is reasonable. This section would require that employers take certain critical preliminary actions very quickly after a covered MSD occurs (*i.e.,* provide MSD management within 5 days, analyze the job with 2 months and put in at least interim controls within 3 months). At the same time, it would allow employers up to a year to get effective permanent controls into place. OSHA believes this time period would be sufficient to allow employers to use the standard's incremental process of trying out one or more controls first to see if they work before moving on to other controls. Finally, to ensure that the additional time is reasonable in those cases in which some of the compliance deadlines have passed, this section would allow employers to comply by the compliance deadlines in this section or those in section 1910.942, whichever comes later.

Section 1910.944 May I discontinue certain aspects of my program if covered MSDs no longer are occurring?

Yes. However, as long as covered MSDs are reported in a job, you must maintain all the elements of the ergonomics program for that job. If you eliminate or materially reduce the MSD hazards and no covered MSD is reported for 3 years, you only have to continue the elements in this table:

IF YOU ELIMINATE OR MATERIALLY REDUCE THE HAZARDS AND NO COVERED MSD IS REPORTED FOR 3 YEARS IN . . .	THEN YOU MAY STOP ALL EXCEPT THE FOLLOWING PARTS OF YOUR PROGRAM IN THAT JOB . . .
A manufacturing or manual handling job	• Management leadership and employee participation, • Hazard information and reporting, and • Maintenance of implemented controls and training related to the controls.
Other jobs in general industry where a covered MSD had been reported	• Maintenance of controls and training related to the controls.

In section 1910.944, OSHA is proposing to allow employers to discontinue some significant portions of their ergonomics program when no covered MSD has been reported in a problem job for 3 years after the problem job was controlled. OSHA is proposing this provision because, where employers have implemented controls and those controls have eliminated or materially reduced the MSD hazard to the extent that a covered MSD is not reported for several years, it is reasonable to conclude that the physical work activities and conditions in that job are no longer reasonably likely to cause or contribute to an MSD. When this level of control has been reached, OSHA believes it is appropriate for employers to focus their efforts on maintaining the controls that have corrected the problem (along with the training related to those controls).

OSHA is proposing a 3-year time period to coincide with the timing of other requirements of the proposed standard. For example, in the proposed rule periodic program evaluation must be done every three years, and the start-up deadlines for implementing permanent controls and initially evaluating the program is 3 years. OSHA believes that employers should only be permitted to discontinue parts of the program where permanent controls have been implemented and an evaluation of the program and controls shows that the program and controls have been effective in eliminating or materially reducing the MSD hazards in the job. Without this type of information, employers would not have the knowledge and information necessary to make a determination about whether another MSD is reasonably likely to occur. Allowing employers to discontinue certain elements only after a program evaluation has been done will help to ensure that the employer's decision is based on knowledge that the MSD reporting system has been effective, that the job hazard analysis did identify all of the MSD hazards, and that the permanent controls are in place and working.

If a covered MSD has not been reported in a problem job for 3 years, employers would only be required to maintain the controls in the problem job (including the training related to those controls) and to continue those elements of the program they must have even where no covered MSDs have been reported. Employers with manufacturing and manual handling jobs would be required to implement the management leadership and employee participation, and hazard information and reporting elements of the program. Employers with jobs other than manufacturing and manual handling would not be required to do anything beyond maintaining the controls (and related training).

Definitions (§ 1910.945)

Section 1910.945 What are the key terms in this standard?

The proposed ergonomics program standard includes a number of definitions which should be consulted to properly understand the terms used in the standard. Most of the definitions are straightforward and self-explanatory. Clarification of many terms is provided in the summary and explanation of the sections where those terms are used. Other definitions are explained in greater detail in the following paragraphs.

Musculoskeletal disorders (MSDs) are defined in the proposal as injuries and disorders of the muscles, nerves, tendons, ligaments, joints, cartilage and spinal disks. Examples of some of the more frequently occurring occupationally induced MSDs are given in the definition. These are medical conditions that generally develop gradually over a period of time, and do not typically result from a single instantaneous event. This definition specifically states that MSDs do not include injuries caused by slip, trips, falls, or other similar accidents. They can differ in severity from mild periodic symptoms to severe chronic and debilitating conditions.

No cost to employees means that the employer must bear any costs associated with the proposed requirements. Employees must be compensated at their regular rate of pay for time spent receiving training and medical management, or obtaining personal protective equipment. Where these activities require employees to travel, the employer must pay for the cost of travel, including travel time when the activities are not scheduled during the employee's normal work hours. The intent of this definition is to include any financial or other cost which, if borne by the employee, would serve as a disincentive to participating in the proposed rule's training, medical management, and personal protective equipment activities.

Periodically means on a regular basis appropriate for the conditions in your workplace, or as needed. The proposed standard would require that certain activities occur periodically; these activities include hazard identification, evaluation of the ergonomics program and the effectiveness of controls, and provision of information and training. The term periodically does not establish a specific frequency that is acceptable for conducting these activities; rather, the activities must be performed as often as necessary in order for them to be effective in the particular workplace in question. In some work environments with relatively few MSD hazards and little or no change in the work process over time, for example, refresher training may be adequate if performed every three years. A workplace with more substantial hazards or more complex controls may require training at more frequent intervals to ensure employee retention of information. If significant changes to the job occur, if new MSDs or MSD hazards are identified in the job, or if unsafe work practices are observed, then additional training would be necessary. The same performance orientation would apply to the other activities that the proposed standard would require to be provided periodically.

Physical work activities include any movements of the body or any static exertion involved in performing a job. This term is intended to cover all activities that have the potential to stress or strain muscles, nerves, tendons, ligaments, joints, cartilage or spinal disks.

Work restrictions are limitations prescribed by the employer, other qualified individuals, or health care professional on the work activities of an employee who is recovering from a MSD. Work restrictions are designed to prevent the employee from futher exposure to the MSD hazards that gave rise to the covered MSD. Work restrictions may involve limitations on activities the employee is permitted to perform in the current job, assignments to an alternative job (light duty), or complete removal from the workplace.

V. Health Effects

Activity-related disorders of the musculoskeletal and neuromuscular systems, acquired in the course of adult working life, are common in the population. Unlike acute injuries, these chronic conditions usually cannot be attributed to a single traumatic event. Instead, they often result from repeated episodes of exposure to causal and exacerbating factors.

The purpose of the Health Effects Section is to summarize knowledge in the field of musculoskeletal disorder (MSD) etiology and provide an overview of the multidisciplinary evidence that has established the relationship between work and these disorders. This body of evidence also provides the basis for the growing literature of intervention studies. These studies demonstrate the practical value of applying this well-established etiological knowledge to the reduction of the incidence of musculoskeletal disorders.

A more complete analysis of the studies underlying OSHA's Health Effects section is identified as Exhibit 27–1 in the docket for this rulemaking, (Docket S–777).

Following this introduction are five sections detailing the concepts of risk factors and their effects:

- Section A, Issues of Causation. This section discusses the etiology of MSDs and describes the multifactoral causation and exacerbation of MSDs by exposure to workplace risk factors, the role of personal factors and pre-existing disease, and medical and diagnostic issues.

- Section B, Biomechanical Risk Factors for MSDs. This section begins with an examination of the epidemiological criteria used to strengthen the argument for a causal relationship between a risk factor and an adverse health outcome. This is followed by a discussion of the basic biomechanical risk factors and modifying factors involved in MSD etiology.

- Section C, Evidence for the Role of Basic Risk Factors and Modifying Factors in the Etiology of MSDs. This section presents an overview of three bodies of evidence supporting the causal relationship between these risk factors and disease development: epidemiological studies, laboratory/medical studies, and psychophysical research. The Health Effects Section demonstrates that the sheer volume of evidence, plus the congruence of evidence from very different research traditions, makes a very strong case implicating of workplace biomechanical risk factors in the causation and/or exacerbation of MSDs. The Appendices provide a more detailed treatment of this evidence.

- Section D, Pathogenesis and Pathophysiologic Evidence for Work-Related MSDs. This section presents an overview of the mechanisms through which the risk factors detailed in Section B may cause physiological alterations, anatomical alterations, and disease in different types of soft tissues. Because one of the criteria useful in establishing a causal relationship between a risk factor and disease is the existence of a plausible biologic mechanism, the pathophysiological evidence in this section is an important link in the argument establishing such a relationship between workplace exposures and MSDs. Some redundancy exists between this generic discussion of risk factors and target tissues and the site-specific disorders examined in the Appendices. However, the goal is to underline common exposure and injury patterns without trivializing the complexity of tissue function and remodeling in disease and in health. For example, the ligamentures of the knee and the carpal bones are highly dissimilar in function and structure, requiring both generic and site-specific discussion.

- Section E, Glossary and List of Acronyms. This section provides definitions of terms and acronyms used throughout the document.

These basic overview sections are supported by set of Appendices (Ex. 27–1) that present, in much greater detail, the evidence linking workplace risk factors to outcomes of musculoskeletal disease:

- Appendix I, Epidemiology of MSDs, examines in more detail the epidemiologic evidence for work-related causation and exacerbation of MSDs. The Appendix begins with a summary of the NIOSH publication Musculoskeletal Disorders and Workplace Factors and continues to detail research in specific body areas. This section also contains a detailed overview of individual factors associated with work-related MSDs.

- Appendix II, A Review of Biomechanical and Psychophysical Research on Risk Factors Associated with Upper Extremity Disorders, details laboratory and psychophysical studies as well as the value of using biomechanical modeling to estimate risk associated with low-back and upper-extremity disorders.

- Appendix III, Pathophysiology of Regional MSDs, examines the pathophysiology of common MSDs by body region.

The Health Effects Section focuses on research in which investigators have found sizable and consistent results associating clinical disorders, such as chronic low back pain and injuries to muscle-tendon units in the forearm, with identifiable (extrinsic) work characteristics such as force and posture. There is less attention to conditions in which personal (intrinsic) risk factors or underlying disease status predominate, or in which there is conflict over disease etiology. However, there is widespread agreement in the literature that workplace risk factors play the major, although not the only, role in the development of work-related MSDs.

The Health Effects Section concentrates on external factors or stressors, because this is where the causes of human disease and discomfort in the workplace have been most clearly identified and where interventions have produced the greatest reduction in injury and illness. Intrinsic or personal factors, such as anthropometry, gender, age, physical conditioning, and general health are treated within each major subject area, where appropriate. Intrinsic predispositions are treated as modifiers of effect, reflecting the variability of their influence and the primacy of the basic risk factors.

The case of aging provides an example. The important body of information on physical performance and injury risk evolving from Finland (Tuomi, 1997) invalidates the notion of a simple relationship between dysfunction and age, even when the complex issues of survivorship are taken into account. Further, it is difficult to separate the effects of aging from the effects of years of exposure to workplace risk factors. The ergonomic literature in general, and the materials cited in this section specifically, have not been designed to explore associations between subtle predisposition and observed risk. Moreover, much of the literature on acquired physical injury has identified particular patterns of susceptibility within each age stratification (Krause *et al.,* 1997).

Finally, the Health Effects Section concentrates on well-recognized studies and common disorders, and does not address the more unusual disorders and patterns of injury. The study of MSDs is an evolving field that requires improved and broad-based surveillance techniques to identify less common patterns of association between exposure and disease. However, the body of evidence in this Health Effects section makes a convincing case for the work-relatedness of many MSDs and the effectiveness of interventions designed to reduce the risk factors that caused the MSD in the first place.

A. Issues Of Causation

1. Multifactoral Causation and Exacerbation by Extrinsic Risk Factors at Work

MSDs usually result from exposure to multiple risk factors (Putz-Anderson, 1988; Kourinka and Fourcier, 1995, Ex. 26–432; Bernard and Fine, 1997, Ex. 26–1), with the possible exception of vibration-related disorders, which are discussed in Section D. The present state of knowledge does not allow a clear determination of whether these multiple risk factors act additively or synergistically (*i.e.,* in a true, multiplicative interaction) within the workplace, although some studies suggest the latter (*e.g.,* Silverstein, Fine, and Armstrong, 1986, 1987, Exs. 26–1404 and 26–34). The combination of this multifactoral causation, lack of knowledge about interaction, and the unavoidable difficulty of studying risk factors in isolation makes it difficult to determine a numerical limit for a given type of biomechanical exposure.

A more practical approach, accepting the intricate interplay of risk factors in MSD causation, may be to simultaneously assess all the risk factors in a given workplace. Punnett (1998) has demonstrated the effectiveness of predicting MSD prevalence using an exposure index that combines assessment of multiple risk factors: work pace, grip force, postural stressors, contact (compressive) stress, vibration, and machine-pacing of work. This research found that the prevalence of MSDs (whether defined by symptom reports or physical examination) increased markedly as the number of risk factors contributing to the index increased. The obvious corollary is that multifactoral interventions will reduce MSD incidence more effectively than interventions targeting only a single risk factor or a small subset of the risk factors actually present in the workplace.

2. Multifactoral Etiology and Other Contributions to MSD Causation and Exacerbation

The concept of multifactoral etiology of MSDs can easily lead to confusion. Various literatures define the concept in at least three different ways, as follows:

- ‘‘Multifactoral etiology’’ means that MSDs generally result from simultaneous exposure to, and often synergy among, several different risk factors—*e.g.,* high force requirements and awkward postures. (This is the meaning of ‘‘multifactoral’’ in Section A.2.a above.)
- ‘‘Multifactoral etiology’’ means that MSDs often result from exposure to and interplay between both work and non-work risk factors, although work factors are the greater influence in most cases (see Section A.2.b below).
- ‘‘Multifactoral etiology’’ means that MSD incidence and severity are affected by personal characteristics (physiological susceptibility and repair capacity, anthropometry, psychological characteristics, level of fitness, etc.) and underlying or preexisting disease (see Section A.2.b.ii below).

This Health Effects Section primarily uses the first of these definitions, which focuses on the contribution of multiple risk factors in the workplace to MSD etiology. Because the other two definitions can complicate the establishment of worksite MSD causation, the contribution of non-work exposures, personal (intrinsic) factors, and underlying or preexisting disease are briefly addressed here. Other parts of the Health Effects Section address issues of work-relatedness in detail, by specific body location, and also discusses personal factors where appropriate.

a. Non-Work-Related Risk Factors. The risk factors presented in Section B are not encountered solely in the work environment. Non-work risk factors obviously may contribute to disease causation, but they are as likely to exacerbate existing or work-related disease as to cause new disorders. Most non-work activities are not performed with the duration or intensity, or under the time constraints characteristic of occupational exposures. In addition, certain industries, such as meatpacking (OSHA, 1990, Ex. 26–3), demonstrate disease clusters and rates of disease that are substantially above population background rates and rates found in other industries. Franklin *et al.* (1991, Ex. 26–948) reviewed Washington State workers' compensation claims from 1984 to 1988. These investigators found that, compared to industry-wide carpal tunnel syndrome (CTS) incidence rates, oyster and crab packers demonstrated a relative risk (RR) of 14.8 (95% CI: 11.2–19.5) and the meat and poultry industries had an RR of 13.8 (95% CI: 11.6–16.4). The recent NAS report (National Academy of Sciences, 1998, Ex. 26–37) concludes, ‘‘There is a higher incidence of reported pain, injury, loss of work, and disability among individuals who are employed in occupations where there is a high level of exposure to physical loading than for those employed in occupations with lower levels of exposure’’ (p. 23). The existence of these elevated rates, despite the random variety of non-work risk factors experienced by employees in all industries, suggests the primacy of workplace risks in MSD causation.

MSD genesis represents a complex combination (and possibly interaction) of exposures to work and non-work risk factors, modified by the individual's ability to tolerate physical job stress. It is not the intent of this document to attribute sole causation to the workplace, but to establish work-relatedness. Non-work exposures certainly contribute to disease, but OSHA's mandate to create a safe and healthy workplace does not require that the only diseases to be controlled are those caused solely by work. Since the goal of the Health Effects Section is the clarification of workplace risk factors involved in MSD causation or exacerbation, the epidemiological studies cited generally represent research carried out in occupational settings.

b. Personal Factors and Underlying Disease. The third meaning of ‘‘multifactoral,’’ which includes personal factors and pre-existing disease, is also generally beyond the scope of this document. Again, these factors are irrefutably implicated in MSD development and recovery, as factors that modify the body's response to external risk factors and its ability to recover from insult. But their presence in the equation of etiology does not remove the primary necessity to identify and control external, workplace-based risk factors.

Reparative Capacity of Individuals. The physiological effects of the risk factors and modifiers presented in Section D are themselves modified by the worker's individual capacity to accept and repair the damage caused. This capacity may be likened to the ability of the body to process a chemical exposure. Depending on the body's defenses, a given atmospheric concentration of toxin will result in cells and tissues receiving a particular dose of the toxin. Over time, this dose, modified by the body's capacity to detoxify and/or clear the substance and its metabolites, will result in a measurable body burden.

Although the analogy is simplistic, and other disease mechanisms are probable, it is possible to visualize certain effects of biomechanical risk factors through this model. An exposure to a biomechanical risk factor of given intensity, duration, and temporal profile can result in an internal ''dose'' that makes demands on the body's reparative capacity for ''detoxification'' of the dose. The cumulative trauma model suggests that the resultant ''body burden'' may be seen as partly the result of exposure and repair capacity. Armstrong *et al.* (1993) proposed a model (called a ''cascade'' model) of this process that also incorporates a staged series of challenges to the body. The body's response to a particular biomechanical ''dose'' can itself generate new physiological or anatomical stressors; the effectiveness of the body's response to these new stressors also depends partly on individual capacity. Likewise, pre-existing or underlying disease can also compromise reparative capacity as well as predisposing tissues to further injury.

The components of individual reparative capacity include:

• Genetic factors. These include basic inherited characteristics of the individual, such as body dimensions (anthropometry), physiological variables, and gender. Genetically based personal differences include variation in bone length and tendon attachment points (which affect the mechanical advantage of a muscle in a given posture), muscle mass and distribution of fiber types, laxity of ligaments, intervertebral disk cross-sectional area and nucleus fluidity, tendon size, and carpal tunnel size (Radwin and Lavender, NRC 1998, Ex. 26–37).

Gender may be seen partly as representing anatomical and physiological differences among workers (see summary in Faucett and Werner, 1998, Ex. 26–425). Women's anthropometry may not fit many jobs designed originally for the average male. It is important to understand, however, that gender is also a surrogate for a large complex of social and economic differences among workers, as well a differences in exposure between males and females. Many of these differences influence patterns of disease and recovery (Messing, Chatigny, and Courville, 1998a, Ex. 26–566; Messing *et al.*, 1998b, Ex. 26–300).

• Acquired characteristics. Acquired characteristics include physical conditioning, previous or concurrent disease status, and the effects of aging. The aging process is strongly influenced by both genetic and acquired characteristics. In any case, OSHA's mandate to assure a safe and healthy workplace is not limited to workers below an arbitrary age threshold but encompasses workers of all ages. Acquired characteristics can modify some genetically based characteristics. For example, type and intensity of exercise can alter muscle mass and fiber type distribution. Likewise, a worker's level of skill and work habits can substantially affect the impact of biomechanical stressors on body tissues.

It is important to recognize that the effects of risk factors and modifiers found in the work environment are modified at the individual level by these personal factors. However, the primary purpose of job analysis and workplace interventions is to make work safe for as many workers as possible. Hence, this document considers the measurement, characterization, and reduction of work environment risks and modifiers to be the most important objective of the ergonomics program rule.

Work Techniques and Skill Level. Personal factors also include work technique and skill level. In some situations, the predominant factors influencing MSDs are individual anatomy, work style, posture, and technique. For example, the well-recognized upper extremity disorders of sign language interpreters (Feuerstein and Fitzgerald, 1992, Ex. 26–1284), or the hand problems of musicians (Amadio and Russotti, 1990, Ex. 26–925; Fry, 1986, Ex. 26–850), are usually addressed on an individual (intrinsic) basis, because either no tool is involved, or the potential for tool modification is limited.

Other situations clearly preclude addressing problems on an individual basis. For example, the vascular and neurologic problems produced by hand-arm vibration occur with such high attack rates and predictability that an effective control strategy necessarily addresses the tool and extrinsic exposure rather than individual susceptibility (Pyykko 1986, Ex. 26–662). In some industries, such as meatpacking, hand and wrist problems have been so prevalent and associated so strongly with particular tasks that identifying cause in a work process is unambiguous (Schottland *et al.*, 1991, Ex. 26–1001; Masear, Hayes, and Hyde, 1986, Ex. 26–983).

In still other settings, the multi-dimensional pattern of personalized risk factors, non-work risk factors, and external, work-related risk factors complicates etiology identification. As with other chronic and sub-chronic diseases, it may be difficult, and sometimes impossible, to differentiate between underlying morbidity and causative, exacerbating, or even disabling features (stressors) in the external environment.

3. Medical and Diagnostic Issues

The development of an ergonomics standard for U.S. workplaces poses specific challenges for disease identification. The relationship between MSDs and exposure to even well-recognized risk factors, such as heavy repetitive lifting and hand-arm vibration, poses different sets of challenges for the recognition of exposures and their control than has been the case for many more traditional workplace exposures and disorders. The inhalation of asbestos fibers, for example, has well-defined and accepted endpoints, such as lung cancer and mesothelioma, and intermediate health effects at the tissue or cellular level are less important objects of dust control. Formaldehyde and other irritants have immediate and recognizable effects on mucosa, so that overexposure is often obvious, and the parameters of acute effects and detection thresholds all fall within a limited range of measurements. Physical hazards such as noise and radiation are highly organ-specific or have universally accepted risk profiles. For such hazards, exposure assessment does not require significant attention to individual work factors or personal factors, or there may be a consensus test for disease (as for noise).

For MSDs, on the other hand, microanatomic injury and repair is often sub-clinical and generally invisible to clinical testing or surveillance measures. Although, the object of much active research, the relationship between sub-threshold injury and the onset of recognized clinical disorders is imprecisely understood. Because of regional and individual differences in diagnosis and treatment, disease recognition depends on professional practice, diagnosis, and treatment patterns.

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B. Biomechanical Risk Factors and Modifiers

1. Overview

This section has two purposes:

• To present a framework for and classification of major observable and quantifiable workplace risk factors for neuromuscular and musculoskeletal disorders (MSDs).

• To define and explain these risk factors and to briefly explore possible mechanisms by which exposure to these stressors could cause MSDs.

The section begins with a summary exploration of the issues involved in establishing a causal relationship between aspects of the work environment/process and musculoskeletal disorders (Section B.1). It then presents the classification scheme used in the section, with brief reference to possible mechanisms of effect. Sections B.2 and B.3 present current knowledge of the basic physical risk factors and modifying factors identified by epidemiological and laboratory research.

a. Epidemiological Criteria for Establishing Causation. Good epidemiology requires accurate and consistent identification and quantification of both exposure and outcome. In the rapidly evolving fields of research relevant to MSD etiology, there are still problems with measurement, quantification, and even recognition of particular risks and disease outcomes. However, the research referenced in this document demonstrates substantial agreement over a wide range of research methodologies concerning the causal association between a set of commonly recognized stressors and MSD outcomes.

The risk factors discussed in this section have been shown to cause or contribute to MSDs, in accordance with generally accepted criteria for assessing a cause-effect relationship.

The following list of such criteria (based on Hill, 1965, Ex. 26–376; Hennekens, Buring, and Mayrent, 1987, Ex. 26–428; Bernard and Fine, 1997, Ex. 26–1; Rothman and Greenland, 1998, Ex. 26–870) is not exhaustive but represents consensus in the field of epidemiology. Note that, with the exception of temporality, none of these criteria is a necessary or sufficient basis for determining causality: the absence of any criterion other than temporality in a study does not necessarily invalidate a causal hypothesis. But the presence of each factor, while not proving causality, does strengthen that hypothesis. Any given study may not satisfy each criterion, but the cumulative burden of evidence, from the many studies cited in this document, strongly argues for a causal relationship between the risk factors presented in this section and MSDs. These criteria are:

- The strength of the association. The larger the association, the less likely is an interpretation invoking undetected bias or unmeasured confounders. If bias or confounding are operative, they would have to be of a larger magnitude to explain the size of the association, making it less likely that the study would have overlooked them.
- Biological plausibility. Knowledge of a known or understandable proposed mechanism aids determination of causality.
- Consistency with other research. Similar results from independent studies, especially with different measurement techniques, strengthen a causality hypothesis.
- Temporality or appropriate time sequence. The proposed exposure (the risk factor) should be present prior to the proposed effect or outcome (here, indicators of MSDs).
- Dose-response relationship (biologic gradient). If higher levels of exposure are associated with higher levels of outcome, this can indicate causality. However, a causal relationship may exist but be hidden by a non-linear dose-response relationship. The presence of a dose-response relationship can also indicate a confounder with its own biologic gradient.

A sixth criterion, specificity of association, is often added to this list. This term refers to the degree to which a particular outcome is always associated with a particular risk factor. Because of the overwhelming evidence for multifactoral causation of MSDs, the specificity of association is low for most risk factors and musculoskeletal outcomes (Kourinka and Forcier, 1995, Ex. 26–432). Thus, this criterion is generally not useful in assessing causality in MSD etiology (with the possible exception of the specific association of vibration exposure with neurovascular disorders in the hands). In general, a specific risk factor can be associated with a number of different outcomes.

b. Classification of Risk Factors and Modifiers. As much as possible, the risk factor classification employed in this document uses the definitions and concepts defined by NIOSH in the publication, ''Musculoskeletal Disorders and Workplace Factors'' (Bernard and Fine, 1997, Ex. 26–1), combined with definitions and concepts developed in the draft ANSI ergonomics standard, Z–365 (1998, Ex. 26–1264). This discussion separates the risk factors into two basic families of concepts: basic risk factors and modifiers. The basic risk factors presented here are the aspects of work that most researchers agree cause or exacerbate MSDs. The modifiers are characteristics of a specific exposure to a risk factor that may affect the level or type of strain produced within tissues. Although there is a growing body of evidence linking psychosocial and work organization factors with the development of MSDs, those factors are not addressed here (other than the obvious impact of work organization on work pace). The following sections focus on the biomechanical or physical risk factors:

- Basic Biomechanical Risk Factors (Section B.2):

—Force
—Awkward Postures
—Static Postures
—Repetition
—Dynamic Factors
—Compression
—Vibration

- Modifying Factors (Section B.3):

—Intensity
—Duration
—Temporal Profile
—Cold Temperatures

Other classification systems are possible and valid. For instance, Kourinka and Forcier (1995, Ex. 26–432) present a broader system that links force, repetition, and duration as components of ''musculoskeletal load.'' Radwin and Lavender (in NAS, 1998, Ex. 26–37) and the ANSI draft standard Z–365 (1998, Ex. 26–1264) prefer to list repetition as a modifier or ''characteristic property'' rather than as a basic risk factor. The system used here represents one useful classification scheme; the component terms maintain essentially the same definition in any of the frameworks currently in use. Most importantly, these differences in classification are relatively trivial and do not affect the evidence showing that all of these factors are implicated in the etiology of work-related MSDs.

2. Basic Risk Factors

This section details the definitions, measurement issues, and some of the proposed effect mechanisms associated with basic biomechanical risk factors. No attempt is made to prioritize risk factors by importance, because the relative contribution of each stressor to MSDs depends on the particulars of the work environment and task structure, including the presence or absence of other risk factors. For instance, Radwin and Lavender (in NAS, 1998, Ex. 26–37) note that for a primarily static task, postural risks merit the closest attention in job analysis, while a dynamic manual material handling job requires more attention to dynamic stressors, such as range of motion, velocity, and acceleration of movement. Evidence for the relationship between these risk factors and MSDs is presented in detail in Section V.C of this preamble and the Appendices (Ex. 27–1). This section provides only cursory treatment of the mechanism of tissue injury attributable to these risk factors; Section V–C presents this aspect of MSD etiology in detail.

a. Force. Force is the mechanical effort required to carry out a movement or to prevent movement. Force may be exerted against a work piece or tool, or against gravity, to stabilize body segments. Force does not necessarily imply motion. The dynamic act of lifting a work piece and the static act of holding that work piece in position both require force, generated by muscles, transmitted through tendons, and exerted by body segments on the work piece. In determining the risk posed by force requirements of the task, it is useful to consider muscle force and output force of body segments separately.

Muscle Force. Muscle force is the actual mechanical effort exerted by the combined contraction of muscle fibers. The total force generated by any one muscle is a function of many factors, including the cross-sectional area of the muscle, the length of the muscle during contraction (*i.e.*, where the length range falls between full contraction and full extension), and the degree of fatigue. Research generally characterizes muscle force by surrogate measures of muscle activity (*e.g.*, amplitude of electromyographic [EMG] signals, generally expressed as a percentage of the amplitude measured at maximum voluntary contraction [MVC]). Because of the electrical activity associated with muscle contraction, muscle force is the most easily measured aspect of tissue involvement. But full characterization of potential tissue damage requires attention to all links in the pathway through which muscle force is transmitted to output force (Section 2.a). Thus, force requirements affect tension on tendons (which transmit muscle force to bones), shear force, friction, and irritation induced by lateral forces on tendons and tendon sheaths (as they are pressed against surrounding anatomical structures) and the strain at the insertion of tendons on bones.

Estimating muscle force from external characteristics of the task can be complicated compared to measuring muscle activity (such as taking EMG measurements with deep wire electrodes implanted directly in the muscle fibers of interest). First, many external job characteristics can affect muscle force requirements, and some of these characteristics may not be recognized in a job analysis. For example, Kourinka and Forcier (1995, Ex. 26–432) note several factors that affect muscle force required for a grip: presence of other risk factors (such as awkward postures required by grip type and handle size), the coefficient of friction of the work piece surface, whether gloves are required, and individual variations in technique.

Second, the lever arm (the distance from point of force application to the fulcrum—the joint center) for most muscles is generally much smaller than that of the external load (Radwin and Lavender, in NAS, 1998, Ex. 26–37). This means that muscle forces are usually several times greater than the external load. Thus, accurate modeling requires precise estimation or modeling of actual lever arm lengths.

Third, fatigue affects muscle fiber recruitment patterns within a single muscle, as well as recruitment (substitution) patterns of alternative muscles (Parnianpour *et al.,* 1988, Ex. 26–1150). When secondary muscles are recruited to assist a fatigued primary muscle, the recruited secondary muscles may be more vulnerable to injury due to less-advantageous lever arm length, smaller size, or less-than-optimal fiber length in the work posture (see Section 2.b).

Despite these difficulties, modeling approaches can often predict internal force requirements accurately. For instance, Marras and Granata (1997a, Ex. 26–1380) showed that measured pressures in the L5S1 intervertebral disk generally match values predicted by modeling. (Internal disk pressure is a result of forces exerted on the disk by muscles and gravity.)

Output Force. The force exerted by body parts to move or hold the work piece (often against gravity) is obviously a function of muscle force. However, the relationship is strongly affected by other variables, the most important being posture. Deviations from a so-called ''neutral posture'' (see Section 2.b) can dramatically reduce the amount of muscle force translated into output force. The ''lost'' force is generally seen in inefficient coupling of the contractile proteins in muscle fibers or in force exerted by muscles and tendons against adjacent anatomical structures as the force transmission changes direction. In addition, most holding and moving tasks involve input from several muscles, often working in opposition. Skilled, small-motor activities involve co-contraction of antagonist muscles to generate precisely graded movements, joint stabilization, or holding forces. Thus, substantial muscle activity can be associated with very little net output force. In addition, these co-contractile forces act additively on the joint components (ligaments, cartilage, and bone). For the researcher, this has important implications. For example, measurements of the weight of a work piece or the finger forces necessary to move a computer mouse may substantially underestimate the potential damage to the muscles, tendons, joints and other soft tissues involved.

Guidelines for manual materials handling (*e.g.,* Snook and Ciriello, 1991, Ex. 26–1008; NIOSH, 1981, 1994, Exs. 26–393 and 26–572) clearly note that the weight of the load, in isolation, is not a sufficient measure of musculoskeletal stress.

b. Awkward Postures. This risk factor is generally conceptualized as postures deviated from a neutral position. In this document, ''posture'' means the angle between two adjacent body segments. A so-called ''neutral posture'' angle can be determined for each joint. This term seems to suggest the resting position of the joint, but it actually encompasses two biomechanical criteria necessary for optimal development of muscle force:

- The biomechanical relationship of the two body segments that presents the largest lever arm upon which the muscle force acts.
- The length of the muscle that allows it to develop the greatest force most rapidly. For most muscles, the physiological and physical relationships between the two contractile proteins, known as the length-tension and the length-velocity relationships, mean that maximum force and speed of contraction can be developed when the muscle is in a position between greatest extension and greatest contraction.

However, the term ''non-neutral posture'' should only be seen as a first approximation of a stressful, awkward posture, for several reasons. First, neutral posture is generally defined in terms of muscle length, although joint angles have implications for other tissues: what is optimal for one tissue may not be the optimal joint angle for another. For example, a roughly 90-degree elbow angle satisfies both criteria above for optimal biceps activity. But that posture may stretch the ulnar nerve against the elbow, suggesting that a more open elbow angle is necessary for optimal nerve function and safety.

Second, most body exertions involve more than one muscle, each of which may be in optimal biomechanical and length relationship at a different joint angle. Third, the body can adopt postures that are not necessarily the optimal biomechanical or length-tension relationships for muscles, but that result in the lowest sum of muscle activation to stabilize body parts against gravity.

Fourth, non-neutral postures are sometimes defined in relation to their association with tissue damage, not to a biomechanically sub-optimal joint angle. For example, a 90-degree abduction of the upper arm may put some shoulder muscles (*e.g.,* the deltoids) in a relatively ''neutral'' posture, but can expose the brachioplexus to compressive forces from other muscles and anatomical structures. This posture can also entrap the tendon of the supraspinatus muscle between the acromion and the head of the humerus (Hagberg, 1984, Ex. 26–1271). To fully characterize the degree to which a posture is ''awkward,'' it is necessary to take an integrated overview of the tissues involved, defining which muscles and other tissues are involved in the position and what the implications are for tissue damage.

With these concerns in mind, Kourinka and Forcier (1995, Ex. 26–432) separate the term ''awkward postures'' into three concepts, which may characterize a particular posture in combination or alone:

• Extreme postures. This term is used in the NIOSH review of epidemiological evidence (Bernard and Fine, 1997, Ex. 26–1). Extreme postures are joint positions close to the ends of the range of motion. They require more support, either by passive tissues (*e.g.,* ligaments and passive elements of the muscles) or increased muscle force. These positions may also exert compressive forces on blood vessels and/or nerves. Note, however, that some joints, such as the knee, are designed to be used close to the range-of-motion extremes.

• Non-extreme postures that expose the joint to loading from gravitational forces, requiring increased forces from muscles and/or load on other tissues. For instance, holding the arm at 90 degrees to the body does not represent an extreme posture in terms of muscle length. But the position allows gravitational forces to exert a pull requiring roughly 10% of maximal strength from the associated muscles (Takala and Viikari-Juntura, 1991, Ex. 26–1014).

• Non-extreme postures that change musculoskeletal geometry, increasing loading on tissues or reducing the tolerance of these tissues. This third factor includes the reduction in available lever arm for muscles, described above. An example of increased loading is provided by experiments (Smith, Sonstegard, and Anderson, 1977, Ex. 26–1006) demonstrating that even non-extreme wrist flexion can press the finger flexor tendons against the median nerve. Experiments by Adams *et al.* (1980, Ex. 26–701) indicate that combined flexion and twisting or bending of the spine reduces tissue tolerance of the intervertebral disks, predisposing them to rupture.

c. Static Postures. Static postures—postures held over a period of time to resist the force of gravity or to stabilize a work piece—are particularly stressful to the musculoskeletal system. More precisely, static postures are usually defined as requiring isometric muscle force—exertion without accompanying movement. Even with some movement, if the joint does not return to a neutral position and continual muscle force is required, the effect can be the same as a non-moving posture. Since blood vessels generally pass through the muscles they supply, static contraction of the muscle can reduce blood flow by as much as 90%. The consequent reduction in oxygen and nutrient supply and waste product clearance results in more rapid onset of fatigue and may predispose muscles and other tissues to injury. The increased intramuscular pressure exerted on neural tissue may result in chronic decrement in nerve function. The viscoelastic ligament and tendon tissues can exhibit ‘‘creep’’ over time, possibly reaching failure thresholds beyond which they are unable to regain resting length.

d. Repetition. Appendix I lists repetition as a basic risk factor. This section follows that categorization. However, repetition can have characteristics of both a basic risk factor and a modifier (the ANSI draft standard, Z–365, 1998, Ex. 26–1264, gives repetition modifier or ‘‘characteristic property’’ status). High repetition may act as a modifying factor, exacerbating the basic risk factors of force and posture. But high repetition also may have its own tissue effects (combined with the dynamic factors described in Section 2.e). For example, increased friction-induced irritation of finger flexor and extensor tendons in their sheaths can result in tendinitis and lead to increased pressure in the carpal canal. A moderate level of repetition can be seen as protective, since it can increase muscle strength and flexibility (this is the concept behind exercise). It can also assist blood flow through muscles, thus relieving the stressful nature of static muscle contractions. Ideal work cycles keep overall repetition rates in a middle zone between the injurious extremes of static contraction and excessive repetition.

e. Dynamic Factors (Motion). Motion of body segments consists of both linear motion and rotational motion around a joint. Present research addresses the effects of kinematic measures of posture: both angular and linear velocity (speed of motion) and acceleration (rate at which velocity increases or decreases). It is possible that, to a degree, measured acceleration and velocity are surrogates for increased force and postural risk factors. For example, Marras and Granata (1995, 1997b Exs. 26–1383 and 26–169) find that increased velocity and acceleration in trunk lateral bending and twisting result in measurable increases in both compressive and shear forces experienced by the intervertebral disks. But dynamic factors themselves may result in increased tendon travel and irritation. Viscoelastic soft tissues, such as tendons, spinal discs, and ligaments, have a fixed, intrinsic capacity to regain resting dimensions after stretching. Brief movement cycles may involve peak accelerations that can exceed tissue elasticity limits during an otherwise moderate task. The biodynamic literature suggests that, even in tasks performed for a short time, the acceleration and velocity of movements may pose risks that would not be predicted by the muscle forces or joint angles alone.

f. Compression. Compression of tissues can result from exposure that is external or internal to the body. Depending on the tissue compressed, the effects are manifested in quite different ways (see Section V–D of this preamble).

External Compression. Moderately sharp edges, such as tool handles, workbench edges, machine corners, and even poorly designed seating, concentrate forces on a small area of the anatomy, resulting in high, localized pressure. This pressure can compress nerves, vessels, and other soft tissues, resulting in tissue-specific damage (*e.g.,* degraded nerve transmission, reduced blood flow, and mechanical damage to tendons and/or tendon sheaths). These changes may themselves result in disease or predispose other tissues to damage.

The most common sites for compression MSDs are in the hands and wrists. Since natural selection has resulted in well-developed, padded gripping areas on the hands (in particular, finger pads and the thenar and hypothenar pads on the palm), injury is most often seen outside these areas: the sides of the fingers, the palm, and the ventral side of the wrist. For instance, the prolonged use of scissors can cause nerve damage on the sides of the fingers. Compression MSDs have also been identified in the forearm, elbow, and shoulder.

Internal Compression. Nerves, vessels, and other soft tissues may be internally compressed under conditions of high-force exertions, awkward postures, static postures, and/or high velocity or acceleration of movement. For example, strong abduction or extension of the upper arm, as well as awkward postures of the neck, can compress parts of the brachioplexus under the scalene muscles and other anatomical structures. This compression can result in nerve and/or blood vessel damage or in eventual damage to the tissues served by these nerves and vessels.

There are other sources of internal compression, also the secondary result of exposure to other risk factors noted in this document. Examples include:

• Intramuscular pressure developed during forceful contraction. (This is the main mechanism resulting in compression of blood vessels internal to the muscles during static contraction).

- Pressure due to reparative swelling of tissues injured in work processes. (For example, the inflammatory swelling of flexor tendon synovial sheaths, in response to friction and irritation, can increase pressure in the carpal tunnel and compress the median nerve.)

g. Vibration. Vibration is normally divided into two categories:

- Segmental vibration or vibration transmitted through the hands. Segmental vibration appears to damage both the small, unmyelinated nerve fibers and the small blood vessels in the fingers, resulting in two specific diseases: vibration-induced white finger (VWF) and vibratory neuropathy. Together, these are called the hand-arm vibration syndrome (see below). Segmental vibration has also been implicated in carpal tunnel syndrome.
- Whole-body vibration, or vibration transmitted through the lower extremities and/or the back. Whole-body vibration is implicated in low back disorders and a host of less well-understood symptoms.

Recent research suggests that vibration should be further subdivided into two types:

- Harmonic or oscillatory vibration (due to a constant driving source, such as a grinding wheel or holding a powered tool such as an electric drill)
- Impact vibration (due to single impact, such as hammering a nail)
- Percussive vibration (bursts of separable impacts, such as those produced by a pneumatic riveting tool or a jackhammer)

It is possible that the thresholds for effects of these three types of vibration are quite different, with impact and percussive vibration having physiological effects at much lower measured exposure times.

Three classes of effect due to vibration are discussed in Section V–D and the Appendices (Ex. 27–1):

- Vascular damage, leading to premature vasoconstriction and insufficient circulation in the fingers. These effects give rise to the original name for occupationally induced Raynaud's syndrome: vibration-induced white finger (VWF). In 1987, a consensus panel, meeting in Stockholm, coined the term hand-arm vibration syndrome (HAVS) to give equal weighting to neurological symptoms (Gemne *et al.*, 1987, Ex. 26–624).
- Neurological effects. These effects involve damage to both the median nerve and to the small, unmyelinated nerve fibers in the fingers.
- Musculoskeletal effects. Kourinka and Forcier (1995, Ex. 26–432) list a number of possible effects in this category, including impaired muscle strength and osteoarthrosis of some upper extremity joints.

Finally, some research suggests that vibration received aurally (*i.e.*, noise) can, itself, result in increased static muscle loading (Kjellberg, Sköldström, and Tesaiz, 1991, Ex. 26–432).

3. Modifying Factors

This section elaborates on the definitions and measurement issues associated with the classification of modifying factors presented in Section B.1. Evidence for the relationship between these modifying factors and MSDs is presented in Section C. The following measures are not risk factors in themselves; rather, they modify the effects of the basic risk factors. To fully characterize exposure, investigators measure both the basic risk factors and the relevant modifiers.

a. Intensity or Magnitude. Intensity or magnitude is a measure of the strength of each risk factor: how much force, how deviated the posture, how great the velocity or acceleration of motion, how much pressure due to compression, how great the acceleration level of vibration, etc.

b. Duration. Duration is the measure of how long the risk factor was experienced. This is a task-specific measure and is generally combined with a comprehensive, job-specific characterization of the temporal profile of the exposure (Section 3.c). Frequency and duration are related, *i.e.*, the more frequently a task is performed, the greater the duration of exposure.

c. Temporal Profile (Recovery Time and Pattern of Exposure). The combined effects of the basic risk factors, modified by intensity and duration, tax the recovery and repair capacities of the body. Recovery capacity is strongly related to the time available for tissue repair. Thus, accurate exposure assessment takes into account the way that risk factors vary over time. Excessive metabolic load and inadequate rest schedules deprive the body of recovery time to accomplish repair on strained tissues. The pattern of exposure can be as important as total magnitude or cumulative exposure. For instance, a cumulative exposure duration of 4 hours, spread over two 8-hour work days, can be associated with substantially different health effects than a single, one-time exposure of 4 hours. Kourinka and Forcier (1995, Ex. 26–432) note that assessment of temporal profile would include:

- Task variation over a given time period (hour, day, week)
- Characteristics of the duty cycle: the proportion of the task in which stressors are high, compared to when they are low
- Schedule of micropauses (of a few seconds) every few minutes
- Distribution of formal rest breaks
- Shift and overtime schedules

d. Cold Temperatures. Cold is a well-established exacerbating factor in the development of vibration-related disease. In addition to aggravating pre-existing disease and injury, cold environments compromise muscle efficiency. Cold-related injuries to the hands result in several vascular and neurological disorders. Perhaps the most common effect of cold is its ability to reduce cutaneous sensory sensitivity and thus compromise manual dexterity. Workers with cold-desensitized fingers may grasp loads with more force than necessary, due to reduced sensory feedback, thus exposing muscles, soft tissues, and joints to increased tensile and compressive forces.

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C. Evidence for the Role of Basic Risk Factors and Modifying Factors in the Etiology of MSDs

This section summarizes the extensive body of evidence for the involvement of workplace stressors in musculoskeletal disorder (MSD) causation. For each of the basic risk factors and modifying factors described in Section V–B, this section presents highlights from the relevant epidemiological, laboratory, and psychophysical studies, as well as a summary of the evidence. Section V–D and the Appendices (Ex. 27–1) explore this body of evidence in much greater detail.

1. Quality of the Evidence

The evidence from epidemiologic, laboratory, and psychophysical studies in the Health Effects Section supports a causal relationship between workplace stressors and MSD outcomes. The proposed mechanisms of effect, detailed in Section V–D of the preamble and in the Appendices (Ex. 27–1), support the biological plausibility of the link between stressors and disease—one of the five criteria useful in establishing causality (see Section B.1.a). These criteria require attention to population studies relating exposure and effect (epidemiology), to physiological measurements that show a plausible mechanism for disease causation or exacerbation (laboratory studies), and to subjective perceptions of fatigue and pain (psychophysical studies).

The epidemiological studies in this field have been criticized because they tend to feature cross-sectional research design and rely on worker self-reports. These studies may have an increased risk of common-instrument bias (if based on self-report) and present obstacles to determining causality, due to their inability to establish temporality. The NIOSH review discussed below (Bernard and Fine, 1997, Ex. 26–1) selected the studies with the best design and further weighted these studies' contributions to the review's conclusions by methodological quality. Still, some investigators feel that NIOSH was not exclusive enough in its selection of acceptable studies. (Note that although Gerr [1998, Ex. 26–426] makes this criticism in the NAS symposium [1998, Ex. 26–37], he also states that he doubts whether the exclusions he suggests would make a substantial difference in the overall conclusions NIOSH reaches about work-relatedness.) NIOSH notes that ''The document represents a first step in assessing work-relatedness of MSDs.''

It is useful, however, to look more deeply at the criticisms of self-reported studies. Punnett (1998, Ex. 26–442) reviews the wide variety of studies that demonstrate the validity of self-report measures. These studies further suggest that common-instrument bias (the notion that a worker's perception of high exposure might lead him/her to report higher symptom status, or vice versa) may pose less of a problem than critics suppose. Punnett notes that a number of well-designed keyboard studies found differences between self-reported and observed keying times, but these differences were non-differential between cases and controls. Symptom status, in other words, did not bias overall reporting of exposure one way or the other. The NIOSH summary of epidemiological evidence for low-back MSDs (Bernard and Fine, 1997, Ex. 26–1) does not support the assumption that self-reported bias inflates associations. Of the 13 studies (out of 18 reviewed) with a positive relationship between work-related lifting and forceful movements, those relying on objective measures of exposure showed higher odds ratios (ORs) (2.2–11) than those relying on subjective measures (1.2–5.2).

Likewise, looking at objectively measured as opposed to self-reported MSD outcomes, self-reported symptoms do correlate with objectively measured disease. Bernard *et al.* (1993, Ex. 26–439), for example, found that when compared to non-cases for increased median nerve latency, subjects defined as CTS cases on the basis of self-reported symptoms showed an OR of 42.5 (with a wide 95% CI: 1.61–1122, due to small sample size).

Although other types of bias are difficult to detect in cross-sectional studies, when they occur they are likely to underestimate rather than overestimate the relationship between exposure to stressors and disease. For instance, the ''healthy worker'' bias, the preferential departure of symptomatic workers from high-exposure jobs, artificially lowers the disease prevalence in these jobs, reducing the calculated association of stressor exposure to MSD in analysis. The clear association noted by the NAS report (1998, Ex. 26–37) between MSDs and jobs with high physical load is thus derived despite the effect-reducing influence of the ''healthy worker'' bias. This example also demonstrates that a researcher can make plausible hypotheses about the direction of effect in some cross-sectional studies. It is highly unlikely that workers experiencing MSD symptoms would preferentially transfer into jobs with higher physical exposure (which would artificially elevate epidemiological estimates of effect). It has, in fact, been shown that symptomatic workers do tend to leave jobs that have high levels of MSD risk (Punnett, 1998, Ex. 26–442). Silverstein *et al.* (1988, Ex. 26–1004), in a follow-up study at one of the plants examined in their earlier studies, found that those subjects in the high-force/high-repetition exposure category who were symptomatic in the original study were no longer in that exposure category at the time of follow-up.

This section does not evaluate the growing body of intervention research relating reduction in the number and severity of MSDs to intentional reductions in exposures. However, the recent NIOSH study of MSDs and workplace factors (Bernard and Fine, 1997, Ex. 26–1) includes studies that demonstrate a reduction in disease as a result of interventions that reduce exposures. Goldenhar (1994, Ex. 26–126) and Smith, Karsh, and Moro (1998, Ex. 26–445) carried out reviews of the intervention literature. While noting the potential value of intervention research, both reviews note substantial deficits in research sample size and study design. Despite these drawbacks, Smith, Karsh, and Moro find evidence for the injury-reduction potential of redesigned hand tools, weight-handling devices (*e.g.*, hoists, articulated arms), and other work station alterations, as well as exercise and training. The General Accounting Office study (1997, Ex. 26–5) of ergonomic program effectiveness (focusing on five case studies) found that successful programs were based on a core set of elements: management commitment and employee involvement, identification of problem jobs, development of solutions, training and education, and medical management. Programs based on these elements showed reductions in injuries, illnesses, lost work days, and associated workers' compensation costs. Qualitative evidence from these case studies showed improvements in worker morale, productivity, and product quality.

Psychophysical experiments, explored in Appendix II, (Ex. 27–1) measure subjective responses of individuals performing various laboratory tasks designed to mimic real work procedures. The measures are self-reports of discomfort, fatigue, level of exertion, etc. These measures have been found to correlate well with objective measures of injury frequency in workplaces (Snook, Campanelli, and Hart, 1978, Ex. 26–35; Herrin, Jaraiedi, and Anderson, 1986, Ex. 26–961).

2. NIOSH Summary of the Epidemiological Evidence

The following sections present selected epidemiological evidence organized by risk factor. However, it is helpful first to look at a summary of this evidence, taken from the very thorough analysis carried out by NIOSH (Bernard and Fine, 1997, Ex. 26–1). NIOSH lists reasonable and consistent criteria for including studies in this summary. The Workshop Summary and Papers document from the recent NAS symposium on MSDs (National Academy of Sciences, 1998, Ex. 26–37) contains assessments of the NIOSH analysis by seven respected epidemiologists. This group noted the drawbacks to many of the studies included in the analysis:

- Difficulty in establishing causal direction from any one study.
- Variability in assessment measures (also a strength of the combined body of studies).
- Lack of information concerning disease prevalence in non-working populations.
- The common epidemiological problem of possible unmeasured factors contributing to the effects seen.

However, the group concluded that:

- The NIOSH criteria for study inclusion in the summary were, in general, adequate.
- The preponderance of evidence, particularly from studies with high exposure contrasts among study groups, supports the association between work-related stressors and MSD development.
- The demonstrated reduction of MSDs in workplaces where stressors were reduced also strongly supports this association.

Bernard and contributors (1997, Ex. 26–1) established a four-part classification system to characterize the strength of evidence for work-relatedness, examining the contribution of each risk factor to MSDs, categorized by body location (see Tables V–1 and V–2).

Table V–1.—Upper-Extremity MSDs

MSD LOCATION OR DIAGNOSIS	NUMBER OF STUDIES	RISK FACTOR				
		FORCE	STATIC OR EXTREME POSTURES	REPETITION	VIBRATION (SEGMENTAL)	COMBINATION
Neck and Neck/ Shoulder	>40	++	+++	++	+/0	(—)
Shoulder	>20	+/0	++	++	+/0	(—)
Elbow	>20	++	+/0	+/0	(—)	+++
Carpal Tunnel	>30	++	+/0	++	++	+++
Hand/Wrist Tendinitis	8	++	++	++	(—)	+++
Hand-Arm Vibration	20	(—)	(—)	(—)	+++	(—)

Note: (—) means the association is not reported in the NIOSH publication.

Table V–2.—Lower-Back MSDs

MSD LOCATION OR DIAGNOSIS	NUMBER OF STUDIES	RISK FACTOR				
		HEAVY PHYSICAL WORK	LIFTING AND FORCEFUL MOVEMENTS	STATIC POSTURES	AWKWARD POSTURES	VIBRATION (WHOLE BODY)
Low Back	>40	++	+++	+/0	++	+++

In this determination, the investigators weighted the contribution of individual studies by the quality of the study design:

- Strong evidence of work-relatedness (+++): a very likely causal relationship between exposures of high intensity and/or duration and an MSD, using the epidemiologic criteria for causality (similar to those presented above).
- Evidence of work-relatedness (++): some convincing evidence of a causal relationship.
- Insufficient evidence of work-relatedness (+/0): some suggestion of causality, but most studies lack sufficient quality, consistency, or statistical power; study quality may be lower.
- Evidence of no effect of work factors (-): Adequate studies consistently and strongly show a lack of association between a risk factor and MSDs.

The study considered five categories of risk factors for upper-extremity MSDs (see Table V–1):

- Forceful exertions.
- High levels of static contraction, prolonged static loads or extreme working postures (termed ''awkward postures'' in Section B).
- Highly repetitive work.
- Vibration.
- A combination of these factors.

Table V–1 also shows that there is evidence or strong evidence of work-relatedness for most MSDs and risk factors.

The NIOSH study presents a somewhat different set of risk factors for low-back MSDs (see Table V–2). The classification:

- Looks at static and awkward postures separately, explicitly substituting ''awkward postures'' for extreme postures.
- Inserts ''heavy physical work'' and ''lifting and forceful movements'' in place of ''force.''
- Assesses whole-body vibration instead of segmental vibration.
- Removes assessment of repetition as a separate risk factor.
- Does not address combinations of risk factors.

This modified selection of risk factors is, overall, appropriate to the particular nature of back exposures and injury and reflects the foci of attention in the epidemiological research literature. The last two omissions are unfortunate, however, because both repetition rate and combined exposures to stressors are relevant to the etiology of low-back disorders. In practice, the studies that assessed heavy physical work used definitions of this stressor that include ''high energy demands * * * heavy tiring tasks, manual materials handling tasks, and heavy, dynamic, or intense work'' (Bernard and Fine, 1997, p. 6–4, Ex. 26–1). These stressors probably implicitly include both repetition and a combination of risk factors. Table V–2, like Table V–1, shows that there is evidence or strong evidence of work-relatedness for low back MSDs. Due to the multifactoral nature of MSD causation, the separation of evidence by individual risk factor is artificial. But this separation is useful for clarity and is continued in this section, which presents other epidemiological studies as well as evidence from laboratory and psychophysical studies pointing to the role of workplace stressors in the causation or exacerbation of MSDs.

3. Workplace Risk Factors and MSDs

a. Force.

Epidemiological Evidence. The NIOSH summary (Bernard and Fine, 1997, Ex. 26–1) of upper-extremity MSDs found evidence of a causal relationship between exposure to force and disorders of the neck and elbow, as well as carpal tunnel syndrome (CTS) and hand/wrist tendinitis. (In general, the evidence for work-related MSDs at the elbow has been less convincing than that for other body locations. Although the NIOSH review finds evidence for a relationship between force and epicondylitis, Kourinka and Forcier (1995, Ex. 26–

432) conclude that the evidence is not yet convincing.) Silverstein, Fine, and Armstrong (1987, Ex. 26–34), studying CTS as an outcome, found an OR of 15.5 (95% CI: 1.7–142) for high-force/high-repetition jobs, compared to jobs with low levels of both. The interaction of force and repetition was important in this study; in separate models, force alone had a non-significant OR of 2.9 and repetition alone had an OR of 5.9 ($p < .05$). Nathan *et al.* (1988, Ex. 26–990) also found elevated prevalences of CTS in workers holding high-force/high-repetition jobs. The case definition of these authors did not include self-reported symptoms but only measurable decrements in nerve conduction velocity. This is a stricter case definition than that of Silverstein *et al.* (1987, Ex. 26–34), which was based on self-reported symptoms and physician examinations. This stricter case definition resulted in a smaller but more rigorously defined set of cases; the calculated OR was correspondingly lower (2.0, 95% CI: 1.1–3.4, comparing the highest-force/repetition group to the lowest). Note that this author did not find significant relationships between force and CTS in subsequent work (Nathan *et al.*, 1992, Ex. 26–988).

In addition to the NIOSH summary, other epidemiological studies point to an association between force requirements and work-related MSDs. Silverstein's 1985 cross-sectional research on male and female industrial workers is suggestive, although the NIOSH summary found insufficient evidence for an association between force and shoulder MSDs and did not include this study (Ex. 26–1173). The study compared workers in jobs characterized by a combination of high force and high repetition, measured at the wrist, to those in jobs with low levels of both exposures; the authors calculated an OR of 5.4 (95% CI: 1.3–23) for prevalence of shoulder tendinitis and degenerative joint disease (thus using wrist measurements as a surrogate for shoulder exposure, a possible source of criticism). This study also found an OR for hand/wrist tendinitis of 29 (CI not reported).

Vingärd *et al.* (1991, Ex. 26–1400), in a registry-based cohort study of people hospitalized for osteoarthrosis over 3 years, compared men and women with high exposure to dynamic and static forces at the knee to those with low exposure. Occupations with significantly elevated relative risk were firefighter, farmer, and construction worker for men, and cleaner for women.

Coggon *et al.* (1998, Ex. 26–1285) carried out a case-control study of 611 subjects with hip replacements due to osteoarthritis, compared to matched controls. Men who reported lifting more than 25 kilograms at least 10 times per week for 10 years prior to age 30 or for more than 20 years over their working life had higher rates of surgery (OR 2.7 and 2.3, respectively significant at a 0.05 level). The association did not hold for females.

Laboratory Evidence. Ashton-Miller (1998, Ex. 26–414), summarizing a large body of laboratory evidence assessing the effects of loading on body tissues, concludes that muscle, tendon, and ligamentous tissues can fail when subjected to sufficient force under certain conditions. Faulkner and Brooks (1995, Ex. 26–1410) found that excessive force can cause muscle fiber damage, either by disruption of the actin-myosin (the contractile proteins) interdigitation or of the Z-lines between single sarcomeres (the contractile units in the muscle fibril). Muscles are particularly likely to be injured through exertion of excessive force in eccentric contractions (*i.e.*, as the muscle is being lengthened, such as when stopping the motion of the body or an external object) (Brooks, Zerba, and Faulkner, 1995, Ex. 26–87). Ashton-Miller (1998, Ex. 26–414) suggests that these injuries, although seemingly traumatic, commonly occur in combination with accumulated strain from lower levels of repeated forceful exertions (Wren, Beaupre, and Carter, 1998, Ex. 26–245).

Laboratory evidence for viscoelastic strain in tendons and ligaments under forceful loading is suggestive (*e.g.*, Goldstein *et al.*, 1987, Ex. 26–953; Crisco *et al.*, 1997, Ex. 26–1373). However, more research is necessary to establish whether this strain progresses to MSDs. Animal studies have shown that forceful loading of tendons can produce structural changes similar to those found in MSDs (Rais, 1961, Ex. 26–1166; Backman *et al.*, 1990, Ex. 26–251).

Forceful muscle contraction raises intra-muscular pressure, potentially increasing pressure on nerves and vessels within the active muscle. Abundant animal studies (see summary, Rempel *et al.*, 1998, Ex. 26–444) demonstrate that increased pressure on neurons can reduce blood flow around, and inhibit transport in, axons. Pressure elevations can impair nerve function, increase neural edema, and even alter myelin sheath structure. Many of these changes can occur over relatively short exposure times and in the presence of relatively low pressure elevations. These changes demonstrate a dose-response relationship. This suggests that elevated pressure around nerves during work tasks might cause decrements in nerve function. Both human cadaver studies (Cobb *et al.*, 1996, Ex. 26–98) and work with healthy volunteers (Rempel *et al.*, 1997, Ex. 26–889; Keir *et al.*, 1998, Ex. 26–289) demonstrate that forceful loading of fingertips results in elevated carpal tunnel pressures, well within the range demonstrated to cause damage to animal neurons.

Psychophysical Evidence. Experiments performed over many years at the Liberty Mutual laboratories in Hopkinton, Massachusetts (Snook, 1996, Ex. 26–1353), have examined, in detail, the effects of different biomechanical stressors on subjects' reports of acceptable lifts, carries, pushes, pulls, etc. In general, the experimenter sets all parameters of a simulated task, with the exception of the load, which can be varied by the subject. The subjects are asked to rate task acceptability as if they were performed for a full day, so that the ratings of acceptable load include allowances for fatigue over the course of a workday. The research group has published extensive tables of these acceptable loads (Snook and Ciriello, 1991, Ex. 26–1008). Although there is great individual variation, these experiments generally show the subjects' ability to precisely estimate and regulate the load that would allow them to work a full day without becoming overtired or out of breath. These studies demonstrate the interrelatedness of the biomechanical stressors examined in the Health Effects Section. They show that acceptable load estimates are very sensitive to variations in posture, frequency, and the distance the load is moved.

Klein and Fernandez (1997, Ex. 26–1357) administered a variant of this study design, allowing subjects to adjust the frequency of a repeated pinch grip (determining the maximum acceptable frequency [MAF]) under varying conditions of force, wrist posture, and pinch duration. They found that, as the force of the pinch grip was experimentally increased, the MAF fell.

Summary: Force and Work-Related MSDs. The NIOSH findings of evidence for force-related MSDs in most upper-extremity locations, combined with the few studies addressing lower-extremity MSDs, make a case for a causal association of between increased workplace force requirements and disease. The large number of laboratory studies (see Appendix II, Ex. 27–1) provides evidence for several plausible and repeatable mechanisms by which forceful exertions could cause MSDs. The psychophysical studies lend support to these conclusions, due to the demonstrated correlation between subjective workload estimates (discomfort, fatigue, and level of exertion) and objectively measured outcomes of injury frequency in workplaces (Snook *et al.*, 1978, Ex. 26–35; Herrin *et al.*, 1986, Ex. 26–961). These studies also demonstrate the interrelatedness of force exposures with several other risk factors for MSDs—in particular, repetition and awkward postures. Taken as a whole, the evidence is consistent and makes a strong case for force as a risk factor for work-related MSDs.

b. Awkward Postures.

Epidemiological Evidence. The NIOSH summary of upper-extremity MSDs (Bernard and Fine, 1997, Ex. 26–1; see Table V–1 above) did not separate static and awkward postures in their conclusions. The summary found evidence of a causal relationship between exposure to static or extreme postures and disorders of the shoulder and hand/wrist tendinitis. There is strong evidence of a causal relationship between postural stressors and neck MSDs. The summary found insufficient evidence for a relationship between these risk factors and elbow disorders or CTS. Of the 15 studies that addressed postures, many with positive results were carried out on VDT workers (*e.g.*, Bernard *et al.*, 1993, Ex. 26–439; Kukkonen *et al.*, 1983, Ex. 26–1138). The research on the largest study population (Linton, 1990, Ex. 26–977) examined combined biomechanical and psychosocial exposures. The study looked at 22,180 Swedish employees undergoing screening examinations at their occupational health care service. Combined exposures to ''uncomfortable posture'' and poor psychosocial work environment showed an OR of 3.5 (95% CI: 2.7–4.5) for neck pain cases (defined as those who reported a visit to a health care professional in the last year for neck pain) compared to low-exposure jobs. The studies in the NIOSH summary support the conclusion that a combination of risk factors carries increased risk. In particular, the studies reviewed provide strong evidence for the causal relationship of combined risk factors (especially force, postural stressors, and repetition) with disorders of the elbow, CTS, and hand/wrist tendinitis.

Other epidemiological studies demonstrate an association between awkward or extreme postures and work-related MSDs. Bjelle *et al.* (1979, Ex. 26–1112) found a strong relationship between industrial work with hands at or above shoulder level and outcomes of shoulder tendinitis (OR: 11; 95% CI: 2.7–42). Similar findings appeared in studies by Herberts *et al.* (Ex. 26–960) on shipyard welders (1981; OR: 13; 95% CI: 1.7–95) and shipyard plate workers (1984; OR: 11; 95% CI: 1.5–83). The referent group in these studies consisted of office workers. A cross-sectional study of female assembly line packers, compared with department store shop assistants (Luopajärvi *et al.*, 1979, Ex. 26–56), found an OR of 7.1 for hand/wrist tendinitis (95% CI: 3.9–12.8). In this study, exposure was a combination of awkward postures, static postures and repetitive motions.

The bulk of the NIOSH-reviewed studies (Bernard and Fine, 1997, Ex. 26–1) do not provide sufficient evidence for the link of postural factors with CTS. However, de Krom *et al.* (1990, Ex. 26–102) found associations between awkward (flexed and extended) wrist postures and CTS. The strength of association increased with hours of exposure. Marras and Schoenmarklin (1993, Ex. 26–172) were able to distinguish between jobs carrying a high and low risk of CTS, using a combination of measured wrist flexion and two dynamic factors (wrist extension angular velocity and wrist flexion angular acceleration).

Laboratory Evidence. Ashton-Miller (1998, Ex. 26–414) cites a number of studies demonstrating that a change of force direction over bony or ligamentous structures creates transverse or shear forces and increases in friction experienced by tendons and tendon sheaths. Increased angles adopted by tendons as they pass around a tendon pulley (related to awkward posture) and increased longitudinal tension (related to the required muscle force) combine to increase friction on the tendon (Uchiyama *et al.*, 1995, Ex. 26–339).

In addition, extreme postures can require elevated muscle activity simply to overcome the resistance of passive tissues. Zipp *et al.* (1983, Ex. 26–1270) found that adopting an extremely pronated forearm position (such as that required by computer keyboard operation) requires high muscle activity, even without any external loading. Non-extreme postures can still trap tissues in injurious positions. Smith, Sonstegard, and Anderson (1977, Ex. 26–1006) demonstrated that even non-extreme wrist flexion can cause the finger flexor tendons to compress the median nerve. Buchholz *et al.* (1988, Ex. 26–1297) detail a sophisticated modeling approach that explains the measured increased muscle force demands associated with non-optimal grip diameters (putting the fingers into awkward biomechanical relationships).

Nerve tissue may also be at risk in anatomical sites associated with awkward posture. Any posture that compresses or crushes a nerve may cause the histological changes noted in Section C.3.a. Human studies (Armstrong *et al.*, 1984, Ex. 26–1293) have shown that histological changes (edema, thickening, fibrosis) occur in nerves at the site of compression injury and possibly at sites of bending (*e.g.*, the ulnar nerve at the elbow). The human cadaver studies (Cobb *et al.*, 1996, Ex. 26–98) and healthy volunteer studies (Rempel *et al.*, 1997, Ex. 26–889; Keir *et al.*, 1998, Ex.26–289) cited above also demonstrate that non-neutral hand postures, combined with forceful loading of fingertips, result in elevated carpal tunnel pressures, well within the range demonstrated to cause damage to animal neurons. Rempel *et al.* (1998, Ex. 26–444) cite eight human studies measuring pressure in the carpal tunnel when the wrist is in a flexed or extended posture relative to a neutral posture. Most of these studies show elevation of carpal pressure, again into the range that causes damage in the animal studies.

Studies of the spine demonstrate similar negative effects of awkward postures. Marras *et al.* (1993, Ex. 26–170) include maximum sagittal trunk flexion angle as one of the five predictors of high risk for low-back injury. In a study by Hutton and Adams (1982, Ex. 26–1381), intervertebral disks in undeviated cadaver spines did not fail until loads exceeded 10,000 Newtons (N). However, disks in extremely flexed spines failed at roughly half that loading (average 5400 N—Adams and Hutton, 1982, Ex. 26–1379). Repetitive loading reduced this average failure point to 3800 N (Adams and Hutton, 1985, Ex. 26–1315). Although the relative magnitude of these forces is important, they may suggest lifting limits that are too high for many living workers. NIOSH, noting the large variability in compression forces associated with disc failure, estimated that 21% of spinal segment specimens would fail at the 3400 N level used as a basis for the NIOSH lifting equation (Waters *et al.*, 1991, Ex. 26–521). Adams *et al.* (1980, Ex. 26–701) report experimental and modeling evidence suggesting that combined forward flexion and lateral bending of the lumbar spine reduce the injury tolerance of intervertebral disk fibers, possibly increasing chance of rupture. A possible mechanism for disk injury may relate to the fact that lateral flexion and axial rotation of the lumbar spine increase antagonistic muscle activity, thereby increasing the overall disk loading. This is consistent with observations that the combination of lifting, twisting, and bending is one of the most frequent causes of low-back pain (Rowe, 1983, Ex. 26–699).

Psychophysical Evidence. The Liberty Mutual studies cited in Section C.3.a also demonstrate the subjective effect of awkward postures. The maximum acceptable weight (MAW) arrived at by the subjects in these experiments decreased if the lifts were carried out above shoulder height. The MAW was also inversely related to object size (reflecting the fact that moving bulkier loads generally requires more awkward postures).

As described in Section C.3.a, Klein and Fernandez (1997, Ex. 26–1357) allowed subjects adjust to the frequency of a repeated pinch grip (determining the MAF) under varying conditions of force, wrist posture, and pinch duration. They found that the MAF at two-thirds the maximum wrist flexion was significantly less than in a neutral wrist posture. Wrist flexion angle was a significant factor for several variables.

Marley and Fernandez (1995, Ex. 26–863), looking at the stressors associated with hand-held tools, assessed MAF for a simulated drilling task. Compared to ratings in a neutral wrist posture, when the wrist was at one-third maximum flexion, MAF was 88%; at two-thirds maximum flexion, MAF was 73% of the neutral posture value. Subjects used Borg RPE ratings (self-reported ratings of perceived exertion) (Borg, 1982, Ex. 26–705) to estimate required exertion at various body locations. Compared to a neutral wrist position, subjects performing the task with the wrist in two-thirds maximum flexion reported increases in exertion in the wrist, forearm, shoulder, and whole body.

Asymmetrical lifting postures also resulted in a reduction in the MAW. Garg and Badger (1986, Ex. 26–121) asked subjects to carry out a floor-to-table lift twisted 30, 60 and 90 degrees from neutral trunk posture. The MAWs showed significant decreases of 7%, 15%, and 22%, respectively.

Summary: Awkward Postures and Work-Related MSDs. The epidemiological evidence for a causal association between awkward postures and MSDs is strong, especially for neck disorders. Although the NIOSH review (Bernard and Fine, 1997, Ex. 26–1) found insufficient evidence that posture alone can cause CTS, the studies found strong evidence for CTS causation by a combination of risk factors. This suggests that the harmful effects of exposure to awkward posture may be experienced primarily in combination with other risk factors. The numerous laboratory studies examining the relationship between postural stressors and CTS, in particular, strengthen the evidence for a combination of awkward postures and force as risk factors for this outcome. Likewise, extensive epidemiological and laboratory evidence for increased risk of low-back injury due to bending and twisting also demonstrates the important role that postural stressors play in MSD causation.

This evidence is further strengthened by the sensitivity to postural variables of subject-estimated safe loads in the psychophysical literature. These psychophysical studies lend support to these conclusions, due to the demonstrated correlation between subjective workload estimates (discomfort, fatigue and level of exertion) and objectively measured outcomes of injury frequency in workplaces (Snook *et al.*, 1978, Ex. 26–35; Herrin *et al.*, 1986, Ex. 26–961). These studies also demonstrate the interrelatedness of postural exposures with several other risk factors for musculoskeletal disorders, in particular, repetition and force. The convergent evidence from these diverse areas, with very different methodological approaches, strongly supports the hypothesis that awkward postures have a causal role in the etiology of MSDs.

c. Static Postures.

Epidemiological Evidence. Since the NIOSH summary (Bernard and Fine, 1997, Ex. 26–1) did not distinguish between awkward and static postures, the summary in section C.3.b applies here as well. In addition to the NIOSH summary (see Tables V–1 and V–2 above), other epidemiological studies demonstrate an association between static contractions or prolonged static load and work-related MSDs. In a review of the epidemiological evidence for three neck-related MSDs, the contributors to Kourinka and Forcier (1995, Ex. 26–432) report consistent associations between exposures to static head and arm postures and outcomes of tension neck syndrome. Grieco *et al.* (1998, Ex. 26–627) also report associations between static work and tension neck syndrome in several different occupations. Looking at the neck region more generally, Hales and Bernard (1996, Ex. 26–896) report several studies showing consistent association between neck disorders and work involving static or constrained postures. A review of neck studies by Hidalgo *et al.* (1992, Ex. 26–631) proposes that prolonged static contraction of neck muscles be limited to force levels at or below 1% of maximum voluntary contraction (MVC). In an intervention study, Aarås *et al.* (1998, Ex. 26–597) found that introduction of a workstation arrangement that allowed forearm support (thus lowering static load on the shoulders) reduced trapezius muscle activity from 1.5% to 0.3% of MVC and was associated with a reduction in neck pain.

A cross-sectional study of 152 female assembly line packers, compared with department store shop assistants (Luopajärvi *et al.*, 1979, Ex. 26–56), found an OR of 7.1 for hand/wrist tendinitis (95% CI: 3.9–12.8). In this study, exposure was a combination of static postures, awkward postures and repetitive motions.

A population-based case-control study (Cooper *et al.*, 1994, Ex. 26–460), comparing cases with knee osteoarthritis to matched controls with non-arthritic knee pain, found that squatting more than 30 minutes per day was associated with an increased prevalence of osteoarthritis (OR: 6.9, 95% CI 1.8—26.4). Vingärd *et al.* (1991), in a registry-based cohort study of people hospitalized for osteoarthrosis over 3 years, compared men and women with high exposure to static and dynamic forces at the knee to those with low exposure. Occupations with significantly elevated relative risk were firefighter, farmer, and construction worker for men, and cleaner for women.

Laboratory Evidence. In general, the laboratory literature cited above for force and awkward posture is relevant to the prolonged exposures involved in static postures (Zipp *et al.*, 1983, Ex. 26–1270; Buchholz *et al.*, 1988, Ex. 26–1297; Smith, Sonstegard, and Anderson, 1977, Ex. 26–1006). Many of the same mechanisms apply, but the duration is increased and the temporal profile of exposure is made worse by the reduction in rest breaks and opportunity for recovery time. Lundborg *et al.* (1982, Ex. 26–979) showed that a constant hydrostatic pressure (*i.e.*, during a static muscle contraction) of between 30 and 60 mm Hg reduces microcirculation of the nerve and compromises nerve conduction.

Rohmert (1973, Ex. 26–580) found that muscle contractions can be maintained for prolonged periods if kept below 20% of MVC. But other investigators (Westgaard and Aarås, 1984, Ex. 26–1026) found chronic deleterious effects of contractions even if they are lower than 5% of MVC. This latter finding is supported by the observation that low-level static loading (such as shoulder loading in keyboard tasks) is associated with shoulder MSDs (Aarås *et al.*, 1998, Ex. 26–597). The supraspinatus muscle, a muscle severely constrained by bone and ligamentous tissue, demonstrates increased intramuscular pressure during small amounts of shoulder abduction or flexion (Järvholm *et al.*, 1990, Ex. 26–285). This suggests the possibility of chronic blood vessel and nerve compression during static tasks.

Chronic reduction of blood flow may be a mechanism by which static muscle contractions lead to MSDs. Several studies have found that the small, slow motor units in patients with chronic muscle pain show changes consistent with reduced local oxygen concentrations (Larsson *et al.*, 1988, Ex. 26–1140; Dennett and Fry, 1988, Ex. 26–104). Reduced blood flow and disruption of the transportation of nutrients and oxygen can produce intramuscular edema (Sjogaard, 1988, Ex. 26–206). The effect can be compounded in situations where recovery time between static contractions is insufficient. Eventually, a number of changes can result: muscle membrane damage, abnormal calcium homeostasis, an increase in free radicals, a rise in other inflammatory mediators, and degenerative changes (Sjogaard and Sjogaard, 1998, Ex. 26–1322).

Psychophysical Evidence. Several studies have evaluated the maximum acceptable weight (MAW) in conditions requiring prolonged stooping (low ceiling height). Smith *et al.* (1992, Ex. 26–1007) performed laboratory experiments on 100 subjects (50 male, 50 female) recruited from a college-age population at Texas Tech University. The study collected data on a number of awkward postures, such as twisting, lying down, kneeling, squatting, and carrying loads with a restricted ceiling. The authors found that the MAW decreased with decreasing ceiling height (which requires forward flexion during lifting) as well as with twisted postures.

Klein and Fernandez (1997, Ex. 26–1357) allowed subjects to adjust the frequency of a repeated pinch grip (determining the MAF) under varying conditions of force, wrist posture and pinch duration. They found that, as the pinch grip was held for longer increments of time (1, 3, and 7 seconds), the MAF fell.

Summary: Static Postures and Work-Related MSDs. The epidemiological evidence is particularly strong for the causal role of static postures in MSDs of the neck and shoulder region. This evidence is suggestive but less convincing for disorders of the distal upper extremities. Laboratory evidence for muscle and tendon damage in these areas, as well as secondary compression of blood vessels and nerves, lends support to the connection between work-related static postural requirements and the development of these disorders. The psychophysical studies have not generally focused on static postures, but the two studies cited in section C.3.c provide evidence of increased fatigue and discomfort related to static postures of the back and fingers. These psychophysical studies lend support to the conclusions of work-relatedness, due to the demonstrated correlation between subjective workload estimates (discomfort, fatigue, and level of exertion) and objectively measured outcomes of injury frequency in workplaces (Snook *et al.*, 1978, Ex. 26–35; Herrin *et al.*, 1986, Ex. 26–961). These studies also demonstrate the interrelatedness of postural exposures with several other risk factors for musculoskeletal disorders, in particular repetition and force. Taken as a whole, the evidence suggests that static postures are causal factors in the etiology of MSDs, both through exacerbation of the mechanisms explored under other risk factors (*e.g.*, awkward postures, force) and through chronic reductions in blood flow and neural function caused by prolonged elevations of intramuscular pressure.

d. Repetition. Repetition has qualities of both a risk factor and a modifying factor (or ''characteristic property'' (ANSI, 1998, Ex. 26–1264)). Because of this borderline position, repetition is often reported as an exposure intensifier (*e.g.*, Radwin and Lavender, 1998, Ex. 26–37) and often as a risk factor in itself (*e.g.*, Kourinka and Forcier, 1995, Ex. 26–432). Thus, a substantial portion of the evidence presented in subsequent sections, supporting the association of repetition with work-related MSDs, examines repetition in combination with other risk factors. In fact, the NIOSH summary (Bernard and Fine, 1997, Ex. 26–1) found that a combination of risk factors increases the strength of the evidence for work-relatedness. This suggests that each individual risk factor has characteristics of both a basic risk factor and a modifier, and the distinction becomes somewhat academic.

Epidemiological Evidence. The NIOSH summary (Bernard and Fine, 1997, Ex. 26–1; see Table V–1 above) found evidence for work-related MSDs connected with exposure to repetitive work for all body locations considered except the elbow. Of the 16 selected studies that addressed repetition exposure and found a positive association with neck disorders, 11 found associations that were statistically significant. Ohlsson *et al.* (1995, Ex. 26–868) compared 82 female industrial workers exposed to short-cycle tasks (less than 30 seconds) to 64 referents with no exposure to repetitive work. The OR for tension neck syndrome was 3.6 (95% CI: 1.5–8.8), and the OR for shoulder symptoms (several types of tendinitis, frozen shoulder, acromioclavicular syndrome) was 5.0 (95% CI: 2.2–11.0). Silverstein *et al.* (1987, Ex. 26–34), studying CTS as an outcome, found an OR of 15.5 (95% CI: 1.7–142) for high-force/high-repetition jobs, compared to jobs with low levels of both. Jobs with only high-repetition exposure still demonstrated an OR of 5.5, compared to low-force/low-repetition jobs. Nathan *et al.* (1988, Ex. 26–990) also found an elevated prevalence of CTS in workers holding high-force/high-repetition jobs. Their stricter case definition was based on nerve conduction velocity decrements, and the calculated OR was correspondingly lower (2.0, 95% CI: 1.1–3.4). Note that subsequent investigations by this investigator did not find a significant association of repetition with CTS (Nathan *et al.*, 1992, Ex. 26–988).

Other epidemiological studies demonstrate an association between repetitive movements and work-related MSDs. The contributors to Kourinka and Forcier (1995, Ex. 26–432), in a review of the epidemiological evidence for three neck-related MSDs, report weak-to-moderate, but consistent associations between exposures to repetitive work and outcomes of tension neck syndrome and thoracic outlet syndrome (TOS). They and other reviewers (*e.g.*, Grieco *et al.*, 1998, Ex. 26–627) did not find convincing evidence of a connection between repetition and cervical radiculopathy. Looking at the neck region more generally, Hales and Bernard (1996, Ex. 26–896) report several studies showing consistent association between neck disorders and repetitive work/forceful repetitive work.

Silverstein's (1985, Ex. 26–1173) cross-sectional study of male and female industrial workers compared workers in jobs characterized by a combination of high force and high repetition to those in jobs with low levels of both exposures. She calculated a risk ratio of 5.4 (95% CI: 1.3–23) for prevalence of shoulder tendinitis and degenerative joint disease. This study found an OR for hand/wrist tendinitis of 29 (CI not reported). A cross-sectional study of female assembly line packers, compared with department store shop assistants (Luopajärvi *et al.*, 1979, Ex. 26–56), found an OR of 7.1 for hand/wrist tendinitis (95% CI: 3.9–12.8). In this study, exposure was a combination of awkward postures, static postures and repetitive motions. Other studies have also demonstrated a strong association between CTS and repetition (reviewed in Kourinka and Forcier, 1995, Ex. 26–432).

A population-based case-control study (Cooper *et al.*, 1994, Ex. 26–460), comparing cases with knee osteoarthritis to matched controls with non-arthritic knee pain, found that climbing more than 10 flights of stairs per day was associated with increased prevalence of osteoarthritis (OR: 2.7, 95% CI 1.2–6.1).

Laboratory Evidence. In 1951, Sperling (Ex.26–1411) subjected his own fingers to a series of prolonged, repetitive movements, against resistance. In all cases, the area around the affected tendon became tender and swollen, and in most cases, he began to notice snapping and thickening. These symptoms remained for several months. Sperling concluded that tendon injury could be caused by simple, repetitive loading, without the necessity for traumatic injury. Rais (1961, Ex. 26-1166) performed two experiments subjecting rabbits to varying degrees of stressful, repetitive leg movement. Overall, he found evidence of peritendinitis, localized to the area of the myotendinous junction. The changes indicated cellular damage and restorative activities. In the muscles themselves, he also observed degeneration of varying degrees, fibrin deposition, and evidence of regeneration.

Experimentally, Hagberg (1981, Ex. 26–955) demonstrated that a 1-hour course of repetitive shoulder flexion movements could induce acute shoulder tendinitis. Several investigators found an increase in shoulder muscle activity and/or pain when assembly line work pace was increased (*e.g.*, Odenrick *et al.*, 1988, Ex. 26–576; Ohlsson *et al.*, 1989, Ex. 26–1290). These findings should be interpreted with caution: Shoulder tension is strongly affected by psychosocial factors (although it should be noted that the overall effect is still the increase of shoulder muscle activity).

A few investigators have studied the effects of repeated loading on cadaver spinal segments (Brinckmann, *et al.*, 1987, Ex. 26–1318; 1988; Hansson, *et al.*, 1987, Ex. 26–279). These studies applied a submaximal load (a percentage of the load associated with failure in a single application). A strong dose-response relationship emerged. Even with compressive loads set at 55% of the single trial failure load, mechanical failure occurred in 92% of the specimens after 5000 cycles. At 65% of this load, 91% of the specimens failed after only 500 cycles. At 75% of this load, some specimens failed after only 10 cycles. Although cadaver tissue probably acts differently from living tissue, these results do suggest that repetition is a risk factor for spinal injury.

Psychophysical Evidence. The Liberty Mutual studies cited in Section C.3.a.iii also demonstrate the subjective effect of repetition rates on subject estimates of tasks that could be performed over the course of a work day without undue fatigue, discomfort, or overexertion (Snook, 1996, Ex. 26–1353). As noted above, the experimenter sets all parameters of a simulated task, with the exception of the load, which can be varied by the subject. The subjects are asked to rate task acceptability as if they were performing the task for a full workday, so the ratings of acceptable load include allowances for fatigue over the course of a workday. The research group has published extensive tables of these acceptable loads (Snook and Ciriello, 1991, Ex. 26–1008). Although there is great individual variation, these experiments in general show the subjects' ability to precisely estimate and regulate the load that would allow a full day of work without becoming overtired or out of breath. These studies show that acceptable load estimates are very sensitive to variations in the repetition rate of the task. In all variations, the MAW that was estimated by the subjects in these experiments decreased as the frequency of the lift, lower, push, or pull increased.

Separate studies by Garg and Banaag (1988, Ex. 26–951) and Mital and Fard (1986, Ex. 26–182), in addition to replicating the MAW decrements attributable to asymmetric lifting noted under "awkward postures," also found that increased frequency of lifting reduced the MAW reported by their subjects. Klein and Fernandez (1997, Ex. 26–1357) administered a variant of this study design, allowing subjects to adjust the frequency of a repeated pinch grip (determining the MAF) under varying conditions of force, wrist posture, and pinch duration. They found that, as force of the pinch grip was experimentally increased, the MAF fell.

Summary: Repetition and Work-Related MSDs. Despite the difficulties in assessing repetition in isolation from other risk factors, the epidemiological evidence strongly implicates repetitive motions in the etiology of work-related MSDs. A large body of laboratory studies demonstrates a biological plausibility for this relationship. The psychophysical research lends support to the epidemiological and laboratory results: it demonstrates a correlation between subjective workload estimates (discomfort, fatigue, and level of exertion) and objectively measured outcomes of injury frequency in workplaces (Snook *et al.*, 1978, Ex. 26–35; Herrin *et al.*, 1986, Ex. 26–961). These studies also demonstrate the interrelatedness of repetition with several other risk factors for musculoskeletal disorders, in particular, force and awkward postures. In sum, the congruence of evidence from several different research traditions, with different methodologies, strongly implicates repetition in the etiology of work-related MSDs.

e. Dynamic Factors.

Epidemiological Evidence. The contributors to the NIOSH summary (Bernard and Fine, 1997, Ex. 26–1) did not examine evidence linking dynamic factors with work-related MSDs. Most research on dynamic factors has been carried out on low-back injury. Sudden maximal lifting effort and unguarded movements appear to be risks for developing work-related low-back pain (Magora and Schwartz, 1976, Ex. 26–389). Marras and Granata (1995, Ex. 26–1383) categorized jobs into three levels of risk (meaning risk of low-back injury, assessed by medical reports). They then calculated ORs of a job, characterized by five measures of exposure falling into the high-risk category. The OR of a job with the highest combined exposure score, compared to the lowest combined score, was 10.7 (95% CI: 4.9–23.6). These exposure measures (assessed by sophisticated electrogoniometry) include dynamic factors: linear and angular velocity and acceleration of the lumbar spine. Marras and Schoenmarklin (1993, Ex. 26–172) also implicate dynamic factors in wrist MSDs. Using a similar, job-based analytic design, they found that angular velocity of wrist extension and angular acceleration of wrist flexion could distinguish between jobs having high and low prevalence of CTS.

Laboratory Evidence. The most persuasive evidence for the risks associated with dynamic factors comes from work on the intervertebral disks. Marras and Granata demonstrated that the magnitude of compressive and shear forces on the disks is related to the speed and acceleration of movement in both lateral bending (1997, Ex. 26–169) and twisting (1995, Ex. 26–1383). Degree of asymmetry also affects the trunk motion characteristics associated with increased risk of back injury (Marras *et al.,* 1993, Ex. 26–170). Velocity and acceleration measures were all higher with one-handed lifts, the size of increase being proportional to the angle of asymmetry.

Szabo and Chidgey (1989, Ex. 26–1168) found that repetitive, passive wrist flexion and extension resulted in higher pressures in the carpal tunnel. These elevated pressures took longer to return to normal in their CTS patients than in normal subjects. These investigators also found evidence that, if the wrist and finger motions are active (in other words, if the subject rather than the investigator moves the wrist), the effect may be larger.

Psychophysical Evidence. The psychophysical laboratory studies have not explicitly examined the impact of dynamic factors, although it is likely that the studies of repetition (Section C.3.d) do address dynamic factors by proxy (Snook, 1996, Ex. 26–1353; Snook and Ciriello, 1991, Ex. 26–1008; Garg and Banaag, 1988, Ex. 26–951; Mital and Fard, 1986, Ex. 26–182; Klein and Fernandez, 1997, Ex. 26–1357). Increased repetition rates necessarily entail increases in angular and linear velocity and acceleration of some body segments. The resultant increases in forces experienced by body tissues (*e.g.,* Marras and Granata, 1995, 1997 Exs. 26–1383 and 26–169) might explain the subjective perceptions of fatigue and discomfort that result in a particular estimated MAW.

Summary: Dynamic Factors and Work-Related MSDs. Attention to dynamic factors in their own right (as opposed to the proxy representation of repetition) is very recent. The bodies of epidemiological and laboratory evidence relating dynamic stressors to MSD development are consistent with each other and with research centered on the other risk factors. But the existing studies are limited in number and in scope. As a result, the literature does not allow quite as much confidence in connecting these factors with work-related MSDs as can be demonstrated for the other risk factors addressed in this section. Further research is needed to more firmly establish the link between dynamic factors and work-related MSDs.

f. Compression. The classification of risk factors presented in Section B separated compression into external and internal compression. Internal compression has been addressed above, as the consequence of other biomechanical exposures, such as force, awkward and static postures, and repetition. This section only addresses externally applied compressive forces.

Epidemiological Evidence. The NIOSH summary (Bernard and Fine, 1997, Ex. 26–1) did not examine the association of compressive forces with MSDs. A few epidemiological studies have assessed the role of compression as a risk factor. Hypothenar hammer syndrome, characterized by signs of blood deprivation in the fingers, is caused by thrombosis or aneurysm in the ulnar artery or the superficial palmar arterial arch. This condition has been linked to the practice of using the palm as a hammer, exposing the palm to repetitive, forceful compression. Little and Ferguson (1972, Ex. 26–1144) calculated an OR of 16.3 (95% CI: 2.7–100) for objectively verified (by a Doppler flow detector) ulnar artery block, comparing vehicle maintenance workers who used their hands as a hammer (n=79) to those who did not (n=48). Nilsson *et al.* (1989, Ex. 26–1148) found a smaller effect (OR: 2.8; 95% CI: 1.3–6.2), comparing 890 plate workers to 61 office workers in the same plant. This study also found a dose-response relationship, with the OR increasing with increasing years on the job. However, inappropriate palm use and vibration exposure occurred together in this population.

Two studies also link bursitis of the knee with jobs that require a substantial amount of time in a kneeling position. Thun *et al.* (1987, Ex. 26–60) found a non-significant prevalence ratio for bursitis of 3.2 (90% CI: 0.8–3.9), comparing tile and terrazzo setters to bricklayers and millwrights. Kivimäki *et al.* (1992, Ex. 26–1137), comparing carpet layers to painters, calculated an OR of 11.2 (95% CI: 3.4–38) for doctor-diagnosed prepatellar bursitis. A population-based case-control study (Cooper *et al.,* 1994, Ex. 26–460) compared cases with knee osteoarthritis to matched controls with non-arthritic knee pain. They found that kneeling more than 30 minutes per day was associated with increased prevalence of osteoarthritis (OR: 3.4; 95% CI: 1.3–9.1).

Laboratory Evidence. Most of the research concerning the relationship of mechanical compression to MSDs has been conducted in the laboratory. Researchers have known for years that tools with inappropriately short handles, such as pliers and paint scrapers, can apply substantial compressive force to the blood vessels and nerves in the palmar area, resulting in occlusion of the ulnar artery, in particular, and possible neuropathy (Tichauer; 1966, Ex. 26–1172; Tichauer and Gage, 1977, Ex. 26–1269). There is medical evidence for compression-related MSDs. Finelli (1975, Ex. 26–115) describes the compression of an ulnar nerve branch in the palm by both occupational (tool handles) and non-occupational (bicycle handle grips) exposures. Sauter *et al.* (1987, Ex. 26–199) present a case example of injury due to wrist compression at a keyboard job. Several investigators describe compression of the ulnar nerve at the elbow, caused by leaning the ulnar side of the elbow on a hard surface (*e.g.,* Aguayo, 1975, Ex. 26–702). Nevasier (1980, Ex. 26–394) found examples of shoulder tenosynovitis in individuals who habitually carried heavy loads (such as lumber) on their shoulder.

Psychophysical Evidence. Psychophysical studies have not examined the effects of compression.

Summary: Compression and Work-Related MSDs. Despite the long history of recognition (particularly the relationship between tool handles and palmar compression), relatively little research has been performed on this risk factor. The existing epidemiological and laboratory evidence is congruent in suggesting the linkage between compression and at least two medical conditions. Particularly in the case of hypothenar hammer syndrome, a plausible physiologic mechanism exists.

g. Vibration.

Epidemiological Evidence. The NIOSH summary (Bernard and Fine, 1997, Ex. 26–1; see Table V–1 above) finds strong evidence for a causal relationship between segmental vibration and hand-arm vibration syndrome (HAVS). The only study to meet all four of the NIOSH inclusion criteria (Bovenzi *et al.,* 1995, Ex. 26–354) compared forestry workers with more than 400 hours of sawing to shipyard workers with no vibration exposure. These authors found increasing effect sizes, depending on the intensity of vibration exposure. The OR for forestry workers using anti-vibration saws was 6.2 (95% CI: 2.3–17.1); the OR for workers using no anti-vibration measures was 32.3 (95% CI: 11.2–93). This study also found a dose-response relationship to number of years exposed. Nilsson *et al.* (1989, Ex. 26–1148), comparing platers with current vibration exposure to office workers in the same workplace, calculated an OR of 85 (95% CI: 15–486). The high ORs in these studies have large confidence intervals but demonstrate the strength of effect that is characteristic of many vibration studies.

Other epidemiological studies demonstrate an association between vibration and work-related MSDs. Most work reported in the Health Effects Section addresses segmental vibration exposure of HAVS or occupational Raynaud's syndrome. Studies of select populations using vibrating tools find high concentrations of vascular and neurological symptoms compared to these in other working populations. Examples include shipyard workers (Cherniack *et al.*, 1990, Ex. 26–1116), surgeons (Cherniack and Mohr, 1994, Ex. 26–1341), and dental technicians (Hjortsburg, 1989, Ex. 26–1131).

The NIOSH summary also found evidence for a causal link between segmental vibration and CTS. Chatterjee *et al.* (1982, Ex. 26–941) compared 16 rock drillers to 15 controls unexposed to vibration. The OR for CTS, identified by nerve conduction studies, was 10.9 (95% CI: 1.02–524). Weislander *et al.* (1989, Ex. 26–1027), comparing 32 male CTS patients to population referents, found an OR for vibrating tool use of 6.1 (95% CI: 2.4–15). Several other studies have also found an association between CTS and vibration exposure in jobs involving the use of vibrating tools, such as grinders and chipping hammers (*e.g.*, Nathan *et al.*, 1988, Ex. 26–990; Hagberg *et al.*, 1992, Ex. 8–1). In this literature, however, it is extremely difficult to separate the association of CTS and vibration from the association of CTS and the other biomechanical stressors that often are associated with these tools: awkward and static postures, repetition, and high force requirements.

Some literature has addressed the consequences to other body parts of whole-body vibration exposure to other body parts. Hedlund (1989, Ex. 26–1279) found a foot analogue of HAVS in miners exposed to whole-body and segmental vibration. However, other research suggests that foot symptoms may be a more generalized sympathetic nervous system response to segmental exposure in the upper extremities (Sakakibara *et al.*, 1991, Ex. 26–1356). Other studies of whole-body vibration have suggested links to driving. Jensen *et al.* (1996, Ex. 26–145), studying a cohort of more than 89,000 drivers hospitalized for prolapsed cervical disks over 10 years, found a Standardized Hospitalization Ratio (SHR) of 142 (95% CI: 126.8–159.6), compared to other male workers. They also reported a prevalence ratio for self-reported vibration exposure of 7.1 (95% CI: 4.1–11.7) for the drivers. This research did not directly link vibration exposure with outcomes of prolapsed cervical disk.

Laboratory Evidence. Short-term and long-term changes to human neural tissue have been demonstrated by a number of researchers. These effects include intraneural edema, structural changes in non-myelinated fibers, demyelination, fibrosis, and even loss of axons (Takeuchi *et al.*, 1988, Ex. 26–682; Stromberg *et al.*, 1997, Ex. 26–894). Chang *et al.* (1994, Ex. 26–357) found similar changes in rat peripheral nerves. Finger biopsies of workers heavily exposed to local vibration have shown signs of significant endothelial injury (Takeuchi *et al.*, 1986, Ex. 26–681).

In the back, vibration may diminish the blood flow to the intervertebral disks. This has been demonstrated by Hirano, Tsuji, and Oshima (1988, Ex. 26–140) in rabbit intervertebral disks exposed to in vivo vibration. This could predispose the spine to injury by reducing both the transport of nutrients to the disk interior and the degree of hydration necessary to support the spine under load.

Psychophysical Studies. Although the weighting curves established for vibration exposure rely heavily on perceived discomfort, no formal psychophysical laboratory work has been performed on vibration.

Summary: Vibration and Work-Related MSDs. Vibration is the one biomechanical stressor that may be able to cause a specific disease (HAVS) as the only exposure. The epidemiological evidence is considered strong for vibration as the only causal factor for this outcome. Epidemiological evidence also exists for a causal link between vibration exposure and CTS.

The laboratory evidence supports these conclusions with findings of anatomical and physiological changes, due to segmental vibration, that are consistent with the symptoms and signs of HAVS. This congruent evidence strongly supports the implication of segmental vibration as the risk factor for the development of HAVS.

The evidence supporting the association between whole-body vibration exposure and disk degeneration is not as strong, but it is suggestive. More research into this association is required.

4. Modifying Factors and MSDs

Many of the studies cited above also indicate the importance of the modifying factors in this section's classification scheme: intensity/magnitude, duration, temporal profiles, and cold temperatures. Much of the research summarized by Bernard and Fine (1997, Ex. 26–1) finds that exposures characterized by high intensity and/or duration are associated with higher levels of MSD outcome than those with lower levels of these modifiers. These two modifiers are examined more fully in Section C.5, below.

a. Intensity. Intensity is included in many of the epidemiological and laboratory studies cited above. In particular, studies assessing the effects of high and low force are based in measures of intensity. The evidence for intensity as an important modifier of exposure in MSD etiology is presented below, in Section C.5.

b. Duration. As with intensity, duration is often the measure of high and low exposure in studies cited above. Much epidemiologic research measures the hours of exposure and has documented a dose-response relationship between duration and MSD outcomes. For example, Brisson *et al.* (1989, Ex. 26–937) found that the length of exposure to piecework in the garment industry was associated with increased MSD levels. de Krom *et al.* (1990, Ex. 26–102) found that hours of exposure increased the association of awkward, flexed wrist postures with CTS. Hagberg *et al.* (1990, Ex. 26–1317) demonstrated a duration/MSD association for vibration exposure. Kourinka and Forcier (1995, Ex. 26–432) summarize a collection of similar studies, all of which find that length of exposure, either per day or over a lifetime, increases the size of the association between exposure and work-related MSD outcome.

Duration may be measured in much longer time spans than hours. Anderson and Felson (1988, Ex. 26–926), analyzing the First National Health and Nutrition

Examination Survey (HANES I) data, found that an increased risk of osteoarthritis related to job characteristics appeared only in older workers, suggesting that lifelong exposure may be a part of the etiology.

The evidence linking duration with MSD causation is presented in detail below, in Section C.5.

c. Temporal Profile (Fatigue/Inadequate Recovery Time). In general, repeated damage to body tissues without adequate recovery time for repair may create permanent structural damage. Fatigue has been shown to modify muscle response to external load. As noted above, when muscles fatigue, the characteristics and effects of internal muscle loading can be changed in two ways. Within a given muscle, fiber recruitment generally proceeds from small to large fibers. Some small, slow-twitch fibers may be almost constantly in use and become fatigued and possibly injured, even during very-low-force contractions (see Section C.3.c) (Radwin and Lavender, in NAS, 1998, Ex. 26–37). This phenomenon, termed the ''Cinderella fiber theory,'' is discussed in more detail in later sections. This theory suggests one physiological reason that adequate rest cycles in work activities are important.

d. Cold Temperatures. Research has strongly linked cold to the exacerbation of effects due to vibration exposure. Lundström and Johansson (1986, Ex. 26–164) demonstrated the reduction in mechanoreceptor sensitivity with combined exposure to vibration and cold. This was accompanied by an increase in finger force exerted by subjects, creating better coupling between hand and vibration source and increasing the amount of vibration absorbed by the upper extremities. Simultaneously, this increased force is itself a possible risk factor for CTS.

Cold temperatures may also increase muscle activation required for a given task. Hammerskjöld *et al.* (1992, Ex. 26–957) found increased EMG signals in carpenters after hand exposure to cold, as well as increased perceived exertion and increased time required to carry out nailing tasks. Riley *et al.* (1983, Ex. 26–1358) showed that exposure to cold temperatures resulted in decreased performance on an assembly task. The experimentally demonstrated decrease in strength and coordination of the hands after exposure to cold (*e.g.*, Vangaard, 1975, Ex. 26–506; Vincent and Tipton, 1988, Ex. 26–592) may be the mechanism through which greater force requirements are made on muscles and tendons, causing or exacerbating MSDs.

e. Summary: Modifiers and Work-Related MSDs. The evidence for the effects of these modifying factors is contained within each risk factor section, as well as in the brief review above. Section C.5 below explores the evidence for the roles of intensity and duration in modifying the relationship of stressors to MSD outcomes. This evidence makes a strong case for the impact that each of these workplace modifiers has on the way the body tissues receive a given ''dose'' of a biomechanical stressor and the way in which that tissue can process, repair, and recover from this dose.

5. Evidence for the Relationships Between Exposure Intensity and MSD Prevalence

This section reviews studies designed to examine the relationships between intensity and/or duration of exposure to workplace risk factors and the magnitude of the risk for developing a work-related MSD (typically measured as an OR). In this capacity, the section reviews some of the studies presented above in greater detail. Data demonstrating a positive relationship between exposure and response provide evidence for a causal relationship between exposure to the hazard in the workplace and an increase in the occurrence and/or severity of the adverse response. Often, regression analysis is used to verify that the relationship is statistically significant even when potential confounding factors, such as gender and age, are taken into consideration. The strength of the association between exposure and response is reflected in the slope of the exposure-response curve; as the slope increases, the strength of the association increases and provides greater evidence of a causal relationship between exposure to the hazard of interest and increased risk of injury or illness.

Generalized models do not exist that would permit OSHA to use these data to quantify risk across all working populations. Nevertheless, these studies are useful to illustrate the extent to which risk can be reduced by reducing the intensity and duration of exposures to workplace risk factors.

The relationship between duration of exposure to workplace risk factors and prevalence of MSDs has been demonstrated in numerous studies. For example, the 1988 Occupational Health Supplement to the National Health Interview Survey (NHIS–OHS) conducted by the National Center for Health Statistics (NCHS) showed a clear dose-response relationship between hours engaged in manual handling and episodes of back pain lasting 7 days or longer. NCHS interviewed 27,408 currently employed workers between 18 and 64 years of age to gather information on the health conditions of the currently employed noninstitutionalized civilian population and to develop weighted national estimates of the incidence of health conditions, including episodes of back pain, known to occur in association with employment. All estimates were based on self-reports.

NIOSH (Exs. 26–1104, 26–1105, 26–1106) used the NCHS data to develop weighted national estimates of the number of currently employed workers by the status of back pain episodes lasting 1 week or longer, and by number of hours exposed to some of the workplace risk factors associated with MSDs of the back: strenuous physical activity and repeated bending, twisting, or reaching. Exposure was divided into categories of 0 hours, 0 to less than 2 hours, 2 to less than 4 hours, 4 to less than 6 hours, 6 to less than 8 hours, and 8 hours or more.

Of particular interest were:

- The number of currently employed workers experiencing no episodes of back pain.
- The number of currently employed workers experiencing an episode of back pain lasting 1 week or longer due to repeated activities at their current or most recent job and not due to any accident.

With these data categorized by hours of exposure to workplace risk factors, ORs could be calculated for episodes of back pain due to repeated activities at work for each of the exposure categories and each of the workplace risk factors considered.

Table V–3 presents the estimated number of currently employed workers engaged in strenuous physical activity such as lifting, pushing, or pulling heavy objects. Table V–4 presents the estimated number of currently employed workers engaged in repeated bending, twisting, or reaching. In each table the estimated numbers are broken down by hours per day engaged in each of the work activities, and by back pain status (either none or an episode lasting at least 1 week due to repeated activities at a current or most recent job and not due to any accident). In addition, ORs are presented.

The ORs in Table V–3 clearly indicate that exposure to strenuous physical activity increases the risk of episodes of back pain. The data show a clear positive exposure-response trend: the risk of episodes of back pain increases with an increase in the daily number of hours engaged in strenuous physical activity. Table V–4 shows the same results: the risk of episodes of back pain increases as the number of hours engaged in repeated bending, twisting, or reaching increases. These results are shown graphically in Figure V–1. They indicate that the risk of severe back pain can be reduced substantially by reducing the daily duration of exposure to these risk factors. For example, the risk can be reduced by about half if exposure to these risk factors is reduced from 6 to 8 hours to 2 hours or less per day.

Table V–3 shows that for some exposure categories, the ORs do not increase as exposure increases. The OR for workers engaged in strenuous physical activity for 6 to 8 hours is lower than the OR for workers engaged in strenuous physical activity for 4 to 6 hours. This deviation from an increasing trend, however, does not mean that there is no such trend. NIOSH used its estimated numbers to conduct a logistic regression of episodes of back pain on duration of exposure, adjusting for age and gender. The parameter estimates for each of the two types of exposure were positive and highly statistically significant ($p < .01$). This means that the increasing trend observed in the relationships between episodes of back pain and duration of each type of exposure is statistically significant.

Table V–3.—Estimated Number of Currently Employed Workers Engaged in Strenuous Physical Activity Such as Lifting, Pushing, or Pulling Heavy Objects, by Duration and Back Pain Status [1]

HOURS ENGAGED	BACK PAIN: NONE #	BACK PAIN: NONE % [5]	BACK PAIN: AT LEAST 1 WEEK DUE TO REPEATED ACTIVITIES AT WORK [3] #	BACK PAIN: AT LEAST 1 WEEK DUE TO REPEATED ACTIVITIES AT WORK [3] % [5]	PERCENT	ODDS RATIO [4]
0	70.960,000	71.7	1,233,700	26.8	1.7	1.00
0–2	7,431,700	7.5	549,200	11.9	6.9	4.25
2–4	5,776,000	5.8	566,100	12.3	8.9	5.64
4–6	4,955,800	5.0	749,500	16.3	13.1	8.70
6–8	3,235,600	3.3	431,800	9.4	11.8	7.68
Over 8	6,669,300	6.7	1,072,200	23.3	13.9	9.25
Total	99,028,400		4,602,500		4.4	

[1] Numbers estimated by NIOSH using data from the 1988 NHIS–OHS conducted by NCHS (Exs. 26–1104, 26–1105, 26–1106).
[2] Estimated number of currently employed workers experiencing no episodes of back pain every day for 1 week or more during the 12 months prior to the survey.
[3] Estimated number of currently employed workers experiencing an episode of back pain every day for 1 week or more due to repeated activities at their current or most recent job during the 12 months prior to the survey.
[4] The odds ratio approximates the risk of an episode of back pain lasting 1 week or more due to repeated activities at work for workers engaged in strenuous physical activity such as listing, pushing, or pulling relative to the risk of an episode of back pain for workers with no such exposure.
[5] Percentage may not add to 100 due to rounding.

Table V–4.—Estimated Number of Currently Employed Workers Engaged in Repeated Bending, Twisting, or Reaching, by Duration and Back Pain Status [1]

HOURS ENGAGED	BACK PAIN: NONE #	BACK PAIN: NONE % [5]	BACK PAIN: AT LEAST 1 WEEK DUE TO REPEATED ACTIVITIES AT WORK [3] #	BACK PAIN: AT LEAST 1 WEEK DUE TO REPEATED ACTIVITIES AT WORK [3] % [5]	PERCENT	ODDS RATIO [4]
0	57,020,000	58.1	501,100	11.0	0.9	1.00
0–2	5,664,100	5.8	288,200	6.3	4.8	5.79
2–4	7,478,000	7.6	553,500	12.2	6.9	8.42
4–6	8,088,800	8.2	736,600	16.2	8.3	10.36
6–8	6,556,800	6.7	766,500	16.9	10.5	13.30

Table V–4.—Estimated Number of Currently Employed Workers Engaged in Repeated Bending, Twisting, or Reaching, by Duration and Back Pain Status [1]—Continued

HOURS ENGAGED	BACK PAIN				PERCENT	ODDS RATIO [4]
	NONE		AT LEAST 1 WEEK DUE TO REPEATED ACTIVITIES AT WORK [3]			
	#	% [5]	#	% [5]		
Over 8	13,340,000	13.6	1,697,100	37.4	11.3	14.08
Total	98,148,600		4,543,000		7.1	

[1] Numbers estimated by NIOSH using data from the 1988 NHIS–OHS conducted by NCHS (Exs. 26–1104, 26–1105, 26–1106).

[2] Estimated number of currently employed workers experiencing no episodes of back pain every day for 1 week or more during the 12 months prior to survey.

[3] Estimated number of currently employed workers experiencing an episode of back pain every day for 1 week or more due to repeated activities at their current or most recent job during the 12 months prior to the survey.

[4] The odds ratio approximates the risk of an episode of back pain lasting 1 week or more due to repeated activities at work for workers engaged in repeated bending, twisting, or reaching relative to the risk of an episode of back pain for workers with no such exposure.

[5] Percentage may not add to 100 due to rounding.

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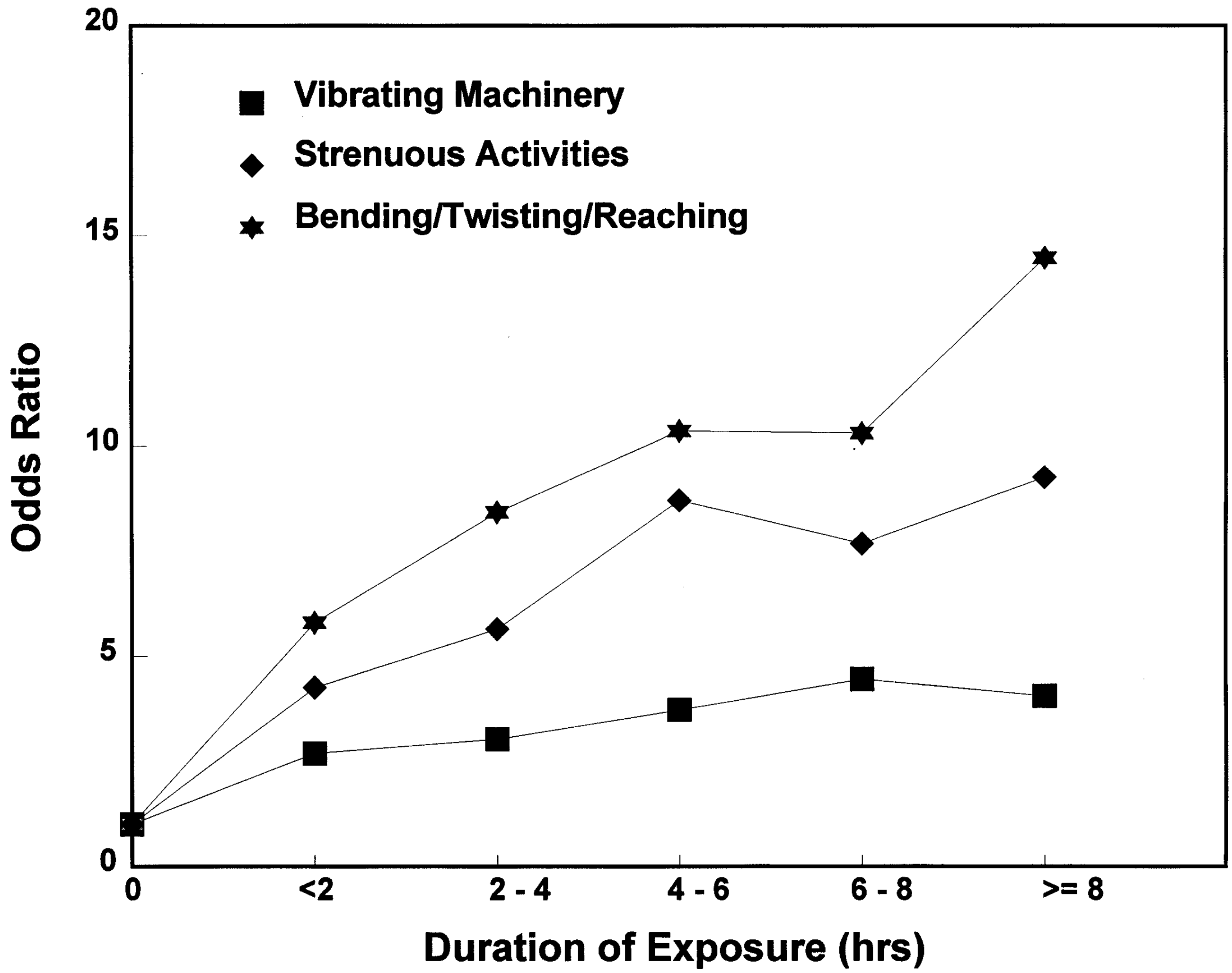
Figure V-1.
Relationship Between Duration of Exposure and Risk of Back Pain



Source: NIOSH analysis of data (Exs. 26-1104, 26-1105, 26-1106, 26-1107) from the National Health Interview Survey conducted by the National Center for Health Statistics.

Note: The odds ratio approximates the risk of an episode of back pain lasting 1 week or more due to repeated activities at work relative to the risk of an episode of back pain for workers with no such exposure. Work-related exposures include strenuous physical activity; repeated bending, twisting, or reaching; or the hand operation of vibrating machinery. Data excludes bac pain reported from acute injury or trauma.

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The ORs calculated from the data provided by NIOSH are very conservative. It is highly likely they underestimate the true ORs for the currently employed population. Only workers suffering episodes of back pain due to repeated activities at their current or most recent job are included. Workers who suffered episodes of back pain at a previous job are excluded. Workers who suffered episodes of back pain due to repeated activities on the job and due to an accident are also excluded. Finally, as observed by Bernard *et al.* (1993, Ex. 26–439), workers tend to overestimate the amount of time they spend daily at specific activities, particularly when such activities are hard and/or painful. Therefore, exposure is likely to be overestimated, meaning that risks at the lower exposure levels are likely to be underestimated. Despite the limitations of this analysis, the NCHS data clearly show a relationship between episodes of back pain lasting 1 week or longer and duration of exposure to workplace risk factors.

A similar analysis was conducted by Punnett *et al.* (1991, Ex. 26–39), using data from a case-control study of automobile assembly workers. To determine the relationship between back disorders and both postural stress and daily duration of exposure, the authors estimated the ORs from a logistic regression analysis. Duration of exposure was divided into two categories: 0 to 10% of cycle time and 10% or more of cycle time. Three types of postural stress were examined: any postural stress, mild flexion, and severe flexion. The results of this study, presented in Table V–5 and Figure V–2, show that for any postural stress and for mild flexion, the risk of back disorders was approximately 1.4 times greater for workers exposed for 10% or more of cycle time compared to workers exposed less than 10% of cycle time. For severe flexion, the risk of back disorders was approximately 2 times greater for workers exposed for 10% or more of cycle time than it was for workers exposed less than 10% of cycle time. The greatest increase in risk was seen among workers exposed to severe trunk flexion for more than 10% of cycle time (OR = 8.9 compared to unexposed workers). Thus, this study suggests that reductions in severity or duration of exposure to awkward trunk postures, even where exposure cannot be eliminated, may reduce risk of back disorders up to 2-fold.

Holmstrom, Lindell, and Moritz (1992, Ex. 26–36) estimated age-standardized prevalence rate ratios to examine the relationship between duration of exposure to different working postures and low-back and neck/shoulder pain in construction workers. Age standardization ia a statistical approach that controls for the effect of age on the health outcome being studied. This is usually done by selecting control subjects that match the ages of the individuals in the study cohort, or by using standardized illness rates for local or national populations. Controlling for age permits the investigator to compare the effect of age on the health outcome of interest with the effect of other variables, such as degree of exposure to a hazard. The age-standardized prevalence ratio is comparable to an age-adjusted odds ratio.

Table V–5.—Estimated Odds of Back Disorders in Workers With Varying Durations and Severities of Exposure [1]

TRUNK POSTURE	PERCENT OF CYCLE TIME	ODDS RATIO
Any posture	0–10%	3.8
	>10%	5.5
Mild Flexion	0 to 10%	4.2
	>10%	6.1
Severe Flexion	0 to 10%	4.4
	>10%	8.9

[1] Punnett *et al.,* 1991, Ex. 26–39.

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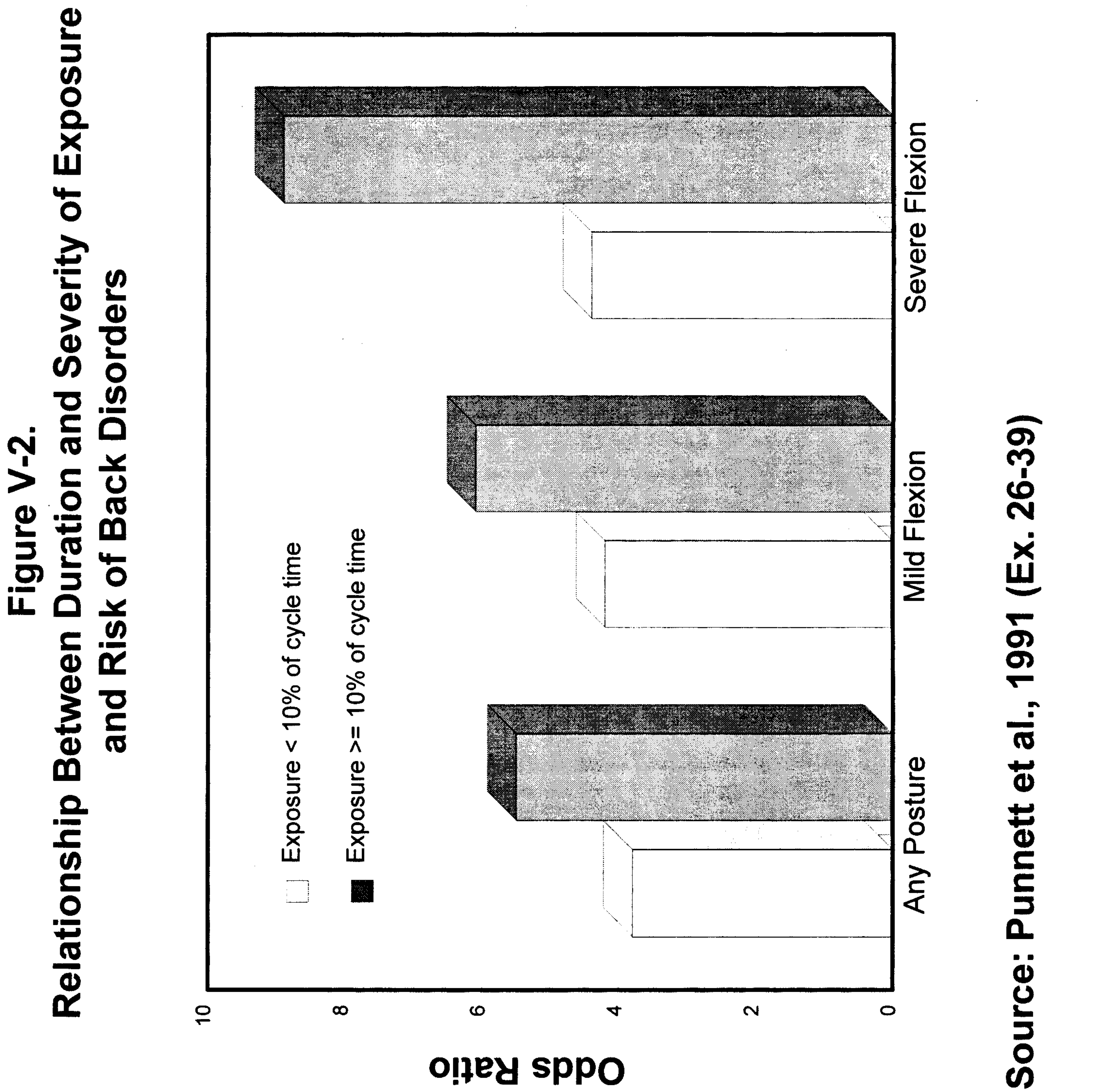

Figure V-2.
Relationship Between Duration and Severity of Exposure and Risk of Back Disorders

Source: Punnett et al., 1991 (Ex. 26-39)

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The results of the Holmstrom study are presented in Tables V–6 and V–7, and in Figure V–3. Three working postures were found to be associated with low-back pain: hands above shoulder level, stooping, and kneeling. In each case, the risk of severe back pain increases with exposure, with the largest increases in risk being associated with more than 4 hours per day of exposure to kneeling or stooping. Table V–6 shows that the greatest risk, associated with kneeling more than 4 hours per day, is 3.5 times greater among exposed workers than among workers with no exposure. These three working positions are also associated with considerable neck/shoulder pain. For this outcome, risk increases with duration of exposure as well. Table V–7 shows that for neck/shoulder pain, however, the greatest risk is associated with a posture of hands above shoulder level for more than 4 hours per day.

Table V–6.—Estimated Prevalence Rate Ratios of Severe Low-Back Pain in Construction Workers Engaged in a Variety of Postures, by Duration of Exposure [1]

POSTURE	HOURS OF EXPOSURE PER DAY	ODDS RATIOS	CONFIDENCE INTERVAL
Hands Above Shoulder Level	<1	1.09	0.8–1.5
	1–4	1.46	1.1–2.0
	>4	1.61	1.0–2.6
Stooping	<1	1.31	0.9–1.8
	1–4	1.88	1.4–2.6
	>4	2.61	1.7–3.8
Kneeling	<1	2.4	1.7–3.3
	1–4	2.6	1.9–3.5
	>4	3.5	2.4–4.9

[1] Holmstrom, Lindell, and Moritz, 1992, Ex. 26–36.

Table V–7.—Estimated Prevalence Rate Ratios of Neck/Shoulder Pain in Construction Workers Engaged in a Variety of Postures, by Duration of Exposure [1]

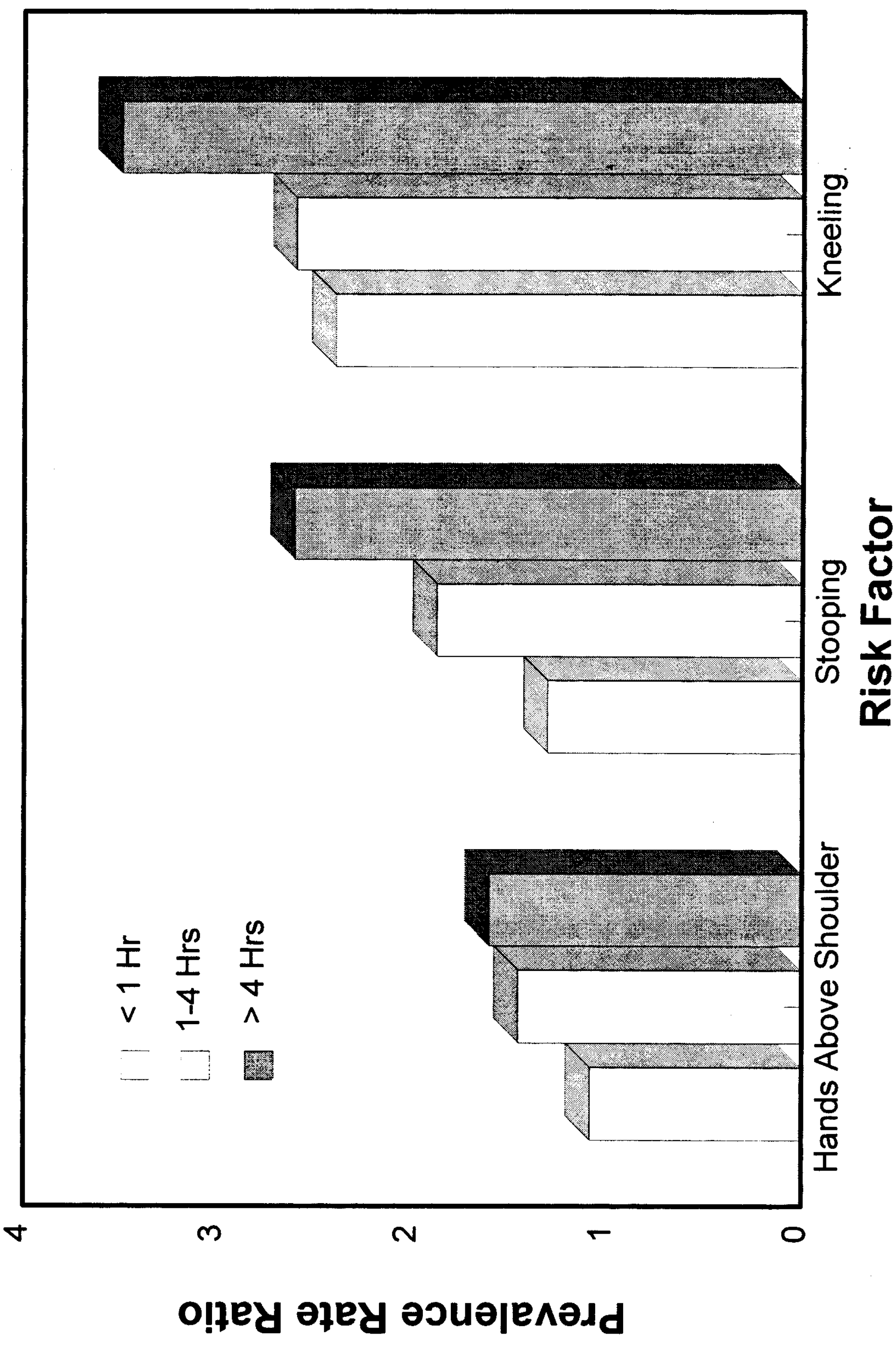
POSTURE	HOURS OF EXPOSURE PER DAY	ODDS RATIOS	CONFIDENCE INTERVAL
Hands Above Shoulder Level	<1	1.1	0.8–1.5
	1–4	1.5	1.2–1.9
	>4	2.0	1.4–2.7
Stooping	<1	1.0	0.8–1.3
	1–4	1.4	1.1–1.8
	>4	1.5	1.1–2.1
Kneeling	<1	1.4	1.1–1.8
	1–4	1.4	1.1–1.8
	>4	1.5	1.1–2.1

[1] Holmstrom, Lindell, and Moritz, 1992, Ex. 26–36.

BILLING CODE 4510–26–P

Figure V-3

Relationship Between Duration of Exposure, Type of Risk Factor, and Risk of Severe Lower Back Pain



Source: Holmstrom et al., 1992 (Ex. 26-36)

Note: Severe lower back pain defined as pain lasting at least 8-30 days over the past year and with "very severe" functional impairment.

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A prospective study by Liles *et al.* (1984, Ex. 26–33) demonstrated a clear relationship between intensity of exposure to manual handling risk factors and incidence of both total and lost-work-day back injuries. The study is unusual in that healthy workers were followed for over 1 year to determine the annual rate of back disorders. Exposure to manual handling risk factors was measured using a job severity index (JSI). A JSI is a measure of musculoskeletal strain based on weight handled, frequency of lifting, and a worker's physical capacity for lifting. A JSI of 1 or less means that the work task involved handling loads at or less than the worker's physical capacity for lifting. There was no apparent increase in either total or lost-work-day back injuries among workers whose jobs scored below a JSI of 1.5. Above this level, both total and lost-work-day injury rates increased dramatically, about 5-fold. The authors interpreted this finding as indicating that there is a threshold exposure level for back injuries due to manual handling and that back injuries can be expected to increase when workers handle loads exceeding their capacities by 50%. These data also suggest that back injury rates can be reduced by as much as 5-fold in manual handling tasks if they are designed to impart a physical load below 1.5 times the physical capacity of the worker, either by reducing duration of exposure or by reducing load weights or geometries. Figure V–4 graphically presents the relationship between the JSI and back injury rates.

Exposure-response relationships have also been demonstrated for upper-extremity MSDs. As with back disorders, studies have demonstrated that the risk of these illnesses increases dramatically with increasing daily duration of exposure to risk factors. For example, de Krom *et al.* (1990, Ex. 26–102) used ORs from a case-control study to assess the relationship between duration of exposure and MSDs. The authors estimated ORs from a logistic regression analysis that controlled for sex, age, and the interaction between age and sex to determine whether there was a relationship between CTS and the amount of time workers were engaged weekly in activities requiring a flexed wrist position, and between CTS and the amount of time workers were engaged weekly in activities requiring an extended wrist position. The results of this study, presented in Table V–8 and in Figure V–5, show that for both of these workplace risk factors—activities requiring a flexed wrist position and activities requiring an extended wrist position—the risk of CTS clearly increases as the number of hours spent each week in these activities increases.

Table V–8.—Estimated Odds of Carpal Tunnel Syndrome in Workers Engaged in Flexed Wrist and Extended Wrist Activities, by Duration of Exposure[1]

ACTIVITY	HOURS OF EXPOSURE PER WEEK	ODDS RATIOS	CONFIDENCE INTERVAL
Flexed Wrist	0	1.0	
	1–7	1.5	1.3–1.9
	8–19	3.0	1.8–4.9
	20–40	8.7	3.1–24.1
Extended Wrist	0	1.0	
	1–7	1.4	1.0–1.9
	8–19	2.3	1.0–5.2
	20–40	5.4	1.1–27.4

[1] de Krom *et al.,* 1990, Ex. 26–102.

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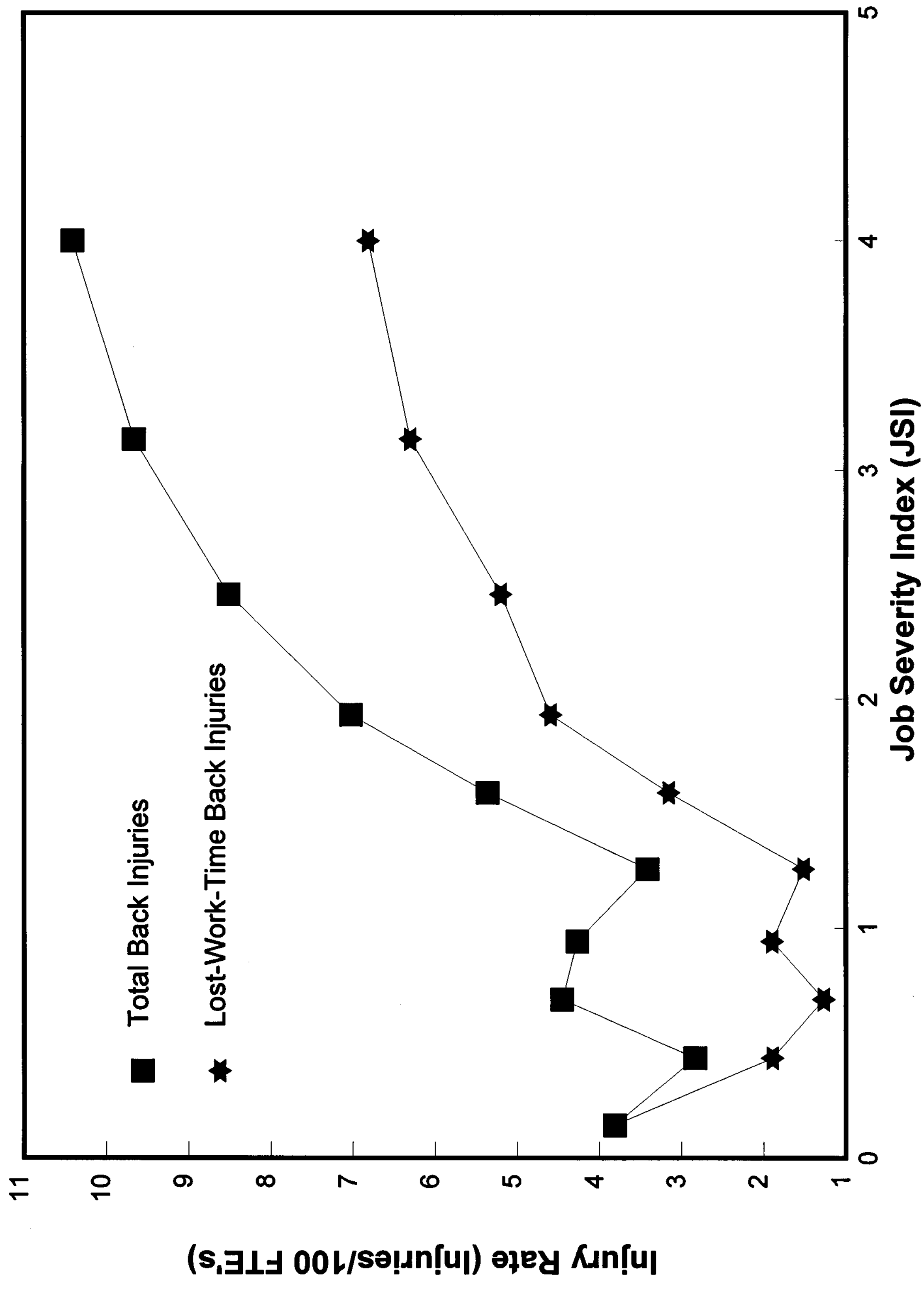
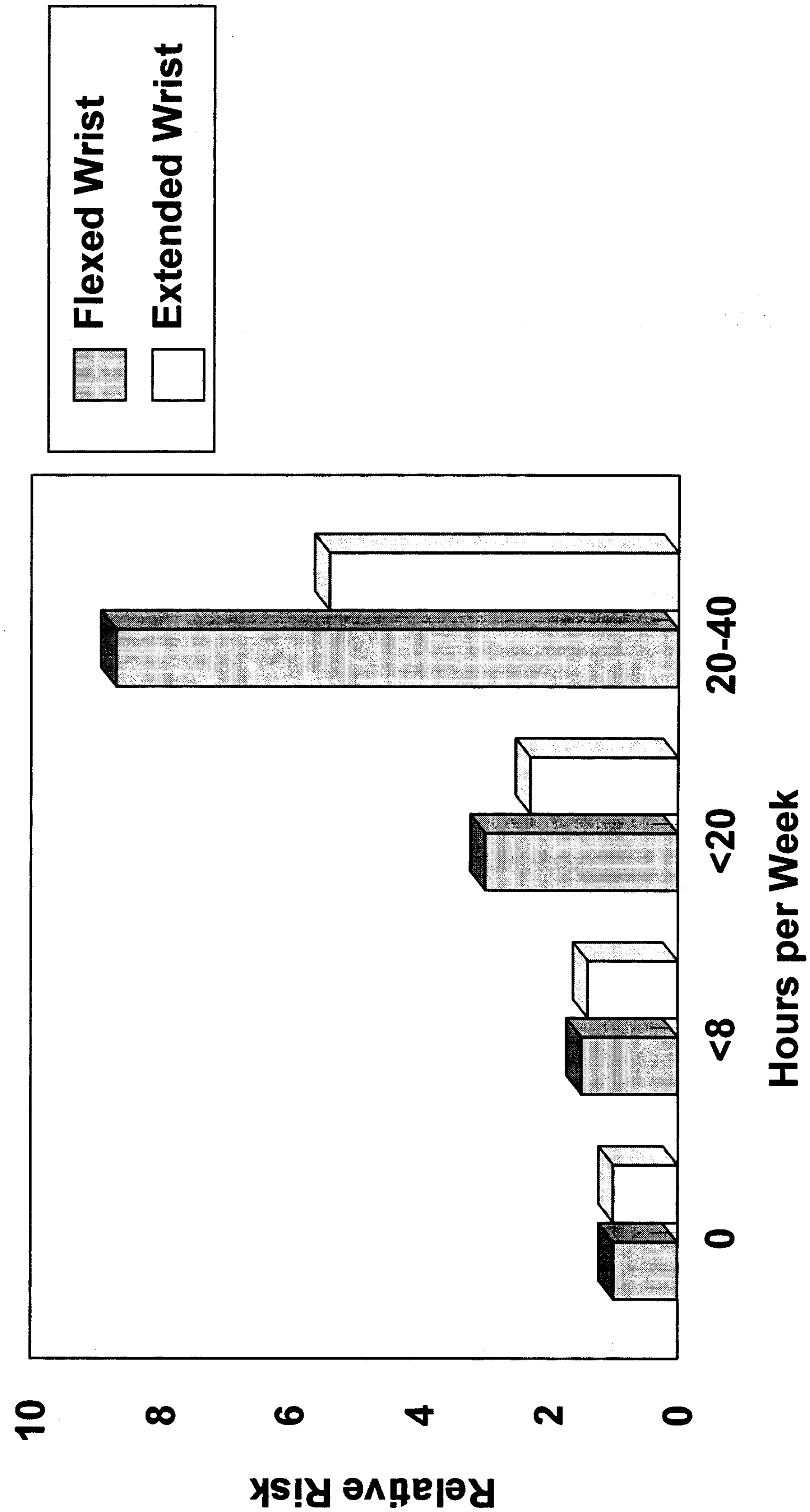
Figure V-4
Cumulative Injury Rate vs. Job Severity Index



Source: Liles et al., 1984 (Ex. 26-33)

Figure V-5
Relationship Between Duration of Exposure to Flexed or Extended Wrist and Relative Risk of Carpal Tunnel Syndrome



Source: deKrom et al., 1990 (Ex. 26-102)

BILLING CODE 4510–26–C

For workers engaged in activities requiring flexed wrists for as few as 8 to 19 hours per week (averaging approximately 1.5 to 4 hours per day), the odds of suffering CTS were three times greater than for workers engaged in activities that did not require flexed wrists. In contrast, the odds of suffering CTS in workers with average daily exposure to activities requiring flexed wrists in excess of 4 hours per day was 8.7 times greater than in workers with no exposure, or almost 3 times greater than for workers exposed less than 4 hours per day. Similarly, for workers engaged in activities requiring extended wrists for as few as 8 to 19 hours per week, the odds of suffering CTS were 2.3 times greater than for workers engaged in activities that did not require extended wrists. The odds of suffering CTS in workers with average daily exposure to activities requiring flexed wrists in excess of 4 hours per day was 5.4 times greater than in workers with no exposure. Thus, for workers engaged in tasks involving flexed or extended wrists for more than 4 hours daily, this study suggests that the risk of CTS can be reduced 2- to 3-fold by reducing daily exposure to less than 4 hours.

The duration of exposure to workplace risk factors is not the only factor associated with increased risk of work-related MSDs. Exposure to multiple workplace risk factors has also been found to be associated with increased risk. For example, in a study of workers at six industrial sites, Silverstein *et al.* (1986, Ex. 26–1404) studied the relationship between hand/wrist cumulative trauma disorders and exposure to activities requiring low force and low repetition, high force and low repetition, low force and high repetition, and high force and high repetition. Using logistic regression analysis to estimate ORs, these authors reported that the odds of suffering hand/wrist cumulative trauma disorders were 1.0 for workers engaged in low-force and low-repetition activity (*i.e.*, the control group), 3.3 for workers engaged in low-force and high-repetition activity, 5.2 for workers engaged in high-force and low-repetition activity, and 29.1 for workers engaged in high-force and high-repetition activity (see Figure V–6).

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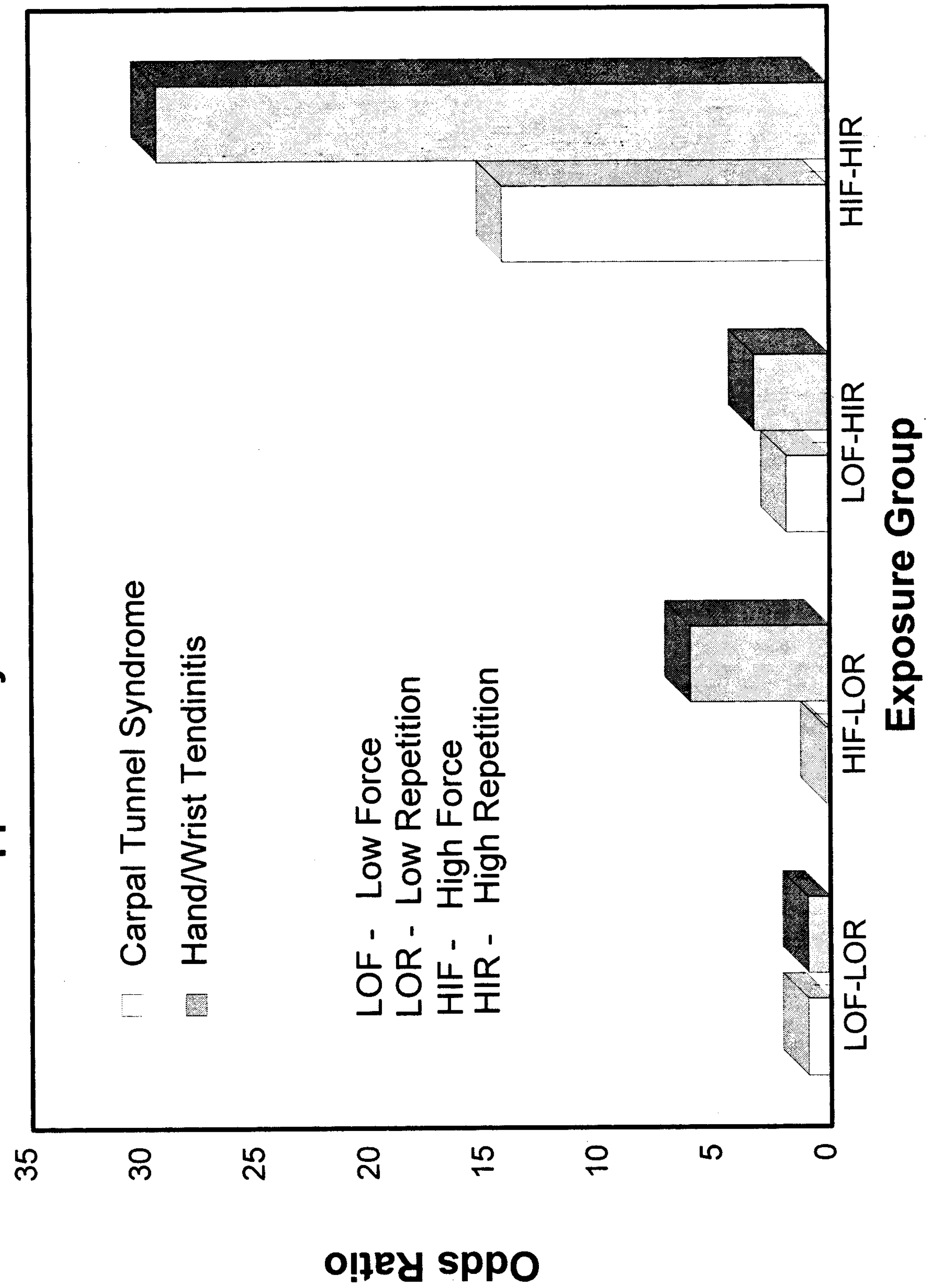
Figure V-6

Relationship Between Exposure to Risk Factors and Risk of Upper Body Musculoskeletal Disorders



Source: Armstrong et al., 1987 (Ex. 26-48); Silverstein et al., 1987 (Ex. 26-34)

BILLING CODE 4510–26–C

Similar findings for CTS were reported for workers in seven industrial sites (also shown in Figure V–6). Using logistic regression analysis to estimate ORs, these authors reported that the odds of suffering CTS were 1.0 for workers engaged in low-force and low-repetition activity (*i.e.*, the control group), 1.8 for workers engaged in high-force and low-repetition activity, 2.7 for workers engaged in low-force and high-repetition activity, and 15.5 for workers engaged in high-force and high repetition activity. Thus, the risk to workers exposed to two risk factors (high repetition and high force) was 7 to almost 10 times higher than the risk to workers exposed to only one risk factor. These data also suggest that risk increases more than linearly with increasing duration or intensity of exposure. Moore and Garg (1994, Ex. 26–1033) reported a similar finding among meat processing workers at risk for upper-extremity disorders. They found that the incidence of all upper-extremity disorders increased by the square of the amount of hand force applied in the job.

Loslever and Ranaivosoa (1993, Ex. 26–161) examined 17 jobs at high risk for CTS. For each job, they measured the amount of time the workers spent with flexed or extended wrists, the degree of flexion or extension, and the amount of force exerted. They found that the prevalence across jobs of CTS in both wrists increased in a dose-dependent manner as the combined exposure to force and flexion across jobs increased. In addition, the combination of force and flexion explained approximately 39% of the total variation in the prevalence of bilateral CTS across jobs.

Other supporting evidence for the existence of exposure-response relationships for upper-extremity disorders includes studies by Viikari-Juntura *et al.* (1994, Ex. 26–873) of neck disorders among machine operators, construction carpenters, and office workers, and a case-control study by English *et al.* (1995, Ex. 26–848) showing an exposure-response relationship between the rate of wrist flexion/extension and the ORs for disorders of the thumb.

Punnett (1998, Ex. 26–442) conducted a cross-sectional study in an automobile stamping plant and an engine assembly plant using an exposure-scoring protocol that reflected the intensity and duration of exposure to any of several workplace risk factors (*e.g.*, lifting/lowering, pushing/pulling, repetitive hand motion, awkward postures). The total exposure score had a possible range from 0 to 25 and was divided into quartiles, as indicated in Tables V–9 and V–10. The results are quite consistent, indicating that regardless of whether a case was defined by a physical examination or by self-reported symptoms, the prevalence of illness increased in a dose-dependent manner through exposure levels 13 to 18. Above that level, prevalence appears to hit a plateau. The author suggests that this plateau may be due to a ‘‘healthy worker’’ effect. By this she means that exposures at this level are so severe that workers move out of these jobs quickly, either to other jobs or to disability status. As a result of this relatively high turnover, healthy workers are frequently moved into these jobs. Thus the observed prevalence does not conform to a monotonic dose-response model.

Table V–9.—Prevalence Ratios for MSDs

[Based on Physical Exam]

EXPOSURE SCORE BASED ON CHECKLIST	SHOULDER/UPPER-ARM MSDs	HAND/WRIST MSDs	ALL UPPER-EXTREMITY MSDs
0–6	1.0	1.0	1.0
7–12	2.6	1.9	2.0
13–18	3.6	2.4	2.6
19–25	2.3	2.3	2.8

Table V–10.—Prevalence Ratios for MSDs

[Based on Symptom Reporting]

EXPOSURE SCORE BASED ON CHECKLIST	SHOULDER/UPPER-ARM MSDs	HAND/WRIST MSDs	ALL UPPER-EXTREMITY MSDs
0–6	1.0	1.0	1.0
7–12	2.5	2.0	1.8
13–18	3.8	2.5	2.4
19–25	3.5	2.5	2.3

Source: Punnett, 1998, Ex. 26–442.

Taken together, these studies provide compelling evidence of a causal relationship between exposure to workplace risk factors and an increased risk of developing MSDs. Furthermore, these studies demonstrate that the risk of work-related MSD can be substantially reduced by reducing the frequency or duration of exposure to any workplace risk factor, and by reducing the number of workplace risk factors to which workers are exposed.

6. Summary

The evidence summarized in this section is convincing and consistent. Studies from very different research traditions, and incorporating very different research methodologies, strongly support the causal association of force, awkward postures, static postures, repetition, and vibration with work-related MSD outcomes. The evidence also strongly supports the effects of the four modifying factors on the impact of the exposures and the body's ability to repair the damage. The evidence is less strong in the case of external compression and dynamic factors, partly because of a relative shortage of studies in these areas. But the evidence that does exist is congruent.

In sum, although not all the epidemiological studies reviewed demonstrate significant associations, the overwhelming majority justify a conclusion that the risk factors noted in this section, with effects adjusted by the four modifying factors, cause or exacerbate work-related MSDs. The laboratory evidence in each case provides plausible and demonstrable biologic mechanisms through which these exposures can cause the anatomical and physiological changes characteristic of these disorders. The psychophysical evidence, relying on research that has linked subjective reports of fatigue, discomfort, and exertion to measurable disease rates in industry, further strengthens this conclusion.

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D. Pathogenesis and Pathophysiologic Evidence for Work-Related Musculoskeletal Disorders

1. Overview

An extensive body of scientific research and information has led to the conclusion that specific work factors, combinations of these factors, and modifying attributes or conditions contribute to the development and manifestation of work-related musculoskeletal disorders (MSDs). The term ''work-related'' refers to the performance of work tasks or working in a specific work environment that significantly contributes to the pathogenesis or manifestation of these multifactoral conditions (World Health Organization, 1985, Ex. 26–1040). The multifactoral nature of many of these MSDs, including the potential contribution of pre-existing or non-work factors to the pathogenesis of some work-related MSDs, is recognized. Other sections of this document present epidemiologic and biomechanical evidence that addresses the association of work factors and certain MSDs. This section describes the pathogenic and pathophysiologic mechanisms that establish the biological plausibility of the findings of the epidemiologic and biomechanical observations included in the earlier sections and in the Appendices (Ex. 27–1).

The pathogenesis of work-related MSDs can refer to either single, point-in-time injuries, associated with work tasks that result in activities in which tissue tolerance is acutely exceeded, or circumstances in which the performance of specific work tasks or combinations of tasks over a prolonged period of time results in small and repeated tissue damage to muscles, tendons, joints, or nerve structures (Association of Schools of Public Health/NIOSH, 1986, Ex. 26–1323; Putz-Anderson, Doyle, and Hales, 1992, Ex. 26–419; Rempel, Harrison, and Barnhart, 1992, Ex. 26–520). Work activities suggested as potential factors in the development or expression of work-related MSDs include high rates of task repetition; excessive force requirements; static postures; awkward work postures; vibration; cold temperatures; weight of loads lifted, pushed, or pulled; position of a load in relationship to the spinal axis; frequency and duration of materials handling task performance; hand coupling; dynamics of lifting (*e.g.*, muscle velocity and acceleration); lack of sufficient rest or recovery periods; overtime; piecework; and other issues (Armstrong, 1986, Ex. 26–928; Armstrong *et al.*, 1987, Ex. 26–48; Bergquist-Ullman and Larsson, 1977, Ex. 26–933; Chaffin and Park, 1973, Ex. 26–1115; Frymoyer *et al.*, 1980, Ex. 26–707; Johanning *et al.*, 1991, Ex. 26–1228; Klein *et al.*, 1984, Ex. 26–972; Marras *et al.*, 1993, Ex. 26–170; Rempel, Harrison, and Barnhart, 1992, Ex. 26–520; Silverstein, 1985, Ex. 26–1173; Silverstein, Fine, and Armstrong, 1986a, Ex. 26–1153, 1986b, Ex. 26–1404; Snook, Campanelli, and Hart, 1978, Ex. 26–35; Stock, 1991, Ex. 26–1010; Waters *et al.*, 1993, Ex. 26–521; Waters, 1994, Ex. 26–1403).

To accomplish motion and work, muscle, nerves, connective tissue, and skeleton are affected by a number of external and internal physical demands causing metabolic and compensatory tissue reactions. For example, the forceful, static, continuous, and/or repetitive demands made by manufacturing assembly work or manual materials handling can alter the function and integrity of specifically affected tissues. This can lead to the development and clinical manifestation of MSDs such as tendinitis, epicondylitis, rotator cuff syndrome, or low-back pain. External demands can include direct pressure or tissue friction. As an illustration, prolonged or excessive force exerted over the base of the palm (by tools, handles, etc.) during assembly tasks can damage the median nerve in the palm, causing signs and symptoms of carpal tunnel syndrome (CTS). Internal responses can include inflammatory responses to tissue injury, neurochemical changes, and altered metabolism. For example, a lumbar disc herniation from repetitive lifting of heavy loads can compress a spinal nerve root, with subsequent nerve root edema, altered tissue metabolism, production of inflammatory mediators, and expressed signs and symptoms of lumbar radiculopathy.

The consequences of these external and internal demands associated with work activities can include a spectrum of symptoms or clinical findings, such as subtle or obvious inflammation, pain, swelling, restricted movement, and tissue damage diagnosed as muscle strain or tear, ligamentous or cartilage injury, tendinitis or tenosynovitis, bursitis, nerve entrapment, disc herniation, or degenerative joint or disc disease. This does not mean that a precise dose-response relationship between task factor exposure and disease exists for each of these work-related MSDs. Clear and consistent patterns exist, however, among the epidemiologic studies, biomechanical models, and pathogenetic and pathophysiologic explanations for many work-related MSDs (Gordon, Blair, and Fine, 1994, Ex. 26–1399; National Academy of Sciences, 1998, Ex. 26–37; Bernard and Fine, 1997, Ex. 26–1).

Factors specific to the individual can also affect the development and/or manifestation of pathology. These include, for example, preexisting injuries or illnesses (such as diabetes, degenerative joint disease, or rheumatoid joint disease); individual susceptibility to injury or tissue damage (related to anthropometric characteristics, physical conditioning, age, or genetics); and avocational activities or hobbies. These can interact in a complex fashion, such that work acts either as a causative, contributing, or accelerating factor in the development and/or manifestation of disease (Putz-Anderson, Doyle, and Hales, 1992, Ex. 26–419; Rempel, Harrison, and Barnhart, 1992, Ex. 26–520). However, although non-work risk factors can influence the development or expression of MSDs, their role is generally not as important as workplace risk factors because the duration and intensity of work are seldom matched in the non-work settings. Additional important considerations pertain to interactions between co-existing MSDs. For example, once an MSD is established, subsequent physical compensatory changes can further predispose an individual to the development of additional MSDs. When injury causes an altered posture, decreased range of motion, or weakness or ability to respond to tactile feedback to one joint or region, there is often increased risk of injury to another joint or region due to compensatory, increased loading. One example is the loss of tactile feedback from CTS, leading to greater hand force output that in turn contributes to the development of tendinitis or epicondylitis.

Section D.2 discusses the interaction between work demands and the responses of skeletal muscle, tendon, ligament, nerve, blood vessels, joint, and cartilage. It reviews the biological plausibility of an association between workplace factors and work-related MSDs of the spine and upper and lower extremities. It also considers the contributions of age, genetics, gender, cigarette smoking, and avocational activities to the pathogenesis and pathophysiology of work-related MSDs.

Section D.3 focuses on vibration. A separate section on vibration is included here because real specificity exists for this risk factor. Vibration can be reliably linked with specific outcomes: damage to vessels and small, unmyelinated nerve fibers in the fingers. In contrast, most of the other tissue disorders discussed in Section D result from a combination of exposures.

2. Pathogenesis and Pathophysiology of Work-Related Tissue Injury

a. Skeletal Muscle. There are several explanations for the development of work-related skeletal muscle disorders. Acute muscle tears, an extreme example of work-related skeletal muscle disorders, may develop when task demands exceed muscle tissue tolerance. While this may occur during any type of muscle contraction, it is much more common during eccentric contraction (*i.e.* during muscle lengthening to control, rather than initiate, an action), perhaps due to the nature of muscle recruitment of fibers with less oxidative capacity (Friden and Lieber, 1994, Ex. 26–546). Yet even low-force, static, or prolonged muscle activities commonly noted in a variety of manufacturing and office settings have the potential to cause or contribute to the development of work-related skeletal muscle disorders (Hagg, 1991, Ex. 26–427; Henneman and Olson, 1965, Ex. 26–139; Herberts *et al.*, 1984, Ex. 26–51; Jarvholm *et al.*, 1989, Ex. 26–967; Murthy *et al.*, 1997, Ex. 26–307; Sjogaard, 1988, Ex. 26–206; Sjogaard and Sjogaard, 1998, Ex. 26–1322). Muscle recruitment patterns with low-extension, repetitive, or static activities may selectively injure low-threshold and more easily recruited muscle fibers, which have been referred to as ''Cinderella fibers'' because of their constant activity (Henneman and Olson, 1965, Ex. 26–134; Lieber and Friden, 1994, Ex. 26–559). Alternatively, hypoxia and metabolic abnormalities (fatigue), inflammatory responses, inadequate rest pauses, and repair mechanisms appear to explain some of these skeletal muscle disorders associated with certain jobs or tasks (Armstrong *et al.*, 1993, Ex. 26–1110; Bigland-Ritchie, 1983, Ex. 26–76; Faulkner and Brooks, 1995, Ex. 26–1440; Herberts *et al.*, 1984, Ex. 26–51; Sjogaard, 1988, Ex. 26–206; Sjogaard and Sogaard, 1998, Ex. 26–1322). Electromyography (EMG) has helped researchers to better understand skeletal muscle responses to work tasks, estimate muscle loading with activity and intramuscular pressure generation, and comprehend the development of muscle fatigue (Chaffin, 1973, Ex. 26–876; Chaffin and Andersson, 1991, Ex. 26–420; Dolan *et al.*, 1999, Ex. 26–819; Lieber and Friden, 1994, Ex. 26–559; Nieminen *et al.*, 1993, Ex. 26–1382; NIOSH, 1992, Ex. 26–1325). In addition, at least one study has demonstrated a significant impact of ergonomic interventions on diminishing both EMG-observed trapezius loading and sick time due to skeletal muscle morbidity (Aarås, 1994a, 1994b, 1987, Exs. 26–892, 26–62, 26–1034).

Skeletal muscle is a highly evolved tissue with specialized contractile properties and an exceptional capacity to adapt and change. The bodybuilder's ability to rapidly build muscle bulk and the weakness and atrophy that come with prolonged bed rest or disuse are two examples of this ''plasticity.'' Individual muscle fibers have a unique capacity to convert chemical energy into a specific level of time-limited mechanical work (capacity and endurance). There are hundreds of skeletal muscles in the human body, each responsible for specific motions of bone and joints, that permit work performance. In the setting of normal physiologic responses, the central nervous system (CNS) releases nerve impulses which activate motor units, causing muscle contraction, tendon tension, and movement of bones and joints. Each skeletal muscle is attached to a site of origin, transitions through a myotendinous junction, and attaches to bone as tendon, sometimes crossing joints along the way.

The components of each skeletal muscle include muscle fibers, connective tissue, and nerve endings. Muscle fibers, in turn, are composed of contracting elements called myofibrils. These myofibrils contain thin (actin, troponin, and tropomyosin proteins) and thick (myosin protein) filaments that slide over each other, resulting in muscle contraction. The myofilaments are arranged in compartments (sarcomeres) separated from each other by thin zones of dense material (Z-lines). Upon stimulation from a motor nerve impulse, altered muscle membrane permeability (depolarization) releases calcium ions, which subsequently create cross-bridging between muscle filaments and resultant contraction. Skeletal muscle is covered by a connective tissue called the epimysium, which is contiguous with the perimysium, a septum that separates the muscle into muscle fiber bundles. These muscle fiber bundles further subdivide into individual muscle fibers surrounded by an endomysium. The connective tissue permits the passage of blood vessels and nerves through the skeletal muscle to the muscle fibers, and also contributes to the mechanical characteristics of the muscle, especially with respect to resistance to stretching or deformation.

Peripheral nerves traverse the connective tissue to carry (motor) impulses from the CNS to the muscle, attaching at the neuromuscular junction. The functional unit of a muscle is called the motor unit, and is composed of motor neurons and the muscle fibers they control. Small motor units, with a nerve fiber controlling a few muscle fibers, are located in areas such as the hand where fine motor tasks are performed. These smaller units allow contraction at lower forces. Larger units are located in the leg, where a single nerve fiber can activate hundreds or thousands of muscle fibers to permit gross motor tasks. When a nerve impulse activates a motor unit, all of the fibers in that unit contract simultaneously. The response of the entire muscle depends on several factors. After a nerve impulse, a certain number of motor units will contract in response. As the impulse increases, more units are recruited and greater force results. When stimulation occurs prior to relaxation, a larger contraction (or summation) will evolve. The size, temporal sequencing, and frequency of the stimulus will determine if a muscle reaches maximal contraction, with responses maintained until stimulation ceases or fatigue occurs. Sensory feedback control occurs via muscle spindles that sense the length and speed of contraction or stretch of the muscle fibers.

Muscle power also depends on the composition of the fibers and muscle length. Type I (slow) fibers are smaller, have a large capacity for aerobic work, take a longer time to reach peak tension, and permit sustained, low-level muscle activity. Type II (fast) fibers quickly reach peak tension and help with short-duration, intensive activity. Type II fibers, however, fatigue quickly. With disuse, type II fibers are the first to atrophy (Chaffin and Andersson, 1991, Ex. 26–420). Skeletal muscles at their relaxed length generate the greatest amount of tension. At resting length, there is optimal overlap between the thick and thin filaments to permit maximal shortening. As the muscle contracts, there is greater overlap and less potential to contract further. When muscles are stretched, there is less overlap, and therefore, less tension can be generated (Chaffin and Andersson, 1991, Ex. 26–420). As discussed above, the amount and characteristics of the passive connective tissue in the specific muscle also determine the tension developed when muscles are stretched.

Individual muscle fibers have a unique capacity to convert chemical energy into a specific level of time-limited mechanical work (capacity and endurance). This chemical energy is transported in the form of activated phosphorylated molecules, primarily adenosine triphosphate (ATP). Energy release to accomplish muscle contraction is provided by the splitting off of a phosphate group from adenosine triphosphate (ATP), which converts the ATP to adenosine diphosphate (ADP). Phosphocreatine enables ADP to be converted back to ATP, thereby re-supplying the muscle fiber with energy and permitting the contraction to continue for brief periods. With persistent contraction, ATP resynthesis occurs under aerobic (with oxygen) or anaerobic (without oxygen) conditions. During low to moderate exertion, aerobic conditions predominate. The exhaustion of these energy stores can lead to fatigue, and in extreme cases, injury to the muscle tissue itself (Armstrong, Warren, and Lowe, 1994, Ex. 26–525; Chaffin and Andersson, 1991, Ex. 26–420; Lieber and Friden, 1994, Ex. 26–559). Heat is also generated and expended as a result of this metabolic activity.

Researchers have described several types of muscle contraction. In isometric (static) contraction, the external length of the muscle remains fixed, despite sliding of myofibrils. High muscle tension is generated because there is no expenditure of energy to shorten the muscle. During isotonic contraction, muscle length changes while the tension remains constant. Energy is expended to permit this change in muscle length to occur. Concentric contraction involves muscle shortening. An example of this is when the biceps muscle contracts and shortens during elbow flexion. Eccentric contraction describes contraction during muscle lengthening, as when muscle activity is required to control an action rather than to initiate it. Velocity of contraction affects the tension a muscle generates, with less force generated as the velocity of shortening increases. This relates to the length of the muscle, discussed above, and friction. Endurance depends on the composition of fibers and the percentage of maximal muscle force (Chaffin and Andersson, 1991, Ex. 26–420; Lieber and Friden, 1994, Ex. 26–559). At efforts under 15% of maximal force, endurance can reach 45 minutes (Lieber, 1992, Ex. 26–433). As muscle approaches 35% of maximal force, endurance time decreases to approximately two minutes, and as exertion approaches 100%, endurance time approaches zero (Chaffin and Andersson, 1991, Ex. 26–420, p. 49). Gradual exercise programs, however, have the capacity to improve muscle strength and endurance.

Muscle proteins allow muscle fibers to stretch and to elastically recoil to their resting length. If a muscle is stretched excessively, these mechanoelastic properties of muscle fiber are exceeded and observable physical damage is incurred. There is an important distinction between injuries that are the result of muscle activities that exceed these mechanoelastic capacities of muscle, and injuries that have their origins in activities that are below maximum muscle capacity. The latter may involve sequential or stereotyped patterns of work, whose execution becomes compromised by pain or fatigue. In fact, the bulk of modern work involves activities that neither challenge nor exceed the mechanical limits of muscle fibers.

The types of injury acquired during more routine function involve potentially complex metabolic and neurologic processes. Changes in muscle morphology and fiber type (gene expression), in muscle fatigue and failure (metabolic function), and in loss of centrally mediated coordinated movement (dystonia) are all examples of the biochemical and neurologic origins of some types of muscle injury. These mechanisms, rather than gross patho-anatomic injury and repair, are a major focus of current research on work-related muscle injury.

Muscle tissue has a high intrinsic repair capacity and can effectively adapt to diverse biomechanical loads. Understanding the divergent paths of successful learning and adaptation or injury and degeneration requires an understanding of physiology (Pette, 1980, Ex. 26–1304).

There are three events associated with muscle injury. While injury related to mechanical contraction is usually caused by stretch (eccentric contraction), injury may also occur during muscle shortening (concentric contraction), or while maintaining the muscle at a constant level of stretch and tension (isometric contraction). The basic mechanism is a mismatch between external load and internal contractile capacity. This results in mechanical disruption between the sarcomeres along the Z-lines. The outcome is inflammation, the sensation of muscle soreness, and triggering of repair processes.

A second injury mechanism is fatigue, in which there is an activity-related perception of raised effort or an inability to sustain force. Muscle fatigue occurs when physical tasks require high-power, short-duration repetitive contractions, or when there are low-power, sustained or repetitive contractions (Faulkner and Brooks, 1995, Ex. 26–1410). Fatigue has consequences for task performance and includes both rapidly reversible and non-reversible manifestations.

As a muscle becomes fatigued, it produces a distinct electrical signal that can be picked up by electromyography (EMG). The EMG signal is measured by placing electrical transducers on the skin surface over the muscle, or by inserting a needle or small wire directly into the muscle. EMG measurements are most often taken where muscles are well-defined and accessible. EMG has other uses. EMG has been an important tool in measuring effort and fatigue in the large muscles of the neck and shoulders. Recorded EMG voltage reflects the sum of several motor unit potentials. The primary usefulness of surface EMG in work settings is to estimate muscle tension associated with task performance from measured myoelectric activity. Since many factors affect the relationship between muscle force and the amplitude of myoelectric activity, several methods are used to improve the correlation (Chaffin and Andersson, 1991, Ex. 26–420; Dolan *et al.*, 1999, Ex. 26–819; NIOSH, 1992, Ex. 26–1325). Individual-and activity-specific calibration can be performed by measuring myoelectric activity and external moments while a subject performs graded activity. Normalization can be employed by measuring one isometric maximum voluntary contraction (MVC) and reporting the activity as a percentage of MVC. This appears to correlate reasonably with load moments calculated from other models (Nieminen, 1993, Ex. 26–1382). Measurements of myoelectric activity can then be used to estimate load moments or forces during the performance of more complex tasks in a variety of work settings. Fatigue can also be assessed: muscle activity is observed to show an increased amplitude and decreased frequency in the myoelectric signal with fatigue (Chaffin and Andersson, 1991, Ex. 26–420; Chaffin, 1973, Ex. 26–876; Lieber and Friden, 1994, Ex. 26–559). This is consistent with laboratory observations of the response in fatigued muscle fiber (Bigland-Ritchie *et al.*, 1983); the authors hypothesize that this may be a physiologic adaptation'slower muscles are able to generate higher forces.

Dolan *et al.* (1999, Ex. 26–819) recently validated the usefulness of this technique in evaluating dynamic lumbar spine loading. The authors studied eight male subjects who performed lifting tasks from floor height (boxes weighing 6.7 and 15.7 kg). L5–S1 joint moments were assessed using force plates and by measuring the EMG activity of the erector spinae muscles. The two assessment methods yielded similar peak extensor moments, equivalent to spinal compressive forces of 2.9 to 4.8 kN. The researchers did note, however, that there were small deviations during lifts requiring a vigorous upward thrust from the legs, and that additional force-plate data would mildly improve correlation in these settings.

A third injury mechanism (after mechanical contraction-related injury and muscle fatigue) is the release of neuro-humoral substances and changes in electrolyte balance. Neuro-humoral substances are chemicals that affect cell membranes and cell function and excite afferent nerves. Muscle pain, inflammation, and ischemia, or sustained static contraction, lead to release of potassium chloride, lactate, arachidonic acid, bradykinins, serotinin, and histamine. In addition to producing pain, these agents can excite chemosensitive afferents—gamma muscle spindles—that respond to stretch. It is hypothesized that increased spindle excitation can cause the stiffness and pain of ''myalgia'' (Johannson and Sojka, 1991, Ex. 26–968). There is substantial evidence that these mechanisms of tissue injury can produce a distinct MSD pattern, particularly when the work stressors are not sufficiently intense to produce outright mechanical injury. At even 10% of MVC, muscle oxidation declines significantly (Murthy *et al.*, 1997, Ex. 26–307). Proprioceptive accuracy and efficiency are also significantly limited under conditions of fatigue. The loss of accuracy and fine control in hand-intensive tasks, such as manual tool use, requires greater muscle recruitment and correction, further increasing demands on muscle.

Several mechanical and physiologic muscle responses are involved in the generation of muscle forces and motion of skeletal structures that relate to the development of pathology. Coordination of muscle activity to manipulate bones and joints involves initiation by agonist muscles, with regulatory contributions from synergistically and antagonistically acting muscles. The forces generated by these muscles around a joint produce load moments on the joint. This can cause compression or rotation at the joint with secondary effects on the joint cartilage or bone.

An acute muscle tear is a point-in-time injury that results when the force demands exceed the muscle tissue mechanical tolerance. This can occur during rapid intentional movement or during a loss of balance, such as in a fall. Often there is rapid stretching of muscle in addition to contraction (Lieber and Friden, 1993, Ex. 26–160), and injuries are generally worse when muscle is in its stretched position (Macpherson, Shork, and Faulkner, 1996, Ex. 26–165). Healing requires 1 to 4 weeks (Ashton-Miller, 1999, Ex. 26–414; Brooks and Faulkner, 1990, Ex. 26–85), and there is potential for decreased strength after healing is achieved.

After injury, satellite cells proliferate to repair the muscle damage. As people age, fewer satellite cells are observed in muscle tissue; this may explain the delayed recovery in injured older workers (Carlson, 1994, Ex. 26–530). However, muscle rupture may also occur when mechanical disruption of sarcomeres produces an inflammatory response (free radicals, cytosolic enzymes, phagocytosis) with an increased susceptibility to delayed muscle tear (Faulkner and Brooks, 1995, Ex. 26–1410).

Reduced blood flow and increased transmural muscle pressure appear to be important predisposing factors to injury (Armstrong *et al.*, 1993, Ex. 26–1110; Kilbom, 1994, Ex. 26–1352; Sjogaard and Sogaard, 1998, Ex. 26–1322). The reduced blood flow that is characteristic of static contraction and increased transmural pressure is reversible. However, there is additional evidence that the pattern of reduced flow, injury and diminished repair, and chronic fiber damage all contribute to muscle pain (Lindman *et al.*, 1991, Ex. 26–976). Sufficient blood flow to skeletal muscle is essential for contraction, since force development depends on the conversion of chemical to mechanical energy. EMG studies show increased EMG activity in repetitive and stereotyped work in the setting of myalgia. All of this points to the particular problems of continued use of muscle that has already sustained injury, since the normal processes of adequate blood supply and oxygenation, ability to sustain contraction, and the capacity for repair are all compromised. Prolonged skeletal muscle contraction can produce other complications related to elevated intramuscular pressure. Secondary ischemia and disruption of the transportation of nutrients and oxygen can produce intramuscular edema (Sjogaard, 1988, Ex. 26–206). This is compounded when recovery time between contractions is insufficient. Eventually, muscle membrane damage, abnormal calcium homeostasis, free radicals, other inflammatory mediators, and degenerative changes can occur (Sjogaard and Sjogaard, 1998, Ex. 26–1322).

It is also important to recognize that sustained injury appears to involve the excitation of specific neural pathways, rather than occurring as the result of simple repetitive tonic activities. The implications are that simple overuse is remediable and apparent functional loss is often a protective mechanism against depleting muscle cells' energy stores. However, more complex muscle injury involves changes in nerve-muscle interaction and inflammatory changes, and continued use and insult can cause more chronic aggravation.

Several studies appear to support belief in these pathogenic mechanisms. Veiersted *et al.* (1993, Ex. 26–1154) performed EMG studies on subjects performing machine-paced packing work. Individuals with symptoms of trapezius pain had fewer rest pauses and a shorter total duration of rest pauses, suggesting higher levels of muscle fiber activity. Aarås (1987, Ex. 26–1034) demonstrated that reduction of trapezius muscle activity to less than 2% of MVC in assembly workers reduced sick time. Interesting pathophysiologic findings were noted by Larsson *et al.* (1990, Ex. 26–1141) when they evaluated trapezius muscle biopsies and blood flow in assembly workers with localized chronic myalgia related to static loading during assembly work. In symptomatic workers, reduced muscle blood flow and pathologic changes (ragged red fibers indicating disturbed mitochondrial function were confined to the type I fibers) were recorded. Myalgia was correlated with reduced local blood flow and the presence of mitochondrial changes.

Other authors have noted elevated serum levels of muscle enzymes, particularly creatine kinase, in delayed onset muscular soreness following unaccustomed muscle exertion (Armstrong, 1990, Ex. 26–703; Newham *et al.*, 1983a, Ex. 26–395; Schwane *et al.*, 1983, Ex. 26–716). This is followed by degenerative changes in sarcomeres followed by regeneration and repair within about 2 weeks (Newham *et al.*, 1983b, Ex. 26–741; Ogilvie *et al.*, 1988. Ex. 26–189).

It must also be appreciated that work does not have to be repetitive or forceful to cause MSDs. Static postures involve repeated and prolonged low force contraction of low-threshold motor units. Although the total workload is low, the individual muscles and muscle fibers may approach their maximal capacity, which can lead to injury (Hagg, 1991, Ex. 26–427). For example, intramuscular pressures associated with static muscle contraction have the potential to cause muscle tissue injury. The magnitude of intramuscular pressure varies significantly depending on individual muscle characteristics (there are greater pressures in contracting bulky muscles as opposed to thin ones) and location (constricting fascial compartments and adjacent bony structures may increase pressures reached during contraction) (Sjogaard and Sogaard, 1998, Ex. 26–1322). Muscle activity and position also determine intramuscular pressures. Herberts *et al.* (1984, Ex. 26–51) demonstrated that increased hand loads and larger degrees of arm elevation will increase EMG activity and intramuscular pressures in shoulder girdle muscles (deltoid, infra- and supraspinatus, trapezius). This may be noted during static work tasks adopted to stabilize hand tools near shoulder heights during assembly or construction. While very forceful muscle contractions may produce intramuscular pressures that exceed systemic blood pressure, supravenous intramuscular pressures exceeding 40 to 60 mm Hg have even been observed in the supraspinatus muscle during static contractions of less than 10% of MVC (Jarvholm *et al.*, 1989, Ex. 26–967; Sjogaard *et al.*, 1996, Ex. 26–213). Therefore, muscle pressures during low-force static work may approach the range of diastolic pressures. Of importance, diastolic pressures are more significant than mean blood pressures for maintaining blood flow in low-flow situations (Sjogaard *et al.*, 1986, Ex. 26–207), resulting in the potential for damage to muscle tissues. The mechanism of muscle injury associated with elevated intramuscular pressures relates to secondary abnormalities of microcirculatory regulation caused by these pressure increases. As a result, several changes are noted. Diminished oxygen supply to muscle tissue will reduce its capacity to convert chemical to mechanical energy. Persistent contraction may increase tissue edema, potentially increasing tissue pressures and further impairing microcirculation.

In other circumstances, the recruitment of only a limited number of fibers can result in high fiber stress distributed across the few fibers involved in the contraction, although total muscle forces may be low. Because highly repetitive tasks can only be sustained for prolonged periods when low force is involved, type I fibers are more likely to be involved in repetitive injury.

Increasing attention has been paid to metabolic and neuroregulatory factors to better understand the relationship between acute muscle fatigue and the development of chronic muscle disorders, as well as to characterize the pattern of pain symptoms that affect the neck, shoulders, forearms, wrists, and fingers in manually intensive tasks that occur well below the MVC. Higher subjective levels of fatigue as well as electrophysiological evidence of fatigue are more common in large muscle groups, such as the neck and shoulder muscles, when activities are static and repetitive rather than dynamic (Sjogaard, 1988, Ex. 26–830). During low levels of exertion, skeletal muscle recruitment primarily activates the slower and less fatigable type I muscle fibers because of their lower thresholds (Henneman and Olson, 1965, Ex. 26–139) Lieber and Friden (1994, Ex. 26–559) have demonstrated an activation sequence by which these smaller, more fatigue-resistant muscle units are first recruited, followed by stronger, more easily fatigued fibers. These smaller fibers are the ''Cinderella fibers,'' so named because they are always working in lower-threshold activity, which can be insufficient to recruit stronger fibers (Henneman and Olson, 1965, Ex. 26–139).

The concerns with sustained low-level activity are multifold. Limited muscle fiber recruitment can result in higher individual fiber stresses distributed across the few fibers involved in the contraction, although total muscle forces may be low. Because highly repetitive tasks can only be sustained for prolonged periods of time when low force is involved, type I fibers are more likely to be involved in repetitive injuries. The prolonged recruitment of limited numbers of motor units, even during situations with low stress on these muscle fibers, can deplete available energy, producing eventual fatigue and injury (Lieber and Friden, 1994, Ex. 26–559). At low contraction levels, membrane resting potential is maintained in all fibers, including activated fibers (Sjogaard *et al.*, 1996, Ex. 26–213). Potassium-flux—induced fatigue is an important homeostatic mechanism for protecting essential ATP stores, but this essential mechanism is bypassed at lower activity levels. A fatigued muscle that will not contract prevents direct tissue damage. Otherwise, the infusion of cytosolic calcium continues. Although calcium is essential for contraction, its build-up is directly damaging to membrane lipids and mitochondria. There is mounting evidence that types of lower-output activity that bypass homeostatic protection can dispose active muscle to silent but significant injury. Skeletal muscle recruitment may also explain the observation that eccentric muscle contraction more commonly causes muscle injury than does concentric contraction (Friden and Lieber, 1994, Ex. 26–559), since this type of contraction primarily involves the fastest fibers with the lowest oxidative capacity.

Finally, age effects on skeletal muscle generally result in greater susceptibility to injury with repeated loading. With aging, muscle contractility is diminished (Thelen *et al.*, 1996a, Ex. 26–219), muscle mass and maximum isometric force declines (Faulkner and Brooks, 1995, Ex. 26–1410), and the rate of developing force and power is lower (Thelen *et al.*, 1996b, Ex. 26–220). In older individuals, physical conditioning has more impact on power than it does on force. Age-related changes appear to be an intrinsic function of muscle fibers themselves, rather than a change in muscle recruitment patterns. Injuries from eccentric contractions in older animals heal more slowly and show a greater force deficit (injury effect) than in younger animals.

In summary, a significant body of evidence supports the conclusion that conditions often present at work can be pathogenetic and pathophysiologic links with many muscular disorders. There is strong physiologic evidence that sub-maximal muscle contraction, which is the prevailing pattern in the American manufacturing and office workplace, can produce patterns of chronic muscle injury. Potential etiologies include abnormalities in motor unit recruitment, tissue loading in susceptible positions, altered muscle metabolism and blood flow, energy depletion and fatigue, inflammation, and altered tissue repair. This is especially true when work evolves away from tasks that approach the limit of contractile forces, and specific pathways of injury, rather than force itself, become the critical elements in understanding disease. Applying ergonomic principles to muscle physiology is intended to preserve mechanical output while preventing tissue injury.

b. Tendons and Ligaments. Work-related tendon disorders develop for several reasons. Tendon has viscoelastic properties that may be exceeded when workers perform excessively forceful work activities, carry tasks that overstretch tendons, or have rest periods that are not sufficient to enable normal repair mechanisms to occur (Ashton-Miller, 1999, Ex. 26–414; Chaffin and Andersson, 1991, Ex. 26–420; Moore, 1992a, Ex. 26–985; Woo *et al.*, 1994, Ex. 26–596). Unfortunately, many jobs and tasks in manufacturing and other work settings associated with excessive hand force, machine paced or piece work, overtime, poor tool design, etc. have these associated risks. In addition, repetitive tendon loading may cause tendon deformation and eventual tissue failure at a lower limit during subsequent loading cycles (Goldstein *et al.*, 1987, Ex. 26–953; Moore, 1992a, Ex. 26–985; Thorson and Szabo, 1992, Ex. 26–1171). Compression and friction of tendons as they cross joints or move through tight compartments (*e.g.*, the carpal canal or first dorsal compartment of the wrist) may result in inflammation, degeneration, and metaplastic changes with symptoms and signs of tendon pathology (*e.g.*, stenosing tenosynovitis, tenosynovitis, tendinitis) (Ashton-Miller, 1999, Ex. 26–414; Azar *et al.*, 1984, Ex. 26–1031; Backman *et al.*, 1990, Ex. 26–251; Finkelstein, 1930, Ex. 26–266; Flint *et al.*, 1975, Ex. 26–268; Goldstein *et al.*, 1987, Ex. 26–953; Hart, Frank, and Bray, 1994, Ex. 26–551; Kilbom, 1994, Ex. 1352; Rais, 1961, Ex. 26–1166; Rathburn and McNab, 1970, Ex. 26–1376; Sampson *et al.*, 1991, Ex. 26–322; Uchiyama *et al.*, 1995, Ex. 26–339; Vogel, 1994, Ex. 26–593; Wilson and Goodship, 1994, Ex. 26–241).

Tendons and ligaments are connective tissues that connect either muscle to bone (tendons), or bone to bone (ligaments). Tendons and ligaments are relatively uncomplicated tissues, with a simple structure subject to a limited set of stresses: tensile forces from muscle contraction, shear forces from friction against obstructing anatomic structures, and compressive forces from entrapment. Injuries to the muscle and tendon unit are common in the upper extremity.

Tendon structure consists of parallel-oriented collagen bundles in a water-mucopolysaccharide matrix. In ligament, bundles are primarily parallel, with some bundles arranged in a non-parallel fashion. This results in different mechanical properties for these tissues, with more elasticity noted in ligamentous structures (Chaffin and Andersson, 1991, Ex. 26–420).

Tendons. Skeletal muscle, unlike tendon, is composed of non-parallel fibers. Therefore, as the muscle-tendon unit proceeds from muscle to tendon (myotendinous junction), intracellular contractile muscle proteins transition to extracellular collagen in the tendon, and the arrangement of collagen fibers becomes more parallel. Extensive infolding of fibers in the myotendinous junction increases the surface area of the muscle-tendon interface and decreases the stress from tensile loading in this area (Chaffin and Andersson, 1991, Ex. 26–420). The myotendinous junction then proceeds to a region called the aponeurosis, where tendon connective tissue predominates. Peritenon, a thin membranous sheath, separates the aponeurosis from the surrounding fascia.

Microscopically, the distal tendon consists of multiple bundles of collagen tissue surrounded by epitenon, endotenon, and peritenon membranes. The extracellular matrix of healthy tendon includes water, glycosaminoglycans, and glycoproteins. Blood vessels, lymphatics, and nerves may traverse the epitenon or endotenon layers. However, avascular regions are observed in healthy tendons, and it is presumed that these regions are nourished by diffusion. The distal tendon has a synovial sheath that produces lubricating fluid (synovial fluid). In the hand, transverse ligaments called pulleys are present near the distal metacarpal and permit flexor tendons to flex the finger through a fibroosseous canal without bowing out.

The primary function of tendon is to transmit forces from muscle to bone. Accordingly, its principal injuries involve forces causing stretch, deformation, or inadequate recovery (*i.e.,* return to resting length), on the one hand, and frictional damage due to shear and extrinsic compression, on the other. The tendon is subject to both uniaxial tensile forces from muscles and transverse forces from anatomic pulleys, bursae, and extended range of motion. Tensile and transverse forces produce shear and influence tendon gliding. This phenomenon draws particular attention to awkward or extreme posture, particularly at the wrist (Armstrong *et al.,* 1984, Ex. 26–1293).

Pathophysiologically, four main types of non-acute tendon disorders have been suggested (Leadbetter, 1992, Ex. 26–157). Paratenonitis (tenosynovitis) is the inflammation of the peritenon. Signs and symptoms can include pain, swelling, warmth, and tenderness. Tendinosis involves intratendinous degeneration with fiber disorientation, scattered vascular ingrowth, occasional necrosis, and calcification; tendon nodularity may be noted, but swelling of the tendon sheath is absent. Paratenonitis may be observed with tendinosis. Corresponding signs of inflammation and nodularity are possible. Tendinitis (tendon strain or tear) can range from inflammation with acute hemorrhage and tear to inflammation with chronic degeneration. Clinical symptoms and signs relate to the contributions of inflammation vs. degeneration. This classification into four types, however, is not universally accepted.

To understand how tendons become diseased, one must understand tendon function and repair mechanisms. As muscles contract, tendons are subjected to mechanical loading and viscoelastic deformation. Tendons must have both tensile resistance to loading (to move attached bones) and elastic properties (to enable them to move around turns, as in the hand). When collagen bundles are placed under tension, they first elongate without significant increase in stress. With increased tension, they become stiffer in response to this further loading. If the load on these structures exceeds the elastic limit of the tissue (its ability to recoil to its original configuration), permanent changes occur (Ashton-Miller, 1999, Ex. 26–414; Moore, 1992a, Ex. 26–985; Chaffin and Andersson, 1991, Ex. 26–420). During subsequent loading of the damaged tendon, less stiffness is observed. The ultimate strength of normal tendon and ligament is about 50% of that of cortical bone (Frankel and Nordin, 1980, Ex. 26–1125), but structures that have exceeded the elastic limit fail at lower limits. In addition, if recovery time between contractions is too short, deformation can result in pathologic changes that decrease the tendon's ultimate strength (Thorson and Szabo, 1992, Ex. 26–1171; Goldstein *et al.,* 1987, Ex. 26–953).

Tendon exhibits additional viscoelastic properties of relaxation and creep. That is, when a tendon is subjected to prolonged elongation and loading, the magnitude of the tensile force will gradually decrease (relaxation) and the length of the tendon will gradually increase (creep) to a level of equilibrium (Chaffin and Andersson, 1991, Ex. 26–420; Moore, 1992a, Ex. 26–985; Woo *et al.,* 1994, Ex. 26–596). During repetitive loading, the tendon exhibits these properties and then recovers if there is sufficient recovery time. If the time interval between loadings does not permit restoration, then recovery can be incomplete, even if the elastic limit is not exceeded (Goldstein *et al.,* 1987, Ex. 26–953).

Tendons are also subject to perpendicularly oriented compressive loading. This is seen when tendons are loaded as they turn corners around pulleys or bony surfaces. Friction is generated at these locations as the tendon slides against adjacent surfaces, causing a shearing force. This is significant in the hand and wrist, as demonstrated by Goldstein *et al.* (1987, Ex. 26–953). The authors noted that higher levels of muscle tension are required to achieve a specific level of strength at the fingertip during non-neutral wrist postures, and that tendons are subject to greater shear stress with non-neutral wrist postures. Similarly, compressive force in the A1 pulley has been demonstrated to rise dramatically from the neutral posture (0 to 50 mm Hg) to full flexion (500 to 700 mm Hg) (Azar, Fleeger, and Cluver, 1984, Ex. 26–1031). Tendon friction is proportional to the axial tension of the tendon, the coefficient of friction between the tendon and its adjacent surface, and the angle of the tendon as it turns about a pulley (Uchiyama *et al.,* 1995, Ex. 26–339). Ashton-Miller, Ex. 26–414, suggests that this may be a cause of surface degeneration in tendons. Internal degeneration may be the result of friction-induced internal heat generation (Wilson and Goodship, 1994, Ex. 26–241). One study in exercising racehorses demonstrated that tendon core temperature in the superficial digital flexor tendon was 5.4 degrees above tendon surface temperature, enough to kill fibroblasts in vitro (Wilson and Goodship, 1994, Ex. 26–241).

Clinically, tendon compression in the hand may manifest as stenosing tenosynovitis. Initially, examination in patients with stenosing tenosynovitis may reveal impaired motion, tenderness, pain on resisted contraction or passive stretch, swelling, or crepitation. With time, swelling and thickening of the tendon may occur from fibril disruption, partial laceration, impairment of blood flow and diffusion of metabolites, and the localized repair process. Ultimately, this limits the normal smooth passage of the tendon through its fibroosseous canal. These chronic tissue changes are recognized as triggering. At surgery, findings may include tightness and thickening of the pulley, nodular fusiform tendon swelling, fibrocartilaginous metaplasia, or fraying of the tendon (Finkelstein, 1930, Ex. 26–266; Sampson *et al.,* 1991, Ex. 26–322)

These conceptualized patterns of tendon injury have practical clinical significance, relating to some of the most common MSDs encountered in clinical practice. Micro-tears and gross trauma to the tendon produce an acute inflammatory condition with regeneration and removal of tissue debris. As noted, when the tendon load is great and there is insufficient recovery time between deformations for the tendon to recover its resting length, viscous strain can exceed elastic strain (Goldstein *et al.,* 1987, Ex. 26–953), causing tendon deformation (Thorson and Szabo, 1992, Ex. 26–1171). These are the mechanisms most often involved in the common ''sprain.''

A different injury mechanism occurs when tendon and tendon sheaths are forced over hard anatomic surfaces, producing either an inflammatory tendinitis or a zone of avascularity (lack of blood flow) due to compression (Rathburn and McNab, 1970, Ex. 26–1376). This has been experimentally demonstrated by electrically stimulating muscles to contract, causing friction and tendinitis (Rais, 1961, Ex. 26–1166). Impaired circulation, hard tissue compression, and degenerative change are pertinent to rotator cuff injuries, where tendon insertions on the greater tuberosity of the humerus can be compressed under the coracoacromial arch. Muscle tension, itself, can also restrict circulation when the tendon's supply of arterial blood runs through the contracted muscle, as is the case with the supraspinata (Herberts *et al.*, 1984, Ex. 26–51). Common rotator cuff diagnoses that fall short of surgical intervention often fall under these pathophysiologic mechanisms.

A more subtle friction-related injury is de Quervain's Syndrome, in which a narrowed first dorsal compartment juxtaposes crossed tenosynovium of the abductor pollicis longus and extensor pollicis brevis (Witt *et al.*, 1991, Ex. 26–242). Injury in the first dorsal compartment in de Quervain's Syndrome is actually a disorder of the retinaculum, a specialized ligamentous tissue acting as an anatomic pulley to prevent tendon bowstringing, and involves the fingers and the toes. ''Bowstringing'' refers to the tendency of a tendon, under tension, to assume the shortest distance between its proximal and distal insertion, unless it is tethered and damped. The disorder is a hypertrophy of this retinaculum. Tendon and ligament are elastic and will ''creep'' (*i.e.*, stretch) in response to tensile loading. Creeping involves progressive fiber recruitment and loss of the natural waviness of collagen fibers.

A diversity of clinical terms complicates the description of tendon injuries. As Waldron points out (1989, Ex. 26–509), the traditional peritendinitis crepitans, characterized by an edematous or swollen musculo-tendinous junction, is more limited than the variety of soft tissue pains that are currently described as tendinitis or tenosynovitis. In the older usage, tendinitis was an uncommon and severe condition in which the injured tissues were swollen and crackled under compression. Currently, ''tendinitis'' is used to describe a wide variety of soft tissue pain and is the most widely used term employed to characterize MSDs. Tendons have very different structures, depending on anatomic location and function, so as a general term for a diseased tendon, ''tendinitis'' groups together several different pathologies. In the case of epicondylitis, the insertional tears seen in young athletes playing racket sports have little in common with the non-inflammatory degeneration seen in older populations, whether or not work is implicated as a risk factor (Chaard *et al.*, 1994, Ex. 26–458). The frequent lack of connection between observed gross pathology and clinical or reported symptoms is another consideration. In autopsy series, the majority of cadavers have tears at the TFCC (triangulate fibro-cartilage complex) in the wrist or degeneration of the ECRB (extensor carpi radialis brevis) insertion at the elbow (Mooney and Poehling, 1991, Ex. 26–304; Cherniack, 1996, Ex. 26–258). However, the occurrence of perceptible symptoms is comparatively uncommon.

Tendons and ligaments also undergo significant modification where they turn corners or insert onto bone. Evidence exists that the tendon matrix is reformulated in response to mechanical forces, implying an active process of cell response. However, it has not been determined whether this reaction definitively alters the mechanical properties of the tendon, or what its role is in future injury. Experimental work with rabbit flexor digitorum profundus tendon compressed by adjacent calcaneum and talus (Flint *et al.*, 1975, Ex. 26–268) has demonstrated that fibrocartilagenous metaplasia occurs in response, and that after surgical translocation of the tendon, this will improve. The presence of sex hormone and neurotransmitter receptors in tendon tissues indicates that tissue responses are complex (Hart, Frank, and Bray, 1994, Ex. 26–551). This implies that tendon is affected by internal signals and is subject to regulation beyond stress and strain. The proinflammatory neurotransmitters substance P and calcitonin gene-related peptide are located in the nerve endings present in tendons and ligaments (Goldstein *et al.*, 1987, Ex. 26–953) and constitute a pathway for neurologically mediated tendon injury. The current notion of tendons and ligaments, which are structurally closely related, describes them as dynamic tissues subject to biomechanical strain and the effects of endocrine hormones and neurotransmitters. This suggests potentially complex patterns of injury and pain, and also of adaptation. Although a complete view of tendon function remains to be articulated, for now it seems clear that remodeling of tendons, inflammation, and the response to injury are mediated systemically as well as locally.

Additional experimental evidence relates to a more chronic or cumulative process through which tendon injury can evolve. Much is unknown about underlying pathophysiologic mechanisms in even such common mechanical tendon-and tenosynovium-related disorders as breakdown of the ECRB in lateral epicondylitis and tendinitis of the flexor digitorum in CTS. However, the provocation of a tissue response characterized by proinflammatory mediators in laboratory animals exposed to continuous motion (Backman *et al.*, 1990, Ex. 26–251) strongly suggests that biomechanical loading and stresses induce mechanical tissue injury and acquired micro-structural changes. Although this provides a useful direction, laboratory tendon loading experiments have not permitted a human threshold for repetitions causing tendon injury to be quantified.

Experience suggests that resolution of tendinitis can be surprisingly time-consuming. The reasons can be found in the pathophysiology of tendon repair. Following flexor tendon laceration, tendon healing follows three phases. Initially, inflammation is observed, with cells arising from the epitenon, endotenon, and peritendinous tissue. This stimulates migration and proliferation of fibroblasts and the removal of damaged tissue. The inflammatory phase ends long before tissue remodeling has been completed. Within the first week, collagen synthesis is initiated, though fiber orientation may be chaotic. By the fourth week, fibroblasts predominate and collagen content increases. Maturation of collagen and functional alignment occurs by the second month, with maximum functional restoration requiring exposure of the healing tendon to renewed loading. Exercise and movement are fundamental to the therapeutic process of an injured tendon. But premature exercise can be detrimental; movement of a deformed, devascularized, or inflamed tendon will provoke further injury and breakdown. Mechanical loading that results in a stiffer tendon development can provide structural integrity but a loss of mobility. Pain is an important indicator of either gross or microscopic abnormal tissue responses. In considering MSDs involving tendon and ligament it is especially important to differentiate between aggravation of an injury and exercise, which can be therapeutic. Exercise has proven to be an important component in the remodeling and strengthening of the ligaments of the rat knee (Frank, McDonald, and Shrive, 1997, Ex. 26–623). However, tendon and ligament adaptation and repair are inevitably slow processes'a knee injury can take up to 2 years to fully repair. Thus, although tendon, in particular, can effect a considerable but slow adaptational response to increased physical demand, a progressive increase in loading demands can easily exceed remodeling capacity, increasing the likelihood of re-injury. The slow natural rate of tendon and ligament repair also highlights the importance of prevention and early intervention. Established injuries can persist for weeks and months even after ergonomic review of the workplace and remediation.

In summary, clear evidence exists to support the conclusion that conditions often present at work can be pathogenic for some tendon disorders, as discussed above. Potential etiologies include mechanical disadvantage or tendon related to changes in joint position, changes in tensile and viscoeastic properties of tendon with excessive or repetitive loading, interference with normal repair mechanisms, and the effects of compression and friction leading to internal and external degeneration and inflammatory responses.

Ligaments. Work exposures may contribute to the development of ligament and joint disorders as the result of many pathogenic and physiologic mechanisms. Ligaments, like tendons, have viscoelastic properties that may be exceeded by repetitive loading or deformation, resulting in possible subsequent failure during lower levels of loading (Chaffin and Andersson, 1991, Ex. 26–420). On the one hand, ligamentous laxity has been demonstrated in the wrist after continuous exercise (Crisco *et al.*, 1997, Ex. 26–1373). This type of stress is commonly observed in highly repetitive work settings. On the other hand, immobilization may result in decreased ligamentous tensile strength (Woo *et al.*, 1987, Ex. 26–243). The significance of this finding in workers who perform prolonged, sedentary work merits further investigation.

Although tendon and ligament have many structural similarities, they also have important differences. Ligament structure consists of type I and type III collagen with elastin and glycosaminoglycans. Ligamentous structures are somewhat more elastic than tendon, in part because of the occurrence of non-parallel fibers. As in tendon, there are length and velocity tension relationships, and relaxation and creep are noted (Chaffin and Andersson, 1991, Ex. 26–420). The ability of ligaments to adapt to changes in physiologic loading has been studied in the rabbit medial collateral ligament. After 9 weeks of immobilization, a 50% decline in tensile strength was noted (Woo *et al.*, 1987, Ex. 26–243). With remobilization, stiffness improved, but after 9 weeks was still 20% below initial values. Viscoelastic changes have been reported with repetitive loading, with a 30% increase in wrist laxity in subjects performing 1 hour of exercise. After 24 hours, tissue laxity had returned to baseline (Crisco *et al.*, 1997, Ex. 26–1373). Ligament healing and remodeling is, unfortunately, rather slow and limited. After injury, a vascular response is rather prolonged, and can last for several months (Bray *et al.*, 1996, Ex. 26–773). With aging, a decrease in elastic stiffness and failure can occur at lower loads, as demonstrated in a study comparing tissue samples from old (mean age 76 years) and young (mean age 35 years) subjects (Woo *et al.*, 1991, Ex. 26–244).

Joint hypermobility, the familiar double-jointedness, appears to be more common in women than in men (Bridges *et al.*, 1992, Ex. 26–1312), and appears to have a strong genetic basis (Child, 1986, Ex. 26–358). It is more an anthropometric factor, or effect modifier, than a predisposition to disease. That is, hypermobility is not an intrinsically morbid condition, but it can increase musculo-tendinous loading and effort. It has been recognized as a risk factor for musculotendinous injury in hand-intensive tasks, presumably because of the co-contractive effort required to stabilize small joints in the hand (Pascarelli *et al.*, 1993, Ex. 26–1164). Hyper-mobility means that opposing muscle groups must be simultaneously and antagonistically contracted to maintain the position of a finger or a wrist against resistance. There is considerable speculation that hormones, as well as mechanical stresses, may influence knee and other tendon and ligament injuries in women. Although it is premature to ascribe these factors to the risk of developing a work-related knee injury, it is important to recognize that ligamentous laxity can usually be accommodated through changes in work technique and job design.

Ligamentous laxity is also acquired in the course of continuous work. A 30% increase in wrist laxity (due to visco-elastic stretching) has been observed after 1 hour of continuous exercise (Crisco *et al.*, 1997, Ex. 26–1373). There is a return to normal length and function within 4 hours. This observation highlights the point that maintenance of ligamentous function requires periods of rest and disuse.

c. Nerve. Work-related nerve disorders include compression, entrapment, and vibration-induced and toxic neuropathies. It is the first two that are within the scope of this document. Compression most commonly occurs adjacent to joints or as nerves pass through muscle or connective tissue. This may result in mechanical deformation of nerves, perineural edema, nerve ischemia, and inflammation with secondary nerve damage and delayed conduction (Feldman *et al.*, 1983, Ex. 26–949; Gelberman *et al.*, 1983, Ex. 26–465; Lundborg and Dahlin, 1994, Ex. 26–561; Moore, 1992b, Ex. 26–984; Rydevik *et al.*, 1989, Ex. 26–198; Szabo *et al.*, 1983, Ex. 26–333). Examples of this include carpal tunnel syndrome, cubital tunnel syndrome, entrapment at Guyon's canal, and tarsal tunnel syndrome (Bozentka, 1998, Ex. 26–82; Delisa and Saeed, 1983, Ex. 26–364; Feldman *et al.*, 1983, Ex. 26–949; Moore, 1992b, Ex. 26–984; Terzis and Noah, 1994, Ex. 26–587). External compression with impairment of nerve function may occur from contact stress between body parts and hard work surfaces or sharp edges (*e.g.*, carpal tunnel syndrome, cubital tunnel syndrome) (Feldman *et al.*, 1983, Ex. 26–949; Hoffman and Hoffman, 1985, Ex. 26–141). Alternatively, internal compression may occur from increased compartmental pressures or from contact against bones, tendons, or ligaments (*e.g.*, cubital tunnel syndrome, carpal tunnel syndrome) (Bozentka, 1998, Ex. 26–82; Feldman *et al.*, 1983, Ex. 26–949; Moore, 1992b, Ex. 26–984; Skie *et al.*, 1990, Ex. 26–328). At times, workers may experience anatomic and tissue changes with multiple sites of nerve compression that cause greater damage than would be experienced with a single site of compression (''double crush syndrome'') (Lundborg and Dahlin, 1994, Ex. 26–949; Mackinnon, 1992, Ex. 26–646; Novak and Mackinnon, 1998, Ex. 26–1310). Furthermore, whole-body vibration transmitted by vehicles or segmental vibration from hand tool use may damage nerves directly or indirectly because of ischemia or adjacent tissue changes (Hjortsberg *et al.*, 1989, Ex. 26–1131; McLain and Weinstein, 1994, Ex. 26–1347; NIOSH, 1989, Ex. 26–392; Takeushi *et al.*, 1986, Ex. 26–681; Rempel *et al.*, 1998, Ex. 26–444).

Peripheral nerve is composed of a nerve cell body (motor or sensory) and an axon, which extends to the periphery. An axon with its sheath constitutes a nerve fiber. Myelinated fibers are surrounded by single layers of Schwann cells arranged in a longitudinal manner along the nerve. Spaces on myelinated nerves created by adjacent Schwann cells are called nodes of Ranvier. Bundles of nerve fibers, called fascicles, are wrapped by perineurium and embedded with microvasculature in epineural tissue. The amount of epineural tissue and the presence or absence of myelination depends on the location and purpose of the nerve. The largest myelinated fibers (Group A) have the highest conduction velocity. Group B fibers are myelinated autonomic and preganglionic fibers. The thinnest, non-myelinated fibers have the lowest conduction velocity and make up the visceral and somatic afferent pain Group C fibers.

Substances required for membrane integrity are synthesized in the nerve cell body and transported to the periphery, while disposal of waste materials and transport of trophic and tropic factors both involve transport from the periphery to the nerve cell body (Lundborg and Dahlin, 1994, Ex. 26–561). Both propagation of impulses and transportation of materials require a sufficient energy supply and vasculature. Depending upon location, peripheral nerves are subject to variable amounts of gliding or excursion in response to muscle, tendon, and joint movement (Bozentka, 1998, Ex. 26–82; Chaffin and Andersson 1991, Ex. 26–420; Novak and Mackinnon, 1998, Ex. 26–1310; Rempel, Dahlin, and Lundborg, 1998, Ex. 26–444).

There are several mechanisms by which peripheral nerves are either injured directly or contribute secondarily to pain and dysfunction. Nerve tissue plays a predominant role in transmitting information on the extent of tissue damage and in establishing the CNS link producing sensations of pain. Movement disorders and dystonias, which produce chaotic or uncontrolled patterns of hand movement or cramps, also involve patterns of abnormal nerve transmission, but here the problem has more to do with function and control than pain. Nerve tissue can also be directly injured, producing characteristic symptom patterns.

The most widely recognized lesions of peripheral nerves associated with repetitive work and chronic overuse are the entrapment and compression neuropathies. Mechanical pressure on a peripheral nerve, if severe enough, causes a block or delay in the conduction of nerve impulses, a decline in sensory function, and paresthesias (''pins and needles''). Because defects in the conduction of nerve impulses can be assessed by electrophysiology (Wilbourn and Lederman, 1984, Ex. 26–1409) or by shifts in thresholds of perception (Lundborg *et al.*, 1987, Ex. 26–645), nerve entrapments have traditionally been the most effectively studied MSDs. The notion of nerve entrapment implies that external pressure or resistance on a peripheral nerve restricts free nerve movement or impinges on nerve contents (Lundborg, 1988, Ex. 26–1145). This pressure or resistance can be caused by external compression through soft tissue swelling by a fracture or callus, or by swelling or scarring of the nerve tissues themselves. The necessity for peripheral nerves to move during musculoskeletal activity is often underappreciated, with ulnar nerve range at the elbow approaching 1.5 cm and median nerve mobility being 1.0 cm at the wrist (Millesi *et al.*, 1990, Ex. 26–567). In the upper extremity, areas of potential nerve compression are most frequently situated in the vicinity of joints. The two most common upper-extremity disorders are CTS at the wrist and cubital tunnel syndrome at the elbow. In the low back, degenerative disease and bony compression of nerve roots is the most common cause of radicular pain patterns (Deyo *et al.*, 1990, Ex. 26–106).

The histopathology of human compressive neuropathy has not been well studied, because surgical management does not provide pathological specimens. However, findings from animal experiments appear to correlate with the limited findings from human specimens where nerve was resected or from an autopsy on an individual with compressive neuropathy (Novak and Mackinnon, 1994, Ex. 26–1310; Mackinnon *et al.*, 1986, Ex. 26–1321; Rempel, Dahlin, and Lundborg, 1998, Ex. 26–444; Terzis and Noah, 1994, Ex. 26–587). After compression of nerve, changes in the blood-nerve barrier develop and are followed by subperineurial edema and thickening of both perineurial and epineural layers (Lundborg and Dahlin, 1994, Ex. 26–561 ; Novak and Mackinnon, 1998, Ex. 26–1310; Rempel, Dahlin, and Lundborg, 1999, Ex. 26–444; Terzis and Noah, 1994, Ex. 26–587). After intraneural fibrosis, myelin thinning results, with fibers at the periphery of the nerve affected first. If compression continues, segmental demyelination progresses to more diffuse demyelination and, finally, axonal degeneration occurs (Mackinnon and Dellon, 1988, Ex. 26–296; Mackinnon *et al.*, 1984, 1985, Exs. 26–648 and 26–649).

Histopathologic changes are dependent on the force and duration of compression, as well as the characteristics of the nerve. Changes can also vary among different fascicles within the nerve (Mackinnon, 1992, Ex. 26–646). Nerves composed of large amounts of connective tissue with relatively few fascicles may be less susceptible to injury (Dickson and Wright, 1984, Ex. 26–1298; Lundborg, 1988, Ex. 26–1145). The nearer nerve fascicles are to the site of compression, the sooner pathologic changes will occur.

Laboratory observations appear to support these conclusions. In a study of canine extensor digitorum brevis muscle, Hargens *et al.* (1979, Ex. 26–135) created a compartment syndrome by infusing plasma. As pressure rose, the amplitude of the action potential declined until complete nerve block developed at 2 hours at pressures of 80 to 120 mm Hg. Histopathological evidence of axonal degeneration was noted after 3 weeks. Graded external compression of rabbit tibial nerve demonstrated complete interference with epineural venular, arteriolar, and intrafascicular capillary flow at pressures from 60 mm Hg to 80 mm Hg (Rydevik *et al.*, 1981, Ex. 26–321). The neural ischemia may then cause endoneurial edema, with further rises in intraneural pressure.

As nerves are stretched over another anatomic structure, mechanical deformation can occur with microruptures, abnormal function (ischemia and decreased nerve conduction) and scarring (Armstrong, 1983, Ex. 26–927). In addition, there can be an incompatibility between the anatomic space available for the nerve and the volume and pressure of the space (Lundborg, 1988, Ex. 26–1145). For example, in cubital tunnel syndrome, repeated flexion results in stretch and friction of the ulnar nerve (Harter, 1989, Ex. 26–958). This can be compounded by elevations in the pressure in the cubital tunnel that have been observed with elbow flexion (Pechan and Julis, 1975, Ex. 26–575). Elbow flexion also places the ulnar nerve in a more superficial position, where it can be damaged by leaning the elbow on a work surface.

Because it is the most common nerve entrapment disorder of the upper extremity and because it is easily studied, CTS has become the benchmark nerve compression disorder (Szabo and Gelberman, 1987, Ex. 26–1013). In CTS, postural extremes can cause significant increases in mean intracarpal pressures from 2.5 to 30 mm Hg in normal subjects, and from 32 to 94 (flexion) or 110 (extension) mm Hg in patients with CTS (Gelberman *et al.*, 1981, Ex. 26–1127; Szabo and Chidley, 1989, Ex. 26–1168). Similarly, pressures can rise with exposure of flexor tendons to high forces (Smith, Sonstegard, and Anderson, 1977, Ex. 26–1006), or repetitive hand/wrist motions (Gelberman *et al.*, 1981, Ex. 26–1127; Szabo and Gelberman, 1987, Ex. 26–1013). Within 1 hour, elevated carpal tunnel pressures can result in impaired conduction and median nerve sensory function (Gelberman *et al.*, 1981, Ex. 26–1127; Lundborg, 1988, Ex. 26–1145). Even transient increases in intracarpal pressure can produce slowed nerve conduction and altered sensory function of the hand (Lundborg *et al.*, 1982, Ex. 26–979). These types of pressure can be induced by prolonged isotonic or isometric contractions of wrist and digital flexors (Werner, Elmquist, and Ohlin, 1983, Ex. 26–1025). Studies of intracarpal pressure in these more exaggerated or non-neutral positions have had consistent results, demonstrating large increases in pressure when the wrist is forcefully stressed, particularly in hyperextension (Rempel *et al.*, 1994, Ex. 26–1151; Werner *et al.*, 1994, Ex. 26–237). Relatively low fingertip loads (5 to 15 N) raise carpal tunnel pressures by 4 to 6.6 kPa (Rempel *et al.*, 1997, Ex. 26–889). Classic studies in the meatpacking industry (Masear, Hayes, and Hyde, 1986, Ex. 26–983) and in the automobile industry (Silverstein, Fine, and Armstrong, 1987, Ex. 26–34) have shown a consistent pattern of forceful wrist exertions and nerve compression syndromes. This same pattern of risks is evidenced in the so-called pinch grip, leading to innovations in tool handle design (Tichauer, 1978, Ex. 26–446). Use of modifications tend to involve the full palm rather than the fingers alone.

Because of the strong association of CTS with repetitive and forceful work and awkward postures (Silverstein, Fine, and Armstrong, 1987, Ex. 26–34), there has been particular attention to the process by which joint deviation and loading and repetitive muscle contraction can raise pressure at an anatomic canal. In the upper extremity, fibrotic changes in the radial and ulnar bursae and at the carpal tunnel have been located consistently. These changes potentially produce compressive stresses on the median, ulnar, and radial nerves from bone and retinaculum (Armstrong *et al.*, 1984, Ex. 26–1293).

The transition from acute compression injury to a chronic nerve entrapment condition involves an extension of these pathophysiologic models. However, Mackinnon *et al.* (1984, Ex. 26–648) have presented a histologic model showing the gradual transition from a recoverable nerve compression injury, in which there is swelling and thickening of the connective tissue lining bundles of nerve fibers, to demyelination of the nerve and nerve fibrosis, in which there are often irreversible changes to the nerve. This has been extended to a model of CTS (Mackinnon and Novak, 1997, Ex. 26–1309).

Novak and Mackinnon (1998, Ex. 26–1310) suggest that many patients with diffuse upper-extremity symptoms may experience problems from multiple levels or sites of nerve compression and concomitant muscle imbalance. These observations come from the often surprising clinical evidence that symptomatic patients often express signs at multiple sites of potential compression. This so-called ‘‘double crush’’ syndrome (Hurst *et al.*, 1985, Ex. 26–965) can be a consequence of degenerative cervical spine disease or acquired postural torsion at the brachial plexus (Mackinnon and Novak, 1997, Ex. 26–1309). In the ‘‘double crush’’ syndrome, there is compression at the carpal tunnel as well.

The concept of ‘‘double’’ or ‘‘multiple crush syndromes’’ is a controversial subject. In 1973, Upton and McComas first proposed that a proximal site of nerve compression, such as a cervical disc herniation, could make a distal nerve more susceptible to injury. Other potential scenarios could include ulnar nerve entrapment at the brachial plexus and cubital tunnel, or at the cubital tunnel and Guyon’s canal. Mackinnon (1992, Ex. 26–646) and Dellon and Mackinnon (1991, Ex. 26–616) have further describe the concept. These observations can be significant in situations where work postures place muscles in shortened positions. For example, workers who perform tasks requiring prolonged or resisted pronation may develop pronator muscle shortening that compresses the median nerve in the forearm when the forearm is placed in supination. Alternatively, prolonged and static work postures that result in pectoralis minor or scalene muscle tightness can compress the brachial plexus. Alterations in axoplasmic flow and transport of neutrophic substances has been proposed as the mechanism of this injury. Dellon and Mackinnon (1991, Ex. 26–616) devised an experimental animal study to evaluate these phenomena. The authors banded either sciatic nerve, posterior tibial nerve, or both nerves in rat subjects. The group of rats with double banding demonstrated significantly worse mean amplitudes of the compound action potential than either group of single-banded rats. In theory, metabolic abnormalities (*e.g.*, diabetes, alcoholic neuropathy, collagen vascular disease) could weaken a nerve and make it more susceptible to injury from less significant levels of compression. In the case of diabetes, a recent article by S.E. MacKinnon (1992, Ex. 26–646) describes rodent and primate models of diabetes with superimposed nerve compression. With alcohol, it is biologically plausible, although not specifically documented, that a ‘‘sick’’ neuron resulting from alcoholism could similarly render a nerve metabolically damaged and therefore more susceptible to injury from compression at a distal site.

A related observation is that persistent stretching of a nerve over an anatomic landmark, such as the ulnar nerve at the medial epicondyle of the elbow, can produce nerve trauma and inflammation (Harter, 1989, Ex. 26–958). The notion that micro-ruptures produce micro-anatomic injury and fibrosis of the epineurium (connective tissue lining the nerve) has been offered as a general model for CTS (Armstrong *et al.*, 1993, Ex. 26–1110). This model has its analogue in the epineural fibrosis that can be a consequence of nerve release surgery.

It is important to recognize that CTS is not responsible for all cases of numbness and tingling in the fingers that occur in demanding work settings. Furthermore, there is no ‘‘gold standard’’ for diagnosis, and the presence of even classical symptoms does not necessarily mean that surgery is required. There is a high level of reversibility in CTS, and job modification can be enough to eliminate symptoms without aggressive individual therapy. Moreover, without job modification, surgery may only delay a recurrence. Even for this most accessible MSD, modest changes in diagnostic criteria—for example, whether symptoms and signs are weighted or full reliance is placed on the nerve conduction study—can alter the case rate by as much as 50% (Katz *et al.*, 1991, Ex. 26–151; Moore, 1991, Ex. 26–1335, Cherniack *et al.*, 1996, Ex. 26–258).

Other work-induced causes of peripheral nerve injury, such as hand-arm vibration, can induce small fiber nerve injury that is unrelated to entrapment or compression (see Section D.3). The result, however, is a similar pattern of symptoms. Even when the pattern of nerve injury distinctly implicates a focal site of compression, there is no automatic requirement for surgical decompression. It is also important to recognize that in the setting of low-back pain, even when symptoms radiate to the lower extremity along a nerve dermatome, fixed nerve root lesions and the correlated need for decompression are relatively rare (Andersson and McNeill, 1989, Ex. 26–413). The same is probably true for CTS, although the proportion of surgical cases for CTS remains comparatively high.

Although most work-related peripheral entrapment disorders affect myelinated nerve fibers, there are other nerve tissue components that are at risk. Mechanoreceptors in the glabrous pads of the digits are intrinsic to touch and spatial discrimination (Vallbo and Johansson, 1984, Ex. 26–

717). Their quantitative function has been effectively assessed through the testing of vibrotactile thresholds (Brammer *et al.*, 1987, Ex. 26–935; Verrillo and Capraro, 1975, Ex. 26–591). Individual mechanoreceptors, such as Pacinian corpuscles, which measure acceleration as a sensation of touch, respond to particular frequencies of vibration. This principle is useful in establishing thresholds of response and function for individual mechanoreceptor populations. Mechanoreceptor injury is a well-recognized consequence of exposure to hand-arm vibration, and dysfunction documented in objective tests has correlated with decrements in hand performance and sensitivity (Virokannas, 1992, Ex. 26–1355). Quantitative sensory dysfunction consistent with mechanoreceptor injury has also been observed in manual workers unexposed to vibration, but for whom energy transfer still occurs in the form of shock and impact (Flodmark and Lundborg, 1997, Ex. 26–370).

There are several proposed mechanisms for the development of lumbar nerve root pain, including mechanical deformation, compression, ischemia, and inflammatory mediators. It appears that the spinal nerve root may be more susceptible to compression than peripheral nerves (Olmarker and Rydevik, 1991, Ex. 26–190). In an in-vivo experiment compressing the porcine cauda equina (Olmarker, Holm, and Rydevik, 1990, Ex. 26–518; Olmarker, Rydevik, and Holm, 1989, Ex. 26–191; Olmarker *et al.*, 1989, Ex. 26–311), venous flow was observed to cease at relatively low pressures (5 to 10 mm Hg), resulting in retrograde stasis of capillaries and impaired nutrient transport (Rydevik *et al.*, 1990, Ex. 26–197). Changes in the permeability of the spinal nerve root endoneurial capillaries, intraneural edema, increased endoneurial fluid pressure, and impaired nutrition of the nerve roots have been described by others as resulting from compression (Low and Dyck, 1977, Ex. 26–482; Low, Dyck, and Schmeizer, 1982, Ex. 26–385; Lundborg, Myers, and Powell, 1983, Ex. 26–162; Myers *et al.*, 1982, Ex. 26–308; Olmarker, Rydevik, and Holm, 1989a, Ex. 26–191; Rydevik, Myers, and Powell, 1989, Ex. 26–198).

Inflammatory mediators have also been implicated in the etiology for low-back pain, and histopathologic signs of inflammation have been observed in compressed nerve roots (Bobechko and Hirsch, 1965, Ex. 26–252; Diamant, Karlsson, and Nachemson, 1968, Ex. 26–261; Marshall, Trethewie, and Curtain, 1977, Ex. 26–483; Marshall and Trethewie, 1973, Ex. 26–564; Nachemson, 1969, Ex. 26–742). Proposed mediators include lactic acid, pH, substance P, bradykinin, cytokines, prostaglandins, and carrageenan, among others.

In recent years there has been a growing recognition of pain syndromes maintained by the sympathetic nervous system. These sympathetically maintained pain syndromes (SMPSs), of which reflex sympathetic dystrophy (RSD) is the best known, are characterized by pain and swelling, usually of the hands or feet, and vascular dysfunction (Roberts, 1986, Ex. 26–402; Kozin, 1994, Ex. 26–556). Traumatic origins are common, particularly following fracture to the hand, but there is evidence of a more widespread occurrence, in the setting of CTS, for example. This broader definition of SMPS appears to have substantial relevance to chronic soft tissue injuries, such as MSDs, associated with the workplace.

The evidence reviewed supports the conclusion that work conditions can be pathogenic for some nerve disorders. Mechanisms include external or internal nerve compression or mechanical deformation with subperineurial edema, altered metabolic nerve activity, demyelination, and axonal degeneration.

d. Vasculature. The ability of muscles, tendons, ligaments and cartilage to perform work and permit repair is dependent upon adequate blood flow, tissue oxygenation, and transmission of nutrients and metabolic end products. Therefore, when the performance of work tasks results in exposure to external or internal factors that impair normal tissue blood flow, tissue damage can occur and result in the development of MSDs. Mechanisms of injury may include tissue hypoxia from elevations in intramuscular pressure associated with forceful work or postural task requirements (Armstrong *et al.*, 1993, Ex. 26–1110; Herberts *et al.*, 1984, Ex. 26–51; Sjogaard and Sjogaard, 1998, Ex. 26–1322), vascular occlusion from direct pressure to anatomic structures (Duncan, 1996, Ex. 26–366; Kleinert and Volianitis, 1965, Ex. 26–380; Nilsson, Burstrom, and Hagberg, 1989, Ex. 26–693; Wheatley and Marx, 1996, Ex. 26–693), and vibration-induced vasospasm or impairment of microcirculation from hand tool use or whole-body vibration (Hirano *et al.*, 1988, Ex. 26–140; Kaji *et al.*, 1993, Ex. 26–854; NIOSH, 1989, Ex. 26–392). Thus it appears that vascular changes resulting from work exposures may contribute to the development or manifestation of MSDs.

The circulatory system is a major target of acquired morbidity for general health. However, while conditions such as atherosclerosis and smoking-related endothelial dysfunction can compromise neuromuscular function, their etiology does not evolve out of the workplace. Ischemia due to arteriosclerosis is an important component of muscle pain and dysfunction, but it is not a primary acquired work-related disorder. Ischemia caused by static contraction and transmural pressure from muscles and bone across arteries is work-related, and is usually reversible. There are distinct vaso-occlusive and vasospastic disorders of the hand that have a singular work-related etiology.

Arterial occlusive disease, expressed as either Raynaud's phenomenon or digital pain, has been described in a variety of hand-intensive tasks (Schatz, 1963, Ex. 26–200). Palmar and digital artery occlusion that is work-induced is usually due to traumatic ulnar artery occlusion, the so-called hypothenar syndrome or ulnar hammer syndrome (Wheatley and Marx, 1996, Ex. 26–693; Duncan, 1996, Ex. 26–366). The general mechanism causing thrombotic emboli in the palm and fingers is blunt trauma, caused by using the hand as a percussive object or by aggressively twisting hard objects (Pineda *et al.*, 1985, Ex. 26–493; Kreitner *et al.*, 1996, Ex. 26–557). The disorder has also been associated, albeit uncommonly, with the use of hand-held pneumatic tools (Kaji *et al.*, 1993, Ex. 26–854). The usual mechanism is ascribed to trauma and abrupt injury of the endothelium (the blood vessel lining), with the ulnar artery being bludgeoned against the hook of the hamate (Benedict, Chang, and McCready, 1974, Ex. 26–352). Contractions around the ulnar artery due to an anatomic muscle sling or anomalous hypothenar muscle has also been described (Benedict, Chang, and McCready, 1974, Ex. 26–352). Physiologically, the lesion is the consequence of thrombi, or small clots, that lodge in smaller or more peripheral vessels. This can occur because of pressure, the blockage of blood flow, and stasis-related clot formation. It is also hypothesized that shear forces injure the endothelium and expose the underlying tissues, the vascular intima, to injury. The repair mechanism leads to clot formation.

The most common vasospastic disorder associated with workplace exposure is occupational Raynaud's or vibration-induced white finger (VWF). In the field of hand-arm vibration, exposure measurement and specialized disease testing have produced highly evolved, methodologically detailed, and technically sophisticated approaches that have few equivalents in the occupational health literature, and none in the literature on soft tissue injury. Because vibration is a complex physical factor, lending itself to quantification and modeling, and because it produces distinct and reproducible effects on vessels and nerves, there are parallels to noise in the formality of measurement methodology. VWF is largely associated with hand-held oscillating pneumatic tools, such as metal grinders and pneumatic drills. It is also associated with chain saws and with powered tools causing repetitive impact, such as riveters and impact wrenches. The mechanisms producing Raynaud's in the setting of hand-arm vibration are not fully understood. However, there is evidence for a sympathetically mediated constriction of small arteries in the hand, interrupting cutaneous blood flow. There is also evidence of impaired dilatation of larger arteries. Section D.3.b presents a more complete discussion of hand-arm vibration.

Vibration can also diminish the blood flow to the intervertebral disc. This has been demonstrated by Hirano *et al.* (1988, Ex. 26–140) in the rabbit intervertebral disc exposed to in-vivo vibration. Unfortunately, the lumbar intervertebral disc is avascular, and its nutritional supply comes from diffusion through blood vessels surrounding the annulus fibrosus and under the hyaline end plate cartilage. Diminished blood flow to the cartilage end plate would limit the ability of the disc to maintain the degree of hydration necessary to provide support for the lumbar spine during loading. In the hand, direct pressure over the hypothenar eminence can also occlude the ulnar artery and result in hypothenar hammer syndrome (Conn, Bergan, and Bell, 1970, Ex. 26–821; Kleinert and Volianitis, 1965, Ex. 26–380; Nilsson, Burstrom, and Hagberg, 1989, Ex. 26–1148). Thus, it appears that vascular changes resulting from work exposures may contribute to the development or manifestation of MSDs.

Extrinsic ischemic compression, while not an intrinsic disease of blood vessels, is also considered here to complete the discussion of vascular responses to work exposures. The ability of muscles, tendons, ligaments, and cartilage to perform work and permit repair depends on adequate blood flow, tissue oxygenation, and transmission of nutrients and metabolic end products. When external or internal factors impair normal tissue blood flow, tissue damage can occur and result in the development of MSDs. As discussed, elevations in intramuscular pressure with forceful exertion, confinement from bony structures, or tight fascial compartments can contribute to the onset of work-related MSDs as a result of tissue hypoxia (Armstrong *et al.*, 1993, Ex. 26–1110; Sjogaard and Sogaard, 1998, Ex. 26–1322). For example, work tasks that require shoulder abduction and/or elevation to perform activities at or above shoulder height can decrease blood flow to the hypovascular portion of the supraspinatus tendon (Herberts *et al.*, 1984, Ex. 26–51). A decrease in blood flow to the trapezius muscle has also been observed in assembly workers with localized chronic myalgia related to static loading (Larsson *et al.*, 1990, Ex. 26–1332).

e. Synovial Joints and Hyaline Cartilage. Work exposures may contribute to the development of joint disorders for many reasons. Joint cartilage matrix metabolism may be disturbed and inflammatory and chemical mediators stimulated by joint trauma or repetitive loading (Allan, 1998, Ex. 26–1316; Howell, 1989, Ex. 26–1308; Radin *et al.*, 1994, Ex. 26–578). Experimental animal studies have documented the loss of proteoglycans, fibroblast synthesis of inflammatory mediators, and the development of osteoarthritis from repetitive tissue loading (Allan, 1998, Ex. 26–1316; Farkas, 1987, Ex. 26–463; Poole, 1986, Ex. 26–1316; Vasan, 1983, Ex. 26–590). With inadequate repair, cartilage thinning and hypertrophic remodeling may lead to osteoarthritis (Chaffin and Andersson, 1991, Ex. 26–420; Radin, 1976, Ex. 26–663; Radin *et al.*, 1976, 1994, Exs. 26–443 and 26–578). Repetitive or prolonged stair or ladder climbing, kneeling or squatting, standing, carrying heavy loads, and jumping are all work tasks that may be associated with lower-extremity joint loading. This is explored further in the sections on epidemiology and pathogenesis of lower-extremity disorders. Recurrent microtrauma associated with the pinching mechanism, highly intensive hand tasks requiring dexterity during assembly work or food preparation, and pneumatic tool use have all been observed to associated with upper-extremity joint loading and the development of upper-extremity osteoarthritis (Bovenzi *et al.*, 1987, Ex. 26–605; Fam and Kolin, 1986, Ex. 26–1123; Felson, 1994b, Ex. 26–543; Nakamura *et al.*, 1993, Ex. 26–1314).

A synovial joint consists of bone ends covered by hyaline articular cartilage and separated by a synovial-fluid-filled joint cavity. A synovial membrane and capsule cover the joint. The joint capsule contains dense connective tissue and is attached to the distal ends of the articulating structures. It is innervated by sensory nerves that provide proprioceptive feedback and the sensation of pain. The normal synovium consists of one to three layers of cells. Type A synoviocytes are derived from monocytes and behave as phagocytes for joint space debris. Type B synoviocytes produce glucosaminoglycans for joint lubrication and enzymes in response to inflammatory stimuli. Cytokines secreted by both cells help to regulate the structural repair process after injury or antigenic stimulation (Allan, 1998, Ex. 26–1316).

Synovium has a rich vascular supply. It secretes synovial fluid and permits the transport of oxygen, carbon dioxide, nutrients, waste products, and immunologic cells to the joint. Trauma and inflammation impair the synovial microcirculation and transport of these substances across the joint.

There are three zones or layers of the articular cartilage. In the superficial zone adjacent to the joint cavity, collagen fibers are parallel to the articular surface. This orientation becomes more random in the middle zone. At the deep zone adjacent to the subchondral bone, fibers are mostly perpendicular because they anchor to the underlying bone (Allan, 1998, Ex. 26–1316; Mow, Lai, and Rodler, 1974, Ex. 26–653).

Collagen fibers are stable in the articular cartilage until degraded by age or disease, but proteoglycans are continuously synthesized by the chondrocytes (Allan, 1998, Ex. 26–1316). The proteoglycan matrix is hydrophilic, and osmotic pressure is resisted by tension in the collagen fibers in the unloaded joint. Once osmotic pressure is exceeded from external joint loading, water is squeezed out of the cartilage and the cartilage is flattened. Loaded, the articular cartilage undergoes elastic deformation followed by gradual creep. With unloading, the articular cartilage undergoes an initial elastic recoil followed by gradual recovery of its unloaded characteristics (Chaffin and Andersson, 1991, Ex. 26–420). Some joints, such as the knee, also contain fibrocartilage discs (menisci) to help protect the articular cartilage and distribute load forces.

It is clear that significant joint trauma can initiate hypertrophic remodeling, usually at sites of synovial membrane and ligament attachment. The result is secondary cartilage breakdown (Howell, 1989, Ex. 26–1308). Unfortunately, cartilage has a limited vascular supply and ability to heal itself. With damage to subchondral tissues, there is reactive ossification and secondary cartilage thinning (Radin *et al.,* 1976, 1994, Exs. 26–443 and 26–578). After cartilage deteriorates, bone becomes subject to increased stress from loading, and reactive bone deposition occurs, resulting in sclerosis, spurring, or bone cysts noted in osteoarthritis. As the joint spaces narrow, the joint becomes more susceptible to further mechanical damage, inflammation, and scarring

Mechanical stresses associated with certain tasks that exceed the limits of tissue tolerance can either cause degenerative joint disease and/or accelerate the normal degenerative process that occurs with aging. They can also interact to hasten other forms of secondary osteoarthritis, including cases that occur after trauma or infection, and congenital, developmental, or anatomic abnormalities. For example, repetitive joint loading can impair cartilage matrix metabolism and disturb the repair processes (Allan, 1998, Ex. 26–1316; Radin *et al.,* 1994, Ex. 26–578). Studies of repetitive loading in dogs after 8 months of treadmill exercise have demonstrated a loss in proteoglycan similar to findings in models of osteoarthritis (Poole, 1986, Ex.26–1316; Vasan, 1983, Ex. 26–590). Rabbits subjected to 8 weeks of repetitive loading on the tibia show severe osteoarthritis after 24 weeks (Farkas *et al.,* 1987, Ex. 26–463). In-vitro fibroblast studies have also shown that repetitive motion can stimulate the synthesis of inflammatory mediators, including prostaglandins (Allan, 1998, Ex. 26–1316).

Degenerative joint disease can occur even after relatively low loads on joints if the forces are applied impulsively and repetitively (Radin and Paul, 1971, Ex. 26–496). This may occur because loads that are applied too rapidly to permit normal cartilage fluid movement could result in microscopic injury to the matrix (Radin *et al.,* 1994, Ex. 26–578). Loss of proteoglycans and cartilage fibrillation is also noted in this setting (Radin *et al.,* 1976, Ex. 26–443). Allan (1998, Ex. 26–1316) suggests that several joint interactions involved with repetitive loading may contribute to pathology. Since joints involve many structures, including tendon, muscle, nerve, and bone, damage to one structure may occur although the recovery cycle of another structure was not exceeded. Pain from one structure may also alter feedback from other structures. In the absence of cartilage pain receptors, excessive force may be applied to damaged cartilage without the ability to promote adequate protective responses.

Aging itself is associated with gradual physiologic changes in cartilage matrix, loss of repair activity of chondrocytes, and eventual development of degenerative joint disease. This is most commonly noted in people over 40, and affects mostly large joints like the hip or knee that are exposed to repeated loading (Felson, 1994, Ex. 26–544). Felson (1988, Ex. 26–114) postulated the following reasons for age-induced degenerative joint disease: metabolic changes in cartilage increase susceptibility to fatigue fracture, bone adjacent to damaged cartilage becomes increasingly stiff from microfractures, and declining muscle mass and tendon strength decrease protective shock absorbency.

At times, it can be difficult to distinguish degenerative changes caused by age from those caused by work, although many studies have demonstrated increased rates of osteoarthritis in certain working populations (see Appendix I, Ex. 27–1), and there are consistent pathogenic explanations to link work conditions to some degenerative joint diseases. Potential mechanisms include damage to subchondral tissue from excessive, impulsive, or repetitive joint loading; impaired cartilage matrix metabolism; reactive ossification and cartilage thinning; reactive bone deposition; and disturbed repair processes.

3. Vibration

Vibration is traditionally divided into whole-body vibration, particularly pertinent for seat design and transportation, and segmental vibration, affecting the hand and arm. In the latter case, health effects are usually related to energy transfer to the upper extremity from either powered tools or from stationary sources producing oscillatory vibration, such as mounted drills and pedestal grinders. Because vibration is a complex physical factor, lending itself to quantitation and modeling, and because it produces distinct and reproducible effects on blood vessels and nerves, there are parallels to noise in the formality of measurement methodology.

a. Whole-Body Vibration. Whole-body vibration can affect skeletal muscle and predispose an individual to work-related low-back pain. Etiologies for this can include bursts of cyclic muscle contraction, muscle fatigue, decreased ability of fatigued muscles to protect spinal structures from loads, continuous compression and stretch of structures, decreased blood flow, and altered neuropeptides (Brinckmann, Wilder, and Pope, 1996, Ex. 26–418; Friden and Lieber, 1994, Ex. 26–546; Hansson and Holm, 1991, Ex. 26–134; Seidel, 1988, Ex. 26–1003). Whole-body vibration, especially seated vibration, has been associated with the development of low-back disorders (Damkot *et al.,* 1984, Ex. 26–1121; Frymoyer *et al.,* 1983, Ex. 26–950; Kelsey and Hardy, 1975, Ex. 26–855; Bernard and Fine, 1997, Ex. 26–1; Troup, 1988, Ex. 26–1021). Several mechanisms have been postulated. These include microfractures at vertebral endplates, vasospasm and decreased blood flow, tissue fatigue from mechanical overload and stretching of spinal structures, and ultrastructural changes in the spinal nerve root dorsal ganglion with biochemical alterations involving pain-inducing neuropeptides (Hansson, Kefler, and Holm, 1987, Ex. 26–134; Hirano *et al.,* 1988, Ex. 26–140; Kazarian, 1975, Ex. 26–379; Keller, Spengler, and Hansson, 1987, Ex. 26–290; McLain and Weinstein, 1994, Ex. 26–1347; Pope *et al.,* 1984, Ex. 26–440; Seidel and Heide, 1986, Ex. 26–672; Seroussi, Wilder, and Pope, 1989, Ex. 26–205).

Radiographic and pathologic changes have been noted in human subjects exposed to whole-body vibration (Frymoyer *et al.,* 1980, 1983, Exs. 26–707 and 26–950; Kelsey, 1975, Ex. 26–1134; Pope *et al.,* 1991, Ex. 26–1305; Wilder *et al.,* 1982, Ex. 26–694). Christ and Dupuis (1966, Ex. 26–134) evaluated radiographic lumbar spine findings for tractor operators. As the annual number of hours of operation increased, so did the prevalence of x-ray changes. Changes were observed in 61% of operators who drove for less than 700 hours per year, 68% in those who drove for 700 to 1,200 hours per year, and 94% in those who drove for over 1,200 hours per year. The small number of subjects weakened the study. Other studies, though, have reported similar associations of driving time, symptoms of low-back disorder, and radiographic abnormalities of the lumbar spine (Fishbein and Salter, 1950, Ex. 26–267; Seidel and Heide, 1986, Ex. 26–672). Findings reported with increased frequency include reduced disc height, facet arthrosis, spondylosis, Schmorl's nodules, and spondylolisthesis. It has been pointed out that these studies have been retrospective, and some lack adequate controls (Hansson and Holm, 1991, Ex. 26–134). Unfortunately, many heavy-equipment operators and fork truck drivers are exposed to a number of additional factors that increase disc stress, including seated postures, kyphotic postures, twisting, and whole-body vibration (Dupuis, 1994, Ex. 26–847). These probably accounts for the premature onset of degenerative disc disease in these workers.

The natural resonance frequency of the human lumbar spine in the seated position is in the range of 4 to 6.5 Hz (Magnusson *et al.*, 1990, Ex. 26–166; Wilder, Pope, and Frymoyer, 1982, Ex. 26–694). This is similar to the vibration characteristic of many motor vehicles. Whole-body vibration imposes several motions on the body and the spine, including impact, translation, and rotation. Within the natural frequency range, one animal in-vivo study demonstrated that disc pressure and axial and shear strain from vibration can increase 2 to 3 times (Hansson *et al.*, 1987, Ex. 26–134). The significant increase of spinal loading from vibration in the natural frequency has the consequence of exacerbating the amount of disc shrinkage noted after simple sitting. This has been demonstrated in human subjects using continuous measurement of the spine (Kazarian, 1975, Ex. 26–379; Magnusson *et al.*, 1990, Ex. 26–166). As frequency increases within the range of 0 to 15 Hz, stiffening of the spinal structure is noted in normal human subjects (Wilder, Pope, and Frymoyer, 1982, Ex. 26–694). Shifting to positions of mild lateral spinal flexion transiently decreases stiffness, but this posture imposes other mechanical disadvantages, such as paraspinal and abdominal muscle fatigue (Wilder, Pope, and Frymoyer, 1982, Ex. 26–694). Brinckmann *et al.* (1987, 1988, Exs. 26–84 and 26–1318) performed in-vitro experiments and noted that repeated cyclic loading of vertebral bone, as opposed to single loading events, reduced the strength of the material. They suggested that the resulting endplate fractures were a possible mechanism of later disc injury and low-back pain.

Vibration has additional effects on the erector spinae muscles, with observations of greater myoelectric activity and fatigue (Seidel and Heide, 1986, Ex. 26–672; Seroussi, Wilder, and Pope, 1989, Ex. 26–205; Wilder, Pope, and Frymoyer, 1982, Ex. 26–694). Johanning (1991, Ex. 26–1228) observed that subway operators experienced trunk muscle fatigue after being exposed to whole-body vibration for 1 hour. Pope *et al.* (1984, Ex. 26–440) also believe that the fatigue of paraspinal muscles, ligaments, and discs contributes to low-back pain associated with exposure to whole-body vibration. Progressive muscle fatigue limits the ability of skeletal muscle to protect spinal structures. Additional spinal loading can also result when the muscle response diverges out of phase with the vibration input (Seroussi, Wilder, and Pope, 1989, Ex. 26–205).

The physiologic result of vibration in the natural resonance frequency is structural failure. This occurs first in the vertebral end plate, adjacent spongy bone of the vertebral body, and the intervertebral disc (Keller, Spengler, and Hansson, 1987, Ex. 26–290). Hirano *et al.* (1988, Ex. 26–140) demonstrated that blood flow decreased in the rabbit intervertebral disc exposed in vivo to vibration. Porcine intervertebral disc experiments have shown that solute transport is also disrupted (Holm and Nachemson, 1985, Ex. 26–1374). Both of these effects are likely to precipitate disc degeneration because of disturbed metabolic activity, as discussed earlier. McLain and Weinstein (1994, Ex. 26–1347) studied ultrastructural and neuropeptide changes in the rabbit lumbar spine dorsal ganglion exposed to whole-body vibration at amplitudes and frequencies similar to those of motor vehicles. On electron microscopy, the group exposed to vibration had more significant findings of nuclear clefting, mitochondrial, rough endoplasmic reticulum, and ribosomal changes relative to controls. The authors suggested that this may provide an anatomic link between the clinical observation of increased back pain and the biochemical alterations involving pain-related neuropeptides.

b. Hand-Arm Vibration. Disorders resulting from hand-arm vibration are the sole subject of the cited epidemiologic studies on vibration. Outcomes involving measurable neurological and arterial dysfunction have taken precedence over pain and function, in marked distinction to more clinically appreciated musculoskeletal diseases. In 1986, the International Standards Organization published methods for measuring vibration and controlling its exposure—ISO 5349 (1986, Ex. 26–1301). The approach was adopted by the American National Standards Institute in ANSI S3.34 (1986, Ex. 26–1402). This accepted approach to measurement reflects the technical feasibility of characterizing the vibratory qualities of hand tools. Vibration is measured in terms of the frequency distribution of oscillations; the direction, velocity, and acceleration of those oscillations; and the impulsiveness, or force range (amplitude), expressed in each impact cycle (Starck and Pyykko, 1986, Ex. 26–678; Maeda *et al.*, 1996, Ex. 26–562). Each of these physical characteristics has a bearing on symptoms and tissue injuries that may occur, particularly in the palms and digits, but also more proximally in the shoulder and neck.

In the field of hand-arm vibration, exposure measurement and specialized disease testing have produced highly evolved, methodologically detailed, and technically sophisticated approaches. These have few equivalents in the general occupational health literature, and none in the area of soft tissue injury. The industrial control of hand-arm vibration is based on the reduction of the most prominent sign and symptom complex, cold-related finger blanching or Raynaud's phenomenon. The pioneering occupational medicine physician Alice Hamilton first described this phenomenon in the United States, among Indiana quarry workers using air-powered tools (Hamilton, 1918, Ex. 26–1401). By 1960, more than 40 studies had been published (Cherniack, 1999, Ex. 26–1354). NIOSH reviewed the available epidemiology in 1989 and 1997 (NIOSH, 1989, Ex. 26–392; Bernard and Fine, 1997, Ex. 26–1) and found overwhelming evidence of a strong dose effect between duration and intensity of vibration exposure and the onset of acquired Raynaud's, known as VWF. Arterial hyper-responsiveness and impaired vasodilation following cold challenge are also characteristics of vibration white-finger (VWF). In some studies, more than 70% of an exposed workforce evinced signs and symptoms of local vasospasm in the digits of the upper extremity, most often measured by recording finger systolic blood pressure and digital temperature stability in the setting of cold challenge (Bovenzi, 1993, Ex. 26–1280). Although a major mechanism of vibration-induced vasospasm seems attributable to local autonomic dysfunction (Gemne, 1994, Ex. 26–1320; Ekenvall and Lindblad, 1986, Ex. 26–462), a more generalized co-morbid vascular pathology may also contribute to hand symptoms and impaired function. Finger biopsies of workers heavily exposed to local vibration have shown signs of significant endothelial injury (Takeuchi *et al.*, 1986, Ex. 26–681). Increased free radical formation and elevated leukotriene B4 levels, both indicators of atheromatous injury, are observed concomitants of vibration exposure (Lau, O'Dowd, and Belch, 1992, Ex. 26–480). Overall, a satisfactory pathophysiologic model for occupational Raynaud's has been elusive.

Over the past two decades, numerous investigators have noted that neurological symptoms, including paresthesias, dysesthesias, and loss of fine motor skills among workers using air-powered tools, are even more common than vascular effects (Pyykko, 1986, Ex. 26–662; Ekenvall and Lindblad, 1986, Ex. 26–462; Futatsuka, Inaoka, Ueno, 1990, Ex. 26–547; Letz *et al.*, 1992, Ex. 26–384). It has often proven difficult to localize clinical neuropathologic symptoms to a precise anatomic locus. Accordingly, there has been considerable attention in the vibration literature to differentiating more proximal entrapment neuropathies such as CTS from distal small fiber nerve injuries in the digits (Pelmear and Taylor, 1994, Ex. 26–880; Wieslander *et al.*, 1989, Ex. 26–1027), and from more diffuse axonopathies (Farkkila *et al.*, 1988, Ex. 26–947). In the past 15 years, most investigators have recognized that small fiber injury to fingertip nociceptors is distinctly more common than CTS in vibration-exposed workers, that electrodiagnostic studies are insensitive measures of this type of injury, and that quantitative sensory testing is essential if unnecessary carpal tunnel surgery is to be avoided (Miller *et al.*, 1994, Ex. 26–303; Pelmear and Taylor, 1994, Ex. 26–880). These tests, particularly measurement of vibrotactile thresholds, have consistently demonstrated deficits in perception in symptomatic and asymptomatic patients exposed to vibration (Flodmark and Lundborg, 1997, Ex. 26–370; Virokannas, 1992, Ex. 26–1355; Cherniack *et al.*, 1990, Ex. 26–1116). They also have shown that subjective deficits in hand functions correlate well with raised sensory thresholds (Virokannas, 1995, Ex. 26–891). The contribution of small fiber injury to deficits in touch and temperature recognition is consistent with the observation that the tissues of the digit and palm absorb well over 90% of transmitted energy from a conventional vibrating tool. The importance of small fiber nerve injury is reflected in current use of terms to characterize the health effects of vibratory hand tool exposure. The historical term ''vibration-induced white finger'' reflects the traditional focus on vasospastic symptoms. In 1987, a consensus panel meeting in Stockholm coined the term hand-arm vibration syndrome (HAVS) to give separate and equal weighting to neurological symptoms (Gemne *et al.*, 1987, Ex. 26–624).

The prominence of digital vasospasm and small fiber nerve injury in HAVS, as an outcome of vibration exposure, does not preclude other potentially important vibration-related health effects in tissues of the upper extremity. The CTS, in particular, has been recognized for its prevalence and severity in workers using pneumatic tools (Koskimies *et al.*, 1990, Ex. 26–973; Chatterjee, 1992, Ex. 26–942). Uncertainty exists, however, over the relative contributions of direct energy transfer to nerve tissue from the vibrating tool and secondary pathophysiologic or biomechanical responses to vibration that might provoke myelinated nerve injury. For example, EMG determined that muscle activity in the finger flexors, but also in the trapezii, has been affected by different qualities of vibration as well as by arm position. This is amplified in the setting of powered tools, such as nutrunners and fasteners, that create predominant biomechanical exposures other than vibration (Freivalds and Eklund, 1993, Ex. 26–116; Radwin, VanBergeijk, and Armstrong, 1989, Ex. 26–519). In these settings, more traditional ergonomic considerations, such as grip force, posture related to work surface, and duration of the torquing phase, have played a role in reported discomfort and EMG activity (Rohmert *et al.*, 1989, Ex. 26–999).

For the purpose of recognizing work-related health effects associated with vibration, it is useful to consider several pertinent features of vibratory exposure:

- Vibration is a physical factor, expressible in precise units: frequency in Hz, acceleration in m/sec^2 or G's, and cycles in milliseconds. This offers highly accessible measurement with available instrumentation, principally accelerometry and frequency spectrum analysis.
- Vibratory characteristics are highly tool-specific. Chainsaws and drills, for example, are primarily oscillatory and continuous; impact wrenches and rivet guns have large physical displacements and are highly impulsive; tools such as nutrunners have major non-vibratory biomechanical components. Thus, simple generic measurements (weighted acceleration, for example) may not capture the extent of a potential tool-specific hazard.
- Vibration can be quite well characterized as an extrinsic exposure, but health effects are the direct result of altered physiology that occurs entirely on the other side of the hand-tool interface.

Appreciation of these properties is essential for hazard identification and medical management, because significant patterns of disease have occurred in exceptional settings or tool applications that are not necessarily predictable from published standards and advisory documents. Frequency, direction of vibration, and arm and hand position all have an effect on impedance to and absorption of vibration energy (Burstrom, 1997, Ex. 26–609; Kihlberg *et al.*, 1995, Ex. 26–755). Push and pull, as well as grip force, affect transmission, and are in turn altered by the characteristics of vibration, including its impulsiveness and frequencies (Keith and Brammer, 1994, Ex. 26–1324; Griffin, 1997, Ex. 26–373).

Perhaps the most problematic area involves high-impulse acceleration. The ISO-and ANSI-weighted curves treat all vibration as harmonic, ignoring impact forces and instantaneous peak accelerations that can exceed 105 m/sec^2. Starck (1984, Ex. 26–677) noted that the dramatic reduction in vascular symptoms occurring with the introduction of anti-vibration chainsaws in the 1970s was better explained by the flattening of high transient accelerations than by a reduction in root mean square (RMS). In addition, the consistent underestimation of vascular symptoms by ISO 5349 for pedestal grinding and stone cutting was better accounted for when high-peak impulsivity was factored into the exposure model (Starck and Pyykko, 1986, Ex. 26–678). This is consistent with, but does not fully explain, the high prevalence of Raynaud's in platers and riveters, who use high-impulse tools only a few minutes per day (Dandanell and Engstrom, 1986, Ex. 26–614; Engstrom and Dandanell, 1986, Ex. 26–620; Burdorf and Monster, 1991, Ex. 26–454).

A similar problem arises in the setting of tools that oscillate at very high frequencies, such as small precision drills and saws. Most measurement protocols exclude frequencies that exceed 1500 Hz. Nevertheless, neurologic (Hjortsberg *et al.*, 1989, Ex. 26–1131) and vascular symptoms (Cherniack and Mohr, 1994, Ex. 26–1341) have been highly concentrated in select populations that use these types of tools.

Another area of importance is the occurrence of neck and shoulder pathology in workers using highly impulsive tools (Viikari-Juntura *et al.*, 1994, Ex. 26–873; Kihlberg *et al.*, 1995, Ex. 26–755). This is a complex area, particularly since the most common shoulder diagnoses—impingement and rotator cuff tendinitis—are clinically useful but without very specific pathophysiologic meaning. In the following epidemiologic review (Appendix I, Ex. 27–1), the neck, but not the shoulder, is shown to be associated with a vibration-related pathology. The separation of biomechanical, physiologically adaptive, and vibration-specific factors is especially difficult for the neck and shoulder. Scapular stability and posture are the heart of large-muscle activation sequences involving efficient distal muscle group movement (Mackinnon and Novak, 1997, Ex. 26–1309). Moreover, static shoulder posture, important for tool stabilization, is an important contributor to early arm fatigue (Sjogaard *et al.*, 1996, Ex. 26–213). Finally, the quality of a vibratory stimulus (continuous or discrete) has significant impacts on efferent recruitment and firing (Maeda *et al.*, 1996, Ex. 26–562). The combined effects of this complexity are not easily modeled. This is all the more reason why neck/shoulder symptoms should be carefully scrutinized when a power tool is part of the exposure background. It may prove difficult in practice to distinguish neck/shoulder symptoms that have their origins in strictly biomechanical processes from vibration-induced injuries. However, there is sufficient evidence in support of an etiology to merit intervention.

The consequent injuries to blood vessels and nerve fibers from vibration are well known. When biomechanical and other ergonomic factors complicate exposures, particular attention should be paid to the tools in use, patterns of use, and specific symptom presentations.

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E. Glossary and List of Acronyms

1. Glossary

Acceleration—time rate of change in velocity (expressed as m/sec^2 or as gravity); the second derivative of displacement with respect to time. Intensity of vibration is measured by acceleration.

Afferent nerves—sensory nerves supplying information, including movement, position, and other sensation, to the central nervous system.

Articular—referring to the joint or, more specifically, to the particular surfaces at the ends of bones that meet (separated by cartilage) in the joint.

Atheromatous—producing plaques or atheroma in arteries.

Autonomic dysfunction—abnormalities of the involuntary or autonomic nervous system. In vibration studies, the term usually refers to abnormal sympathetic nerve response resulting in abnormal vascular musculature response.

Axonopathies—nerve abnormalities affecting the fibers that carry nerve impulse from the nerve cell body to the next nerve cell or effector muscle.

Biomechanical stressor—the physical aspects of workstation, work piece, tools, and work process that exert stress on the body. Biomechanical stressors are distinct from psychosocial or work organization risks, which are not addressed in this document. The document uses ''biomechanical stressors'' instead of the commonly employed ''ergonomic stressors.'' The term ''ergonomics'' refers to ''fitting the work to the worker,'' a much broader concepts that includes all aspects of the worker/task/work environment interaction: biomechanical stressors and psychosocial stressors, human factors concepts of information exchange and ease of use, and higher-level constructs of organizational structure and culture.

Carpal tunnel—an anatomic tunnel in the wrist through which the median nerve and nine digital flexor tendons pass. It is formed by the wrist bones and a dense trans-carpal ligament. Pressure on the median nerve in the carpal tunnel causes carpal tunnel syndrome.

Cartilage—a thick, white connective tissue that attaches to the articular surfaces of bones, forming a low-friction cushion. It is structurally more rigid than tendon.

Central and peripheral nervous systems—the central nervous system includes the brain and spinal cord; the peripheral nervous system consists of nerves linking the central nervous system to muscles (via efferent motor nerves) and sensory receptors (via afferent sensory nerves).

Concentric contraction—muscle contraction in which tension is greater than external load, resulting in muscle shortening.

Demyelination—a loss of the myelin sheath. Myelin is a fatty tissue that surrounds large and medium-size nerves and speeds the rate of electrochemical conduction through the nerve. In the setting of work-related injury, demyelination is usually caused by nerve compression and entrapment.

Dermatome—an area of the body innervated by a specific nerve or nerve branch.

Dorsal wrist compartments—hand tissue areas divided by fascia that represent hydraulic cushions. The first dorsal compartment contains tendons that extend the thumb.

Dysesthesias—abnormal nerve sensations.

Eccentric contraction—muscle contraction in which tension is less than the external load, resulting in muscle elongation against contractile force. Muscles in eccentric contraction can develop the highest tension and are thus the most vulnerable to rupture.

ECRB—the extensor carpi radialis brevis, a muscle that extends the wrist and inserts at the lateral elbow.

Efferent nerves—motor nerves effecting and coordinating voluntary and reflexive muscle activity.

Efferent nerve axons—motor nerves effecting and coordinating voluntary and reflexive muscle activity.

Endothelial—in vascular studies, referring to the inner lining of blood vessels (more broadly, the term refers to tissues derived from embryonic endothelial cells).

Epicondylitis—elbow pain at the site where the proximal flexor or extensor tendons insert at the lateral or medial epicondyles (bony prominences on the inside and outside of the elbows).

Etiology—the cause or origin of disease or study of the causes of disease.

Exposure—an epidemiological concept used to describe the particular risk factor experienced by the worker, with its particular profile of modifying factors: intensity, time characteristics, and duration.

Fibroblasts—cells that produce connective tissue such as ligaments and tendons.

Fibrocartilage—cartilage that contains dense bands of connective tissue, having elements of rigid support and flexibility.

Fibrosis—the replacement of normal tissues by fibrous scar tissue at the site of injury.

Frequency—number of oscillations per unit of time; 1 hertz (Hz) = 1 cycle/sec.

Gamma muscle spindles—specialized nerve afferents that send signals to the central nervous system indicating muscle stretch (thus providing information on body segment position).

Glabrous pads—the fatty pads at the fingertips and toetips.

Humerus—the long bone of the upper arm.

Hydrophilic—reactive with water.

Hypertrophic—referring to a growth or increase in tissue mass.

Ischemia—the condition of restricted blood flow to an area, resulting in insufficient oxygen and nutrients for tissue function and reduced clearance of CO_2 and metabolites.

Isometric contraction—muscle contraction in which tension equals the external load, resulting in a constant muscle length.

Isotonic contraction—muscle contraction in which a constant internal force is developed, usually resulting in concentric contraction.

Mechanoreceptors—specialized nerve endings and sense organs that convey the senses of touch, spatiality, and pressure.

Median nerve—the nerve suppling most of the sense of sensation to the first through fourth fingers. The median nerve can be entrapped in carpal tunnel syndrome.

Metaplasia—non-neoplastic change in the form and function of cell, usually due to an external stimulus.

Mitochondria—the bodies within cells that conduct oxidative metabolism, the oxygen-dependent, energy-producing chemical reactions that are essential for muscle contraction.

Musculoskeletal disorder (MSD)—an injury or illness of soft tissues of the upper extremity (fingers through upper arm), shoulders and neck, low back, and lower extremity (hips through toes) that is primarily caused or exacerbated by workplace risk factors, such as sustained and repeated exertions or awkward postures and manipulations.

Since the Health Effects Section deals only with work-related disorders, the abbreviation ''MSD'' is equivalent to the term ''work-related musculoskeletal disorder'' (WRMSD or WMSD) found elsewhere in the literature. MSDs, as discussed in this document, are assumed to arise out of regular work processes as acquired disorders and exclude acute traumatic injuries, such as falls or amputations. The term ''MSD,'' however, does not exclude acute injuries that arise out of occasional or atypical work processes, such as handling particularly heavy or poorly balanced materials. MSDs include disorders of the following tissues: muscles; tendons, paratendons, and retinaculum; ligaments; peripheral nervous system (including the sympathetic and parasympathetic nervous system); cartilage and synovium (including joints, intervertebral discs, and fibro-cartilage complexes); bone; and blood vessels. The term ''MSD'' is used to maintain consistency with current practice and nomenclature, and does not imply a hierarchy or emphasis on injuries to muscle and bone in contrast to other soft tissues. In fact, injuries to muscle and tendon are distinctly more common than injuries to bone. Subordinate terms like ''neuromuscular disorders'' and ''musculotendonous disorders'' are used to emphasize a particular, tissue-based etiology.

''MSD'' is used in place of ''CTD'' (cumulative trauma disorder) or ''RSI'' (repetitive strain injury) because it does not necessarily presuppose etiology from accumulation or repetition of trauma, and it does not imply a category of medical diagnoses. For establishing a standard and for recognizing hazards, persistent symptoms, clinical signs, or clinical diagnoses are sufficient to establish the existence of MSDs.

Myelin—the external lining of large and medium size nerves with a fatty sheath, enhancing nerve conduction velocity.

Nocioceptors—nerve fibers, usually C fibers, responsible for the sensation of pain.

Odds ratio—relates the odds of being a case to those of not being a case. It is the odds of being a case given the risk factor is present divided by the odds of being a case given the risk factor is not present. If the following table is used the odds ratio is:

OR = (A/B)/(C/D)

Risk Factor Classification	Cases	Noncases
Risk Factor Present	A	B
Risk Factor Absent	C	D

Oscillation—rhythmic variation in the position of an object in reference to the starting point, measured over time.

Paresthesias—abnormal sensations of tingling and numbness.

Proprioception—the conduction of sensory nerve signals that indicate muscle and joint position to the central nervous system.

Raynaud's phenomenon—a painful condition affecting the fingers or toes, caused by compromised circulation. It is provoked by the cold. Raynaud's causes the digits to turn white from lack of blood supply.

Risk factor (stressor)—a characteristic of the work environment that research has shown to be associated with an elevated occurrence or severity of MSDs. Risk factors can involve purely external exposures, such as shock or percussion, that act on the musculoskeletal system. They can also involve intrinsic response to a load or task, such as lifting or rapid and awkward movement. The effect of a risk factor may be modified by personal characteristics, such as anthropometry and physical conditioning, or by concurrent or previous non-work exposure. Risk factors can also involve work organizational or social factors.

The Heath Effects Section uses the terms ''stressor'' and ''risk factor'' interchangeably.

Root mean square (RMS)—the square root of the arithmetic mean of the squares of a series of numbers.

Sarcomere—the basic skeletal muscle cell.

Skeletal muscle—striated muscle constituting the major muscle groups in the body that are responsible for voluntary and reflex movement of body segments.

Subchrondral bone—bone located beneath the cartilaginous lining of a joint.

Synoviocytes—the matrix cells of the synovial membrane.

Synovium—a lubricating tissue located at the sheaths of joints, in bursae and as the innermost layer of joint capsules. High-usage tendons, such as the finger flexor and extensor tendons, are also surrounded by lubricating synovial tissue.

TFCC—the triangulate fibro-cartilage complex, a structure of cartilage and tendons that holds the ulna (forearm bone) to the bones of the wrist.

Transmural pressure—pressures resulting from increased volume or force in an anatomic structure that is no longer expandable (such as a blood vessel, or a muscle encircled by surrounding tissues).

Transverse—operating across different planes.

Ulnar nerve—an important bundle of sensory and motor nerve fibers to the arm, particularly to the hand. Its sensory fibers innervate the fifth and part of the fourth fingers.

Uniaxial—operating in a single plain along a single axis.

Vaso-occlusion—blocking of an artery by a fixed obstruction, often caused by clot or degenerative disease.

Vasospastic—referring to reversible arterial occlusion caused by sympathetically mediated constriction of arteries.

Vibration—oscillation or periodic motion of a rigid or elastic body from equilibrium.

Vibrotactile threshold—different classes of mechanoreceptors are sensitive to specific frequencies of vibration. The vibration amplitude at which conscious perception occurs is the vibrotactile threshold.

Vibrotactile thresholds—different classes of mechanoreceptors are sensitive to specific frequencies of vibration. The acceleration amplitude at which the vibration is consciously perceived is the vibrotactile threshold.

Viscous strain—refers to the biological incapacity of a tissue to retain its fluidity due to extremely rapid deformation. Viscous strain is usually distinguished from elastic strain, the mechanical incapacity of a tissue to regain its resting position.

Weighted curves—the progressive filtering or downweighting of accelerations, due to presumed reduction in physiological effect, as they exceed 16 Hz.

Work-related disease—a disease caused by or exacerbated by stressors encountered during work. More precisely, the World Health Organization (1985) defines disease as work-related if work procedures, equipment, or environment contribute significantly to its causation.

Z-lines—microscopically observed divisions in functioning muscle cells.

2. List of Acronyms

A

ADP: adenosine diphosphate
ALL: anterior longitudinal ligament
ANSI: American National Standards Institute
APL: abductor pollicis longus
ATP: adenosine triphosphate
ASC: total ascorbate
ASOII: Annual Survey of Occupational Injuries and Illnesses

B

BMI: body mass index

C

CAT: computerized axial tomography
CCR: cervico-collic reflex
CL: Chinese line
CMC: carpal-metacarpal
CNS: central nervous system
COS: Clearwater Osteoarthritis Study
CT: computed tomography
CTD: cumulative trauma disorder
CTP: carpal tunnel pressure
CTS: carpal tunnel syndrome

D

DIP: distal interphalangeal
DPC: desktop PC

E

ECRB: extensor carpi radialis brevis (see glossary entry)
ECRL: extensor carpi radialis longis
ECU: extensor carpi ulnaris
EDC: extensor digitorum communis
EGM: electrogram
EGPT: erythrocyte glutamic pyruvic transaminase
EMG: electromyography
EPB: extensor pollicis brevis

F

Fc: compression forces
FCR: flexor carpi radialis
FCU: flexor carpi ulnaris
FDP: flexor digitorum profundus
FDS: flexor digitorum superficialis
FPL: flexor pollicis longus
FTE: full-time equivalent

G

GAG: glycosaminoglycan

H

HANES: Health and Nutrition Examination Survey
HANES I: First National Health and Nutrition Examination Survey
HAVS: hand-arm vibration syndrome
Hz: Hertz

I

IP: interphalangeal
ISO: International Standards Organization

J

JSI: job severity index

K

kPa: kilopascal

L

LMM: Lumbar Motion Monitor

M

MAF: maximum acceptable frequency or maximum acceptable force
MAT: maximum acceptable torque
MAW: maximum acceptable weight
METS: metabolic equivalents
MP: metacarpophalangeal
MPF: mean power frequency
MR: magnetic resonance
MRI: magnetic resonance imaging
MSD: musculoskeletal disorder
MVC: maximum voluntary contraction
MVIS: maximum voluntary isometric strength
MVPS: maximum voluntary pinch strength

N

N: Newtons
Nm: Newton meters
Nm/s: Newton meters/second
NAS: National Academy of Sciences
NCHS: National Center for Health Statistics
NHIS–OHS: National Health Interview Survey
NIOSH: National Institute for Occupational Safety and Health
NPC: notebook PC
n.s.: not significant

O

OCD: occupational cervicobrachial disorder
OR: odds ratio

P

PCID: prolapsed cervical intervertebral disc
PDTS: predetermined time systems
PE: physical examination
PEL: perceived exposure limit
PHD: peak handle displacement

PHV: peak handle velocity
PINS: posterior interosseous nerve syndrome
PIP: proximal interphalangeal
PLL: posterior longitudinal ligament
PLP: pyridoxal 5′-phosphate
PPT: pressure pain thresholds
PRR: prevalence rate ratio

Q

QCT: quantitative computed tomography

R

RMS: root mean square (see glossary entry)
ROM: range of motion
RPE: range of perceived exertion
RPM: revolutions per minute
RR: relative risk
RSD: reflex sympathetic dystrophy
RSI: repetitive strain injury

S

SCTL: spinal compression tolerance limits
SHR: Standardized Hospitalization Ratio
SL: Swedish line
SMPS: sympathetically maintained pain syndrome

T

TCL: transverse carpal ligament
TFCC: triangulate fibro-cartilage complex (see glossary entry)
TLV: threshold limit value
TOS: thoracic outlet syndrome
TTS: tarsal tunnel syndrome

V

VAS: visual analog scale
VDT: video display terminal
VWF: vibration-induced white finger

W

WMSD: work-related musculoskeletal disorder
wpm: words per minute
WRMSD: work-related musculoskeletal disorder

VI. Preliminary Risk Assessment

A. Introduction

The United States Supreme Court, in the Benzene decision (*Industrial Union Department, AFL–CIO* v. *American Petroleum Institute,* 448 U.S. 607 (1980)), has ruled that the OSH Act requires, prior to the issuance of a new standard, that a determination be made that there exists a significant risk of health impairment and that issuance of a new standard will substantially reduce that risk. The Court stated that ''before he can promulgate any permanent health or safety standard, the Secretary is required to make a threshold finding that a place of employment is unsafe in the sense that significant risks are present and can be eliminated or lessened by a change in practices'' (448 U.S. 642). The Court also stated that ''the Act does limit the Secretary's power to require the elimination of significant risks' (448 U.S. 644).

Although the Court rejected the use of cost-benefit analysis in setting OSHA standards in the Cotton Dust case (*American Textile Manufacturers Institute* v. *Donovan,* 452 U.S. 490 (1981)), it reaffirmed the position it had previously taken in the Benzene decision that a risk assessment is not only appropriate but required to identify significant health risks in workers and to determine if a new standard will reduce those risks. Although the Court did not require OSHA to perform a quantitative risk assessment in every case, the Court implied, and OSHA as a matter of policy agrees, that assessments should be put into quantitative terms to the extent possible.

The weight of evidence presented in the Health Effects section of this preamble indicates a causal relationship between exposure to workplace risk factors and work-related musculoskeletal disorders. As discussed in that section, the major workplace risk factors include exposure to repetitive motions, forceful exertions, vibration, contact stress, awkward or static postures, and cold temperatures. The Health Effects section also demonstrates that the risk associated with occupational exposure to these risk factors increases with frequent or prolonged exposure.

OSHA believes there is ample evidence that exposure to physical stresses at work can cause or contribute to the development of MSDs and that reductions in these stresses can reduce the number and severity of these work-related MSDs. The underlying evidence falls into three broad categories:

—Studies of groups of workers showing a relationship between exposure to risk factors in the workplace and an increased incidence or prevalence of MSDs;
—Biomechanical studies that show that adverse tissue reactions and damage can occur when tissues are subjected to high forces and/or a high number of repetitive movements; and
—Case studies that demonstrate that workplace interventions designed to reduce exposures to risk factors are effective in reducing the incidence and severity of MSDs.

There are hundreds of studies of the incidence or prevalence of MSDs in groups of workers who are exposed to risk factors in their jobs. In most of these studies, the MSD prevalence of a group of exposed workers is compared to that in another worker group that is not exposed to the risk factors of interest. If the exposed group shows a higher MSD prevalence than does the reference group, the study provides evidence of an association between exposure and an increased risk of developing MSDs, particularly if the study is of good quality and adequately controlled for potentially confounding factors (such as age and gender) and biases.

These epidemiological studies were recently reviewed by the National Institute for Occupational Safety and Health (NIOSH) to evaluate the strength of the evidence for a causal relationship between several types of MSDs and workplace risk factors. More than 600 peer-reviewed studies were critically reviewed, making this one of the largest human data bases ever built to examine work-related adverse health outcomes. NIOSH found that for most combinations of MSDs and risk factors, the evidence in humans that a causal relationship existed between workplace exposure to risk factors and the development of MSDs was either ''sufficient'' or ''strong.'' For a few MSD/risk factor combinations, there was insufficient evidence of a causal relationship, but in no case did NIOSH determine that there was evidence for the absence of a relationship between exposure to workplace risk factors and the development of MSDs. NIOSH concluded that ''* * * a substantial body of credible epidemiologic research provides strong evidence of an association between MSDs and certain work-related physical factors when there are high levels of exposure and especially in combination with exposure to more than one physical factor * * *''. (NIOSH 1997, ES p. xiv, Ex. 26–1).

A similar conclusion was reached by the experts participating in a workshop conducted by the National Academy of Sciences/National Research Council (NRC) (Ex. 26–37. For the NRC report, a panel of experts critically reviewed the methods used to select and evaluate the human studies relied on in the 1997 NIOSH study (Ex. 26–1). The 1998 NRC report concluded as follows:

''[the association between MSDs and exposure to risk factors at work that have been] identified by the NIOSH review * * * as having strong evidence are well supported by competent research on heavily exposed populations.''

''There is a higher incidence of reported pain, injury, loss of work, and disability among individuals who are employed in occupations where there is a high level of exposure to physical loading than for those employed in occupations with lower levels of exposure.'' (Ex. 26–37)

That exposure to workplace risk factors can cause or contribute to MSDs is made more plausible by the growing body of studies of biomechanical effects, which are designed to explore how tissues react to mechanical stress and how those reactions are related to disease processes. Although all soft musculoskeletal tissue can tolerate certain physical loads, these tissues will respond adversely if the load becomes excessive. Muscles, ligaments, tendons, and tendon sheaths can become inflamed with repetitive or prolonged loading, cartilage can deteriorate when subjected to abnormal loads, and nerves can exhibit dysfunction and eventually permanent damage if compressed or subjected to extended tension. Other studies have shown that the kinds of risk factors present in many industrial occupations can impose internal forces on soft musculoskeletal tissue sufficient to cause the kinds of physiologic responses described above. The relationships between external and internal loads have been demonstrated using both biomechanical models and direct measurement and observation in the workplace.

Finally, evidence of the work-relatedness of MSDs comes from several studies and case reports that document the effectiveness of ergonomic interventions in reducing exposures to risk factors and the successes of individual companies' ergonomics programs in reducing the incidence or prevalence of MSDs and the severity of MSDs among their workers. After reviewing intervention studies, including both field and laboratory studies, the NRC (1998, Ex. 26–37) concluded that ''* * * specific interventions can reduce the reported rate of musculoskeletal disorders for workers who perform high-risk tasks. No known single intervention is universally effective. Successful interventions require attention to individual, organizational, and job characteristics, tailoring the corrective action to those characteristics.''

In addition to biomechanical risk factors present at work, the risk of developing an MSD is also influenced by individual, organizational, and social factors. Factors that affect individual susceptibility include age, general conditioning, and pre-existing medical conditions. Although some of these individual factors have been identified in human studies as being statistically significant predictors of disease, they are generally much weaker predictors than are biomechanical factors (NRC 1998, Ex. 26–37) of force, repetition, posture, and vibration. Organizational factors that have been linked to MSDs include poor job content (*e.g.*, lack of job variety) and job demands (*e.g.*, excessive or highly variable workload and time pressure). The importance of poor job content is difficult to evaluate since this factor can coexist with biomechanical factors (for example, excessive workload can result in a worker needing to increase repetitive movement and/or force). Social factors refer to a lack of social support from management and supervisors, which can lead to psychological stress and dissatisfaction with work, both associated with an increased prevalence of MSDs. However, according to the NRC review (1998, Ex. 26–37), neither organizational nor social factors have proven to be strong predictors of these disorders. Thus, although individual, organizational, and social factors may have some relationship to the observed increases in the incidence of MSDs among workers exposed to risk factors, their contribution does not compare with the contribution of work-related physical risk factors to increased risk.

OSHA believes that the human epidemiologic studies, the biomechanical and physiological studies, and the studies of the effectiveness of workplace ergonomic interventions together constitute a compelling body of evidence that demonstrates that exposure to risk factors at work is a major factor in the development of MSDs, and that reducing or eliminating exposures to these risk factors will reduce the number and severity of these MSDs.

Although the epidemiological data base that describes the associations between exposure to workplace risk factors and increased prevalences or incidences of MSDs is vast, the nature of the available data have not permitted OSHA to construct generalized quantitative exposure-response relationships, as is usually done to assess occupational risks from chemical exposures. There are many reasons for this, in particular the complex interactions among different kinds of exposures that lead to tissue injury and disorders and the difficulty of defining exposure metrics that apply across a wide range of industries and operations. This is not to say that exposure-response relationships have not been observed or cannot be defined in specific circumstances; in fact, there are many cases in which the risk of MSDs has been quantitatively related to the degree and intensity of exposure. In the Health Effects section of this preamble, OSHA describes several scientific studies that demonstrate a positive association between the magnitude and/or duration of exposure to workplace risk factors and the prevalence of MSDs, including upper extremity disorders and back injuries. OSHA believes that these studies provide compelling evidence of the work-relatedness of MSDs since a finding of positive exposure-response trends is one of the key findings necessary to establish a causal relationship between exposure and disease. The lack of generalized quantitative exposure-response relationships for work-related MSDs, however, does not limit the Agency's ability to quantify risk. Using data on the incidence of work-related MSDs, risk can be quantified using a population-based approach similar to the one used by OSHA to quantify the risk of Hepatitis B among workers with frequent occupational exposure to blood and other potentially infectious material (56 FR 64004). For the proposed ergonomics program rule, OSHA uses a similar approach in its preliminary risk assessment. In this assessment, OSHA relies on data from the Bureau of Labor Statistics (BLS) to estimate the annual incidence of work-related MSDs in different industry sectors and occupations, by type of injury and type of exposure. A description of these data and OSHA's analytical approach are described in section B below, and the results of this analysis appear in section C. Information on the effectiveness of ergonomics programs is important to evaluate the extent to which the standard as proposed is likely to reduce significant risk in the covered worker population. This information comes from a variety of published studies and unpublished data that describe the degree to which ergonomics programs have reduced injury rates and decreased the numbers of lost workdays caused by MSDs. OSHA's discussion of these data appears in section D below.

B. Data Sources and Analytical Approach

The annual Survey of Occupational Injuries and Illnesses conducted by the Bureau of Labor Statistics (BLS) is the principal data source for evaluating the risks to employees of developing a work-related musculoskeletal disorder. This survey is a Federal/State program that collects workplace injury and illness data from about 165,000 private industry establishments. The survey requests information only on non-fatal injuries and illnesses, and excludes the self-employed, farms with fewer than 11 employees, private households, and employees in Federal, State, and local government agencies.

For this survey, selected employers are required to provide statistics on the total number of injuries and illnesses recorded on the OSHA Form 200, as well as information describing the nature and causes of their lost workday injuries and illnesses. Thus, according to BLS, the data provided by employers ''* * * reflect not only the year's injury and illness experience, but also the employer's understanding of which cases are work-related under current recordkeeping guidelines of the U.S. Department of Labor.'' Information is provided in sufficient detail to permit BLS to systematically code each reported case and develop estimates of the numbers and incidence of each specific type of LWD injury and illness for the United States as a whole, by industry sector and by occupation.

Although the BLS data are the best available data on the number and kinds of job-related injuries and illnesses occurring among U.S. workers in any given year, they are not easy to use for risk assessment purposes. In other words, there is no single BLS-reported number that represents all employer-reported musculoskeletal injuries and illnesses occurring in that year. Instead, employer-reported injuries and illnesses are coded by BLS according to a classification system that categorizes each incident by type of injury or illness and by nature of the exposure event leading to the injury or illness (BLS 1992, Ex. 26–1372). The types of disorders that are addressed by the proposed standard fall into several of these BLS injury and illness categories.

To use these data, OSHA identified the kinds of cause-specific injuries and illnesses, as coded by BLS, that are believed to reflect MSDs of the kinds that will be covered by the proposed ergonomics program standard. An OSHA panel, which included an occupational physician and two professional ergonomists, examined the BLS listing of occupational injury and exposure event codes and their definitions from the manual provided to State personnel who code the data from the BLS employer survey. The table contained in Appendix VI–A to this Preliminary Risk Assessment provides the list of injury categories that were initially selected by this panel as being likely to include at least some work-related MSDs. From this initial list, the panel selected a subset of injury categories that predominately included work-related MSDs; these categories appear in Table VI–1. Of the injury categories selected, OSHA chose to base its analysis on only six injury categories that were deemed by these experts to be most relevant and most likely to represent a large proportion of lost workday MSDs. These injury categories include:

—Sprains, Strains, and Tears;
—Back Pain, Hurt Back;
—Soreness, Hurt, except back;
—Carpal tunnel syndrome;
—Hernia; and
—Musculoskeletal and connective systems diseases and disorders.

In addition, only those injuries and illnesses attributed to overexertion, repetition, or bodily reaction (which includes only the subcategory of ''bending, climbing, crawling, reaching, twisting'') are included in OSHA's analysis because injuries and illnesses caused by these risk factors represent chronic exposures that have the potential to cause musculoskeletal damage (the BLS definitions for these exposure event categories appear in Table VI–2). Thus, musculoskeletal injuries and illnesses caused by acute events, such as slips, trips, falls, or being struck by objects, are excluded from the data relied on in OSHA's risk analysis.

Table VI–1.—BLS Injury Categories Consisting Predominately of Employer-Reported Musculoskeletal Disorders

BLS CODE	NATURE OF INJURY	DESCRIPTION
021	Sprains, strains, tears	This nature group classifies cases of sprains and strains of muscles, joints tendons, and ligaments. Diseases or disorders affecting the musculoskeletal system, including tendonitis and bursitis, which generally occur over time as a result of repetitive activity should be coded in Musculoskeletal system and connective tissue diseases and disorders, major group 17. Includes avulsion, hemarthrosis, rupture, strain, sprain, or tear of joint capsule, ligament, muscle, or tendon. Excludes hernia (153), lacerations of tendons in open wounds (034), torn cartilage (011).
0972 0973	Back pain, hurt back Soreness, pain, hurt, except the back	Subcategories under nature group 097, Nonspecified injuries and disorders, which includes traumatic injuries and disorders where some description of the manifestation of the trauma is provided and generally where the part of body has been identified. Subcategory 0972 includes hurt back, backache, low back pain.
1241	Carpal tunnel syndrome	Subcategory under nature group 124, Disorders of the peripheral nervous system, which includes the nerves and ganglia located outside the brain and spinal cord.

Table VI–1.—BLS Injury Categories Consisting Predominately of Employer-Reported Musculoskeletal Disorders—Continued

BLS CODE	NATURE OF INJURY	DESCRIPTION
153	Hernia	This nature group classifies hernias of the abdominal cavity. Includes: femoral (1539), esophageal (1539), hiatal (1532), inguinal (1531), paraesophageal (1539) scrotal (1531), umbilical (1539), and ventral (1533) hernias. Excludes: herniated disc (011), herniated brain (1231), and strangulations (091).
17	Musculoskeletal system and connective tissue diseases and disorders	This major group classifies disease of the musculoskeletal system and connective tissue.
170	Musculoskeletal system and connective tissue diseases and disorders, unspecified.	
171	Arthropathies and related disorders (arthritis)	This nature group classifies joint diseases and related disorders with or without association with infections. Includes: ankylosis of the joint, arthritis, arthropathy, and polyarthritis. Excludes: disorders of the spine (172), gouty arthropathy (1919), rheumatic fever with heart involvement (131).
172	Dorsopathies	This nature group classifies conditions affecting the back and spine. Includes: spondylitis and spondylosis of the spine (1729); intevertebral disc disorders, except dislocation (1723); sciatica (1721); lumbago (1722); and other nontraumatic backaches (1729). Excludes: dislocated disc (011), curvature of the spine (1741), fractured spine (012), herniated disc (011), ruptured disc (011), traumatic sprains and strains involving the back (021), and other traumatic injuries to muscles, tendons, ligaments, or joints of the back (02), and traumatic back pain or backache (0972).
173	Rheumatism, except the back	This nature group classifies disorders marked by inflammation, degeneration, or metabolic derangement of the connective tissue structure of the body, especially the joints and related structures of muscles, bursae, tendons and fibrous tissue. Generally, these codes should be used when the condition occurred over time as a result of repetitive activity. Includes: rotator cuff syndrome (1739), rupture of synovium (1739), and trigger finger (1739). Excludes: rheumatism affecting the back is included in code (172), traumatic injuries and disorders affecting the muscles, tendons, ligaments and joints (02).
174	Osteopathies, chondropathies, acquired deformities	This group is comprised of diseases of bones, diseases of cartilage, and acquired musculoskeletal deformities. Includes: osteomyelitis, periostitis and other infections involving bone; and acquired curvature of the spine.
179	Musculoskeletal system and connective tissue diseases and disorders, n.e.c.	This nature group classifies musculoskeletal system and connective tissue diseases and disorders that are not classified elsewhere.

Source: Occupational Injury and Illness Classification Manual, Bureau of Labor Statistics, December 1992 (Ex. 26–1372).

For several reasons, risk estimates based on the BLS data are likely to understate the true risk of incurring a work-related MSD posed to employees who are exposed to workplace risk factors that are associated with the development of MSDs. First, the BLS data include only those lost workday (LWD) cases that resulted in at least one day spent away from work, and thus do not capture either non-lost workday MSD cases nor MSD cases that resulted in the employee being temporarily reassigned to another job. Second, some LWD MSDs reported to the BLS by employers are likely to have been coded in BLS injury categories excluded from OSHA's with overexertion, repetition, and bodily reaction (bending, climbing, crawling, reaching, twisting). Finally, the incidence of MSDs reported by the BLS is the reported incidence of MSDs among *all* production workers in the industries surveyed; that is, the incidence for each industry sector is calculated by BLS as the number of cases reported in 1996 divided by the total number of production employees in that industry sector in 1996. Expressing the incidence in this way has the effect of diluting the estimated incidence of disorders that are actually occurring predominately among those employees who are routinely exposed to workplace risk factors that have been associated with the development of work-related MSDs. The risk to those employees who are exposed to the workplace risk factors considered relevant by OSHA is expected to be higher than the risk reflected by the BLS estimates of MSD incidence, since most of the injuries reported to the BLS will in fact have occurred among the subset of production employees whose jobs expose them to these risk factors (that is, the incidence that would be calculated among exposed employees will reflect a much smaller denominator that reflects the number of exposed employees, resulting in a higher incidence estimate). Evidence that workers exposed to workplace risk factors are at substantially higher risk than other workers in their industry comes from the large data base of formal scientific studies of exposed worker populations and a few studies that have demonstrated a positive analysis (*e.g.*, unspecified disorders of the peripheral nerves) even though they were associated e relationship between exposure to workplace risk factors and the relative risk of developing an MSD (see the Health Effects section of this preamble). These studies show that the prevalence of MSDs among exposed employees is often 2- or 3-fold higher, and can be as much as 10 to 20 times higher, than the prevalence among workers who are not so exposed. Thus, OSHA believes that the risk to exposed employees in each industry sector is in fact several-fold higher than is reflected by the BLS estimates of injury incidence.

Table VI–2.—Description of BLS Exposure Event Categories Corresponding to Workplace Risk Factors Associated With Work-Related Musculoskeletal Disorders

BLS CODE	NATURE OF EXPOSURE EVENT	DESCRIPTION
21	Bodily reaction [a]	Codes in this major apply to injuries or illnesses resulting from a single incident of free bodily motion which imposed stress or strain upon some part of the body. Generally, codes in this major group apply to the occurrence of strains, sprains, ruptures, nerve damage or other internal injuries or illnesses resulting from the assumption of an unnatural position or from voluntary or involuntary motions induced by sudden noise, fright, or efforts to recover from slips or loss of balance (not resulting in falls). This major group includes cases involving musculoskeletal or internal injury or illness resulting from the execution of personal movements such as walking, climbing, bending, etc. when such movement in itself was the source of injury or illness. Group does not include falls.
210	Bodily reaction, unspecified.	
211	Bending, climbing, crawling, reaching, twisting.	
212	Sudden reaction when surprised, frightened, startled.	
213	Running—without other incident.	
214	Sitting.	
215	Slip, trip, loss of balance—without fall.	
216	Standing.	
217	Walking—without other incident.	
219	Bodily reaction, n.e.c.	
22	Overexertion	Overexertion applies to cases, usually non-impact, in which the injury or illness resulted from excessive physical effort directed at an outside source of injury or illness. The physical effort may involve lifting, pulling, pushing, turning, wielding, holding, carrying, or throwing the source of injury/illness. Free bodily motions that do not involve an outside source of injury or illness are classified either in major group 21, Bodily reaction, or in major group 23, Repetitive motion.
220	Overexertion, unspecified.	
221	Overexertion in lifting.	
222	Overexertion in pulling or pushing objects.	
223	Overexertion in holding, carrying, turning, or wielding objects.	
224	Overexertion in throwing objects.	
229	Overexertion, n.e.c.	
23	Repetitive motion	Repetitive motion applies when an injury or illness resulted from bodily motion which imposed stress or strain upon some part of the body due to a task's repetitive nature. Instances of carpal tunnel syndrome (CTS) from typing or any type of keyentry, including the use of calculators or nonscanning cash registers are coded 231. CTS resulting from cutting with a knife, repeated use of a power tool should be coded Repetitive use of tool (232). If an injury or illness resulted from prolonged vibration in long distance driving, the event should be coded in event group 061, Rubbed, abraded, or jarred by vehicle or mobile equipment vibration.
230	Repetitive motion, unspecified.	
231	Typing or key entry.	

Table VI–2.—Description of BLS Exposure Event Categories Corresponding to Workplace Risk Factors Associated With Work-Related Musculoskeletal Disorders—Continued

BLS CODE	NATURE OF EXPOSURE EVENT	DESCRIPTION
232	Repetitive use of tools.	
233	Repetitive placing, grasping, or moving objects, except tools.	
239	Repetitive motion, n.e.c.	

[a] The subcategory of ''Bending, climbing, crawling, reaching, twisting'' is the only subcategory from the Bodily Reaction category used by OSHA to define MSDs.

Source: Occupational Injury and Illness Classification Manual, Bureau of Labor Statistics, December 1992 (Ex. 26–1372).

C. Preliminary Results

OSHA has obtained summary data from the annual BLS surveys for the years 1992 through 1996. Table VI–3 provides the BLS estimates of the number of injuries and illnesses reported nationwide by employers for 1996, by nature of injury and type of workplace exposure, for all injury and exposure event categories deemed by OSHA as representing MSDs. Overall, OSHA estimates that there were a total of 647,344 lost workday MSDs that occurred in 1996, as derived from employer reports of those illnesses and injuries. These disorders represent about 34.4 percent of the 1.88 million LWD Table VI–3 injuries and illnesses reported by employers in 1996 (BLS press release 97–453, 12/17/97).

Table VI–3.—Estimates of the Number of Lost Workday Musculoskeletal Disorders (MSDs) in 1996, by Nature of Injury and Type of Workplace Exposure

NATURE OF INJURY	BLS CODE	TYPE OF WORKPLACE EXPOSURE					
		TOTAL FOR ALL EXPOSURES	OVER-EXERTION	REPETITION	SUBTOTAL (O AND R)	BODILY REACTION [a]	SUBTOTAL
Total for all lost work-day injuries			526,594	73,796	600,390	79,475	679,865
Musculoskeletal Disorders							
Sprains, Strains, Tears	021	819,658	424,290	12,872	437,162	66,068	503,230
Back Pain, Hurt Back	0972	52,046	28,046	861	28,907	4,646	33,553
Soreness, Hurt, except back	0973	73,542	17,984	5,811	23,795	2,896	26,691
Carpal tunnel syndrome	1241	29,937		29,809	29,809		29,809
Hernia	153	29,624	25,819	322	26,141	670	26,811
Musculoskeletal and connective system diseases and disorders	17	35,238	7,761	18,278	26,039	1,211	27,250,
Total Number of MSDs		1,040,045	503,900	67,953	571,853	75,491	647,344

[a] Data from BLS included only those injuries reported to have been associated with ''Bending, climbing, crawling, reaching, twisting.''

Source: BLS-reported estimates for BLS nature-of-injury codes 021, 0972, 0973, 1241, 153, and 17, and for BLS exposure events of overexertion, repetition, and bodily reaction (1996).

To determine whether the injury categories selected by OSHA's panel of experts (representing the disciplines of occupational medicine and ergonomics) were in fact predominately comprised of work-related musculoskeletal disorders, OSHA closely examined those injuries coded by BLS as ''sprains, strains, and tears,'' by far the largest single ''nature of injury'' category for the purposes of this study. About 66 percent of the estimated number of MSDs reported to the BLS in 1996 were categorized by BLS coders as ''sprains, strains, and tears'' due to overexertion. To evaluate the extent to which the injuries in this category represent MSDs, OSHA obtained from the BLS a breakout of the estimated number of injuries, by body part and by type of overexertion event. This breakout appears in Table VI–4 and shows that about 89 percent of these sprain, strain, and tear injuries (379,615) are comprised of injuries due to lifting/lowering, pushing/pulling, holding/carrying, or throwing, all of which are manual handling activities that can lead to work-related MSDs. For the remaining 11 percent of the BLS-coded sprain, strain, and tear injuries, the exact nature of the overexertion exposure was either not reported by the employer or did not fall into any other exposure classification under the BLS system. Of the 379,615 injuries for which the nature of the overexertion exposure was reported, the majority (88 percent) affected body parts that are consistent with the kinds of injuries addressed by the proposed standard, such as upper extremities, neck and shoulder, lower extremities, and back. Fifty-two percent of these injuries represent back injuries due to lifting or lowering. Only a small proportion (12 percent) of sprain, strain, and tear injuries reported by the BLS in 1996 affected body parts that are not relevant to MSDs; these represent 6.9 percent of all MSDs estimated for 1996. Therefore, OSHA is confident that the vast majority of BLS-coded sprain, strain, and tear injuries are appropriately included in the estimated number of MSDs for 1996, and that the judgment of the OSHA expert panel in selecting appropriate BLS injury and event categories for the risk analysis is, in fact, borne out.

Table VI–4.—Number and Percentage of All BLS-Reported Sprain, Strain, and Tear Injuries That are Work-Related Musculoskeletal Disorders (*i.e.,* Caused by Overexertion), by Body Part and Nature of Exposure, 1996

BODY PART AFFECTED	TYPE OF OVEREXERTION EXPOSURE						
	LIFTING/ LOWERING	PUSHING/ PULLING	HOLDING/ CARRYING	THROWING	UNSPEC- IFIED	NOT ELSE- WHERE CLASSI- FIED (NEC)	TOTAL EX- CLUDING NEC AND UNSPEC- IFIED
Shoulder	20,728	8,639	6,895	395	2,277	2,177	36,657
Back	174,107	33,805	35,358	888	15,625	9,811	244,158
Neck	4,844	1,984	1,812		810	720	8,640
Arm	7,012	2,717	2,451	66	751	807	12,246
Wrist	6,567	2,608	2,787		712	866	11,962
Hand	1,417	443	403		210	87	2,263
Finger, fingernails	849	496	319		133	205	1,664
Upper extremities, nec		59					59
Upper extremities, unspecified							0
Multiple upper extremities	1,085	308	342		326	142	1,735
Legs	6,074	4,195	2,426		743	969	12,695
Ankles	829	717	320		126	460	1,866
Foot	236	382	36		65	48	654
Toes		16					16
Lower extremities, unspecified							0
Lower extremities, nec	37						37
Multiple lower extremities	218	61					279
Total all Work-Related MSDs	224,003	56,430	53,149	1,349	21,778	16,292	334,931
Total for Other Body Parts	29,698	8,030	6,843	113	3,304	2,749	44,684
Total Sprains, Strains, Tears	253,701	64,460	59,992	1,462	25,082	19,041	379,615
Percent of Injuries Representing Work-Related MSDs	88	88	89	92	87	86	88

The data summarized above have been broken out by the BLS both by industry sector and by occupation code. In addition, the BLS provided OSHA with estimates of the incidence of MSDs, as defined above by injury type and cause, for each 2-digit SIC. As explained above, the BLS-calculated incidence estimates are based on the incidence among all production employees in each industry sector, and therefore understate the true incidence of work-related MSDs occurring among workers who are exposed to workplace risk factors. Nevertheless, OSHA believes that the incidence estimates are useful for characterizing industry-specific MSD risks and for comparing the extent of the problem between industry sectors covered by the ergonomics program standard as proposed. Table VI–5 provides estimates of the number and incidence of LWD MSDs in each general industry 2-digit SIC group for which BLS provided data. Industries having the highest incidence of MSDs include the following:

—Air transportation (36.6 cases/1,000 workers);
—Local and suburban transit (14.7 cases/1,000);
—Motor freight transportation and warehousing (14.4 cases/1,000);
—Health services (13.8 cases/1,000);
—Transportation equipment (13.4 cases/1,000); and

—Food and kindred products (12.2 cases/1,000).

Table VI–5.—Estimated Number of Lost Workday MSDs IN 1996 and Annual Incidence per 1,000 Workers, by 2-Digit SIC

TWO DIGIT SIC	INDUSTRY SECTOR	ESTIMATED NUMBER OF LWD MSDs	INCIDENCE PER 1,000 WORKERS
45	Transportation by air	34,150.0	36.580
41	Local and suburban transit and interurban highway passenger transportation	4,617.3	14.671
42	Motor freight transportation and warehousing	23,800.1	14.438
80	Health services	103,478.7	13.847
37	Transportation equipment	24,524.0	13.420
20	Food and kindred products	20,540.1	12.242
24	Lumber and wood products, exc. furniture	9,228.5	12.166
34	Fabricated metal, exc. machinery & transportation equipment	17,751.1	12.121
33	Primary metals	8,940.0	12.099
30	Rubber and misc. plastics	11,982.7	12.069
25	Furniture and fixtures	5,892.1	11.741
32	Stone, clay, glass, concrete products	6,316.4	11.444
53	General merchandise stores	22,395.6	11.152
52	Building materials, hardware, garden supply, mobile home dealers	8,621.9	10.699
54	Food stores	25,268.9	10.191
44	Water transportation	1,537.1	9.959
51	Wholesale trade-nondurable goods	24,768.4	9.792
31	Leather and leather products	856.4	9.226
39	Misc. manufacturing industries	3,375.8	8.997
21	Tobacco products	322.9	8.308
70	Hotels, rooming houses, camps, other lodging	11,241.0	8.216
35	Industrial and commercial machinery & computer equipment	17,124.5	7.946
23	Apparel and other finished products made from fabric	6,379.6	7.869
83	Social services	13,755.1	7.483
50	Wholesale trade—durable goods	26,782.1	7.235
57	Home Furniture, Furnishings, And Equipment Stores	6,016.1	7.136
26	Paper and allied products	4,865.2	6.921
27	Printing, publishing, and allied industries	9,195.3	6.547
36	Electronic and other electrical, exc. computer equipment	10,782.5	6.506
76	Miscellaneous Repair Services	2,274.4	6.506
49	Electric, Gas, And Sanitary Services	5,712.1	6.478
79	Amusement And Recreation Services	5,805.4	5.857
22	Texile mill products	3,483.4	5.626
59	Miscellaneous Retail	10,043.2	4.857
65	Real Estate	5,882.8	5.113
55	Automotive dealers and gasoline service stations	10,347.3	4.847
38	Measuring, analyzing, and controlling instruments; photo, medical, optical; watches, clocks	4,036.9	4.785
75	Automotive Repair, Services, And Parking	4,347.9	4.422
48	Communications	5,708.2	4.398
72	Personal Services	3,527.2	3.865
40	Railroad Transportation	932.0	3.702
73	Business services	16,706.8	3.564
28	Chemicals and allied products	3,641.2	3.507
47	Transportation Services	1,263.1	3.262
56	Apparel And Accessory Stores	2,439.1	3.132
29	Petroleum refining and related industries	432.1	2.956
58	Eating and drinking places	14,457.5	2.830
86	Membership Organizations	1,838.5	2.745
82	Educational Services	2,926.6	2.681
87	Engineering, Accounting, Research, Management, And Related Services	5,653.6	2.114
63	Insurance Carriers	2,659.1	2.968
67	Holding And Other Investment Offices	297.6	1.579
81	Legal Services	1,264.4	1.524
60	Depository Institutions	2,487.7	1.355
61	Non-depository Credit Institutions	399.3	0.810
64	Insurance Agents, Brokers, And Service	472.2	0.733
62	Security And Commodity Brokers, Dealers, Exchanges, And Services	276.7	0.533

Source: Estimates provided by BLS for disorders classified by injury types and exposure events shown in Table VII–3.

Note: Estimates include sprain, strain, and tear injuries that are not likely to represent MSDs since data on the estimated number of these injuries were not available by SIC; these injuries represent 6.9 percent of the total number of MSDs.

Table VI–6 provides estimates of the number and incidence of LWD MSDs by occupation code for the 75 occupations having the highest estimated annual incidence of employer-reported MSDs. Because BLS does not provide incidence estimates by occupation, OSHA calculated the incidence using employment estimates from Bureau of the Census Employment and Earnings (1996). Manufacturing occupations having the highest incidence include:

- Punching and stamping machine operators (30.4 cases/1,000 workers);
- Sawing machine operators (18.9 cases/1,000);
- Furnace, kiln, and oven operators, except food (18.0 cases/1,000);
- Grinding, abrading, polishing machine operators (17.9 cases/1,000); and
- Assemblers (16.2 cases/1,000).

Among manual handling occupations, those with the highest incidence of MSDs include:

- Driver—sales workers (42.4 cases/1,000 workers);
- Machine feeders and offbearers (34.6 cases/1,000);
- Nursing aides, orderlies, and attendants (31.6 cases/1,000);
- Laborers, except construction (29.1 cases/1,000);
- Health aides, except nurses (16.9 cases/1,000);
- Licensed practical nurses (16.5 cases/1,000); and
- Hand packers and packagers (13.7 cases/1,000).

Table VI–6.—Estimated Number of Lost Workday MSDs in 1996 and Annual Incidence per 1,000 Workers, by Occupation Code, Ranked by Incidence

OCCUPATION		ESTIMATED NUMBER OF LWD MSDs	MEDIAN NUMBER OF DAYS AWAY FROM WORK	NUMBER OF EMPLOYEES IN 1996 (000)	INCIDENCE PER 1,000 WORKERS
806	Driver-sales workers (8218)	6,614.0	7	156	42.4
878	Machine feeders and offbearers (8725)	2,420.3	10	70	34.6
463	Public transportation attendants (5257)	3,050.0	9	95	32.1
447	Nursing aides, orderlies, and attendants (5236)	58,421.6	5	1,850	31.6
706	Punching and stamping press machine operators (7314, 7317, 7514, 7517)	2,702.8	6	89	30.4
889	Laborers, except construction (8769)	38,873.3	6	1,334	29.1
866	Helpers, construction trades (8641–8645, 8648)	2,465.7	9	106	23.3
727	Sawing machine operators (7433, 7633)	1,470.4	5	78	18.9
766	Furnace, kiln, and oven operators, except food (7675)	1,171.1	7	65	18.0
709	Grinding, abrading, buffing, and polishing machine operators (7322, 7324, 7522)	2,241.8	7	125	17.9
446	Health aides, except nursing (5233)	5,683.3	4	336	16.9
207	Licensed practical nurses (366)	6,514.1	5	395	16.5
785	Assemblers (772, 774)	20,578.8	9	1,271	16.2
804	Truck drivers (8212–8214)	48,334.2	8	3,019	16.0
719	Molding and casting machine operators (7315, 7342, 7515, 7542)	1,757.8	7	110	16.0
364	Traffic, shipping, and receiving clerks (4753)	9,244.0	6	616	15.0
368	Weighers, measurers, checkers, and samplers (4756, 4757)	820.4	8	55	14.9
756	Mixing and blending machine operators (7664)	1,585.7	5	108	14.7
449	Maids and housemen (5242, 5249)	9,754.8	6	683	14.3
888	Hand packers and packagers (8761)	3,824.0	10	279	13.7
783	Welders and cutters (7332, 7532, 7714)	7,997.2	6	605	13.2
754	Packaging and filling machine operators (7462, 7662)	5,145.1	8	393	13.1
686	Butchers and meat cutters (6871)	3,120.0	8	242	12.9
206	Radiologic technicians (365)	1,732.4	3	135	12.8
757	Separating, filtering, and clarifying machine operators (7476, 7666, 7676)	725.7	8	57	12.7
877	Stock handlers and baggers (8724)	13,447.8	5	1,106	12.2
544	Millwrights (6178)	1,005.9	15	89	11.3
799	Graders and sorters, except agricultural (785)	1,883.8	8	169	11.1
529	Telephone installers and repairers (6158)	1,952.5	9	176	11.1
769	Slicing and cutting machine operators (7478, 7678)	1,972.6	5	179	11.0
365	Stock and inventory clerks (4754)	5,443.4	8	497	11.0
748	Laundering and dry cleaning machine operators (6855, 7658)	2,207.2	5	202	10.9
507	Bus, truck, and stationary engine mechanics (6112)	3,618.0	5	336	10.8
593	Insulation workers (6465)	567.1	12	54	10.5
683	Electrical and electronic equipment assemblers (6867)	3,368.2	7	325	10.4

Table VI–6.—Estimated Number of Lost Workday MSDs in 1996 and Annual Incidence per 1,000 Workers, by Occupation Code, Ranked by Incidence—Continued

	OCCUPATION	ESTIMATED NUMBER OF LWD MSDs	MEDIAN NUMBER OF DAYS AWAY FROM WORK	NUMBER OF EMPLOYEES IN 1996 (000)	INCIDENCE PER 1,000 WORKERS
444	Miscellaneous food preparation occupations (5219)	6,815.0	11	664	10.3
523	Electronic repairers, communications and industrial equipment (6151, 6153, 6155)	1,600.1	8	166	9.6
759	Painting and paint spraying machine operators (7669)	1,901.2	5	200	9.5
318	Transportation ticket and reservation agents (4644)	2,869.8	7	304	9.4
516	Heavy equipment mechanics (6117)	1,433.5	14	156	9.2
566	Carpet installers (part 6462)	923.9	12	103	9.0
885	Garage and service station related occupations (873)	1,510.0	9	169	8.9
577	Electrical power installers and repairers (6433)	1,102.3	9	126	8.7
668	Upholsterers (6853)	511.8	7	59	8.7
585	Plumbers, pipefitters, and steamfitters (part 645)	4,742.4	11	555	8.5
439	Kitchen workers, food preparation (5217)	2,063.2	6	257	8.0
573	Drywall installers (6424)	1,317.0	6	168	7.8
268	Sales workers, hardware and building supplies (4353)	1,814.6	6	254	7.1
689	Inspectors, testers, and graders (6881, 828)	925.2	7	131	7.1
856	Industrial truck and tractor equipment operators (8318)	3,580.6	7	512	7.0
865	Helpers, mechanics, and repairers (863)	801.2	5	115	7.0
453	Janitors and cleaners (5244)	15,278.0	6	2,205	6.9
95	Registered nurses (29)	13,595.2	4	1,986	6.8
344	Billing, posting, and calculating machine operators (4718)	710.1	10	104	6.8
588	Concrete and terrazzo finishers (6463)	543.1	10	80	6.8
653	Sheet metal workers (part 6824)	844.0	5	126	6.7
797	Production testers (783)	380.9	25	57	6.7
744	Textile sewing machine operators (7655)	3,971.1	9	595	6.7
637	Machinists (part 6813)	3,193.3	10	491	6.5
103	Physical therapists (3033)	766.4	5	118	6.5
356	Mail clerks, except postal service (4744)	1,198.4	6	188	6.4
796	Production inspectors, checkers, and examiners (782, 787)	3,404.2	6	538	6.3
518	Industrial machinery repairers (613)	3,407.5	8	540	6.3
738	Winding and twisting machine operators (7451, 7651)	351.3	9	56	6.3
508	Aircraft engine mechanics (6113)	835.4	8	137	6.1
734	Printing press operators (7443, 7643)	1,908.2	9	315	6.1
488	Graders and sorters, agricultural products (5625)	379.1	6	63	6.0
448	Supervisors, cleaning and building service workers (5241)	992.9	5	166	6.0
657	Cabinet makers and bench carpenters (6832)	460.8	9	79	5.8
274	Sales workers, other commodities (4345, 4347, 4354, 4356, 4359, 4362, 4369)	8,616.0	7	1,499	5.7
486	Groundskeepers and gardeners, except farm (5622)	4,981.4	5	875	5.7
505	Automobile mechanics (part 6111)	5,042.1	8	889	5.7
98	Respiratory therapists (3031)	543.7	6	96	5.7
634	Tool and die makers (part 6811)	733.7	17	132	5.6

Source: Estimates of number of work-related disorders provided by BLS for disorders classified by injury types and exposure events shown in Table VII–3. Annual Incidence calculated by OSHA based on 1996 employment data from Employment and Earnings (U.S. Bureau of Census, 1996).

Note: Estimates include sprain, strain, and tear injuries that are not likely to represent MSDs since data on the estimated number of these injuries were not available by occupation; these injuries represent 6.9 percent of the total number of MSDs.

Of the 225 occupations for which BLS provided estimates of the numbers of employer-reported MSDs and total employment, the annual incidence of MSDs was 1 LWD case or more per 1,000 workers per year for 178 (79 percent) of the occupations.

Data provided by the BLS for the years 1992 through 1996 indicate that the annual incidence of employer-reported MSDs has been steadily declining over this period for the majority of 2-digit SIC group industry sectors. These data appear in Figure VI–1. There are a few exceptions to this downward trend where the BLS data indicate that the incidence of employer-reported MSDs is on the rise. These industries include Tobacco (SIC 21) and Air Transportation (SIC 45).

The data described above reflect the annual incidence of MSDs estimated to have occurred in 1996 within general industry sectors and within occupations within this sector. Past risk assessments conducted by OSHA in other health standards rulemakings have typically estimated the lifetime risk to workers based on the assumption that they are exposed to the hazard in question for a full 45-year working lifetime. These past risk assessments dealt primarily with chronic, fatal diseases such as cancer. Unlike the impairments of health caused by many other OSHA-regulated hazards, however, MSDs are not fatal, although they are often debilitating. Moreover, a worker can experience more than one work-related MSD over a working lifetime. As a result, the lifetime risk associated with exposure to risk factors on the job can be expressed in a number of ways. One way of doing this is to define lifetime risk as the probability that a worker will experience at least one work-related musculoskeletal disorder during his or her working lifetime (45 years). This probability is calculated as $1-(p)^{45}$, where p is the probability that a worker will *not* experience a work-related MSD in any given year (*i.e.*, p is one minus the estimated MSD incidence for 1996 in the industry sector of interest).[2] For example, the estimated incidence of MSDs in 1996 for SIC 80, Health Services, is 13.847 lost workday cases per 1,000 workers. The probability that a worker in SIC 80 will not experience an MSD in any given year is calculated as $1-.013847$, or 0.9862 (almost 99 percent). Over 45 years, the probability that a worker will never experience a work-related MSD is $(.9862)^{45}$, or 0.534 (*i.e.*, 53 percent). Therefore, the probability that a worker in SIC 80 will experience at least one work-related MSD is 1–0.534, or 0.466 (*i.e.*, 466 per 1,000 workers).

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[2] OSHA used two simplifying assumptions when calculating the probability of experiencing no work-related MSDs in a working lifetime: (1) Employment in an industry was used as a surrogate for exposure to ergonomic hazards in that industry. (2) The probability of experiencing a work-related MSD in any given industry was treated as if it were identical for workers in that industry who had never previously experienced a work-related MSD and those who had previously experienced a work-related MSD.

Figure VI-1.
Incidence of Lost-Work-Day MSDs, by Year and 2-Digit SIC

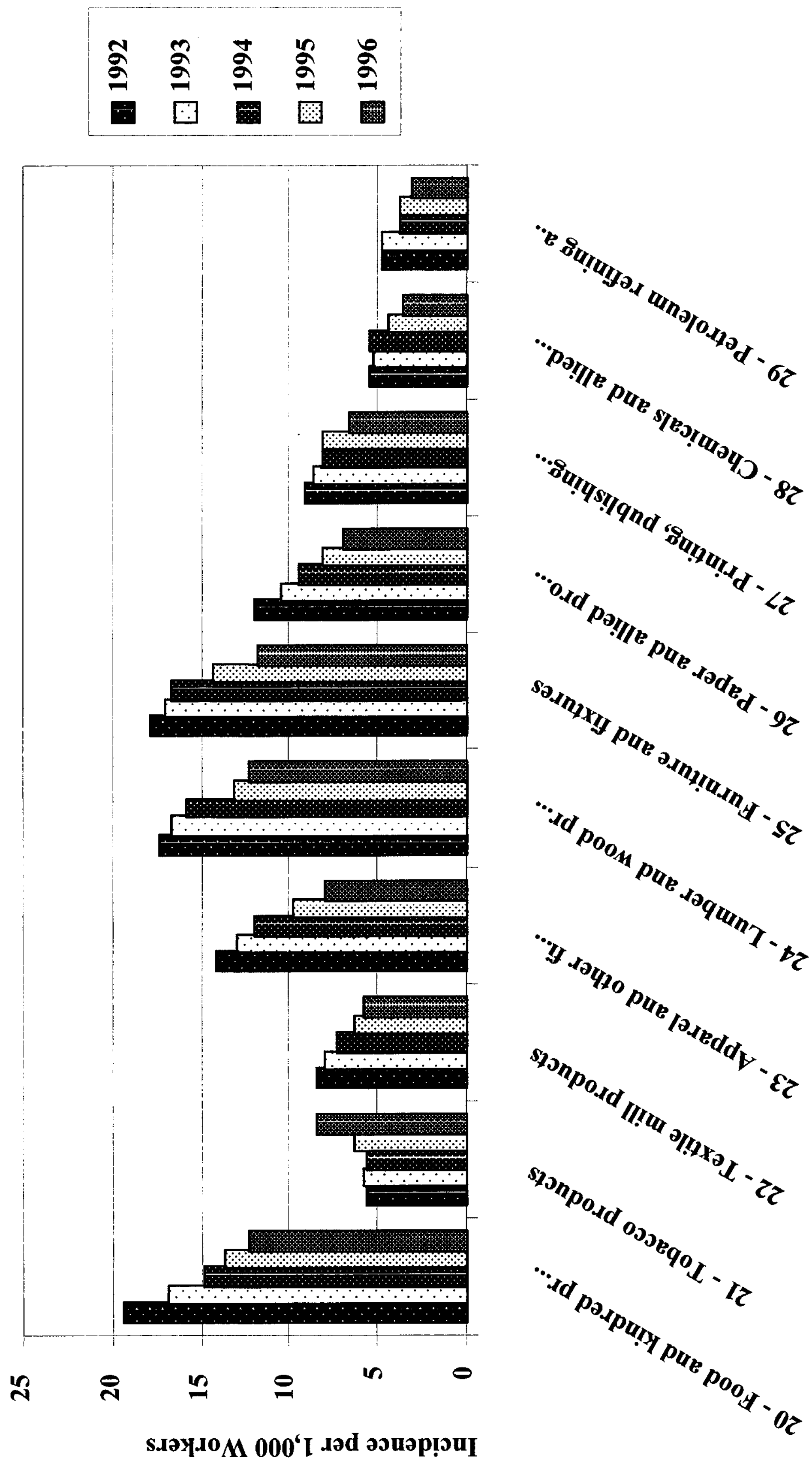


Figure VI-1.
Incidence of Lost-Work-Day MSDs, by Year and 2-Digit SIC (Continued)

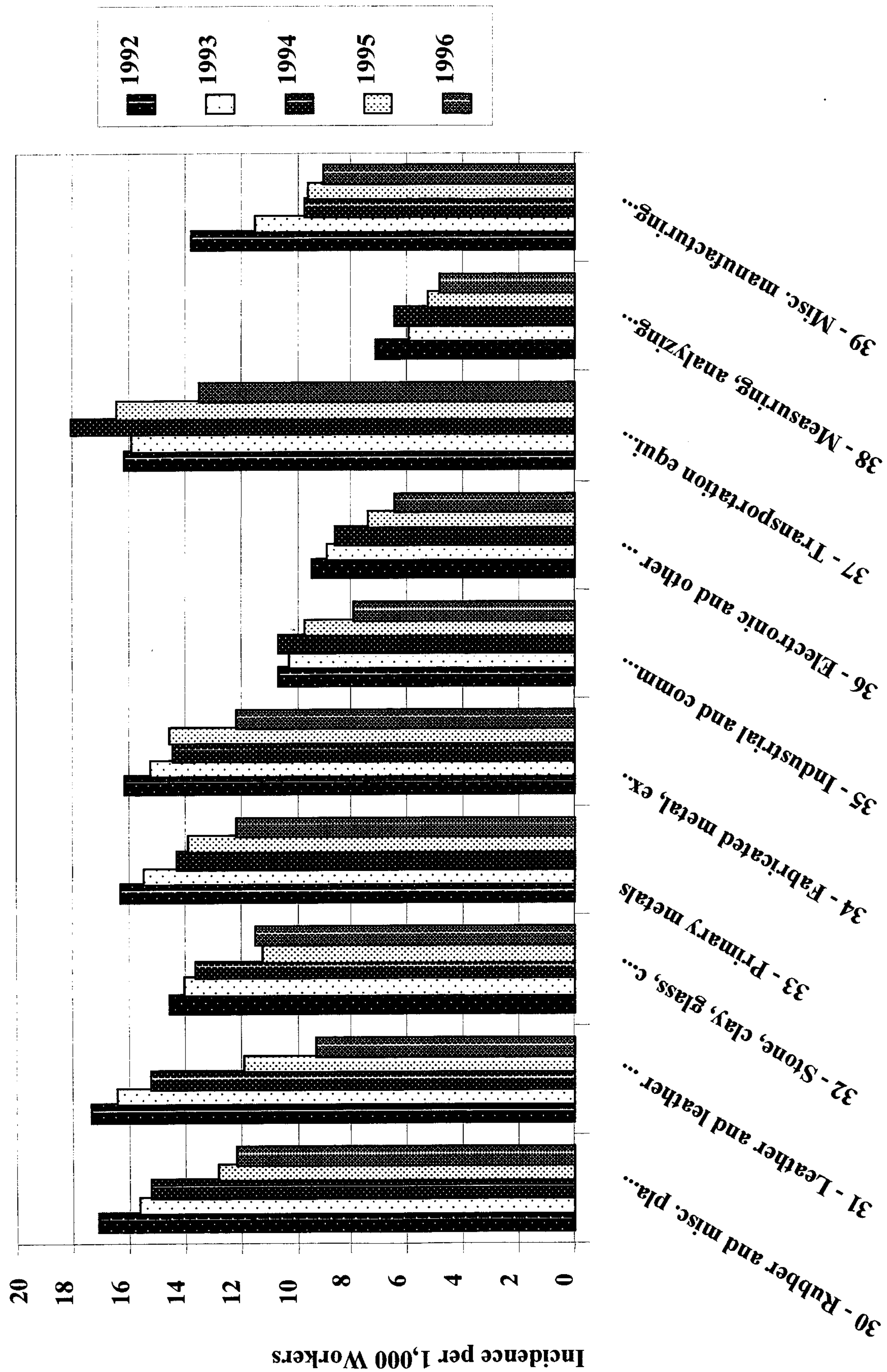


Figure VI-1.
Incidence of Lost-Work-Day MSDs, by Year and 2-Digit SIC (Continued)

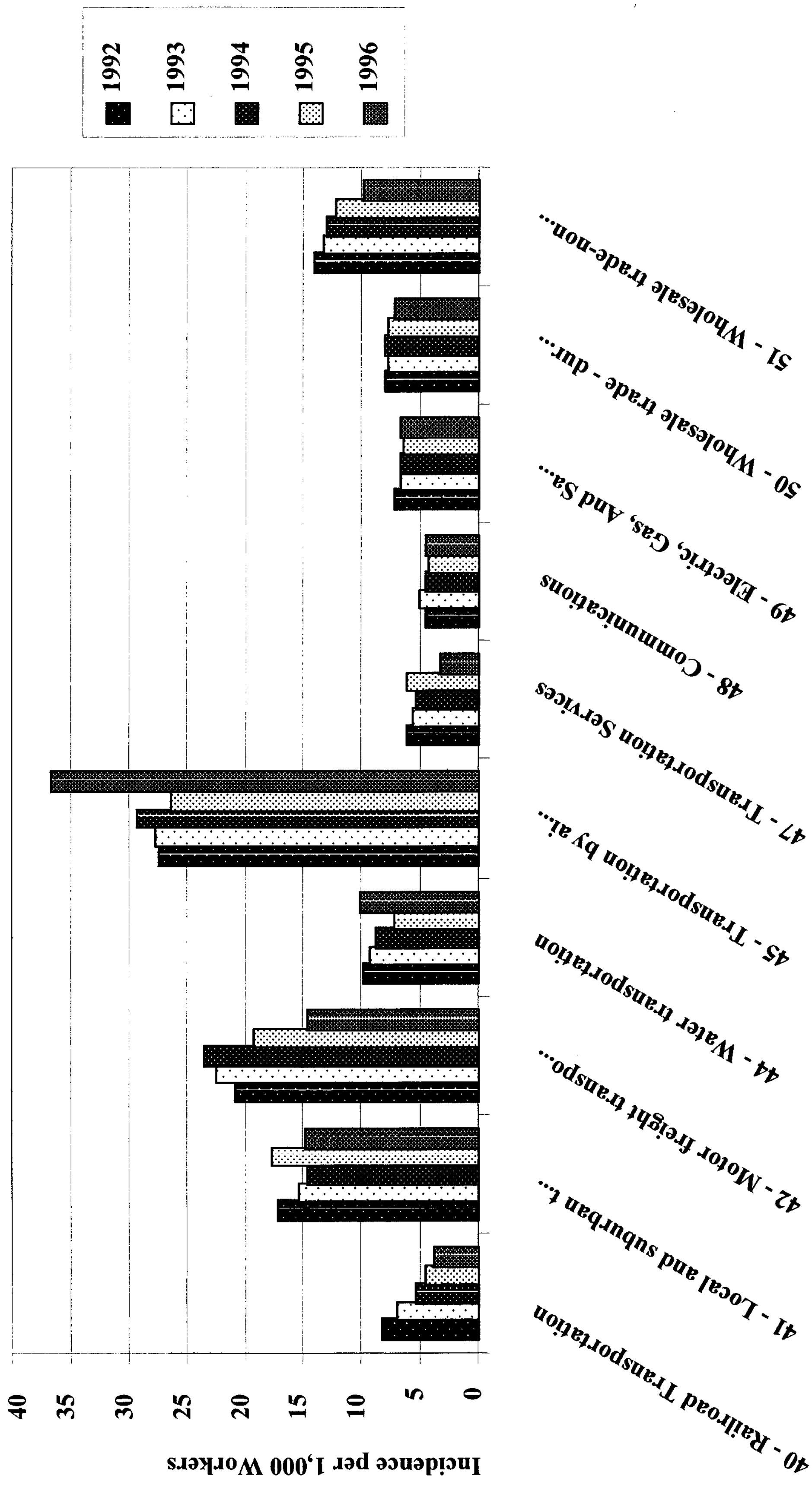


Figure VI-1.
Incidence of Lost-Work-Day MSDs, by Year and 2-Digit SIC (Continued)

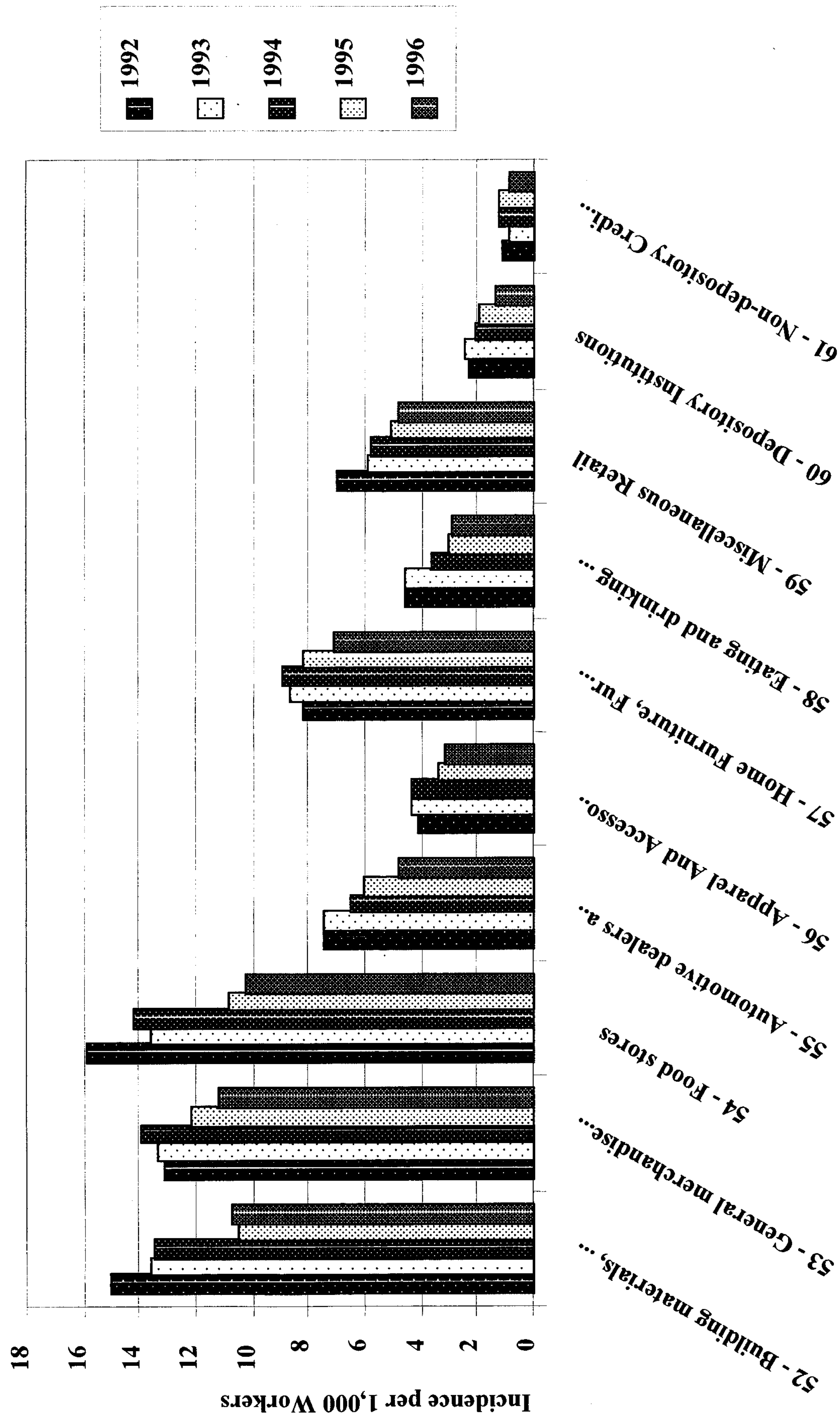


Figure VI-1.
Incidence of Lost-Work-Day MSDs, by Year and 2-Digit SIC (Continued)

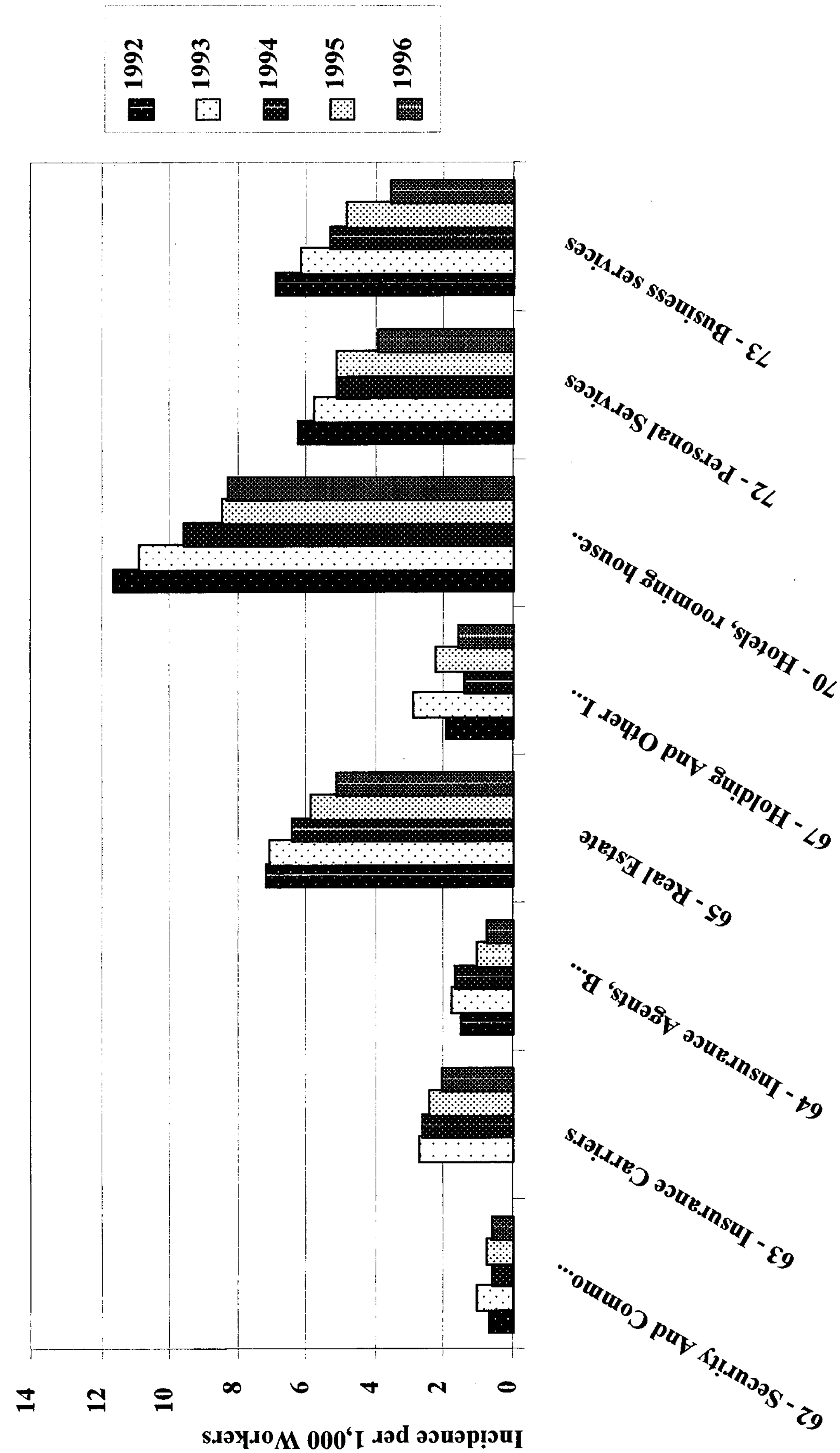
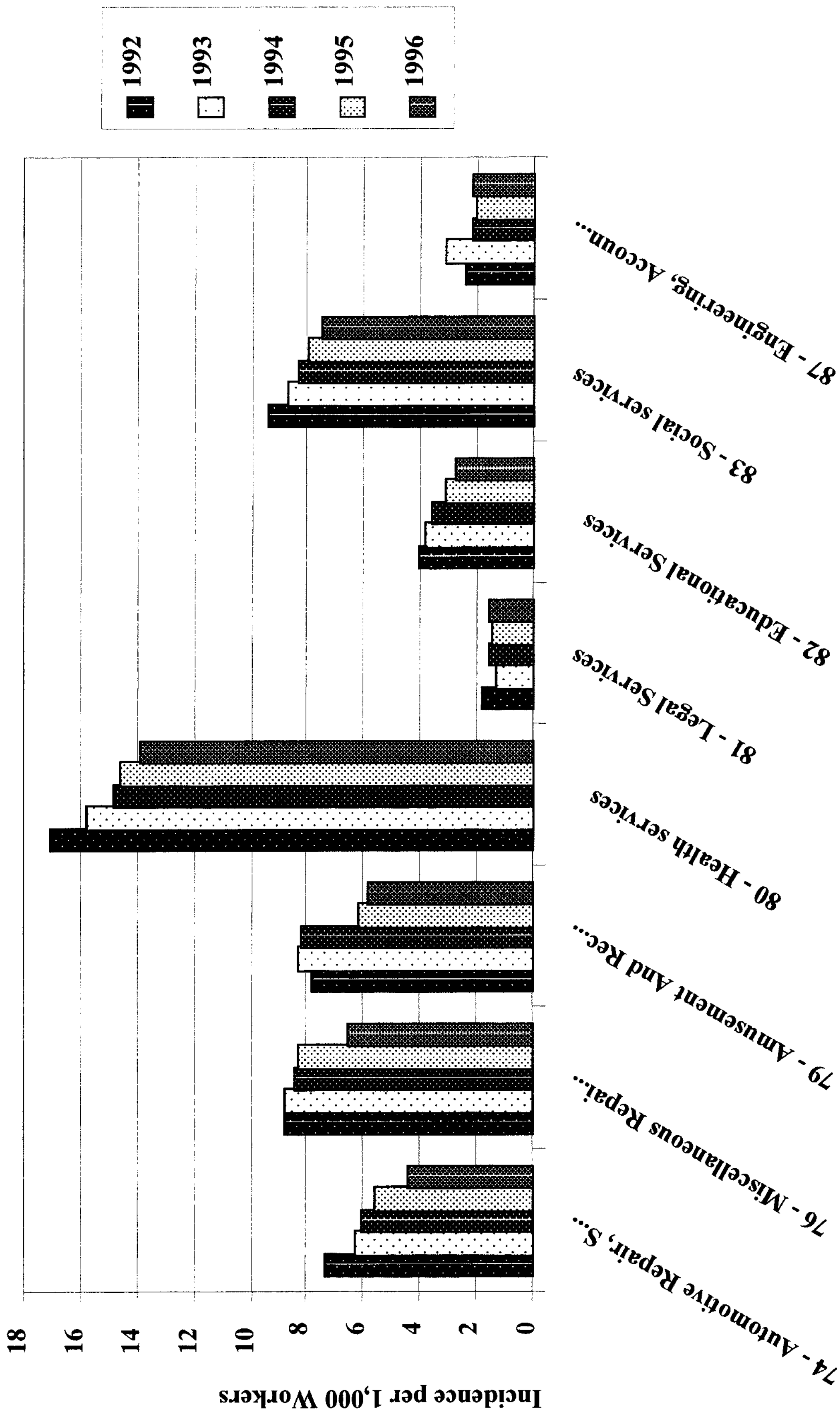


Figure VI-1.
Incidence of Lost-Work-Day MSDs, by Year and 2-Digit SIC (Continued)



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Alternatively, lifetime risk could be defined as the expected number of work-related MSDs an employee entering an industry will experience over a working lifetime in that industry. Unlike a probability, the expected value in such cases can exceed 1. (That is why, in the table below, one industry is identified in which an individual who works for 45 years can expect to experience, on average, more than one work-related MSD during that time.) The expected value represents the experience of the ''average'' individual, a measure that reflects the aggregate experience of many individuals.

Both approaches taken by OSHA to estimate lifetime risk assume that the risk to a worker is independent from one year to the next, *i.e.*, that a worker's injury experience in any one year does not modify his or her risk in any subsequent year. Although this is a reasonable assumption for the purpose of estimating an average lifetime risk, it is likely to be the case that the risk will be higher for workers who have had an MSD and continue to be exposed since musculoskeletal tissue has already been damaged. Among workers who have not experienced symptoms of an MSD, the risk to any individual worker in subsequent years depends on the amount of tissue damage sustained from exposure to risk factors and that worker's individual ability to repair or resist continued injury to the point of experiencing an MSD. In addition, OSHA's approach also assumes that each worker within a given industry sector (defined by 2-digit SIC) has the same risk. For the same reasons as discussed above, a relatively small number of workers will, in fact, experience injury rates far in excess of the average, while a comparatively large number will experience injury rates below the average. At this time, data are not available that would allow OSHA to determine the lifetime MSD risks for subpopulations of workers within each industry sector, *i.e.*, those subpopulations with higher than average or lower than average risks, respectively.

Another meaning or interpretation of expected value may be more intuitive: The expected value is the total number of MSDs that may be expected to occur in a cohort of 1000 workers all of whom enter an industry sector at the same time and all of whom work for 45 years in the industry. The expected value of the number of MSDs occurring among these 1,000 workers over 45 years of employment is calculated as the annual MSD incidence multiplied by 45. For example, the estimated incidence of work-related MSDs in 1996 for SIC 80 (Health Services) is 13.847 cases per 1,000 workers, or a frequency of 0.01387. The expected value of the number of work-related MSDs predicted to occur among those 1,000 workers over 45 years is estimated to be (0.01387*45), or 0.623 (623 per 1,000 workers).

Table VI–7 presents OSHA's estimates of the lifetime risk of experiencing work-related MSDs, by industry sector. Based on the probability approach, the estimated probability of experiencing at least one work-related MSD during a working lifetime ranges from 24 per 1,000 to 813 per 1,000, depending on the industry sector. Based on the expected value approach, the expected number of work-related MSDs that will occur in a cohort of workers all entering an industry at the same time ranges from 24 per 1,000 to 1646 per 1,000, since this approach recognizes that it is possible for a worker to experience more than one work-related MSD in a working lifetime.

D. Analysis of Ergonomic Program Effectiveness

OSHA's evaluation of the effectiveness of ergonomic programs and interventions in reducing MSD risk to employees is derived from three types of data. First, OSHA searched for and evaluated studies that investigated the effect of ergonomic interventions Table VI–7 on reducing exposures to workplace risk factors. These include both field and laboratory studies. Second, OSHA compiled a large database of published and unpublished data from case studies that describe the effect of implementing ergonomic programs on workplace MSD injury rates. Finally, OSHA uses the findings from the epidemiological studies contained in the NIOSH (1997, Ex. 26–1) review to estimate the potential effectiveness of ergonomics programs.

Table VI–7.—Estimated Risk of Developing a Work-Related MSDs Over a 45-Year Working Lifetime, by 2-Digit SIC

TWO DIGIT SIC	INDUSTRY SECTOR	ESTIMATED INCIDENCE PER 1,000 WORKERS	EXPECTED NUMBER OF MSDs PER 1,000 WORKERS DURING A WORKING LIFETIME	NUMBER OF WORKERS PER 1,000 ESTIMATED TO HAVE AT LEAST ONE MSD DURING A WORKING LIFETIME
45	Transportation by air	36.580	1,646	813
41	Local and suburban transit and interurban highway passenger transportation	14.671	660	486
42	Motor freight transportation and warehousing	14.438	650	480
80	Health services	13.847	623	466
37	Transportation equipment	13.420	604	456
20	Food and kindred products	12.242	551	426
24	Lumber and wood products, exc. furniture	12.166	547	424
34	Fabricated metal, exc. machinery & transportation equipment	12.121	545	422
33	Primary metals	12.099	544	422
30	Rubber and misc. plastics	12.069	543	421
25	Furniture and fixtures	11.741	528	412
32	Stone, clay, glass, concrete products	11.444	515	404
53	General merchandise stores	11.152	502	396
52	Building materials, hardware, garden supply, mobile home dealers	10.699	481	384
54	Food stores	10.191	459	369

Table VI–7.—Estimated Risk of Developing a Work-Related MSDs Over a 45-Year Working Lifetime, by 2-Digit SIC—Continued

TWO DIGIT SIC	INDUSTRY SECTOR	ESTIMATED INCIDENCE PER 1,000 WORKERS	EXPECTED NUMBER OF MSDs PER 1,000 WORKERS DURING A WORKING LIFETIME	NUMBER OF WORKERS PER 1,000 ESTIMATED TO HAVE AT LEAST ONE MSD DURING A WORKING LIFETIME
44	Water transportation	9.959	448	363
51	Wholesale trade—nondurable goods	9.792	441	358
31	Leather and leather products	9.226	415	341
39	Misc. manufacturing industries	8.997	405	334
21	Tobacco products	8.308	374	313
70	Hotels, rooming houses, camps, other lodging	8.216	370	310
35	Industrial and commercial machinery & computer equipment	7.946	358	302
23	Apparel and other finished products made from fabric	7.869	354	299
83	Social services	7.483	337	287
50	Wholesale trade—durable goods	7.235	326	279
57	Home Furniture, Furnishings, and Equipment Stores	7.136	321	275
26	Paper and allied products	6.921	311	268
27	Printing, publishing, and allied industries	6.547	295	256
36	Electronic and other electrical, exc. computer equipment	6.506	293	255
76	Miscellaneous Repair Services	6.506	293	255
49	Electric, Gas, and Sanitary Services	6.478	292	254
79	Amusement and Recreation Services	5.857	264	232
22	Textile mill products	5.626	253	224
59	Miscellaneous Retail	4.857	219	197
65	Real Estate	5.113	230	206
55	Automotive dealers and gasoline service stations	4.847	218	196
38	Measuring, analyzing, and controlling instruments; photo, medical, optical; watches, clocks	4.785	215	194
75	Automotive Repair, Services, and Parking	4.422	199	181
48	Communications	4.398	198	180
72	Personal Services	3.865	174	160
40	Railroad Transportation	3.702	167	154
73	Business services	3.564	160	148
28	Chemicals and allied products	3.507	158	146
47	Transportation Services	3.262	147	137
56	Apparel And Accessory Stores	3.132	141	132
29	Petroleum refining and related industries	2.956	133	125
58	Eating and drinking places	2.830	127	120
86	Membership Organizations	2.745	124	116
82	Educational Services	2.681	121	114
87	Engineering, Accounting, Research, Management, And Related Services	2.114	95	91
63	Insurance Carriers	2.068	93	89
67	Holding and Other Investment Offices	1.579	71	69
81	Legal Services	1.524	69	66
60	Depository Institutions	1.355	61	59
61	Non-depository Credit Institutions	0.810	36	36
64	Insurance Agents, Brokers, and Service	0.733	33	32
62	Security And Commodity Brokers, Dealers, Exchanges, And Services	0.533	24	24

ASource: Estimated Incidence of MSDs provided by BLS for disorders classified by injury and exposure events shown in Table VII–3. Lifetime risk estimates calculated by OSHA using methods described in the text.

Many studies were identified that provided quantitative evidence that ergonomic interventions reduce exposures to workplace risk factors. Some of these are summarized in Table VI–8 and include information on the type of study (field vs. laboratory), the nature of the job and exposure being addressed, the kind of intervention(s) examined, and the effect of those interventions on worker exposures to risk factors that could lead, if uncontrolled, to the development of work-related MSDs. These studies show that ergonomic interventions are effective in reducing exposures to workplace risk factors in a wide variety of workplace settings. Interventions represented by these studies include redesigning machines and tools, altering workstation layout or configuration, using lifting devices, and modifying materials to aid in manual handling. These interventions were found to reduce the duration and/or intensity of worker exposures to the risk factors related to MSDs, sometimes by as much as 50 percent. After reviewing some of these same studies, a National Academy of Sciences Panel (NRC 1998, Ex. 26–37) concluded that ''[r]esearch clearly demonstrates that specific interventions can reduce the reported rate of musculoskeletal disorders for workers who perform high-risk tasks. No known single intervention is universally effective. Successful interventions require attention to individual, organizational, and job characteristics, tailoring the corrective action to those characteristics.''

Table VI–8.—Summary of Studies Reporting the Effectiveness of Workplace Interventions on Exposures to Risk Factors Associated With the Development of Work-Related Musculoskeletal Disorders

STUDY	INDUSTRY SECTOR	OPERATION	NATURE OF INTERVENTION	RESULTS
Steele *et al.* (1990, Ex. 26–1254)	Firearms manufacturing	Use of a mechanical test fixture to gauge parts. Work involved intensive hand and wrist motions	Modification of test fixture by using add-on features (*i.e.,* fixture itself was not modified)—change position and angle of parts rack, anchor gauge to bench, use adjustable chair and footrest, install power-grip handle	Reduced the number of damaging wrist motions by 3 to 6 fold. Reduced the number of pinch grips required per cycle. Total cycle time reduced from 5.5 to 3.75 seconds.
Hakkanen *et al.* (1997, Ex. 26–898)	Trailer assembly	Furniture assembly and fixture (female workforce). Work involved driving screws, drilling holes, and lifting	Interventions suggested by ergonomics team and workers. Changes included using modified hand tools, height-adjustable tables, work space redesign, use of hoists, and work enlargement. Workers returning from sick leave were temporarily placed on easier jobs	Driving screws and drilling After intervention, workers selected proper tool for job more frequently (*i.e.,* pistol grip tool for vertical surfaces and an inline tool for horizontal surfaces). Cumulative exposures with deviated wrists (measured in Ns) were reduced for furniture fixers and assemblers. Cumulative exposures were more evenly distributed among workers after intervention due to job enlargement. Low back loading (measured as dose in Nm*s per work cycle) reduced for 3 tasks (reduction ranged from 19–54%), eliminated for 1 task.
Knowlton and Gilbert (1983, Ex. 26–1248)	(Laboratory study)	Driving nails manually	Use of a curve-handled ripping hammer vs. a conventional claw hammer	Use of the curve-handled ripping hammer resulted in a 42-percent lower strength decrement. Ulnar deviation was 2 to 6 times greater when using the conventional hammer.

Table VI–8.—Summary of Studies Reporting the Effectiveness of Workplace Interventions on Exposures to Risk Factors Associated With the Development of Work-Related Musculoskeletal Disorders—Continued

STUDY	INDUSTRY SECTOR	OPERATION	NATURE OF INTERVENTION	RESULTS
Keyserling *et al.* (1993, Ex. 26–1247)	Automotive	Various jobs resulting in prolonged exposure to awkward postures	Administration of checklist by plant personnel after one week of training. Interventions included installing elevated racks and lift tables, and eliminating or reducing horizontal obstructions and overhead reaches	Trunk posture—Decrease in percent of cycle time spent with severe flexion while standing; increase in percent of cycle spent in neutral sitting position. Shoulder posture—Decrease in percent of cycle spent with mild or severe shoulder elevation; increase in percent of cycle time spent in neutral posture. Neck posture—Increase in percent of time spent with mild or severe neck flexion; decrease in time spent with neutral neck posture.
Drury and Wick (1984, Ex. 26–1244) and Wick (1987, Ex. 26–1058)	Shoe manufacturing	Various assembly jobs, clerical, and leather sorting (manual handling)	Install armrests and footrests, elevate and tilt equipment, use better-designed chairs, use pallet leveler to minimize bending while lifting	Reduced number of damaging wrist motions in assembly jobs by at least one-third, and frequently by more than half. Reduced disc compressive forces in clerical jobs by about 17 percent. Reduced disc compressive forces during lifting jobs by more than 50 percent.
Garg and Owen (Undated, Ex. 26–1093)	Health care	Patient transfer	Use of walking belts and mechanical hoists, modifying toilets and shower rooms, modifying patient care techniques	Reduced mean disc compressive forces by 59 percent, reduced mean hand forces by 61 percent, and reduced strength requirements for lifting tasks.
Miller *et al.* (1971, Ex. 26–1250)	Health care	Surgery	Redesign of bayonet forceps	Reduced mean time from grasp to stable hold, reduced workload on thumb and finger flexors (as measured by electromyography).
Hansen *et al.* (1998, Ex. 26–1245)	(Laboratory study)	Prolonged standing or standing/walking	Use of soft shoes and/or mats on hard floors	Standing work for a 2-hour period caused muscle fatigue (measured by electromyography), lower back discomfort, and foot edema. Foot edema was significantly reduced by the use of soft shoes on hard floors. Use of a soft mat had negligible effects. Heel impact forces while walking were reduced by almost half by the use of soft shoes compared to hard shoes. Again, the use of soft mats had little additional effect.

Table VI–8.—Summary of Studies Reporting the Effectiveness of Workplace Interventions on Exposures to Risk Factors Associated With the Development of Work-Related Musculoskeletal Disorders—Continued

STUDY	INDUSTRY SECTOR	OPERATION	NATURE OF INTERVENTION	RESULTS
Johansson *et al.* (1998, Ex. 26–1246)	Retail food stores (laboratory study)	Checkout cashier	Location of scales to the left of the cashier and conveyor vs. in front of the cashier and under the conveyor. Also evaluated standing vs. sitting	There was no effect of the two configurations on work rate. Placing the scales under the conveyor resulted in less external rotation of the left arm, a decrease in the time spent handling articles, an increase in opportunities for resting the left arm, and a reduction in head twisting. A standing position was found to be a more favorable posture for the taller cashier.
Davis *et al.* (1998, Ex. 26–1243)	Various	Palletize/depalletize (manual handling)	Use of handles on items being manually lifted	Use of handles reduced anterior-posterior shear and compressive forces on the spine and reduced muscle activity for several groups of back muscles.
Peng (1994, Ex. 26–1251)	Heavy vehicle manufacture (laboratory study)	Use of pneumatic percussive rivet hammers and bucking bars	Design modifications of rivet hammers and bucking bars to impart recoilless and vibration dampening properties	Mean vibration levels of recoilless rivet hammers and bucking bars were about half that of conventional tools.
Radwin and Oh (1991, Ex. 26–1253)	Various (laboratory study)	Use of pneumatic hand-held power tools	Varying handle span between 4 and 7 cm. Use of extended trigger (permitting two-finger operation)	Use of a handle span between 5 and 6 cm minimized palm and finger exertion levels. A small but statistically significant reduction in palm and finger forces resulted from use of the extended trigger.
Powers *et al.* (1992, Ex. 26–1252)	Various (office work)	Keyboarding	Use of full-motion forearm supports or negative-slope keyboard support	Wrist extension was significantly less for subjects using the negative-slope keyboard support compared to a traditional keyboard ($-1.2°$ vs. $13.0°$). Use of forearm supports did not affect wrist extension compared to use of a traditional keyboard.

Table VI–8.—Summary of Studies Reporting the Effectiveness of Workplace Interventions on Exposures to Risk Factors Associated With the Development of Work-Related Musculoskeletal Disorders—Continued

STUDY	INDUSTRY SECTOR	OPERATION	NATURE OF INTERVENTION	RESULTS
Luttman and Jäger (1992, Ex. 26–1249)	Weaving mill	Handling and mounting 10-kg bobbins onto the beamer. Transferring bobbins from transfer boxes to push carts prior to mounting	Passageways between arrays in the beamer were widened to accommodate the transfer boxes and eliminate the need to first unload bobbins onto the push cart. Bobbins could then be mounted directly from the transport boxes Bobbins were packed horizontally in boxes rather than vertically to permit them to be unloaded with both hands Used transport boxes with detachable sides along with a hydraulic lift truck to eliminate the need to bend over while unpacking bobbins	Prior to interventions, electromyography showed significantly increased electrical activity reflecting muscle fatigue for the finger flexors of both hands. Intervention eliminated muscle fatigue in both hands. The intervention did not affect work rate.

Furthermore, a large body of literature provides strong evidence that implementation of ergonomic programs and interventions can substantially reduce the prevalence or incidence of work-related MSDs. Appendix VI–B of this section summarizes the published literature and other information that OSHA has identified that include measures of the effectiveness of ergonomics programs in reducing the incidence and severity of MSDs. Generally, the studies that are listed involve case studies of individual companies that instituted programs including some or all of the elements in OSHA's proposed ergonomics program studies were conducted in manufacturing establishments as well as in workplaces where jobs routinely involve manual handling. Overall, OSHA identified 92 case studies that quantified the reduction in MSD incidence following implementation of ergonomic programs and interventions; of these, 21 provided data on the reduction in lost-work-day MSDs and 80 provided data on the reduction in total MSDs, which include both lost-work-day and non-lost-work-day cases. From each of these case studies, OSHA calculated the effectiveness of the standard (*e.g.*, employee involvement and training, implementation of engineering or work practice controls). These case ergonomic interventions as the percent reduction in either lost workday or total number of MSDs prior to and after implementation of the program. That is, effectiveness was calculated as the ratio

$$(N_B - N_A)/N_B$$

where N_B represents the number or incidence of MSD cases prior to implementation of the ergonomic intervention, and N_A represents the number or incidence after the intervention.[3]

OSHA's estimate of the overall effectiveness of ergonomics programs is expressed as the median and mean reduction in MSD injury rates contained in this data set. For all MSDs (*i.e.*, lost workday and non-lost workday MSDs), these case studies reported a median 76 percent reduction in injury rates (mean effectiveness was 73 percent). The median and mean reductions for lost workday MSDs only were somewhat higher, at 82 percent and 79 percent, respectively. Although the effectiveness of individual ergonomics programs varied widely among the establishments described in these case studies, most interventions (about 90 percent of the case studies) achieved at least a 30-percent reduction in MSD injury rates, 70 percent of the case studies reduced MSD rates by half or more, and several achieved the total elimination of lost workday MSDs (see Appendix VI–B).

The effectiveness of ergonomics programs in reducing MSD injury rates is also demonstrated by a group of case studies reported by ergonomists from several countries (including the United States). These studies were compiled

[3] Note that, by this definition, the presence of background MSD cases (non-work-related cases) will decrease the apparent effectiveness of ergonomic interventions since the interventions would presumably not have any effect on the background rate of MSDs in the working population (*i.e.*, both N_B and N_A might contain background MSD cases).

into a volume entitled ''Increasing Productivity and Profit through Health and Safety'' (Commerce Clearing House International, Inc., Book #4703, Chicago, IL) and edited by Oxenburgh (1994, Ex. 26–1041). From these case studies, Oxenburgh concluded that engineering controls can, in general, reduce work-related musculoskeletal disorders by 70 to 90 percent (Oxenburgh 1994, Ex. 26–1041). The large number of case studies summarized by this author in his book support this effectiveness rate.

The companies reflected in the case studies may have policies protecting the reporting of or paying for all lost-time caused by job-related injuries. Companies do not consider their benefits policies noteworthy and do not discuss them in any detail when reporting on successful ergonomics interventions. There is no information on their benefits policies in these materials.

OSHA also reviewed the epidemiological literature to identify evidence of the effectiveness of ergonomic approaches. Although many articles recommend the use of engineering and administrative controls to control workplace risk factors, few articles present quantitative evidence of their effectiveness. However, several articles provide assessments of the extent to which particular types of jobs or particular types of risk factors contribute to work-related musculoskeletal disorders. Because the proposed standard will reduce or eliminate risk factors in problem jobs, these articles are relevant to an assessment of the potential effectiveness of the standard. In a recent meta-analysis, Hagberg and Wegman (1987, Ex. 26–32) reviewed the epidemiological literature and selected 21 studies in which diagnoses of neck and shoulder disorders were made from physical or laboratory examinations. Odds ratio measures from studies describing similar disorders were pooled across studies for common occupations that involved exposures to workplace risk factors, and the authors computed the overall odds ratio for each type of occupation and disorder. In addition, the authors assessed the effect of the exposure to workplace risk factors on MSD risk by computing the etiological fraction in the exposed population; this statistic describes the proportion of MSD cases among the exposed workers that is, in fact, attributable to their exposures (and thus is the fraction of MSDs that is potentially avoidable by reducing or eliminating the exposure to workplace risk factors). The etiologic fraction was computed only from those odds ratios that were statistically significantly higher than 1. Hagberg and Wegman (1987, Ex. 26–32) found the etiological fraction to range from 40 to 99 percent, depending on the specific type of upper extremity disorder. Thus, this study provides evidence that most work-related MSDs could be eliminated by implementing ergonomic interventions that serve to reduce worker exposures to risk factors.

Several other epidemiological studies described in the Health Effects section of this preamble (Liles *et al.*, 1994, Ex. 26–33; Snook *et al.*, 1978, Ex. 26–35; Silverstein *et al.*, 1987, Ex. 26–34; Holmstrom *et al.*, 1992, Ex. 26–36; Punnett *et al.*, 1991, Ex. 26–39; Punnett, 1998, Ex. 26–38) demonstrated that the magnitude of the risk of work-related MSDs is related to the intensity of exposure to workplace risk factors (*e.g.*, amount of force applied, number of repetitive motions per unit of time) and to the duration of exposure.

OSHA believes that these studies also demonstrate that reductions in intensity and/or duration of exposure to workplace risk factors will reduce the risk of work-related MSDs among employees who are so exposed. For example, Liles *et al.* (1994, Ex. 26–33) examined the relationship between a numerical measure of work-related exposure to back stress (called the Job Severity Index) and the number of OSHA-recordable back injuries reported to have occurred among workers in jobs that were rated on this numerical scale. The data from this study show that reducing the stress scores of manual handling jobs rated above 1.5 (the job severity threshold identified in this study for back injuries caused by manual handling) to an average score below 1.5 would reduce the number of back injuries by 79 percent. Another well-known quantitative study conducted by Snook, Campanelli, and Hart (1978, Ex. 26–35) found a statistically significantly higher number of back injuries than would be expected in manual handling jobs that required a level of exertion beyond the physical capabilities of more than 25 percent of the working population. Their findings suggest that back injuries could be reduced by 66.6 percent in jobs where the level of physical exertion associated with the job could be reduced sufficiently by ergonomic controls to enable 75 percent or more of the working population to perform it without overexertion.

In another example, the National Institute for Occupational Safety and Health (NIOSH) analyzed a survey of 27,804 currently employed workers and developed estimates of the relationship between the number of workers reporting one week or more of severe back pain during the previous year and the number of hours these employees were exposed to strenuous physical activity (lifting, pushing or pulling heavy objects) (Wild, 1995, Exs. 26–1104, 26–1105, 26–1106, 26–1107). The workers surveyed were between 18 and 64 years of age. Using these data, NIOSH found statistically significant positive exposure-response relationships between prevalence of back pain and number of hours per week spent performing strenuous physical activity or repeated bending, twisting, and reaching. Thus, these data show that decreasing the duration of exposure to physical exertion can decrease the risk of back pain (for a complete presentation of these results, see the Health Effects section of this preamble). For example, workers exposed to strenuous activity for fewer than 2 hours per day have a prevalence of back pain that is 65 percent less than the prevalence among workers exposed to these stresses for more than 2 hours per day.

For jobs that involve exposure to multiple risk factors, other epidemiological studies provide evidence that the risk of work-related MSDs can be reduced either by reducing or eliminating exposure to one of those risk factors, or by reducing duration of exposure to the risk factors. Silverstein *et al.* (1987, Ex. 26–34) and Armstrong *et al.* (1987, Ex. 26–48) examined the prevalence of carpal tunnel syndrome and tendinitis, respectively, among populations exposed to various combinations of risk factors, including those involving low-force-and-low-repetition, high-force-and-low-repetition, low-force-and-high-repetition, and high-force-and-high-repetition. The high-force-and-high-repetition population in this study is exposed to two or more risk factors (*i.e.*, repetition and force). Silverstein *et al.* (1987, Ex. 26–34) found that the prevalence of carpal tunnel syndrome was statistically significantly elevated among workers exposed to high repetition alone or to both risk factors together; the prevalence of carpal tunnel syndrome was elevated, but not statistically significant, among workers exposed to high force alone. Odds ratios for hand/wrist tendinitis were elevated for all three groups of exposed workers, but was statistically significant only among workers exposed to both high force and high repetition (Armstrong *et al.* 1987, Ex. 26–48). Based on these data, implementing ergonomic interventions that reduce employee exposures from two risk factors to one could be expected to lead to a reduction in injuries of 83 percent for carpal tunnel syndrome and a between 79 and 89 percent for tendinitis. Punnett *et al.* (1998, Ex. 26–38) conducted a cross-sectional study in an automobile stamping plant and in an engine plant, and assessed exposures to workplace risk factors by using an exposure scoring procedure that reflected the intensity and duration of exposure to any of several risk factors and found a positive, statistically significant relationship between risk factor exposure score and prevalence of upper-extremity disorders. Data from her study indicate that the prevalence of employee-reported symptoms of upper extremity disorders, and the prevalence of physician-confirmed MSD cases, could be reduced by more than 50 percent if the exposure score was reduced by at least half, which could be accomplished by eliminating exposures to some risk factors or by reducing exposure durations. These data also show that about one-fourth to one-third of MSD cases could be eliminated from more modest reductions in the exposure score. Thus, the Silverstein *et al.* (1987, Ex. 26–34), Armstrong *et al.* (1987, Ex. 26–48), and Punnett *et al.* (1998, Ex. 26–38) studies show that exposures to workplace risk factors do not need to be entirely eliminated to achieve substantial reductions in MSD injury rates.

Finally, OSHA turned to the large body of scientific epidemiology studies reviewed by NIOSH (1997, Ex. 26–1), which compiled the measured excess MSD risk reported in these studies, to make an overall estimate of the effectiveness of ergonomic programs and interventions from data sources independent of the case studies described earlier in this section. The risk measures contained in the epidemiological studies include odds ratios, prevalence rate ratios, and (for a few studies) incidence ratios, and approximate the relative risk of musculoskeletal disorders in an exposed worker population compared to a referent group. These studies reported a total of 83 risk ratios for neck and/or shoulder disorders, 91 risk ratios for upper extremity disorders, and 56 risk ratios for musculoskeletal disorders of the lower back. (The NIOSH study did not review studies of lower extremity disorders.) To determine the extent to which risk could be reduced, as predicted by the risk ratios reported in these studies, OSHA calculated the median and mean values of the risk ratios from each of the studies included in the NIOSH report, by body part affected. From these values, OSHA estimated the mean and median etiological fraction for each type of disorder; this measure describes the proportion of MSD injuries among exposed workers that is attributable to their exposure and thus potentially avoidable by reducing those exposures. OSHA then estimated the effectiveness of ergonomics programs (defined the same as for the case studies described above, which recognizes that some MSDs represent background and are not work-related), assuming either that half of the work-related MSD injuries would be avoided or that all of the work-related risk would be eliminated. OSHA does not believe that the latter assumption is unreasonable since, as discussed above, epidemiological evidence indicates that it is not necessary to eliminate all exposures to workplace risk factors to achieve substantial reductions in MSD incidence. The results of OSHA's analysis appear in Table VI–9. Under the assumption that the risk attributed to exposure at work is reduced by half, the median estimated effectiveness of ergonomic programs and interventions ranges from about 28 to 43 percent (the mean effectiveness estimate ranges from about 38 to 47 percent). If all of the work-related risk were to be eliminated, the median effectiveness estimate would range from 56 to 86 percent, with a mean estimate of from 75 to 95 percent.[4] The estimates of effectiveness based on the latter assumption are similar to the estimates drawn from the intervention case studies described above, which OSHA believes corroborates the general finding from the case studies that ergonomic interventions will result in substantial declines in MSD case rates.

Table VI–9.—Estimated Effectiveness of Ergonomic Interventions Based on Risk Ratios Contained in the NIOSH (1997) Review of the Epidemiological Literature for MSDs

	BODY PART AFFECTED/DISORDER							RANGE IN MEDIAN OR MEAN EFFECTIVENESS (PERCENT) [a]
	NECK OR NECK/SHOULDER	ONLY SHOULDER	ELBOW	CARPAL TUNNEL SYNDROME	HAND/WRIST TENDINITIS	HAND/ARM VIBRATION	BACK	
Number of Studies Included	57	26	19	38	21	13	56	
Risk Ratios [b]								
Median	3.30	3.30	2.70	2.75	3.70	7.10	2.25	
Average	17.78	4.76	5.03	4.15	6.96	18.71	4.01	
Estimated Etiologic Factor [c]								
Median	0.697	0.697	0.630	0.636	0.730	0.859	0.556	
Average	0.944	0.790	0.801	0.759	0.856	0.947	0.751	

[4] Note that even if all of the work-related risk is eliminated, the effectiveness of the ergonomic interventions is still less than 100 percent because of the presence of background illnesses.

Table VI–9.—Estimated Effectiveness of Ergonomic Interventions Based on Risk Ratios Contained in the NIOSH (1997) Review of the Epidemiological Literature for MSDs—Continued

	BODY PART AFFECTED/DISORDER							RANGE IN MEDIAN OR MEAN EFFECTIVENESS (PERCENT) [a]
	NECK OR NECK/ SHOULDER	ONLY SHOULDER	ELBOW	CARPAL TUNNEL SYNDROME	HAND/ WRIST TENDINITIS	HAND/ ARM VIBRATION	BACK	
Estimated Percent Effectiveness Assuming Exposure-Related Risk Is Reduced by Half [d]								
Median	34.9	34.9	31.5	31.8	36.5	43.0	27.8	27.8–43.0
Average	47.2	39.5	40.5	37.9	42.8	47.4	37.6	37.6–47.4
Estimated Percent Effectiveness Assuming Exposure-Related Risk Is Eliminated [e]								
Median	69.7	69.7	63.0	63.6	73.0	85.9	55.6	55.6–85.9
Average	94.4	79.0	80.1	75.9	85.6	94.7	75.1	75.1–94.7

[a] Effectiveness is the estimated percent reduction in MSD incidence after implementation of ergonomic interventions.

[b] Risk ratios include odds ratios, prevalence rate ratios, and incidence ratios.

[c] Etiologic factor is the proportion of disorders among exposed workers that is attributable to their exposure at work, and is calculated as (RR–1)/RR, where RR is the median or average risk ratio derived from each group of epidemiological studies.

[d] Calculated as half of the etiologic factor, expressed as a percentage. Alternatively, using the formula to calculate effectiveness, $(N_B - N_A)/N_B$, where N_B is the fraction of cases existing before ergonomic intervention=1, and N_A is the fraction of cases remaining after intervention=[1 − (0.5*etiologic fraction)].

[e] Equals the etiologic factor expressed as a percentage. Alternatively, using the formula to calculate effectiveness, $(N_B - N_A)/N_B$, where N_B is the fraction of cases existing before ergonomic intervention=1, and N_A is the fraction of cases remaining after intervention=[1 − etiologic fraction)].

Source: Derived from NIOSH (1997).

Based on this review of an extensive body of case studies, epidemiological studies, and other articles from the trade and scientific literature, OSHA believes that it is reasonable to assume that the proposed standard will reduce work-related musculoskeletal disorders in the high risk population by at least 30 percent and by as much as 100 percent, as has been documented in a number of case studies of ergonomics programs. Overall, OSHA believes that MSD incidence will be reduced by about half or two-thirds as a result of implementing ergonomics programs.

E. Preliminary Conclusions

In this section, OSHA estimated the risk of experiencing a lost workday MSD to workers exposed to workplace conditions such as forceful lifting, pushing, or pulling; repeated bending and twisting; repetitive hand or arm motions; static and awkward postures; contact stress; and whole-body and localized vibration. The basis for these estimates is drawn from BLS data that describe the incidence of employer-reported MSDs from 1992 through 1996. For the latest year for which data are available, the estimated industry-specific annual incidence of MSDs ranges from 0.5 to 36.6 lost workday cases per 1,000 workers (by 2-digit SIC); OSHA believes that, because these figures represent the incidence across the entire production workforce in each industry sector, the true incidence among the subset of workers exposed to workplace risk factors is much higher. This is supported by the vast array of epidemiological evidence showing that the risk among exposed workers is up to 10 or 20 times higher than the risk to workers that are not so exposed. The BLS data also demonstrate a significant risk of experiencing MSDs among workers in specific occupations, with the annual incidence estimated to range between 5.6 and 42.4 lost workday cases per 1,000 workers for the 75 occupations having the highest incidence. From these data, OSHA estimated the lifetime risk to workers exposed to risk factors in the workplace, assuming exposure over a 45-year period. The estimated probability of a worker experiencing at least one lost workday MSD over 45 years ranges from 24 to 813 per 1,000 workers, depending on the industry sector.

OSHA also provided evidence that implementation of ergonomic programs and interventions are effective in reducing the risk of MSDs to exposed workers. This evidence consists of 92 case studies that document reductions in MSD injury rates that have resulted after ergonomic programs and interventions have been implemented by employers; field and laboratory studies that show ergonomic interventions are successful in reducing the magnitude of the forces imposed on the body that can damage musculoskeletal tissues; and several epidemiological studies that have shown quantitative relationships between the intensity and duration of exposure to workplace risk factors and the risk of MSDs, which provides direct evidence that reducing exposures will reduce MSD incidence. From the case studies, OSHA estimates that ergonomic programs and interventions will reduce the incidence of total MSDs (*i.e.*, both lost workday and non-lost workday) by a median value of 76 percent (mean value of 73 percent). Case studies suggest that the effectiveness of ergonomic programs and interventions will be somewhat higher in reducing lost workday MSDs, with median and mean estimates of 82 and 79 percent, respectively. These estimates are consistent with those inferred from the body of epidemiological data, which show that more than one-half of the MSDs that occur among exposed employees is attributable to exposure, and therefore potentially preventable under an ergonomics program. OSHA requests additional information and data describing the effectiveness, or lack thereof, of ergonomics programs on reducing MSD rates

Appendix VI–A.—BLS Injury Categories Likely To Include Employer-Reported Musculoskeletal Disorders

BLS CODE	NATURE OF INJURY	DESCRIPTION
00	Traumatic injuries and disorders, unspecified	This major group classifies traumatic injuries and disorders when the only information available describes the incident as traumatic. For example, employee was hurt in car accident.
01	Traumatic injuries to bones, nerves, spinal cord	This major group classifies traumatic injuries to the bones, nerves, or spinal cord which include breaking and dislocating bones and cartilage and traumatic injury to the brain, spinal cord, and nerves.
011	Dislocations	Subluxations; slipped, ruptured, or herniated disc; partial displacement; and fractured or broken cartilage.
012	Fractures	Closed fractures for which no open wound exists; open fractures for which there is an accompanying open wound; comminuted, compound, depressed, elevated, fissured, greenstick, impacted, linear, march, simple, and spiral fracture; and slipped epiphysis.
013	Traumatic injuries to spinal cord	Severed spinal cord, nonfatal severed spinal cord resulting from a gunshot wound, traumatic transient paralysis, anterior cord syndrome, lesion of spinal cord, and central cord syndrome.
014	Traumatic injuries to nerves, except the spinal cord	This nature group classifies traumatic injuries to nerves other than the spinal cord. Cranial nerves, peripheral nerve of the shoulder or pelvic girdle, and nerves of the limb are possible locations for injuries in this nature group. Diseases or disorders of the nervous system that occur over time as a result of repetitive activity, such as carpal tunnel syndrome, are classified in major group 12. Includes division of nerve, lesion in continuity, traumatic neuroma.
018	Multiple traumatic injuries to bones, nerves, spinal cord	This nature group classifies multiple injuries and disorders of equal severity within Traumatic injuries to bones, nerves, spinal cord, major group 01.
019	Traumatic injuries to bones, nerves, spinal cord, n.e.c.	
020	Traumatic injuries to muscles, tendons, ligaments, joints, etc., unspecified	Traumatic injuries that affect the muscles, tendons, ligaments or joints; exact nature of disorder not specified in employer's report.
021**	Sprains, strains, tears	This nature group classifies cases of sprains and strains of muscles, joints tendons, and ligaments. Diseases or disorders affecting the musculoskeletal system, including tendonitis and bursitis, which generally occur over time as a result of repetitive activity should be coded in Musculoskeletal system and connective tissue diseases and disorders, major group 17. Includes avulsion, hemarthrosis, rupture, strain, sprain, or tear of joint capsule, ligament, muscle, or tendon. Excludes hernia (153), lacerations of tendons in open wounds (034), torn cartilage (011).
029	Injuries to muscles, tendons, ligaments, joints, etc., n.e.c	This nature group classifies injuries to muscles, tendons, ligaments, etc. that are not classified elsewhere in this major group.
0972** 0973** 0978 0979	Back pain, hurt back Soreness, pain, hurt, except the back Multiple nonspecified injuries and disorders Nonspecified injuries and disorders, n.e.c	Subcategories under nature group 097, Nonspecified injuries and disorders, which includes traumatic injuries and disorders where some description of the manifestation of the trauma is provided and generally where the part of body has been identified. Subcategory 0972 includes hurt back, backache, low back pain.
099	Other traumatic injuries and disorders, n.e.c.	

Appendix VI–A.—BLS Injury Categories Likely To Include Employer-Reported Musculoskeletal Disorders—Continued

BLS CODE	NATURE OF INJURY	DESCRIPTION
1240	Disorders of the peripheral nervous system, unspecified	Subcategories under nature group 124, Disorders of the peripheral nervous system, which includes the nerves and ganglia located outside the brain and spinal cord. Subcategory 1249 includes Bell's palsy, tarsal tunnel syndrome, other mononeuritis of the extremities, nontraumatic lesion of the median, ulnar and radial nerves, muscular dystrophies.
1241**	Carpal tunnel syndrome	
1249	Other disorders of the peripheral nervous system, n.e.c.	
1371	Raynaud's syndrome or phenomenon	Subcategory under nature group 137, Diseases of arteries, arterioles, capillaries.
153**	Hernia	This nature group classifies hernias of the abdominal cavity. Includes: femoral (1539), esophageal (1539), hiatal (1532), inguinal (1531), paraesophageal (1539) scrotal (1531), umbilical (1539), and ventral (1533) hernias. Excludes: herniated disc (011), herniated brain (1231), and strangulations (091).
17**	Musculoskeletal system and connective tissue diseases and disorders	This major group classifies diseases of the musculoskeletal system and connective tissue.
170	Musculoskeletal system and connective tissue diseases and disorders, unspecified.	
171	Arthropathies and related disorders (arthritis)	This nature group classifies joint diseases and related disorders with or without association with infections. Includes: ankylosis of the joint, arthritis, arthropathy, and polyarthritis. Excludes: disorders of the spine (172), gouty arthropathy (1919), rheumatic fever with heart involvement (131).
172	Dorsopathies	This nature group classifies conditions affecting the back and spine. Includes: spondylitis and spondylosis of the spine (1729); intevertebral disc disorders, except dislocation (1723); sciatica (1721); lumbago (1722); and other nontraumatic backaches (1729). Excludes: dislocated disc (011), curvature of the spine (1741), fractured spine (012), herniated disc (011), ruptured disc (011), traumatic sprains and strains involving the back (021), and other traumatic injuries to muscles, tendons, ligaments, or joints of the back (02), and traumatic back pain or backache (0972).
173	Rheumatism, except the back	This nature group classifies disorders marked by inflammation, degeneration, or metabolic derangement of the connective tissue structure of the body, especially the joints and related structures of muscles, bursae, tendons and fibrous tissue. Generally, these codes should be used when the condition occurred over time as a result of repetitive activity. Includes: rotator cuff syndrome (1739), rupture of synovium (1739), and trigger finger (1739). Excludes: rheumatism affecting the back is included in code (172), traumatic injuries and disorders affecting the muscles, tendons, ligaments and joints (02).
174	Osteopathies, chondropathies, acquired deformities	This group is comprised of diseases of bones, diseases of cartilage, and acquired musculoskeletal deformities. Includes: osteomyelitis, periostitis and other infections involving bone; and acquired curvature of the spine.
179	Musculoskeletal system and connective tissue diseases and disorders, n.e.c.	This nature group classifies musculoskeletal system and connective tissue diseases and disorders that are not classified elsewhere.
4120	Symptoms involving nervous and musculoskeletal systems, unspecified	Subcategories under nature group 412, Symptoms involving nervous and musculoskeletal systems, which includes symptoms specific to either the nervous or musculoskeletal systems. Subcategory 4129 includes abnormality of gait, lack of coordination, tetany, and meningismus.
4128	Multiple symptoms involving nervous and musculoskeletal systems.	
4129	Symptoms involving nervous and musculoskeletal systems, n.e.c.	

Appendix VI–A.—BLS Injury Categories Likely To Include Employer-Reported Musculoskeletal Disorders—Continued

BLS CODE	NATURE OF INJURY	DESCRIPTION
414	Symptoms involving head and neck	This nature group classifies symptoms which are specific to either the head or neck. Includes: throat pain (4149), aphasia (4149), and epistaxis/nosebleed (4149).

** Categories included in OSHA's preliminary risk assessment.

Source: Occupational Injury and Illness Classification Manual, Bureau of Labor Statistics, December 1992 (Ex. 26–1272).

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Food Packing	20	Implemented full program on packing line, including job task analysis, employee involvement in identifying problems and solutions, worker training, and medical management. Job analysis resulted in 56 proposals for changes in equipment and work environment, half of which were implemented in six months.		In 1976, prior to implementing the program, there were 51 hand MSDs identified among 200 packing workers. Hand MSDs were eliminated by 1980, four years after program implementation. Other upper extremity illnesses declined by about 47% in this same time period.	Luopajarvi *et al.* (1982) (Ex. 26–1042); Luopajarvi *et al.* (Undated) (Ex. 26–1090).
Meatpacker	2011	Training efforts included awareness training of corporate and plant managers and technical training of safety and medical personnel. Ergonomic task forces were established at individual plants to identify problem jobs and implement exposure controls. Controls included use of anti-fatigue mats and manual handling assists such as conveyors and trucks. Job rotation and cross-training of rotated workers was also employed.	Not Reported.	Cumulative trauma injuries reduced from four in one month to none reported during a 6-month period.	McCasland (1992) (Ex. 26–1043).
Meatpacker-pork deboning	2011	Introduction of automated system for deboning/skinning and a pneumatic lifter to automate hanging of large sausage casings onto processing racks.	Lost time due to injury dropped from 30% of total work hours to less than 2%.	CTDs have declined from 84 cases to 9 cases over a 6-year period.	Murphy (1992) (Ex. 26–1103).

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Meatpacker	2011	Implementation of an ergonomics program, including engineering controls, work hardening program, training, and medical management.	Not Reported.	CTDs decreased from 47.8 per 100 workers (1987) to 17.2/100 workers (1990) and 17.7/100 workers (1991).	OSHA Site Visit, Case Study No. 2 (26–1175).
Meat preparation	2011	Introduction of engineering controls: redesigned workstation by sloping the work surface toward the meatcutter; introduced rotary cutter and single hooks.	Not Reported.	80% reduction in musculoskeletal injuries in the first year.	Oxenburgh (1994) (Ex. 26–1041), Case 45.
Poultry processing	2015	Implementation of an ergonomics program, including redesign of processing lines, use of rubber-matted stools and platforms of varying heights to eliminate awkward reaches, worker training, and job reassignment for injured workers.	Not Reported.	Decline in upper-extremity and neck/shoulder injuries from about 32 per month to 0.	Farr (1991) (Ex. 26–1044).
Poultry processing	2015	Introduction of workstation analysis and redesign, including altering heights of products, providing workstands, and installing tank tilters to reduce manual handling. Program also included worker training and development of an integrated medical management/surveillance-analysis system.	Not Reported.	Carpal tunnel incidence rates decreased from 7.8 per 200,000 hours to between 2.4 and 3.7 per 200,000 hours. Back injury rates declined from 4.4 per 200,000 hours to 3.0 per 200,000 hours.	Stuart-Buttle (1994) (Ex. 26–1045).
Poultry processing	2015	Introduction of engineering controls: tool/handle redesign; work practice controls; administrative controls.	Not Reported.	Recordable injuries and illnesses decreased from 10–14/100 workers (1988–89) to 7/100 workers (1991).	OSHA Site Visit, Case Study No. 1 (Ex. 26–1174).

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Ice cream manufacture, various jobs	2024	Performed job hazard analysis, implemented several controls including use of non-skid elevating platforms for shorter workers; modified workspace layout to permit workers to move without being hindered; replaced sharp edges of equipment with sloping angles or padding; replace hygienic thin-filmed gloves with warm, flexible gloves; modified way employees performed lifting and carrying tasks.	In 1985, before implementing the program, there were 4 compensation claims and absenteeism equalled 10% of the number of shifts worked. In 1897, there were no compensation claims and absenteeism was reduced to 4% of shifts worked.		Elie (OH&S Canada, Vol. 4, No. 7) (Ex. 26–1100).
Cattle feed processing operation	2048	Provided a forklift and a bobcat to eliminate manual lifting and relocated the feed mixer in order to install chutes and augers to permit mechanical loading of feed. Installed bulk storage containers so that additives could be gravity-fed to the mixer. Constructed a platform under the auger equal in height to the truck platform, which allowed feed bags to be filled without manual lifting. Program also included providing lifting and handling training to workers.	Not Reported.	The company eliminated manual handling injuries.	Teleki (1995) (Ex. 26–1046).
Bakery	205	Engineering controls: workstation redesign, tool modifications; improved work practices; formation of labor-management CTD committee.	Absenteeism related to carpal tunnel syndrome decreased from 731 lost work days (1987) to 8 lost work days (Jan.–Aug., 1991).	Carpal tunnel cases decreased from 34 (1987) to 13 (1990).	Robinson (1993) (Ex. 26–1102).
Packaging sugar cubes	206	Cubes were packed tightly using a hand tool that required worker to exert considerable pressure on a sharp corner edge. Company changes marketing strategy that permitted cubes to be packed loosely, avoiding use of excessive hand force.	Considerable reduction in sickness absence and workers compensation claims.	Serious strain injuries to hands was ‘‘virtually’’ eliminated.	Oxenburgh (1994) (Ex. 26–1041), Case 41.

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Mattress manufacturer, material handling	2515	Introduction of hand trucks and lift systems to aid in manual handling. Job hazard analysis involving the employees in identification of problem areas and solutions to problems.	53.5% reduction in workers compensation reports in one year (1991).	Not Reported.	Bedtimes (1992) (Ex. 26–1047).
Mattress manufacturer, material handling	2515	Job hazard analysis of all job functions to resolve ergonomic problems. Modified workstations, tools, and manufacturing procedures. Modified equipment to reduce need to lift items above shoulder height or below knee level.	Lost time reduced 1/4 to 1/3 in 3 years.	Not Reported.	Bedtimes (1992) (Ex. 26–1047).
Mattress manufacturer, warehousing	2515	Added conveyor, increased fork truck use, reduced stacking heights, and revised handling procedures. Production process changed to eliminate material handling and loading onto truck.	Not Reported.	Decreased injuries from 9 to 1 in one year.	Marcotte (undated) (Ex. 26–1048).
Office furniture manufacturing, various jobs	252	Introduction of a plant ergonomics program employing engineering controls, work practice controls, administrative controls, medical management, and education and training.	Restricted workdays decreased from 301/100 employees to 221/100 employees.	Decreased rate of MSDs from 21/100 employees (1989) to 19/100 employees (1991–1992).	Robinson (1993) (Ex. 26–1102).
Office furniture manufacturing, various jobs	252	Installed scissor lifts to aid in packaging file cabinets of different sizes. Small-assembly workstations were altered to eliminate twisting and bending during lifting.	Not Reported.	Back injuries have been cut by 50 percent.	LaBar (1991) (Ex. 26–1078).
Pulp and paper mill workers	2611 & 2621	Conducted training sessions covering CTD issues and hazardous postures at the workplace. Job analysis included interviews of employees. Program included strengthening exercises and fitness initiatives. The following engineering controls were implemented: • Reduced the number of wires per bale to reduce weight, • Use of padded bolt cutter handles, • Provided better lifting devices.	Not Reported.	In a six-month follow-up to the interventions, the CTD rate had been diminished to zero and there were no wrist and elbow problems.	‘‘Avenor’s fitness a warm-up to ergonomics.’’ CTD News (1996) (Ex. 26–1050).

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Printing, glue machine operators	27	Installed partial mechanical aid for off loading of cartons.	Not Reported.	No injuries reported in 2 yrs since changes.	Shinnick (1985) (Ex. 26–1049).
Book binding operator	278	Introduced industrial load leveler (a spring loaded table) for loading/unloading pockets, binders, stitchers, and off-line mailers.	Lost workdays fell from 413 to 112.	Not Reported.	Ferris (1992) (Ex. 26–1051).
Organic chemical manufacture, manual handling	283	Analysis of injury data, observation of material handling tasks. Installed materials handling equipment, automated container-packaging and inspection equipment. Reduced weight of bags and drums. Worker training program.	Severe back injuries resulting in lost workdays were eliminated (1979–1989).	62% reduction in the incidence of total overexertion back injuries.	Ridyard (1990) (Ex. 26–1052).
Paint manufacturing, manual handling	2851	Installation of material handling equipment. Medical management of injuries.	From 1990–1993, lost time injury rate decreased by approximately 63%.	Total OSHA recordables reduced by 40% from 1990–1993.	Akzo Coatings, Inc., Louisville, KY. correspondence with OSHA (1994) (Ex. 26–1054).
Oil refinery, handling hoses and valves, manual handling	2911	Added platforms that make valve access easier, added extensions to valve stems to eliminate bending to turn valves, installed hoists over work tables to eliminate lifting and bending, purchased adjustable height carts, upgraded lighting, and conducted back injury training.	Not Reported.	Injury rates dropped by 90%.	Bone (1993) (Ex. 26–1055).
Rubber hose manufacturing	3052	A new hand tool was designed (an air gun) that is counterbalanced to reduce the amount of weight supported. This tool also has better handles.	No lost time incidents from repetitive trauma since the new tool was introduced.	Not Reported.	Oxenburgh (1994) (Ex. 26–1041), Case 7.

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Shoe/luggage manufacturing, various jobs	31	Instituted a comprehensive ergonomics program as part of a total quality management initiative. Program included elements of worker participation, medical management, job analysis and control of exposures to risk factors, and employee education and training. Exposure controls included installation of adjustable workstations; new jig fixtures to hold work pieces at proper angles; partial automation of processes; and use of anti-skid surfaces on tools, fixtures, and handles.	Reduced lost time upper extremity and back disorders by 79%.		Rooney and Morency (1992) (Ex. 26–1056).
Shoe manufacturer, various jobs	314	Several programs implemented that included exercise and conditioning, stretching, and ergonomics awareness training. Conducted special training on ergonomics for industrial engineers and maintenance workers. Continuous flow manufacturing including group working, cross training, and job rotation was instituted. Engineering controls implemented included: • Purchase of new adjustable chairs; • Use of anti-fatigue mats for all employees whose jobs involved prolonged standing; • The cast iron base on heavy equipment was cut off and refitted with an adjustable base; • Electric or pneumatic foot pedals were used instead of non-adjustable mechanical ones; • Prepackaged shoe laces were purchased to eliminate hand-tying repetition; and • Sewing machines were tilted toward the worker to eliminate awkward posture.	Not Reported.	Repetitive motion injuries in two problem areas were reduced from 70 percent to between 25 and 30 percent of the total OSHA recordable incidents in three years.	''Red Wing Shoes' early warning system.'' CTD News (1995) (Ex. 26–1057).

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Shoe manufacture, pneumatic press operator	314	Workstation design improvements included use of adjustable chairs and footrests, providing armrests, changing angle of the presses, providing parts bins to reduce extreme wrist flexion, and redesigning shoe ornaments so prongs were angled for easier insertion and pressing.		No injuries reported for 2 years since changes were implemented.	Wick (1987) (Ex. 26–1058).
Footwear assembly and fabrication	3149	Extensive ergonomic training program.	Lost-time injuries dropped 67% in 2 years.	Total number of CTDs dropped by 62% in 2 years.	Holland (1991) (Ex. 26–1059).
Sewing and cutting operations	3199	Introduction of ergonomics program, including medical program to detect and treat CTDs early. Workplace modifications included use of adjustable workstations, footrests, and anti-fatigue mats; installing larger handles on hot irons to improve grip; installing proximity switches on presses; adjusting glue stations to prevent awkward upper-extremity postures; and automating some processes.	Not Reported.	CTD incidence fell from 14.6% in 1990 to 11% in 1992.	Nickasch (1994) (Ex. 26–1060).
Encapsulating automotive glass windows	3229	Ergonomics program and control measures, including installation of adjustable workstations, job rotation, and anti-fatigue matting; medical management program and an employee training program.	Incidence of lost-work-day injuries declined from 8.6% to 0.2% in 2 years. Rate of lost workdays declined from 1,615/100 workers (1990) to 0.9/100 workers (1992).	Not Reported.	OSHA Site Visit, Case Study No. 12 (Ex. 26–1182).
Packagers	3231	Workplace improvements included: Reduced all material handling to less than 50 pounds; Purchased different sizes of gloves, cuffs, and sleeves to reduce additional stress and energy expenditure; Designed a device that allows employees to roll the glass onto the line instead of lifting it;	Not Reported.	Injury incidence rate dropped from 14 per 100 workers in 1987 to 3.3 in 1996. Reduced severity and frequency of injuries.	‘‘PPG learned to overcome ergo innocence.’’ CTD News (1996) (Ex. 26–1061).

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
		Raised the racks to knuckle height to avoid bending while lifting the windshields; and Altered the racks to allow workers to step into them and load them from back to front in order to eliminate stressful forward reaches.			
Ceramic tile manufacturing, various jobs	3253	Implementation of an ergonomics program including engineering controls (workstation redesign), job rotation, changes in work practices, and an ergonomic training program for employees.	Lost-time injury rate for repetitive motion injuries decreased from 1.6 in 1988/1989 to 0 in 1993.	Not Reported.	Stuart-Buttle (1994) (Ex. 26–1045).
Fiber-cement board manufacture, manual handling	3272	Install on-loader at from of conveyor to permit workers to load boards at their own pace. Automate process for separating boards and transferring them to the on-loader. Automate stacking of final product.	Eliminated lost-time MSDs in 2 years after improvements were made.	Not Reported.	Oxenburgh (1994) (Ex. 26–1041), Case 11.
Metal castings, unpacking operation	33	Frequent, excessive reach was required to unpack 15- to 18-pound casting from crates. Crates were modified by adding drop gates at each end of the crates and installing a scissor lift to lift crates. In addition, changes were made in the way the castings were stacked in the crates to permit the workers' arms to remain close to the body while unpacking.	Not Reported.	Eliminated back injuries associated with this operation.	Oxenburgh (1994) (Ex. 26–1041), Case 34.
Palletizing operation	33	Scissor lift tables with turntable tops were installed alongside each packing station.	Not Reported.	Five out of six back injuries were eliminated.	Benson, (1987) (Ex. 26–1062).
Aluminum manufacturer, materials handling	3350	Establishment of an ergonomics program, including of introduction lift tables, cranes, and mechanical assists in overhead lifting, rearrangement of work to allow use of cranes in lifting.	Not Reported.	Reduced overexertion injuries of the back by 40% to 60%.	Mandelker (1993) (Ex. 26–1063).
De-burring and finishing cast metal parts	34	Parts were held still by hand during finishing operations. Work bench was replaced by a potter's wheel to hold the part and rotate it as necessary. Finishing tools were redesigned.	Not Reported.	Upper-extremity disorders were eliminated.	Oxenburgh (1994) (Ex. 26–1041), Case 43.

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Welding	34	Manual welding of a 5-meter weld required welder to work in a prolonged static posture. This process was replaced by a semi-automatic powder welding process, permitting welder to work from a standing position.	Not Reported.	All knee, neck, and shoulder injuries from this operation have been eliminated.	Oxenburgh (1994) (Ex. 26–1041), Case 33.
Materials handling, hardware manufacture	3411	Use of adjustable lift tables/transporters completely eliminated manual lifting from the job.	Not Reported.	Back injuries reduced by 90%.	''Put ergonomics to practical use.'' Material Handling Engineering (1988) (Ex. 26–1064).
Packager	3452	Packaging area was redesigned; raised the level at which boxes are lifted, installed semi-automatic sealing machines and adjustable chairs, and eliminated loading of pallets; training introduced.	Nearly a five-fold decrease in musculoskeletal injuries based on days lost. (equivalent to 5% of the department's total wage costs).	Not Reported.	Oxenburgh (1994) (Ex. 26–1041), Case 10.
Manufacturing automotive cables	3496	Introduction of ergonomics program utilizing engineering controls, work practice training, and medical management.	Lost workday cases decreased from 48 (1991) to 27 (1993). Number of lost workdays decreased from 1,287 days (1991) to 275 days (1993).	Decreased illnesses from 47 (1991) to 17 (1993).	OSHA Site Visit, Case Study No. 11 (Ex. 26–1181).
Steel furniture manufacturing, various jobs	3499	Employee involvement in identifying hazards and developing interventions. Engineering approaches included the following: • An enclosed shotblaster machine has been used to automate polishing of the steel. • An automatic washing system has been provided. • Lighting placement and brightness have been improved to reduce the awkward posture required to inspect and brush the products. • Many of the jigs were improved to be adjustable.	Lost days from carpal tunnel syndrome, back strain and other CTDs dropped to zero in 1996, down from 176 lost workdays in 1991.	Not Reported.	''Charleston Forge welds homemade approach.'' CTD News (1996) (Ex. 26–1065).

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
		• And other engineering controls.			
Farm equipment manufacture, assembly and materials handling	3523	Initiated an eight-hour engineer ergonomics training program. Appointed ergonomics coordinators in all U.S. and Canadian factories, foundries and distribution centers chosen from the industrial engineering and safety departments. Conducted training through attending professional courses and conferences, memberships in professional organizations, subscriptions to ergonomics publications and tracking the latest ergonomics research. Conducted ergonomic review of new office furniture purchases. Conducted VDT ergonomics awareness training for video display operators. Engineering Controls included: • Limiting manual lifting to 40 pounds or less; • Redesigning the assembling operations so that assemblers worked in an upright position; • Altered hand tools for better fit; and • Installed hoists and lift tables.	83 percent reduction of back injuries that resulted in lost time.	Not Reported.	"An ergo process that runs like a Deere." CTD News (1995) (Ex. 26–1101).
Welding, vehicle manufacture	3531	Ergonomic training program implemented, seat height adjustments installed, and work station height adjusted.	Not Reported.	Back injury rate went down by 27%.	"Caterpilar, Inc." Welding Journal (1992) (Ex. 26–1066).
Chain saw assembly	3546	Introduction of new tools and modified production methods, and employee training.	The sick-leave rate decreased from 17.0 to 13.7 on an average annual basis.	Not Reported.	Parenmark *et al.* (1993) (Ex. 26–1067).

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Computer manufacturer	3571	The company engaged in several training and education initiatives, including: • Mandated ergonomics training classes for high risk groups; • Created and distributed a 16-page ergonomics brochure; and • Created an ''ERGO Hotline'' to schedule ergonomics evaluations, report problems, and seek information; Exposure control approaches included: • Limiting manual lifting to 40 pounds or less; educated the employees via a brief program on the basic ergonomics fundamentals; • Purchased new office sit-stand workstations; • Adjusted the workstation surface height to accommodate each worker; and • Attached a wider, adjustable keyboard and mouse platform to the standard desk.	Not Reported.	• 41 percent drop in reportable upper limb disorders from 1994 to 1995 which addressed about 70 percent of the company's upper-limb reportable injuries. • Further 50 percent decrease in reportable CTD cases from 1995 to 1996. • Reportable cases of CTDs decreased to 25 through November of 1996 compared to 70 cases in 1994.	''Silicon Graphics melds high- and low-tech.'' CTD News (1997) (Ex. 26–1068).
Computer mainframe assembly	3571	Training had been provided for proper lifting techniques, general safety and use of special tools. Extensive office workstation ergonomics training was provided. Engineering controls included: • Providing new workbenches to accommodate workers' shorter reaches; • Adding roller-ball conveyor belts and lifting devices were added to raise the units onto the conveyor belt; • Replacing pneumatic drivers with lighter electric units which had much less vibration and weighed about one pound; • Installing lift platforms that would raise the cabinets and 3 feet off the floor; • Providing seated and standing workstations so one employee could build the entire cabinet instead of working on an assembly line in order to reduce the static fatigue; and	There are no lost days due to CTDs in the office workplace.	CTD related injuries were eliminated in production.	''AT&T uses cost-conscious program to fight CTDs.'' CTD News (1995) (Ex. 26–1069).

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
		• Modifying scissor lifts to rise up to 4 feet off the floor.			
Copying machine control system assembly	3579	Assembly of the systems was performed on a workbench and required frequent lifting and turning of the part. The bench was replaced by an adjustable stand designed to take the weight of the part being assembled.	Not Reported.	MSD rate declined by 50% in the first year. In the second year, the MSD rate declined to one-third.	Oxenburgh (1994) (Ex. 26–1041), Case 37.
Hand tool operation, tele-communications manufacturing	36	Safety and health committee implemented program that included creation of task force, worker training, improvements in workstation design and tooling, and medical management of workers on restricted duty.		Plant-wide incidence of repetitive trauma disorders was 2.2 cases per 200,000 work hours, reduced to 0.53 cases per 200,000 workhours in 1 year after program implementation.	McKenzie *et al.* (1985) (Ex. 26–1070).
Electronics manufacture	36	Controls: workstation redesign and job rotation.	Not Reported.	CTDs reduced by 46% in one year.	Robinson (1993) (Ex. 26–1102).
Electrical equipment manufacture, press operator	36	Automated handling and grinding of resistance elements. Eliminated possibility for hazardous exposures.	Not Reported.	Eliminated MSDs.	Oxenburgh (1994) (Ex. 26–1041), Case 16.
Press operator, small electronic parts manufacture	36	Press operation caused excessive wrist flexion and palm compression. The press was modified by adding switches that either eliminated hand contact or only involved contact with parts of the hand that do not have nerves close to the skin surface.	Not Reported.	29% reduction in musculo-skeletal injury incidence.	Oxenburgh (1994) (Ex. 26–1041), Case 42.
Lamp manufacturing, materials handling	3641	Added a vacuum hoist, reduced equipment height, reduced box size and weight, and introduced a back awareness program for employees.	Not Reported.	Eliminated back and upper extremity disorders in the last four years.	Carreau and Bessett (1991) (Ex. 26–1071).

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Telephone systems assembly	3661	Implemented an ergonomics program for the assembly line. Elements included an employee awareness program, disorder treatment protocols, job task analyses, job redesign, and cost savings analysis.	Lost-time repetitive strain injuries dropped from 20 to 4 over 1.5 years.		Darcangelo (1989) (Ex. 26–1072).
Telecommunications equipment assembly	3661	Introduced a training program, job hazard analysis, and an engineering program to abate ergonomic hazards. Medical management of injured employees on restricted jobs.		Rate of repetitive trauma disorders dropped from 1.1 per 100,000 hours to 0.26 per 100,000 hours in 1 year.	Pope (1987) (Ex. 26–1073).
Telecommunications equipment assembly	3661	Workstation redesign (adjustable tables, illumination), ergonomically designed chairs, and tool redesign.	Musculoskeletal injury sick leave in 1978=5.0, in 1982=2.9.	Not Reported.	Westgaard and Aaras (1984) (Ex. 26–1026).
Electronics assembly	367	Job rotation, new assembly line procedures, and ergonomic line balancing.	Not Reported.	No new cases of cumulative trauma were reported.	Townes and Imrhan (1991) (Ex. 26–1074).
Electronics manufacturing, various jobs	3674	Redesigned workstations; introduced powered-screwdrivers; job rotation.	Not Reported.	Reduced injuries (not quantified).	Burri and Helander (undated) (Ex. 26–1075).
Vehicle seat assembly	371	Ergonomics training was provided. Engineering controls included: • Redesigning seat covers in order to decrease the number of fasteners by more than 50 percent; • Provided a compression tool to clamp the foam padding to the seat; • Installed adjustable workstations; • Provide electric torque guns. • In addition, a program of job rotation was introduced.		Tendinitis cases fell by 93% and carpal tunnel cases fell by 96 percent in the year following program implementation.	''Problem-solving by committee at General Seating.'' CTD News (1995) (Ex. 26–1076).
Unpacking auto parts	371	A plywood sheet end board had to be removed to unpack crates, requiring excessive force and awkward postures. Plywood sheets were modified to reduce their weight and permit them to slide more easily in the grooves.	Not Reported.	Back and shoulder injuries associated with this operation were eliminated.	Oxenburgh (1994) (Ex. 26–1041), Case 38.

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Motor vehicle assembly, various jobs	371	Introduction of an ergonomics program, including engineering controls, work practice controls, job rotation/job enlargement, medical management, education, and training. Controls implemented included counterbalanced tools, lift tables, and workstation redesign to prevent awkward postures and excessive reaches.	Lost-time workday rate decreased 65%, and the lost-time case rate decreased 48%.	Over a 3 year period, the injury and illness rate decreased 11% and the severity rate decreased 39%.	OSHA Site Visit, Case Study No. 10 (Ex. 26–1180).
Truck manufacturing, various jobs	3711	Introduction of company ergonomics program in 1990. Engineering controls: substituted machine riveting for manual riveting, introduced raised work heights, and installed lifting devices. Introduction of job rotation for 85% of the workforce.	• Lost-time injuries fell from 80 to 28 in 2 years. • Lost workdays fell from 1,402 to 193.	CTD cases fell from 105 to 54 in 2 years.	Mandelker (1993) (Ex. 26–1063).
Auto assembly	3711	Introduced variable height car conveyer belt, articulating arms to move large parts, like dashboards, into place. Also redesigned tools.	Not Reported.	50% decline in ergonomic related injuries in the first year. 35% decline in second and third years.	LaBar (1992) (Ex. 26–1053).
Auto assembly line worker	3711	28 projects were redesigned to change specific jobs, making them ergonomically less troublesome.	Reduced from 3,134 lost days per year to 1,355 lost days per year after project completion.	Not Reported.	Brandon (1992).
Auto body assembly, fixing side mouldings to body	3711	Replaced pneumatic nut runner with a lighter model. Used a stepped ramp that allowed workers to select an appropriate position relative to the work piece.	Not Reported.	Upper-body MSDs were eliminated.	Oxenburgh (1994) (Ex. 26–1041), Case 50.
Spot welding onto auto frame	3711	Fixed a large-diameter circular handle to the welding frame, which allowed the frame to be moved into any position while keeping the wrist in a straight posture.	Not Reported.	Wrist injuries were eliminated.	Oxenburgh (1994) (Ex. 26–1041), Case 51.
Spray painting auto bodies	3711	Lengthened spray gun trigger to increase gun's grip diameter and allow the trigger to be operated with three fingers.	Not Reported.	Cases of hand tendinitis were eliminated.	Oxenburgh (1994) (Ex. 26–1041), Case 52.

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Auto instrument panel assembly, manual handling	3714	Installed a hoist system to remove panels from conveyor and transport them to shipping containers.	Lost-time back injuries associated with this operation were eliminated.	Not Reported.	Oxenburgh (1994) (Ex. 26–1041), Case 40.
Pneumatic screw feeder operation, auto instrument panel assembly	3714	Installed a counter-balanced articulated arm to reduce the weight of the tool.	Not Reported.	Upper-body MSDs were eliminated.	Oxenburgh (1994) (Ex. 26–1041), Case 46.
Computer operator	3714	The company instituted a biannual training program to emphasize good lifting and pushing techniques as well as good posture. Also instituted a stretching exercise program and encouraged the CAD operators to take frequent short breaks. Engineering controls included: • Purchased 27 back cushions, 71 lumbar supports in three different sizes, 24 keyboard/mouse rests, and 12 document holders in the past five years; • Provided adjustable chairs; and • Provided foot rests for shorter workers.	Saved 20,000 hours lost time per year since eliminating CTD-related complaints.	Not Reported.	''Communication drives process at Siemens.'' CTD News, (1997) (Ex. 26–1077).
Manufacturing of electronic components, various jobs	3714	Introduction of an in-plant ergonomics program, engineering controls including hand tool and workstation redesign, and lift devices. Job rotation and other administrative controls, work practice controls, medical management, and training also implemented.	Decrease of 50% from 116 lost-time days/100 workers (1990) to 58/100 workers (1991) for MSDS. Additional 50% decrease in 1992 to 29 lost-time days/100 workers.	The incidence rate of ergonomic disorders decreased by 67% from 37/100 workers (1990) to 12/100 workers (1992).	OSHA Site Visit, Case Study No. 8 (Ex. 26–1178).
Automotive engine assembly	3714	A hoist was replaced by a conveyer belt set at waist height and part of the assembly process was automated.	70 days lost time and over 1,000 days on restricted duty were reduced to no lost days and no personnel on restricted duties.	Not Reported.	Oxenburgh (1994) (Ex. 26–1041), Case 2.

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Small parts assembly machine operation	3714	Jammed machine required operator to climb a bar ladder while carrying a heavy load. A correctly designed ladder and catwalk were installed along with a chute to dispose of damaged parts without the need for carrying them.	Not Reported.	Foot and ankle MSDs associated with the operation were eliminated.	Oxenburgh (1994) (Ex. 26–1041), Case 47.
Automotive air conditioner manufacture, material handling	3714	Installed overhead conveyor belt that moves the condenser cores through the various procedures, minimizing manual handling. Also installed box tilers to assist in packaging and scissor lift for stacking.	Prior to program, plant averaged 50 lost-time injuries per year, many of those back injuries. After program implementation, 2 back injuries have been recorded over a 4-year period.		LaBar (1991) (Ex. 26–1078).
Auto instrument panel subassembly	3714	Spring clips were pushed into position using a hand tool that required excessive force to operate. New tool was designed to reduce force and awkward positioning of the hand and wrist.	Not Reported.	Wrist and hand injuries were eliminated.	Oxenburgh (1994) (Ex. 26–1041), Case 49.
Trimming mouldings with hand cutter	3714	Hand cutters were replaced with automated or air-powered cutters.	Not Reported.	Hand and wrist injuries associated with this operation were eliminated.	Oxenburgh (1994) (Ex. 26–1041), Case 54.
Manufacture of jet aircraft engine parts, various jobs	372	Implementation of ergonomics program, including engineering control measures, work practice controls, medical management, education, and training. Controls implemented included redesigning workstations to provide employees with more room to perform tasks, adding anti-fatigue mats and adjustable footrests, removed or padded tables and shelves to reduce contact stress, and installed vibration-absorbing pads onto grinding wheels.	Not Reported.	Decrease in carpal tunnel syndrome cases from 26 in 1988, 11 of which required surgery, to 1 case in 1992 which did not require surgery.	OSHA Site Visit, Case Study No. 9 (Ex. 26–1179).

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Shipbuilder	3731	Initiated training classes covering the nature of CTDs, anthropometry, work physiology, back and wrist anatomy and proper work techniques, In-depth training course covered tool selection, work habits, alternating trigger fingers and hands.	Decreased to only 6 lost-time ergonomics wrist injuries through November 1996, since training completed in June 1995.	Eliminated wrist injury in the welding department until March 1996.	''Training a 'limbsaver' at Newport News.'' CTD News (1997) (Ex. 26–1079).
		Workers participated in evaluating and developing interventions for the welding department, and selecting pistol grip and in-line based tools so as to keep the wrists in a neutral posture. Installed scaffolding at the right height and distance from the work, and used ladders or installed scaffolding to higher positions for the work above shoulder height.	Eliminated lost time back injuries since July 1995.	Reduced ergonomics case rates about 30 percent during 1996.	
Motorcycle manufacturing, flywheel milling operations	3751	Introduction of lighter flywheel castings and an overhead lift; introduction of a customized deburring machine eliminating vibration exposures; introduction of a customized 40-ton press eliminating the use of the brass hammer.	MSDs involving lost or restricted workdays dropped from 27.6 per 100 workers in 1989 to 12.5 per 100 workers in 1993. The severity rate of MSDs dropped from 610 lost or restricted workdays per 100 workers in 1989 to 190 days in 1993.	Not Reported.	McGlothlin and Baron (1991) (Ex. 26–1080).
Assembly of pressure-sensing instruments	3823	Forceful turning actions were required to fit an O-ring in place. Cordless screwdrivers were used with a custom attachment to bring wrists into stronger position and allow hand to employ a power grip.	Not Reported.	Wrist and arm MSDs were eliminated.	Oxenburgh (1994) (Ex. 26–1041), Case 44.
Medical needle manufacture, inspection station	384	Used task forces to identify jobs involving worker exposures to risk factors. Identified problems on quality control line and implemented design changes to the workstations.		Achieved 75% reduction in upper extremity MSD cases.	Benden (1994) (Ex. 26–1081).

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Manufacture of suction canisters used in surgical procedures	3841	Introduction of an ergonomics program utilizing a medical management program, employee training program, job rotation, and engineering controls. Controls implemented include replacing old wooden supply stations with ergonomically designed stations, and automating various processes.	Not Reported.	Decrease in the ergonomic injury rate from 5.2/100 workers (1989) to 2.8/100 workers (1993).	OSHA Site Visit No. 16 (Ex. 26–1183).
Manual handling of bulk paper	386	Two operators manually lifted large wads of paper from a trolley. Manual lifting was eliminated by installing a scissor lift. In addition, the trolley's runners were replaced by roller bearings that enabled the paper to be loaded onto the scissor lift without manual lifting.	Not Reported.	There were 18 back injuries in one year prior to implementing changes. There have been no back injuries in the 3 years since modifications were made.	Oxenburgh (1994) (Ex. 26–1041), Case 36.
Manufacturing board games, inspection and packing	3944	Job analysis and problem solving involving employees to redesign packing workstations. Design changes included raising the height of conveyors, slowing conveyor speed (no effect on throughput), placing roller conveyors on an incline to facilitate carton removal, and changes in work procedures.		Eliminated all cumulative trauma injuries associated with job.	Cook and Marcotte (1990) (Ex. 26–1082).
Railroad repairmen	40	Introduced storage of tools and materials off the ground between knee and shoulder height; devised winches to lift and handle heavy equipment; and redesigned work tables, dollies, and carts to more easily handle train car parts.	Lost-work days reduced to zero for back injuries.	Low-back injuries reduced to zero.	McMahan (1991) (Ex. 26–1083).
VDT operator, package delivery service	42	Introduced sit-stand workstations that permit workers to adjust workstation to meet specific needs.		Reduced MSD cases by half in 12 months.	Nerhood and Thompson (1994) (Ex. 26–1084).

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Freight truck terminal operations	4213	Established ergonomics program in esponse to rising number of back injuries. Program elements include analysis of injury records to identify hazardous operations, extensive use of lifting and carrying devices, providing extra personnel to handle heavy or awkward freight, employee training, and medical management of injured workers.	There were 7 lost-time injuries in 1989, followed by 4 in 1990 and 5 in 1991.	Total number of MSD cases decline from 13 in 1989 to 7 in 1990.	OSHA Site Visit No. 5 (Ex. 26–1177).
VDT operation, telecommunications establishment	481	Retrospective study of the impacts of an ergonomics program on 500 VDT operators. Program included job task analyses, workstation redesign, and worker education and training.		Number of upper extremity disorders over the 6 months prior to implementation of the program was 52; this was reduced to 29 for the 6 months following intervention.	Tadano (1990).
Materials handling, electrical utility	4911	Redesigned equipment: • Weight of the water coolers reduced from 10 lbs to 5 lbs. • Rotating platform for transformers. Step and grab handles added to trucks. • New shovel handle and new pry bars. • Position of the kegs on trucks was lowered to minimize twisting of the back.	Lost time injuries reduced to 0.42 per 100 employees in 1989.	Injuries due to getting in and out of trucks reduced from 9 to 0 in year following redesign. No injuries from lifting the water kegs since the changes.	''Foiling field injuries with ergonomics.'' Electrical World (1990) (Ex. 26–1085).
Data entry operator, gas and electric utility	4932	• Engineering controls: workstation design. • Administrative controls implemented.	Lost time due to work-related injuries decreased from 1,008 hours/ month to 584 hours one year later.	Not Reported.	Couch (1990) (Ex. 26–1086).
Sewing machine operator	5137	Installed padded, swivel chairs with adjustable backs and improved materials handling methods. Also instituted an exercise program.	Not Reported.	Incidence rate of tendinitis decreased from 12% to less than 1% in some plants.	Hammond-Smith (1990) (Ex. 26–1087).

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Material handling, grocery distribution center	514	Implemented comprehensive program that included hazard identification and job hazard analysis, medical management and reassignment of injured employees, worker training, and implementation of engineering and work practice controls. Controls included making minor modifications to some forklift equipment, replacing other equipment, and providing ergonomically designed workstations for data entry personnel.	Number of MSD workers compensation claims decline from 14 in 1989 to 8 in 1991.	Not Reported.	OSHA Site Visit No. 4 (Ex. 26–1176).
Restaurant worker	5812	Reduced the amount of food served by the workers, and heavy porcelain crockery was replaced with plastic.	Not Reported.	Reported injuries decreased 40%.	Oxenbrugh (1994) (Ex. 26–1041), Case 17.
Pricer—clothing store	5932	Staples were reduced to one per tag and job rotation was introduced so that no one person stapled for more than 45 minutes at a time.	Not Reported.	In 1994–1995, 23% of pricers had CTDs; 2 had bilateral carpal tunnel releases and were unable to return to work. In 1996–1997, 10% of pricers were affected, but all have returned to their jobs without surgery or impairment.	''ARC takes thrifty approach to ergonomics.'' CTD News (1998) (Ex. 26–1089).
Data entry	6021	Adjusted workstations and lighting.	Not Reported.	Reduced neck tension syndrome from 54% to 16%.	Luopajarvi *et al.* (Undated) (Ex. 26–1090).
Nursing assistants, nursing home	805	Implemented program to determine patient lifting tasks that were the most stressful; evaluate alternative devices for acceptability among assistants; train assistants in use of devices; and modifying shower rooms and patient care techniques to facilitate patient handling. Used walking belts and mechanical hoists for lifting aids.	Decrease of 634 lost workdays/100 FTEs before intervention to 317 lost workdays/100 FTEs post intervention.	Incidence for back injuries decreased from 83 to 47 per 200,000 work-hours.	Garg and Owen (undated) (Ex. 26–1093).

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Nursing aides, nursing home	805	Committee of employees determined the types of mechanical devices that were needed, installed in 1993. Implemented employee training and modified duty programs.	Decrease in lost work days 38 in 1991 to 4 in 1994 (as of Nov), is largely attributed to the implementation of a no lifting greater than 50 pounds policy.	Not Reported.	Comments to OSHA from Kennebec, (undated) (Ex. 26–1094).
Nurse, hospital	8062	Professional lifting team of 2 performs 95% of all patient lifts; nurses freed to do more nursing activities.	Not Reported.	Back injuries reduced 94% first year after teams were implemented.	Charney *et al.* (1991) (Ex. 26–1091).
Nursing and laundry workers, hospital	8062	Worker education and training were provided. Employees were encouraged to take breaks. A regular maintenance program for equipment was initiated. New hand tools and lifting equipment were provided. Handles were installed onto tool carts. X-Ray cassettes were reorganized to avoid repetitive bending and back problems.	Lost-time hours in nursing ward fell 83 percent in 4 years. Lost-time hours among laundry workers fell 83 percent in 2 years.	Back injury rates in nursing wards fell 39 percent in 4 years. Back injury rates among laundry workers fell 71 percent in 2 years.	''Giving health-care workers a helping, mechanical hand.'' CTD News (1995) (Ex. 26–1092).
Nursing, hospital	8062	Ergonomic assessment of 14-room surgical suite, implemented changes in procedures for moving patients, maneuvering carts and equipment, using gall bladder boards, walking on wet floors, and accessing power outlets. Workers are periodically retrained in procedures to maintain awareness.	Not Reported.	Back injury rates reduced by 25% in 18 months since program was implemented.	Garb and Dockery (1995) (Ex. 26–1095).
Prescription filling using a syringe, hospital	8062	A manual assist for syringe actuation was developed to reduce the thumb and pinch grasp forces required while using a standard syringe. The system, about the size of a hot dog bun, accommodates standard syringe sizes from 10 cc to 60 cc.	Not Reported.	Upper extremity CTD cases were reduced from six to one.	''Case study 60: Hospital pharmacy liquid IV prescription filling using a syringe.'' ErgoWeb Inc., 1998 (Ex. 26–1096).
Hospital workers	8062	Patient Air Lift Systems introduced.	Not Reported.	Reduced injuries at second hospital by 94%.	Brigham (1994) (Ex. 26–1097).

Appendix VI–B.—Summary of Case Studies Demonstrating Effectiveness of Ergonomic Programs/Interventions—Continued

JOB TITLE OR ACTIVITY	SIC CODE	ERGONOMIC SOLUTIONS	REPORTED REDUCTION IN INJURY RATES		SOURCES
			LOST WORK-DAY MSDs	TOTAL MSDs	
Nursing, hospital	8062	Redesigned work process: Mechanical lifting equipment, slide boards, and patient transfer belts.	Lost-time injuries reduced to 49 (down 35%), with 426 lost days (a 57% decrease), and 1,851 restricted days (a 54% decrease).	In 1994 total back injuries decreased to 85 (a 43% reduction).	Hospital Employee Health (1995) (Ex. 26–1098).
Government employees	91	Introduction of program of ergonomic improvements, education, training, and physical fitness activities.	Not Reported.	1-year prevalence of back pain fell from 65 to 53 percent.	Shi (1993) (Ex. 26–1099).

VII. Significance of Risk

In this section of the preamble, OSHA conducts several analyses and presents data and information to demonstrate, first, that work-related musculoskeletal disorders (MSDs) constitute a material impairment of health or functional capacity under the Occupational Safety and Health Act (OSHAct or Act). This discussion demonstrates that MSDs are painful, often disabling injuries and illnesses that cause lost work time, require medical treatment, involve restricted work, and, all too often, result in surgical interventions.

The Agency then demonstrates the significance of the risk of incurring these material health impairments confronting workers in the industries and occupations covered by the scope of the proposed ergonomics standard. As OSHA's analysis shows, over a working lifetime, workers in these jobs face risks ranging roughly from 24 cases per 1,000 workers to 813 cases per 1,000 workers, risks that are clearly significant by any reasonable measure. Even on an annual rather than lifetime basis, many of the workers who would be covered by the proposed standard are at great risk: nursing aides and truck drivers, for example, can expect to suffer between 20 and 40 lost-workday musculoskeletal disorders for every 1,000 workers in every year that they work. Again, that risks of this magnitude are significant within the meaning of the Act is not disputable.

Sections A and B below thus demonstrate unequivocally that the first two tests OSHA must meet before it can regulate—that the hazard regulated by the standard constitutes material impairment of health or functional capacity and that the risk posed to workers covered by the standard is significant, as that term has been defined in OSHA case law—have been met.

A. Material Impairment

As part of OSHA's threshold determination of significant risk for standards issued under section 6(b)(5) of the Act, OSHA must determine whether exposure to the hazard in question results in ''material impairment of health or functional capacity.'' 29 U.S.C. 655(b)(5). As discussed above in the Health Effects section, the risks posed by exposure to workplace (ergonomic) risk factors are serious and can result in musculoskeletal disorders (MSDs) that cause substantial impairment and permanent disability.

Musculoskeletal disorders represent a set of pathological conditions that impair the normal function of the soft tissue of the musculoskeletal system, such as tendons, muscles, cartilage, ligaments, and nerves. MSDs arise when musculoskeletal soft tissue is subjected to repeated physical stress, usually from repetitive movements, static postures, or continuous loading of tissue structures, which in turn causes gradually accumulating tissue damage. The physical stresses that can contribute to or cause MSDs are called ''risk factors.'' The initial symptoms of MSDs may include fatigue, discomfort, and pain; as tissue damage worsens, other symptoms, such as weakness, numbness, or restricted movement, may also appear. Work-related MSDs occur when the risk factors that cause or contribute to musculoskeletal system pathology are associated with a person's job duties. The disorders represented by the term ''MSDs'' have been referred to by various other names, including ''cumulative trauma disorders,'' ''repetitive strain injury,'' and ''occupational overuse syndrome.'' MSDs do not include musculoskeletal injuries that are clearly caused by accidents, such as a torn Achilles tendon that results from stepping in a hole. Instead, MSDs reflect tissue damage and functional loss that occurs over time from prolonged or frequent exposure to risk factors.

However, some MSDs, particularly those of the back, may appear to be related to acute exposure events although they are actually the result of prolonged exposure to risk factors that has caused gradual tissue deterioration that ultimately led to injury. In other words, although some work-related MSDs may appear to be caused by an acute event (such as a particular lift or movement), the likelihood is high, if such lifts or movements are a routine part of the worker's job, that what appears to be an injury of sudden onset is in fact one of gradual onset. Thus, injuries associated with acute exposure events cannot simply be ruled out as MSDs without determining whether exposure to workplace risk factors may in fact have contributed to the injury. Table VII–1 lists some of the injuries and illnesses that comprise the group of disorders known as MSDs.

Based on the evidence discussed in this and other sections of the preamble, as well as all other evidence gathered by OSHA and placed in the public docket of this rulemaking, OSHA has preliminarily concluded that the musculoskeletal disorders associated with workplace exposure to workplace risk factors constitute material impairments of both health and functional capacity. OSHA recognizes that these disorders are not life-threatening and that some of these disorders may be reversible, particularly if early intervention is provided. Nonetheless, evidence in the record shows that these disorders are debilitating (Brisson *et al.* 1989, Ex. 26–47; Vingård *et al.* 1991, Ex. 26–44; Berg *et al.* 1988, Ex. 26–46; Liss *et al.* 1992, Ex. 26–55; Webster and Snook 1994, Ex. 26–33; Binder and Hazleman 1983, Ex. 26–45; Boshuizen *et al.* 1990, Ex. 26–40; Blanc *et al.* 1996, Ex. 26–42; Liberty Mutual Research Center for Safety and Health, 1998, Ex. 26–54). These disorders cause persistent and severe pain, lost worktime, reduction or loss of the worker's normal functional capacity both in work tasks and in other of life's major activities, loss of productivity, and significant medical expenses. Where preventive action or early medical intervention is not provided, these disorders can result in permanent damage to musculoskeletal tissues, causing such disabilities as the inability to use one's hands to perform even the minimal tasks of daily life (*e.g.,* lifting a child), permanent scarring, and arthritis.

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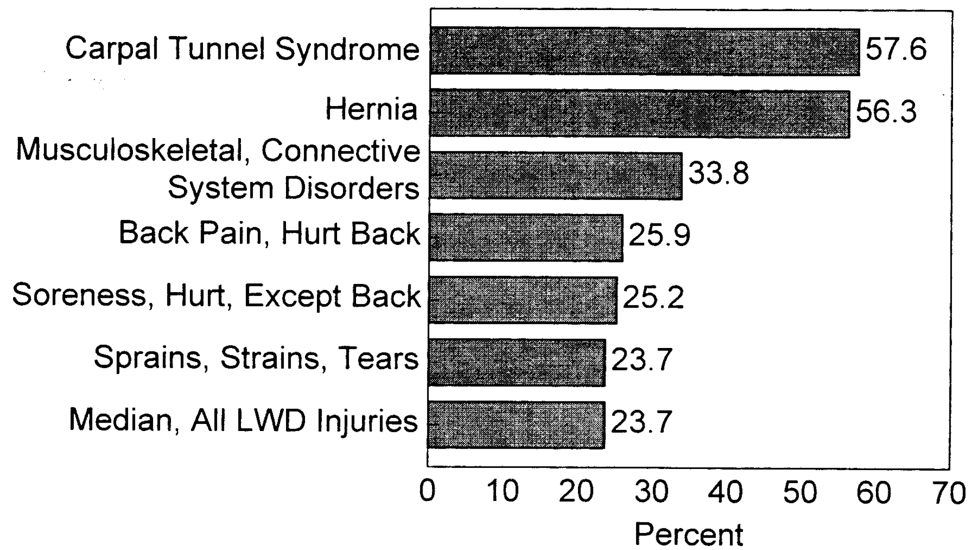
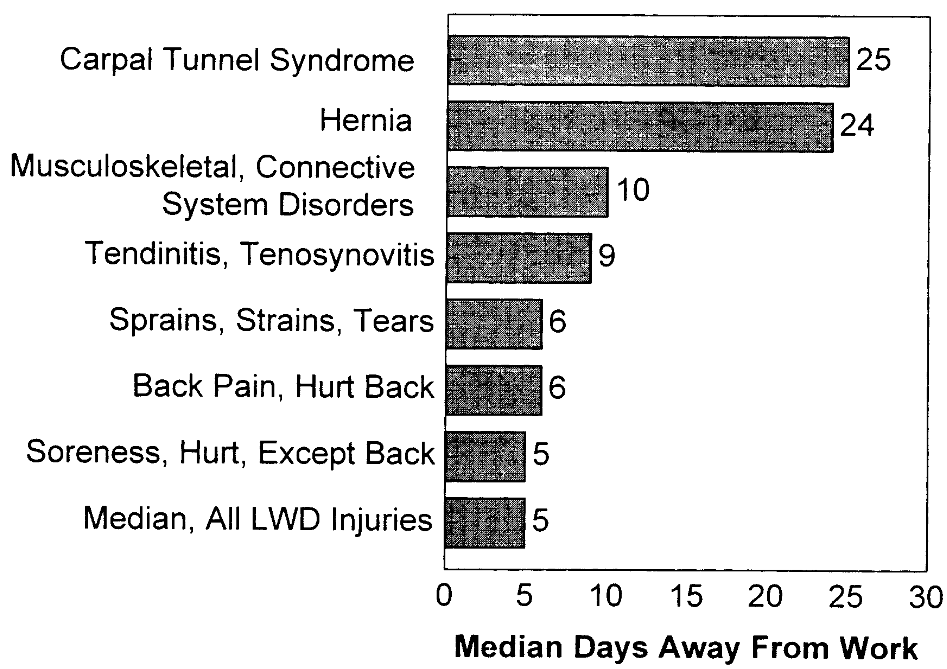
Figure VII-1

Percent of Injuries With More Than 20 Lost Work Days



Median Days Away From Work for Each MSD Category



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The painful and debilitating nature of MSDs is illustrated by several letters from workers who have told the Secretary of Labor and OSHA that they have experienced severe pain, limited work capacity, lost work time, loss of income, and permanent impairment due to overexposure to workplace risk factors (Ex. 26–1263). In addition, these workers have said that the damage and pain have left many of them unable to perform other major life activities, such as walking, cooking, holding children, lifting or grasping objects, or writing (Ex. 26–1263). The pain referred to by these workers is not the normal muscle soreness associated with job break-in or conditioning, or temporary muscle strain due to doing new or unusual tasks. Instead, the pain is severe and persistent. Many employees must be placed on medication to alleviate or at least reduce the intensity of their pain. The pain of MSDs may also continue or may even manifest after the employee is removed from exposure at the end of the workshift (Ex. 26–1263).

Table VII–1.—Examples of Some Types of Musculoskeletal Disorders That are Often Work-Related

—Tension-neck syndrome
—Thoracic outlet syndrome
—Shoulder tendinitis (rotator cuff, bicipital)
—Epicondylitis (elbow)
—Carpal tunnel syndrome (hand-wrist)
—Wrist tendinitis
—Hypothenar hammer syndrome (hand)
—Hand-arm vibration syndrome
—Tenosynovitis
—de Quervain's tendinitis
—Trigger finger
—White finger
—Sciatica, low back pain
—Knee bursitis (carpet layer's knee)

In addition, the pain usually increases if exposure to the ergonomic risk factors continues (Ex. 26–1263). OSHA believes that this type of severe and persistent pain, and the tissue damage underlying this pain, clearly constitutes a material impairment of health under the OSH Act.

Musculoskeletal disorders of most kinds are recognized as compensable under virtually all State workers' compensation plans, and these disorders imposed nearly $20 billion in medical costs and industry payments on the U.S. economy in 1994 (see the Preliminary Economic Analysis section of this preamble). Under workers' compensation, however, employees are reimbursed only where their work-related injury or disorder requires medical treatment and/or results in lost workdays. Moreover, payments for lost wages are not provided unless the employee's injury or disorder results in a certain number of lost workdays (the number varies across the States and ranges from one to seven days). According to evidence presented in the Preliminary Economic Analysis, a significant number of musculoskeletal disorder workers' compensation claims result in lost workdays. For example, according to a study by Webster and Snook (1994, Ex. 26–33) based on workers' compensation data from Liberty Mutual Insurance Company, the largest underwriter of workers' compensation insurance in the country, more than 45 percent of all low back pain cases involved indemnity payments for lost workdays. This study also indicated that, on average, more than 65 percent of the workers' compensation costs for musculoskeletal disorders represented indemnity payments for lost workdays. Overall, work-related low back pain accounts for 15 percent of all Liberty Mutual workers' compensation claims and 23 percent of their costs (Liberty Mutual Research Center for Safety and Health, 1998, Ex. 26–54).

Further evidence of the disabling nature of MSDs comes from the Bureau of Labor Statistics (BLS) data for 1996, which show that the median number of lost workdays (LWD) per recordable lost-time MSD is higher than the median across all lost workday injuries (see Figure VII–1). For example, the median number of lost workdays for cases classified by BLS as carpal tunnel syndrome, tendinitis or tenosynovitis, or musculoskeletal and connective tissue disorders, is 25, 9, and 10 days, respectively. More than one-half of all carpal tunnel LWD cases and one-third of musculoskeletal and connective tissue disorder LWD cases result in more than 20 lost workdays, compared to less than one-fourth of all LWD injuries. Among workers who received compensation awards in 1994 for upper-extremity disorders, the average length of disability was 87 days, with 6.8 percent of the claims covering one-year or more of disability (Liberty Mutual Research Center for Safety and Health, 1998, Ex. 26–54).

Finally, several individual studies provide additional evidence demonstrating the disabling nature of MSDs. A study of female sewing machine operators showed an increased prevalence of disability among both retired and active workers compared to national rates of disability (Brisson *et al.*, 1989, Ex. 26–47). Operators who had left their jobs had a greater rate of severe disability when compared to workers who had left other types of employment. Vingard *et al.* (1991, Ex. 26–44) found an increased risk of early retirement among workers exposed to heavy or medium work loads due to disorders of the lower back, neck/shoulder, hip, or knee. An elevated incidence of long-term absenteeism and disability due to intervertebral disc disorders was found among tractor drivers, with the incidence appearing to increase with whole-body vibration dose and duration (Boshuizen *et al.* 1990, Ex. 26–40). An analysis of data from the National Health Interview Survey showed that repetitive bending of the hand or wrist on the job was significantly associated with the frequency of self-reported carpal tunnel syndrome (CTS), and that work-related disability was common among the 544 subjects reporting CTS. The persistence of symptoms associated with MSDs is illustrated by two other studies. Berg *et al.* (1988, Ex. 26–46) studied the prevalence of MSD symptoms among 327 retired shipyard workers who had been engaged in heavy physical work and found that the prevalence of symptoms remained unchanged over a three-year period. In another study, Binder and Hazleman (1983, Ex. 26–45) followed the health status of 125 patients with lateral epicondylitis over a 1- to 5-year period after initial presentation of the disorder. Over the follow-up period, 40 percent of the patients continued to have discomfort that affected some daily activities.

OSHA has promulgated a wide range of health standards where the adverse health effects associated with exposure to substances or conditions are serious but not necessarily life-threatening, such as health effects that interfere with normal daily life or job performance, or that require substantial medical intervention. *See* Cotton Dust (29 CFR 1910.1046), Occupational Noise Exposure (29 CFR 1910.95), Occupational Exposure to Lead (29 CFR 1910.1025), Occupational Exposure to Formaldehyde (29 CFR 1910.1048). For example, in promulgating the Hearing Conservation Amendment, OSHA determined that ''* * * material impairment of hearing is directly related to people's ability to understand speech as it is spoken in everyday social conditions.* * *'' (46 FR 46236), including being able to understand speech in noisy environments. In the Formaldehyde standard, OSHA based its permissible exposure limit (PEL) and ancillary provisions, in part, on evidence that employees were at significant risk of developing sensory irritation (*e.g.,* burning and tearing of the eyes, severe irritation of the nose and throat) and skin diseases at the existing PEL, and that these effects were sufficiently severe to interfere with the employee's ability to perform job functions (52 FR 46168, 46234–37).

The proposed ergonomics rule is similar to these other OSHA standards in this respect. Work-related musculoskeletal disorders also result in material impairment of functional capacity by causing temporary or permanent physical damage to the body. Such damage can include severe inflammation of joints and tissues; reduced conduction velocity in peripheral nerves; partial or total loss of strength in an extremity; tearing of muscles and tendons; numbness; decreased range of motion; arthritis; and pain. When this damage occurs, employees are unable to perform their jobs at all or at normal performance levels without experiencing pain or causing further damage. Accordingly, OSHA preliminarily concludes that work-related MSDs constitute a material impairment of health.

B. Significant Risk

Section 6(b)(5) of the OSH Act gives the Secretary of Labor authority to issue standards dealing with toxic substances and harmful physical agents. This section provides, in part:

> The Secretary, in promulgating standards dealing with toxic materials or harmful physical agents under this subsection, shall set the standard which most adequately assures, to the extent feasible, on the basis of the best available evidence, that no employee will suffer material impairment of health or functional capacity even if such employee has regular exposure to the hazard dealt with by such standard for the period of his working life. 29 U.S.C. 655(b)(5).

The Supreme Court has said that OSHA may promulgate a standard only if it makes a threshold finding that it is at least more likely than not that the risk OSHA seeks to regulate is ''significant'' and that the change in practices required by the standard would reduce or eliminate that risk. *Benzene,* 448 U.S. at 642. This ''significant risk'' determination constitutes a finding that, absent the change in practices mandated by the standard, the workplaces in question would be unsafe in the sense that workers would be threatened with a significant risk of harm. *Id.* This finding is not unlike the threshold finding that a substance is toxic or that a physical agent is harmful. *Id.,* at 643 n. 48.

In the *Benzene* decision, the Court provided some guidance as to when a reasonable person might consider a risk significant and take steps to decrease it. The Court said:

> Some risks are plainly acceptable and others are plainly unacceptable. If, for example, the odds are one in a billion that a person will die from cancer by taking a drink of chlorinated water, the risk clearly could not be considered significant. On the other hand, if the odds are one in a thousand that regular inhalation of gasoline vapors that are 2 percent benzene will be fatal, a reasonable person might well consider the risk significant and take the appropriate steps to decrease or eliminate it. *Id.,* at 655.

In *Benzene,* the issue before the Court was worker exposure to a cancer-causing agent. OSHA has used the guidelines provided by the Court in setting standards for other carcinogens, such as methylene chloride, butadiene, and ethylene oxide. However, OSHA believes that the Court's guidance is not limited to cancer-causing agents. Material impairment of health refers not only to health outcomes that cause certain death or threaten life, but also to impairment of the employee's ability to engage in the normal activities of life, including work, as a result of workplace events or exposures causing a serious reversible or permanent disorder. Accordingly, OSHA has used the Court's guidelines in setting standards that address such toxic materials and harmful physical agents as cotton dust, occupational noise, and formaldehyde.

The Court indicated that a significant risk finding does not require mathematical precision or anything approaching scientific certainty if the ''best available evidence'' does not allow that degree of proof. *Id.,* at 655–56. The Court also ruled that ''a reviewing court [is] to give OSHA some leeway where its findings must be made on the frontier of scientific knowledge.'' *Id.,* at 656. The Agency is free to use conservative assumptions in interpreting the data, ''risking error on the side of overprotection rather than underprotection.'' *Id.*

> [T]he requirement that a ''significant'' risk be identified is not a mathematical straitjacket. It is OSHA's responsibility to determine, in the first instance, what it considers to be a ''significant'' risk. *Id.*

Thus, the Court said that ''while the Agency must support its findings that a certain level of risk exists with substantial evidence, we recognize that its determination that a particular level of risk is 'significant' will be based largely on policy considerations.'' *Id.,* at 656. The court also said OSHA has considerable leeway in the kinds of assumptions it applies in interpreting the data supporting such a determination. *Id.*

There is no need, in the case of musculoskeletal disorders, for OSHA to engage in risk modeling, low-dose extrapolation, or other techniques of projecting theoretical risk to identify the magnitude of the risk confronting workers exposed to ergonomic risk factors. The evidence of significant risk is apparent in the annual toll reported by the Bureau of Labor Statistics, the vast amount of medical and indemnity payments being made to injured workers and others every year (nearly $20 billion in direct costs and as much as $60 billion more in indirect costs), and the lost production to the U.S. economy imposed by these disorders. Similarly, there is no need for OSHA to turn to complex theoretical projections of reductions in risk to demonstrate that the standard as proposed will substantially reduce this significant risk. Again, the evidence is there for all to see, in the form of hundreds of epidemiological analyses, meta-analyses, and case studies reporting the effectiveness of ergonomic programs in reducing risk. The following discussion, and the analyses presented below, demonstrate the significance of the risk confronting workers in the industries and occupations targeted in the proposed standard and make the case for the standard's effectiveness.

In this rulemaking there are, as mentioned above, extensive data on the adverse effects on the human musculoskeletal system of exposure to workplace risk factors such as repetitive motions; static or awkward postures; and the use of excessive force. As described in the Health Effects and Preliminary Quantitative Risk Assessment sections of this preamble, studies and national statistics are available to demonstrate the high incidence and prevalence of work-related musculoskeletal disorders occurring or existing among workers exposed to ergonomic risk factors. Estimates of the risk of harm confronting exposed workers can be based directly on the rates of work-related musculoskeletal disorders currently being reported, and BLS survey data can be used to demonstrate the degree to which work-related musculoskeletal disorders have occurred across nearly all major industrial sectors and in numerous occupations.

The data used by OSHA to support the proposed ergonomics program rule are similar to the data used to support OSHA safety standards, in that both base their estimates of risk and their case for the effectiveness of the standard on data on injuries being reported in the current workforce. The availability of such data makes it possible to go directly from current rates of injury among workers to an estimate of the likelihood of future harm which could be prevented if a standard were promulgated. In other words, it is not necessary either in the case of OSHA safety standards or in the case of this ergonomics standard to project or estimate risk based on the use of risk models derived from animal data or epidemiological studies. Thus, in the present case, no modeling is needed to make a quantitative assessment of the risk of harm posed to workers exposed to ergonomic risk factors on the job.

The data discussed in the Preliminary Risk Assessment and Health Effects sections of the preamble demonstrate that the risk of work-related musculoskeletal disorders meets the Court's definition of significant risk. For example, OSHA estimates, based on the 1996 BLS data, that more than 647,000 lost-workday (LWD) musculoskeletal disorders were recordable and reported by employers in 1996; these disorders account for more than one-third of all employer-reported LWD injuries. The estimated annual incidence of employer-reported MSDs, defined as the number of MSDs occurring in a given year per 1,000 workers employed in an industry sector or occupation, exceeded 1 LWD case per 1,000 workers for all but a few of the 2-digit SIC general industry groups in 1996; the incidence exceeded 10 LWD cases per 1,000 workers in 15 of these industry sectors (see Table VI–5 in the Preliminary Quantitative Risk Assessment section of the preamble). Further, OSHA estimates that the annual incidence of employer-reported LWD MSDs reached 1 case or more per 1,000 workers for 79 percent of all of the occupational groups for which BLS estimated the numbers of MSDs and employees. For 37 of these occupations, the estimated annual incidence of LWD MSDs exceeded 10 cases per 1,000 workers. For some high risk occupations, such as practical nurses, nursing aides and attendants, laborers, public transportation attendants, and truck drivers, annual incidence rates are on the order of 20 to 40 LWD MSD cases per 1,000 workers per year. These shocking incidence rates, however, are underestimates of the true incidence of MSDs, because they are based only on lost workday cases. OSHA estimates that the number of MSDs that do not result in lost workdays is about twice that of LWD MSDs.

Under section 6(b)(5) of the Act, OSHA has the duty to ensure that no employee suffers material impairment even if that employee has regular exposure to the hazard ''for the period of his working life.'' 29 U.S.C. 655(b)(5). The probability that an employee will suffer at least one musculoskeletal disorder due to workplace risk factors over a 45-year working lifetime is much higher than the risk reflected in the one-year rates presented above. Therefore, in the Preliminary Quantitative Risk Assessment section of this preamble, OSHA also evaluated the risk to exposed employees of incurring a LWD MSD over a 45-year working lifetime. The results are presented by 2-digit SIC industry group in Table VI–7 of the Preliminary Risk Assessment. The probability of experiencing at least one LWD MSD during a working lifetime ranges from 24 per 1,000 workers (in SIC 62, Security and Commodity Brokers, Dealers, Exchanges, and Services) to 813 per 1,000 workers (in SIC 45, Air Transportation). Among the 58 industry groups for which BLS provided estimates of the number of MSDs reported in 1996, the median lifetime risk of experiencing at least one LWD MSD is 255 per 1,000 workers, and for only 8 of these industry groups is the estimated lifetime risk below 100 cases per 1,000 workers. The expected number of MSDs that will occur in a cohort of workers all entering an industry at the same time and working for 45 years ranges from 24 per 1,000 workers to 1,646 per 1,000, depending on the industry sector, since it possible for a worker to experience more than one MSD in a working lifetime.

Although these data indicate that the risk of experiencing an MSD is clearly significant, OSHA believes that these data seriously understate the true risk. First, the BLS data capture only those MSD injuries reported by employers as lost workday injuries. MSDs that force an employee to be temporarily assigned to alternate duty, as well as those work-related MSDs not reported to employers by employees or not recorded by employers, are not included in these risk estimates. In addition, OSHA's estimated incidences of MSDs, which are derived from the BLS data, do not reflect the true risk posed to employees who are exposed to risk factors at work because the BLS-based incidence estimates are based on the risk confronting the entire working population, both exposed and non-exposed. Clearly, the risk of experiencing a work-related MSD is considerably higher among that subset of workers exposed to risk factors in their jobs than it is for the rest of the working population (the ''unexposed'' population). In other words, the risk posed to workers in the operations and jobs targeted by OSHA's proposed ergonomics standard is much higher, in general, than the risk posed to workers in non-targeted jobs and occupations. The method used by BLS to calculate the incidence of MSD's (*i.e.*, using the full working population as the denominator) is not unique to these kinds of injuries, but is the standard approach used by BLS to report the incidences of all kinds of injuries and illnesses.

There is also evidence that the actual risks attributable to occupational exposure to ergonomic risk factors may be much higher than is indicated by the BLS statistics. Many peer-reviewed studies have been published in the scientific literature in the last 18 years that document underreporting of MSDs in OSHA logs (McCurdy *et al.*, 1999, Ex.; Cannon *et al.*, 1981; Mazlish *et al.*, 1995; Silverstein *et al.*, 1997; Biddle *et al.*, 1998; Fine *et al.*, 1986; Pransky *et al.*, 1999; Park *et al.*, 1992; Park *et al.*, 1996; Nelson *et al.*, 1992). Table VII–2 below summarized these studies. These studies document extensive and widespread underreporting on the OSHA log of occupational injuries and illnesses (McCurdy *et al.*, 1999) and of MSDs (Silverstein *et al.*, 1997; Biddle *et al.*, 1998; Fine *et al.*, 1986; Pransky *et al.*, 1999; Park *et al.*, 1992; Park *et al.*, 1996; Nelson *et al.*, 1992). They also demonstrate that a large percentage of workers whose MSDs were identified as work-related by health care providers do not file workers' compensation claims (Biddle *et al.*, 1998; Cannon *et al.*, 1981; Fine *et al.*, 1986). In one early study, only 47 percent of workers with medically diagnosed cases of carpal tunnel syndrome (CTS) filed claims (Cannon *et al.*, 1981). Fine and his co-authors (1986) demonstrated that, in two large automobile manufacturing plants, workers' compensation claims were filed in less than 1 percent of medically confirmed cumulative trauma cases in one plant and in only 14 percent of such cases in another. A recent study of 30,000 Michigan workers who were identified by a healthcare provider as having a work-related injury showed that only 9 to 45 percent of workers filed a workers' compensation claim for their injuries (Biddle *et al.*, 1998). The reasons why as many as 50 percent of injured workers are not reporting their musculoskeletal injuries and other injuries and illnesses to their employers or seeking compensation for their work-related conditions are many. According to the authors of these studies, workers feared reprisal for reporting, were discouraged from reporting by their supervisors or managers, were discouraged from making a workers' compensation claim by the high rates of claims rejection for MSDs, wanted to avoid the ''hassle'' of filing a workers'' compensation claim, or preferred (or were encouraged by their employers) to use the employer's or their own health insurance rather than the workers' compensation insurance system. Because of this evidence pointing to the substantial underreporting of MSDs, and given that the BLS data derives from employers' reports of lost-time injuries and illnesses, OSHA believes that the risk of lost-time, work-related MSDs as quantified from the BLS data are understated by at least a factor of two.

Table VII–2.—Summary of Underreporting Studies

STUDY	MEASURE OF UNDER-REPORTING	EXTENT OF UNDER-REPORTING OBSERVED	COMMENTS
McCurdy, Schenker, and Samuels, *Am. J. Public Health.* 81:85 (1999, Ex. 2–2)	Percentge of cases meeting OSHA reporting criteria not recorded on OSHA log	40% of all reportable cases not recorded; for illnesses, 56% not recorded	10 manufacturing facilities in 6 states from semiconductor industry with approx. 50,000 employees; 24% of cases met OSHA criteria.
NIOSH. Health Hazard Evaluation Report, HETA 93–0233–2498, (1995, Ex. 26–1255)	Failure to report lost workdays and restricted work OSHA 200	Not quantified; ''several'' employees had surgeries for WMSDs in 5-year period and ⅓ of employee were on restricted work, but no LWDIs reported on Log over 5-year period	Winding and taping department of an instrument transformer manuacturer; 27 employees in department.
NIOSH. Health Hazard Evaluation Report, HETA 93–0860–2438, (1994, Ex. 26–1256)	Percent of medically confirmed WMSD cases not recorded on OSHA log or not reported to employer	5 employees reported to NIOSH that they had been diagnosed with carpal tunnel syndrome (CTS); of these, 2 did not report their illness to the employer. 1 of the 5 reported cases were not reported on log	News department of large metropolitan TV-news station; video tape editing and other employees.
Cannon, Bernacki, and Walter, *JOM.* 23:255 (1981, Ex. 26–1212)	Percent of employees diagnosed with work-related carpal tunnel syndrome (CTS) over 2 years not filing workers' compensation claims	16/30 diagnosed employees received workers' compensation benefits for CTS. Others did not file	Four aircraft manufacturing plants; approx. 20,000 employees.
Mazlish, Randolph, Dervin, and Sankaranarayan, *Am. J. Ind. Med.* 27:715 (1995, Ex. 26–1186)	A new survellance system for work-related carpal tunnel syndrome (CTS) was implemented in Santa Clara county, California under the NIOSH SENSOR program. Its findings were compared to physicians' first reports filed under a State of California surveillance system in place since 1973	For the years 1987–1989, SENSOR identified 141 cases. Of these, only 19 cases could be found in doctors' first reports	The population at risk for CTS covered by SENSOR is the entire working population of Santa Clara county. The working population was not reported in the article, but the total population in the county was 1.4 million in 1987.
California Department of Health Services. Surveillance Report SR–88–002 (1990, Ex. 26–1257)	Telephone and mail survey of 515 health care providers in Santa Clara County, California, who estimated carpal tunnel syndrome (CTS) caseloads. Estimates were compared to physicians' first reports filed under a State of California surveillance system in place since 1973	For 1987, respondents estimated that they cared for 3,413 cases of work-related CTS. Only 71 occupational CTS cases were reported in the county through doctor's first reports	The working population in Santa Clara county was not reported in the document, but the total population in the county was 1.4 million in 1987.

Table VII–2.—Summary of Underreporting Studies—Continued

STUDY	MEASURE OF UNDER-REPORTING	EXTENT OF UNDER-REPORTING OBSERVED	COMMENTS
Silverstein, Stetson, Keyserling, and Fine, *Am. J. Ind. Med.* 31:600 (1997, Ex. 26–28)	Incidence (per 100 worker years) of work-related MSDs reported on OSHA 200 logs compared with cases that received medical treatment, as identified by self-administered questionnaire	Plant/year — OSHA 200 log — Self-report Plant 1 1986 — 1.0 — 30.9 1987 — 2.7 1988 — 6.9 Plant 2 1986 — 0.9 — 40.9 1987 — 11.9 1988 — 21.4 Plant 3 1986 — 20.3 — 47.8 1987 — 14.6 1988 — 19.3 Plant 4 1986 — 0.7 — 24.5 1987 — 2.1 1988 — 9.9	Four automobile manufacturing plants. 713 out of 948 workers selected for the study completed the questionnaire.
Biddle, Roberts, Rosenman, and Welch, *JOEM*. 40:325 (1998, Ex. 26–1258)	Percentage of workers identified by a health care provider (HCP) as having a known or suspected occupational illness who filed for workers' compensation	Percentage of HCP-identified cases for which corresponding workers' compensation claim was identified ranged from 9% (almost certain match between HCP case and claims case) to 45.6% (possible match between HCP case and claims case)	Study of 30,000 Michigan workers identified as having work-related illness by an HCP.
	Percentage of workers with sprains or strains who filed for worker's compensation	Percentage of HCP-identified cases for which corresponding workers' compensation claim was identified ranged from 11.6% (almost certain match between HCP case and claims case) to 46.9% (possible match between HCP case and claims case)	
	Percentage of workers with carpal tunnel syndrome (CTS) who filed for workers' compensation	Percentage of HCP-identified cases for which corresponding workers' compensation claim was identified ranged from 22.6% (almost certain match between HCP case and claims case) to 62.5% (possible match between HCP case and claims case)	

Table VII–2.—Summary of Underreporting Studies—Continued

STUDY	MEASURE OF UNDER-REPORTING	EXTENT OF UNDER-REPORTING OBSERVED	COMMENTS
Fine, Silverstein, Armstrong, Anderson, and Sugano, *JOM,* 28:674 (1986, Ex. 26–920)	Incidence (per 100 worker-years) of upper-extremity MSDs reported in OSHA 200 logs compared with workers' compensation (WC), medical absence records (MAR) and medical case records (MCR)	Plant / OSHA 200 / WC / MAR / MRC B / 0.03 / 0.29 / 3.04 / 2.03 C / 0.15 / 0.45 / 1.85 / 13.98	Data from two large automobile manufacturing plants (total employment not reported).
Pransky, Snyder, Dembe, and Himmelstein, *Ergonomics,* 42:171 (1999, Ex. 26–922)	Percent of workers reporting musculoskeletal symptoms caused or aggrevated by work, compared to OSHA log entries	Work-related Symptom / % reporting / % in log Hand/Wrist / 86% / 6% Arm / 33% / 1% Neck / 21% / 0 Back/legs / 28% / 2% 9% of workers reported that symptoms resulted in lost work days over the past year. 6% reported they were formally assigned light-duty work by plant nurse. 15% reported sumptoms resulted in informal light-duty work arranged by co-workers	Questionnaire administered to 110 packers, of whom 98 reponded. Plant produces variety of children's products.
Park, Krebs, and Mirer, *JOEM*, 38:1111 (1996, Ex. 26–1261)	Number of claims made in a sickness and accident (S&A) disability (sick leave) system compared to lost-work-day (LWD) injuries and illnesses recorded in OSHA log	Only 7 of an estimated 47 (15%) S&A upper extremity LWD cases in 1992 were recorded on the OSHA log. For LWD back injuries, 27 of an estimated 36 (75%) S&A cases were recorded	Study of an automotive assembly and stamping complex employing 10,000 workers.
Park, Nelson, Silverstein, and Mirer, *JOM.* 34:731. (1992, Ex. 26–1259)	Medical insurance claims linked to work histories compared to OSHA logs	From 1984 to 1987, OSHA logs failed to record between 20 and 80 percent of occupational MSDs	Conclusion based on authors' own unpublished data from insurance records of five automotive manufacturing plants. These records identified 11,577 MSD health claims made by 3,204 workers.
Nelson, Park, Silverstein, and Mirer, *Am. J. Public Health.* 82:1550 (1992, Ex. 26–1260)	Medical insurance claims linked to work histories compared to OSHA logs	From 1985 through 1986, OSHA logs identified 59 hand/wrist MSD cases compared to 150 cases identified in health insurance records. For all MSDs from 1984 through 1987, only 9% of cases identified through insurance claims were recorded on OSHA logs (the authors cite data from Parks *et al.* (1992) indicating that about half of upper extremity MSD cases from insurance claims are attributable to work)	

In addition to the BLS data, epidemiologic studies comparing the prevalence or incidence of MSDs in exposed populations with the prevalence or incidence in referent groups with lesser or no such exposure also document the elevated risk confronting employees exposed to workplace risk factors. These studies also identify the types of workplace risk factors associated with the development of work-related musculoskeletal disorders, as well as the duration of exposures found to be associated with the disorders. This information further supports the occupational origin of the reported disorders.

For example, the odds of having an upper extremity disorder like carpal tunnel syndrome or tendinitis/peritendinitis of the shoulder or wrist are 5–30 times greater among workers exposed to combinations of risk factors such as high force, repetition and awkward postures (*e.g.*, overhead work) compared either to unexposed workers or workers who are exposed to a single risk factor (*e.g.*, Luopajarvi *et al.*, 1979, Ex. 26–56; Armstrong *et al.*,1987, Ex. 26–48; Silverstein *et al.*, 1987, Ex. 26–34; deKrom *et al.*, 1990, Ex. 26–41; Herberts *et al.*, 1984, Ex. 26–51). The odds of experiencing a low back disorder increased 3–8 fold among those workers exposed to frequent or forceful manual handling, awkward trunk postures (such as severe forward flexion), or to whole body vibration (Liles *et al.*, 1984, Ex. 26–33; Kelsey *et al.*, 1990, Ex. 26–52; Punnett *et al.*, 1991, Ex. 26–39; Wikstrom *et al.*, 1994, Ex. 26–61; Tanaka *et al.*, 1995, Ex. 26–59). Hip and knee disorders are associated with heavy physical work and awkward postures, such as kneeling and squatting, or using the knee as a kicker. Thun *et al.* (1987, Ex. 26–60) reported an increased risk of bursitis in carpet-layers that was 5 times higher than that of the unexposed workers. In a review of 4 studies, Hagberg and Wegman (1987, Ex. 26–32) estimated the work-attributable fraction of shoulder tendinitis in the exposed population to be 90%. In a review of 15 cross-sectional and 6 case control studies of carpal tunnel syndrome, Hagberg *et al.* (1992, Ex. 26–50) estimated the work-attributable fraction in the population exposed to high force, high repetition, vibration or awkward wrist/hand postures to be 50–90%. Olsen *et al.* (1994, Ex. 26–57) estimated that 40% of the cases of coxarthrosis (osteoarthrosis of the hip) seen in the exposed working population was due to heavy physical workload. Thus, in general, strong and consistent associations have been identified in the epidemiologic literature, primarily in cross-sectional and case control studies, but also in prospective studies (*e.g.*, Kurppa *et al.*, 1991, Ex. 26–53; Riihimaki *et al.*, 1994 Ex. 26–58; Felson *et al.*, 1991, Ex. 26–49). Exposure-response relationships have been identified in a number of studies, although precise quantitative modeling is not yet available.

Based on the various data and studies discussed in the Preliminary Risk Assessment and Health Effects sections of the preamble, OSHA preliminarily finds that workers exposed to workplace risk factors are at significant risk of developing work-related musculoskeletal disorders, which are harmful and often disabling conditions. This is particularly true for workers who are exposed to a combination of risk factors over most of the workshift.

The data indicate that this proposed rule would, if promulgated, cause employers to implement, for their problem jobs, interventions that would reduce the exposure of at-risk workers to workplace risk factors, and thus would substantially reduce significant risk. Specifically, the proposed requirements to conduct job analyses and implement controls where exposure to risk factors is high (*i.e.*, for manufacturing jobs, manual handling operations, and other jobs where a work-related MSD has occurred) would help to ensure that employees are exposed to fewer risk factors over time, or to a combination of risk factors for a lesser amount of time, than is now the case. A large body of data demonstrates that workplace interventions, such as job analysis to identify risk factors and implementation of controls to reduce exposures to these risk factors, can be very effective in reducing those forces responsible for musculoskeletal disease and injury; this has been shown in studies that have quantitatively examined the impact of ergonomic interventions on exposures to risk factors, as well as studies and reports that have documented actual reductions in injury prevalence following the implementation of ergonomics programs. Several of the proposed standard's ancillary provisions, such as MSD management and training, will provide additional protection against the significant risk that will remain after controls are implemented in problem jobs.

C. Preliminary Conclusions

OSHA preliminarily concludes, based on the evidence discussed above and elsewhere in the record, that the scientific data are sufficient to demonstrate that exposure to work-related risk factors is associated with the development of musculoskeletal disorders of the upper extremities, back, and lower extremities. Risk factors identified from this body of literature include repetitive motions; use of excessive force; segmental and whole-body vibration; maintaining awkward postures of the neck, wrists, arms, trunk, and lower-extremities; lifting, lowering, pushing, carrying, and pulling loads of excessive weight; and exposing extremities to temperature extremes. Depending on the specific combinations of risk factors encountered in the workplace, musculoskeletal disorders identified as being work-related include nerve entrapments such as carpal tunnel syndrome (hand, wrist), trigger finger (hand), De Quervains' disease (wrist), tendinitis (hand, wrist, shoulder, ankle), epicondylitis (elbow), rotator cuff tendinitis (shoulder and neck), sciatica (lower back), osteoarthritis (hip, knee), bursitis (knee), and tarsal tunnel syndrome (foot).

The evidentiary base on which OSHA relies in making these preliminary conclusions is described fully in the Health Effects section of the preamble. This evidence is comprised of several hundred cross-sectional, case-control, prospective and case series reports of working populations in a variety of industrial settings. Supplementing these reports is a large body of scientific literature that provides data on the mechanisms by which exposure to these risk factors causes musculoskeletal disorders; these data demonstrate the biological plausibility of the relationship between exposure to workplace risk factors and an elevated risk of MSD injury and illness.

MSDs have been recognized as compensable under virtually all State workers' compensation plans, although some states limit the kinds of MSDs considered compensable. Workers' compensation system recognition of the work-relatedness of many MSDs further demonstrates the link between these disorders and risk factors on the job. Taken together, OSHA believes that the scientific and other evidence described in the preamble to this proposed rule constitute an evidentiary base of unusually depth and quality.

Accordingly, OSHA preliminarily concludes that musculoskeletal disorders associated with workplace exposure to workplace risk factors constitute material impairments of health under the OSH Act. Further, as demonstrated by the evidence discussed in Section B above, the data available to the Agency demonstrate clearly that workers in the occupations and industries covered by the proposed ergonomics program standard are at significant risk of experiencing a work-related MSD over their working lifetime; for many occupations and industries, they are at significant risk of experiencing a work-related MSD even in a single year of work in their job.

VIII. Summary of the Preliminary Economic Analysis and Regulatory Flexibility Analysis

A. Introduction

OSHA's Preliminary Economic and Regulatory Flexibility Analysis addresses issues related to the costs, benefits, technological and economic feasibility, and the economic impacts (including small business impacts) of the Agency's proposed ergonomics program rule. The analysis also evaluates regulatory and non-regulatory alternatives to the proposed rule. This rule is a significant rule under Executive Order 12866 and has been reviewed by the Office of Information and Regulatory Affairs in the Office of Management and Budget, as required by the executive order. In addition, this economic analysis meets the requirements of both Executive Order 12866 and the Regulatory Flexibility Act (as amended in 1996). The complete Preliminary Economic and Regulatory Flexibility Analysis has been entered into the rulemaking docket as Exhibit 28–1. The remainder of this section of the Preamble summarizes the results of that analysis.

The purpose of this Preliminary Economic and Regulatory Flexibility Analysis is to:

- Identify the establishments and industries potentially affected by the proposed rule;
- Estimate the benefits of the rule in terms of the reduction in musculoskeletal disorders (MSDs) employers will achieve by coming into compliance with the ergonomics program standard and some of the direct cost savings associated with those reductions;
- Evaluate the costs, economic impacts and small business impacts establishments in the regulated community will incur to establish ergonomics programs to achieve compliance with the proposed standard;
- Assess the economic feasibility of the rule for affected industries;
- Evaluate the principal regulatory and non-regulatory alternatives to the proposed rule that OSHA has considered;
- Present the Initial Regulatory Flexibility analysis for the proposed rule; and
- Respond to the findings and recommendations made to OSHA by the Small Business Regulatory Enforcement Fairness Act (SBREFA) Panel convened for this proposed standard.

The Preliminary Economic Analysis contains the following chapters:

Chapter I, Introduction
Chapter II, Industrial Profile
Chapter III, Technological Feasibility
Chapter IV, Benefits
Chapter V, Costs of Compliance
Chapter VI, Economic Feasibility
Chapter VII, Economic Impacts and Initial Regulatory Flexibility Analysis
Chapter VIII, Assessment of Non-Regulatory Alternatives.

B. Introduction and Industrial Profile (Chapters I and II)

The proposed ergonomics program standard was developed by OSHA in response to the large number of work-related musculoskeletal disorders of the upper extremities, back, and lower extremities that are threatening the health and well-being of many U.S. workers. Musculoskeletal disorders affect workers in almost every occupation and industry, regardless of establishment size, nature of work (clerical, professional, skilled, or unskilled), or industry sector. This is the case because work-related musculoskeletal disorders are caused or aggravated by risk factors—such as repetitive motion, forceful exertion, vibration, and awkward postures—that are present, either alone or in combination, in many jobs. The large number of musculoskeletal disorders—647,000 MSDs resulting in at least one day away from work in 1996, according to Bureau of Labor Statistics (BLS) data [5]—is largely explained by the continued reliance on unassisted lifting, carrying, and pushing/pulling of loads; the increasing specialization of work; and the faster pace of work (Ex. 26–1413).

Because these characteristics of work are not unique to the United States, countries of every size and on every continent are also experiencing significant numbers of musculoskeletal disorders among their workforces. Many of these countries—ranging from the United Kingdom and Sweden to Pakistan, Ecuador, and South Africa—have already established regulatory requirements designed to address some or all of the workplace risk factors giving rise to these disorders. A table summarizing the ergonomics rules and guidelines issued by other countries and organizations can be found in Chapter I of the Preliminary Economic Analysis.

To reflect the ubiquitous nature of MSD hazards in the workplace, the scope of the proposed standard potentially encompasses all workplaces within general industry. However, the scope of the proposed standard is tiered in a way that matches the extent of the ergonomics program required to the extent of the risk in different establishments.

The proposed ergonomics program standard allows employers whose employees are engaged in manual handling or manufacturing operations but have not experienced an MSD that is covered by the standard to implement only a basic program, while employers whose employees work in jobs where there has been at least one covered MSD must implement the full program. The full program requirements apply to any employer in general industry whose employees experience a covered MSD, not just to those whose establishments engage in manual handling or manufacturing operations. Many employers have found that ergonomics programs that have certain elements and provide a framework to systematically consider and address work-related MSDs can substantially reduce the number and severity of these MSDs, as well as the costs associated with them. There is widespread agreement that successful ergonomics programs include the following elements in some form:

- Management leadership and employee participation
- Hazard information and employee reporting
- Medical management (called ''MSD management'' in the proposed rule)
- Job hazard analysis and control
- Training
- Program evaluation.

The proposed standard adopts a tiered approach to program implementation and is job-based. This means that

[5] BLS reports that, in 1997, this number has fallen by about 3% since 1996, to 626,000 lost workday cases. However, in this analysis, OSHA relies on the BLS data for 1996, because the detailed breakdowns of the 1997 data needed for this economic analysis are not yet available.

general industry establishments whose employees work in jobs that have a lower probability of incurring an MSD would not be required to take any action until an MSD has occurred. Moreover, further action would only be triggered if the MSD is determined to be one that is recordable under the OSHA recordkeeping standard and, in addition, is determined by the employer to be the kind of MSD associated with risk factors that are a core element or significant part of the employee's regular job duties. Establishments whose employees have a higher probability of incurring a covered MSD, *i.e.*, those with employees engaged in manufacturing production operations or manual handling jobs, would be required to implement a basic ergonomics program for those jobs. The basic program essentially sets up an ergonomics surveillance system by establishing a way for employees to report MSDs as early as possible, providing them with the information they need to recognize MSDs and MSD hazards, and putting in place the management structure and employee participation mechanisms of an effective ergonomics program.

The full program requires the employer to analyze and control the ''problem'' job (*i.e.*, the job held by the injured employee and other jobs in the workplace that involve the same physical work activities), to provide affected employers and their supervisors with training, and to evaluate their programs periodically. The full program is only required for those jobs where a covered MSD has occurred and those jobs that are essentially the same, with respect to physical work activities, as the job held by the injured employee. In addition, if no covered MSD occurs in a previously controlled job for three years, the establishment is permitted by the standard to drop back to the basic program (if the establishment has employees who are engaged in manufacturing or manual handling operations) or to a program involving only maintenance of the controls in the problem job and any associated employer training (if the establishment does not have employees engaged in manufacturing operations or manual handling).

The basic program includes those elements that are appropriate to workplaces where problem jobs have not yet been identified:

- Management leadership, including allocation of resources, information and training for responsible managers or supervisors, and assignment of program responsibilities;
- Establishment of an employee reporting system and protection against discrimination for employees participating in the program or reporting MSD hazards;
- Providing employees with the information they need to recognize the signs and symptoms of MSDs and MSD hazards; and
- Employer determination of the recordability of the MSD and the relatedness of the MSD to the particular employee's job (to determine whether the MSD is one covered by the standard at all).

Once a covered MSD has been identified, a full program is required. However, even the full program may not be necessary in some circumstances when such an MSD is identified. For example, if the means of controlling the job giving rise to the MSD are obvious and the MSD hazard can be eliminated entirely, the employer may choose the standard's Quick Fix option and is not required to implement the full program for that job.

To determine the number of establishments within the scope of the standard, OSHA needed to obtain data on the number of establishments with employees engaged in manufacturing operations or manual handling, and the number of establishments without employees engaged in these activities who would be brought under the standard as a result of having an MSD. OSHA assumed that all establishments in the manufacturing sector would have employees engaged in manufacturing operations. OSHA estimated the number of establishments engaged in manual handling on the basis of responses to a question on a 1993 ergonomics survey conducted by OSHA. The question asked general industry employers whether any of their employees engaged in lifting more than 25 pounds. Because lifts of 25 pounds or more would not necessarily qualify as a manual handling job under the proposed standard, reliance on the survey responses to estimate the number of establishments with manual handling jobs may mean that OSHA's estimates of the number of such establishments may be high. To determine the likelihood that an establishment would have an employee who would incur an MSD, OSHA needed to determine the rate of MSDs by industry. BLS provided OSHA with data on the rates of lost workday MSDs by industry but does not have data on the rates of all MSDs, including MSDs involving restricted work only and those involving no lost worktime (Ex. 26–1413). In this analysis, OSHA estimates the rate of all MSDs on an industry-by-industry basis. To obtain the total MSD rate for each industry (including lost workday MSDs, restricted work MSDs, and non-lost workday MSDs), OSHA multiplied the reported rate of MSDs involving days away from work by the industry-specific ratio of the rate of all injuries and illnesses involving days away from work to the rate of all injuries and illnesses. The number of reported lost workday MSDs in each industry was then multiplied by this ratio to obtain the total MSD rate for each industry.

Table VIII–1, based on data from *County Business Patterns* for 1996, shows the three-digit industries covered by the standard and the number of employees and establishments in each covered industry within the general industry sector (Ex. 28–2). Table VIII–1 also shows the estimated annual incidence rates for all MSDs (lost workday, restricted work, and non-lost workday) for each industry. (These rates differ from those shown in the risk assessment section of the Preamble because they include an estimate of all MSDs, rather than lost workday MSDs only, and because they use *County Business Patterns* estimates of industry employment in computing MSD rates.) Table VIII–1 shows that the total MSD incidence rates in general industry range as high as 3,434 per 10,000 workers (in Truck Terminal and Joint Terminal Maintenance Facilities for trucks (SIC 423)). A total of about 6 million establishments and 93 million employees are present in general industry.

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Table VIII-1: Estimated Number of Establishments and Employees and Estimated Annual Incidence of All MSD's, by 3-Digit SIC

SIC Industry	Total Number of Establishments	Total Number of Employees in all Establishments	Total MSD Incidence Rate (per 10,000 workers)
Agriculture, Forestry, and Fishing, Excluding 01 and 02			
710 Soil Preparation Services, 0710	641	5,415	238
720 Crop Services, 0720	4,133	46,943	412
740 Veterinary Services, 0740	22,807	174,576	112
750 Animal Services Except Veterinary, 0750	10,369	42,832	71
780 Landscape & Horticultural Services, 0780	68,157	345,871	268
810 Timber Tracts, 0810	862	7,025	202
830 Forest Nurseries, 0830	137	2,082	234
850 Forestry Services, 0850	1,568	12,265	135
910 Commercial Fishing, 0910	1,947	8,850	167
920 Fish Hatcheries & Preserves, 0920	95	1,465	167
970 Hunting, Trapping, & Game Propagation, 0970	339	1,650	172
Oil and Gas Extraction			
1310 Crude Petroleum & Natural Gas, 1310	7,758	83,909	74
1320 Natural Gas Liquids, 1320	560	12,814	110
1380 Oil Gas Field Services, 1380	8,764	159,639	152
Manufacturing			
2010 Meat Products, 2010	3,080	458,861	761
2020 Dairy Products, 2020	1,881	134,051	496
2030 Canned, Frozen, Preserved Fruits, Vegetables, Specialties	2,016	183,797	410
2040 Grain Mill Products, 2040	2,603	109,406	520
2050 Bakery Products, 2050	3,523	230,724	402
2060 Sugar & Confectionery Products, 2060	1,098	86,710	357
2070 Fats & Oils, 2070	507	26,512	311
2080 Beverages, 2080	2,286	144,328	703
2090 Miscellaneous Food Preparations & Kindred Products	4,007	165,889	453
2110 Cigarettes, 2110	15	20,498	319
2120 Cigars, 2120	47	2,737	119
2130 Chewing & Smoking Tobacco & Snuff, 2130	26	2,479	288
2140 Tobacco Stemming & Redrying, 2140	32	5,055	331
2210 Broadwoven Cotton Fabric Mills, 2210	412	50,459	844
2220 Broadwoven Manmade Fiber & Silk Mills, 2220	458	79,013	257
2230 Broadwoven Wool Fabric Mills, 2230	99	13,628	224
2240 Narrow Fabric Mills, 2240	277	17,608	558
2250 Knitting Mills, 2250	1,945	177,354	355
2260 Dyeing & Finishing Textiles Except Wool, 2260	852	53,437	372
2270 Carpets & Rugs, 2270	484	52,137	246
2280 Yarn & Thread Mills, 2280	588	82,102	322
2290 Miscellaneous Textile Mills, 2290	1,010	54,492	329
2310 Men'S & Boys' Suits, Coats, & Overcoats, 2310	293	30,229	338
2320 Men'S & Boys' Furnishings, Work Clothing, Etc., 2320	2,112	211,208	455
2330 Women'S, Misses', & Juniors' Outerwear, 2330	8,954	249,317	206
2340 Women'S, Misses', Children'S & Infants' Undergarments	372	35,283	365
2350 Hats, Caps, & Millinery, 2350	381	18,675	273
2360 Girls', Children'S, & Infants' Outerwear, 2360	585	36,315	233
2370 Fur Goods, 2370	133	550	273
2380 Miscellaneous Apparel & Accessories, 2380	933	30,771	317
2390 Miscellaneous Fabricated Textile Products, 2390	8,797	220,100	310
2410 Logging, 2410	14,273	86,675	67
2420 Sawmills & Planing Mills, 2420	6,103	167,103	401
2430 Millwork, Veneer, Plywood, & Structural Wood Members	9,548	254,660	553
2440 Wood Containers, 2440	2,830	48,027	401
2450 Wood Buildings & Mobile Homes, 2450	1,044	82,857	678
2490 Miscellaneous Wood Products, 2490	3,536	91,967	367
2510 Household Furniture, 2510	5,500	263,791	460

Table VIII-1: Estimated Number of Establishments and Employees and Estimated Annual Incidence of All MSD's, by 3-Digit SIC (Continued)

SIC	Industry	Total Number of Establishments	Total Number of Employees in all Establishments	Total MSD Incidence Rate (per 10,000 workers)
2520	Office Furniture. 2520	1,033	70.867	509
2530	Public Building & Related Furniture, 2530	449	34.886	1,448
2540	Partitions, Shelving, Lockers, & Office & Store Fixtures, 2540	2,996	80.751	507
2590	Miscellaneous Furniture & Fixtures, 2590	1,412	45.588	319
2610	Pulp Mills, 2610	62	15.349	138
2620	Paper Mills, 2620	344	121.373	360
2630	Paperboard Mills, 2630	228	54.165	155
2650	Paperboard Containers & Boxes, 2650	2.809	206.643	327
2670	Convrtd Paper & Pprbrd Prods, Excpt Containers & Boxes	3.033	227.539	303
2710	Newspapers: Publishing, Or Publishing & Printing, 2710	8,878	395.716	196
2720	Periodicals: Publishing, Or Publishing & Printint, 2720	5,781	117,880	117
2730	Books, 2730	3,559	135.942	206
2740	Miscellaneous Publishing, 2740	3,259	61,716	122
2750	Commercial Printing, 2750	34.435	587,534	226
2760	Manifold Business Forms, 2760	911	45.341	359
2770	Greeting Cards. 2770	143	19.958	434
2780	Blankbooks, Binders, & Bookbinding & Related Work	1,583	63,356	317
2790	Service Industries For The Printing Trade, 2790	3,436	56.387	113
2810	Industrial Inorganic Chemicals, 2810	1,390	85,705	163
2820	Plastics Materials & Synthetic Resins, Except Glass, 2820	876	117,868	163
2830	Drugs, 2830	1.637	207.295	193
2840	Soaps, Detergents, Cleaning Preparations, Perfumes, etc.	2,434	120.815	237
2850	Paints, Varnishes, Lacquers, Enamels, 2850	1,479	52,183	264
2860	Industrial Organic Chemicals, 2860	946	121,918	120
2870	Agricultural Chemicals, 2870	938	40,431	152
2890	Miscellaneous Chemical Products, 2890	2,566	86,431	263
2910	Petroleum Refining, 2910	275	70,045	107
2950	Asphalt Paving & Roofing Materials, 2950	1,368	24,390	294
2990	Miscellaneous Products Of Petroleum & Coal, 2990	466	13.874	101
3010	Tires & Inner Tubes, 3010	171	65,902	686
3020	Rubber & Plastics Footwear, 3020	61	8,895	319
3050	Gaskets, Packing Devices, Rubber & Plastics Hose & Belts	826	59,475	578
3060	Fabricated Rubber Products Nec, 3060	1,767	111,074	574
3080	Miscellaneous Plastics Products, 3080	13,648	751,503	420
3110	Leather Tanning & Finishing, 3110	343	14.843	552
3130	Boot & Shoe Cut Stock & Findings, 3130	70	2,103	594
3140	Footwear, Except Rubbeer, 3140	378	38,768	480
3150	Leather Gloves & Mittens, 3150	69	2,349	532
3160	Luggage, 3160	261	10,231	229
3170	Handbags & Other Personal Leather Goods, 3170	343	9,382	385
3190	Leather Goods Nec, 3190	418	8,414	580
3210	Flat Glass, 3210	81	13,203	749
3220	Glass & Glassware, Pressed Or Blown, 3220	589	61,911	562
3230	Glass Products Made Of Purchased Glass, 3230	1,640	61.300	507
3240	Cement, Hydraulic, 3240	231	16,283	311
3250	Structural Clay Products, 3250	593	29,093	532
3260	Pottery & Related Products, 3260	1,200	39,441	625
3270	Concrete, Gypsum, & Plaster Products, 3270	9,498	190,188	360
3280	Cut Stone & Stone Products, 3280	1,071	13.867	399
3290	Abrasive, Asbestos, & Misc. Nonmetallic Mineral Products	1,599	69,785	411
3310	Steel Works, Blast Furnaces, & Rolling & Finishing Mills	1,284	225,373	438
3320	Iron & Steel Foundries, 3320	1,160	133,111	794
3330	Primary Smelting & Refining Of Nonferrous Metals, 3330	201	34,534	444
3340	Secondary Smelting & Refining Of Nonferrous Metals,	299	15,013	543
3350	Rolling, Drawing, & Extruding Of Nonferrous Metals, 3350	1,105	153,482	503
3360	Nonferrous Foundries, 3360	1,662	89,402	629
3390	Miscellaneous Primary Metal Products, 3390	947	31,444	231

Table VIII-1: Estimated Number of Establishments and Employees and Estimated Annual Incidence of All MSD's, by 3-Digit SIC (Continued)

SIC	Industry	Total Number of Establishments	Total Number of Employees in all Establishments	Total MSD Incidence Rate (per 10,000 workers)
3410	Metal Cans & Shipping Containers, 3410	435	35,214	431
3420	Cutlery, Handtools, & General Hardware, 3420	2,446	133,392	476
3430	Heating Equipment & Plumbing Fixtures, 3430	688	46,295	920
3440	Fabricated Structural Metal Products, 3440	13,334	428,117	450
3450	Screws, Bolts, Nuts, Screws, Rivets, & Washers, 3450	2,602	99,345	491
3460	Metal Forgings & Stampings, 3460	3,694	258,010	704
3470	Coating, Engraving, & Allied Services Nec, 3479	5,529	124,099	383
3480	Ordnance, Accessories Excpt Vehicles & Guided Missiles	438	39,859	339
3490	Miscellaneous Fabricated Metal Products, 3490	7,266	296,592	452
3510	Engines & Turbines, 3510	371	75,184	561
3520	Farm & Garden Machinery & Equipment, 3520	1,761	98,072	501
3530	Construction, Mining, & Materials Handling Machinery	3,324	195,304	508
3540	Metalworking Machinery & Equipment, 3540	11,811	295,152	376
3550	Special Industrymachinery Except Metalworking, 3550	4,790	190,365	348
3560	General Industrial Machinery & Equipment, 3560	4,378	260,600	413
3570	Computer & Office Equipment, 3570	2,112	227,720	213
3580	Refreigeration & Service Industry Machinery, 3580	2,246	199,595	566
3590	Miscellaneous Industrial & Commercial Machinery	25,875	377,370	304
3610	Electric Transmission & Distribution Equipment, 3610	875	68,623	369
3620	Electrical Industrial Apparatus, 3620	2,260	162,510	440
3630	Household Appliances, 3630	474	106,685	677
3640	Electric Lighting & Wiring Equipment, 3640	2,117	154,073	474
3650	Househod Audio & Video Equipment & Recordings, 3650	815	50,938	408
3660	Communications Equipment, 3660	2,110	254,639	170
3670	Electronic Components & Accessories, 3670	6,570	594,638	196
3690	Misc. Electrical Machinery, Equipment, & Supplies	1,788	152,482	499
3710	Motor Vehicles & Equipment, 3710	5,049	785,168	1,221
3720	Aircraft & Parts, 3720	1,693	400,899	358
3730	Ship & Boat Building & Repairing, 3730	2,676	52,904	630
3740	Railroad Equipment, 3740	213	35,344	630
3750	Motorcycles, Bicycles, & Parts, 3750	370	16,400	615
3760	Guided Missiles & Space Vehicles & Parts, 3760	105	78,710	141
3790	Miscellaneous Transportation Equipment, 3790	1,135	53,849	569
3810	Search, Detection, Navigation, Related Systems	696	184,871	124
3820	Laboratory Apparatus & Analytical Instruments	4,755	265,806	257
3840	Surgical, Medical, & Dental Instruments &Supplies, 3840	4,471	267,624	221
3850	Ophthalmic Goods, 3850	587	26,417	312
3860	Photographic Equipment & Supplies, 3860	721	62,716	377
3870	Watches, Clocks, Clockwork Operated Devices, & Parts	141	5,765	167
3910	Jewelry, Silverware, & Plated Ware, 3910	2,813	45,819	236
3930	Musical Instruments, 3930	550	13,562	549
3940	Dolls, Toys, Games, & Sporting & Athletic Goods, 3940	3,515	106,609	534
3950	Pens, Pencils, & Artists' Materials, 3950	1,038	28,540	233
3960	Costume Jewelry, Costume Novelties, Buttons, & Notions	1,092	22,970	189
3990	Miscellaneous Manufacturing Industries, 3990	8,803	171,667	338
Transportation, Communication, Electric, Gas, & Sanitary Services, Excluding 40				
4110	Local & Suburban Passenger Transportation, 4110	9,536	194,756	419
4120	Taxicabs, 4120	3,304	27,944	67
4130	Intercity & Rural Bus Transportation, 4130	481	20,621	292
4140	Bus Charter Service, 4140	1,432	29,190	97
4150	School Buses, 4150	4,248	143,919	81
4170	Terminal Facilities For Vehicle Passenger Transport	57	477	364
4210	Trucking & Courier Services Except Air, 4210	116,861	1,725,748	257
4220	Public Warehousing & Storage, 4220	11,856	121,344	441
4230	Terminal & Joint Terminal Maintenance Facilities	80	766	3,434

Table VIII-1: Estimated Number of Establishments and Employees and Estimated Annual Incidence of All MSD's, by 3-Digit SIC (Continued)

SIC	Industry	Total Number of Establishments	Total Number of Employees in all Establishments	Total MSD Incidence Rate (per 10,000 workers)
4510	Air Transportation, Scheduled, & Air Courier Services	6,608	621,649	1,171
4520	Air Transportation, Nonscheduled, 4520	1,831	28,845	175
4580	Airports, Flying Fields, & Airport Terminal Services, 4580	4,014	104,581	322
4610	Pipelines, Except Natural Gas, 4601	963	15,065	47
4720	Arrangement Of Passenger Transportation, 4720	33,106	223,624	27
4730	Arrangement Of Transportation Of Freight & Cargo, 4730	14,771	137,522	148
4740	Rental Of Railroad Cars, 4740	116	2,326	88
4780	Miscellaneous Services Incidental To Transportation, 4780	2,681	42,104	269
4810	Telephone Communications, 4810	27,277	927,967	101
4820	Telegraph & Other Message Communications, 4820	466	5,782	97
4830	Radio & Television Broadcasting Stations, 4830	8,833	238,078	36
4840	Cable & Other Pay Television Services, 4840	4,786	170,300	172
4890	Communications Services Nec, 4890	1,488	22,405	36
4910	Electric Services, 4910	6,278	382,861	187
4920	Gas Production & Distribution, 4920	3,941	135,670	219
4930	Combination Electric & Gas, & Other Utility Services, 4930	1,871	199,685	125
4940	Water Supply, 4940	3,701	26,045	227
4950	Sanitary Services, 4950	6,491	130,347	532
4960	Steam & Air-Conditioning Supply, 4960	69	1,400	280
4970	Irrigation Systems, 4970	366	1,785	225
Wholesale Trade				
5010	Motor Vehicles & Motor Vehicle Parts & Supplies, 5010	45,779	520,711	218
5020	Furniture & Home Furnishings, 5020	16,693	169,720	249
5030	Lumber & Other Construction Materials, 5030	23,678	264,739	411
5040	Professional & Commercial Equipment & Supplies, 5040	51,941	725,137	139
5050	Metals & Minerals, Except Petroleum, 5050	11,416	154,821	296
5060	Electrical Goods, 5060	41,707	508,202	156
5070	Hardware & Plumbing & Heating Equipment & Supplies	26,119	269,607	303
5080	Machinery, Equipment, & Supplies, 5080	76,249	762,397	223
5090	Miscellaneous Durable Goods, 5090	40,029	354,068	190
5110	Paper & Paper Products, 5110	18,712	291,514	129
5120	Drugs, Drug Proprietaries, & Druggists' Sundries,5120	7,316	173,960	147
5130	Apparel, Piece Goods, & Notions, 5130	21,766	209,032	145
5140	Groceries & Related Products, 5140	43,314	846,803	387
5150	Farm-Product Raw Materials, 5150	10,680	98,112	82
5160	Chemicals & Allied Products, 5160	15,171	163,603	152
5170	Petroleum & Petroleum Products, 5170	13,177	153,471	161
5180	Beer, Wine, & Distilled Alcoholic Beverages, 5180	5,055	148,567	553
5190	Miscellaneouls Nondurable Goods, 5190	54,335	505,832	208
Retail Trade				
5210	Lumber & Other Building Materials Dealers, 5210	24,266	475,454	401
5230	Paint, Glass, & Wallpaper Stores, 5230	9,777	49,415	315
5250	Hardware Stores, 5250	14,282	124,402	215
5260	Retail Nurseries, Lawn & Garden Supply Stores, 5260	11,258	80,822	254
5270	Mobile Home Dealers, 5270	4,780	36,746	416
5310	Department Stores, 5310	10,824	1,850,213	378
5330	Variety Stores, 5330	10,848	92,765	513
5390	Miscellaneous General Merchandise Stores, 5390	14,797	316,419	139
5410	Grocery Stores, 5410	129,150	2,980,869	254
5420	Meat & Fish Markets, Including Freezer Provisioners, 5420	7,868	45,979	183
5430	Fruit & Vegetable Markets, 5430	3,342	19,178	106
5440	Candy, Nut, & Confectionery Stores, 5440	4,742	27,794	70
5450	Dairy Products Stores, 5450	2,550	14,746	99

Table VIII-1: Estimated Number of Establishments and Employees and Estimated Annual Incidence of All MSD's, by 3-Digit SIC (Continued)

SIC	Industry	Total Number of Establishments	Total Number of Employees in all Establishments	Total MSD Incidence Rate (per 10,000 workers)
5460	Retail Bakeries, 5460	20,156	148,069	120
5490	Miscellaneous Food Stores, 5490	9,904	55,450	89
5510	Motor Vehicle Dealers (New & Used), 5510	24,639	1,014,799	200
5520	Motor Vehicle Dealers (Used Only), 5520	21,951	85,892	13
5530	Auto & Home Supply Stores, 5530	43,806	345,849	212
5540	Gasoline Service Stations 5540	96,236	713,280	110
5550	Boat Dealers, 5550	5,068	33,121	220
5560	Recreational Vehicle Dealers, 5560	2,995	28,499	300
5570	Motorcycle Dealers, 5570	3,785	29,387	27
5590	Automotive Dealers Nec, 5590	1,234	5,654	203
5610	Men'S & Boys' Clothing & Accessory Stores, 5610	13,844	92,334	67
5620	Women'S Clothing Stores, 5620	40,559	327,351	40
5630	Women'S Accessory & Specialty Stores, 5630	8,647	50,147	39
5640	Children'S & Infants' Wear Stores, 5640	5,186	45,078	56
5650	Family Clothing Stores, 5650	19,583	329,123	165
5660	Shoe Stores, 5660	31,737	180,967	67
5690	Miscellaneous Apparel & Accessory Stores, 5690	10,161	53,173	31
5710	Home Furniture & Furnishing Stores,5710	66,004	475,508	260
5720	Household Appliance Stores, 5720	10,045	63,989	239
5730	Radio, Television, Consumer Electronics, & MuStores	39,074	336,182	105
5810	Eating & Drinking Places, 5810	466,386	7,416,595	79
5910	Drug Stores & Proprietary Stores, 5910	43,221	588,160	75
5920	Liquor Stores, 5920	28,812	128,995	32
5930	Used Merchandise Stores, 5930	23,524	117,116	127
5940	Miscellaneous Shopping Goods Stores, 5940	129,136	850,337	107
5960	Nonstore Retailers, 5960	29,947	372,947	257
5980	Fuel Dealers, 5980	11,317	95,385	155
5990	Retail Stores Nec, 5990	95,174	468,433	83
Finance, Insurance, and Real Estate				
6010	Central Reserve Depository Institutions, 6010	102	25,274	191
6020	Commercial Banks, 6020	67,422	1,507,165	40
6030	Savings Institutions, 6030	16,131	262,936	34
6060	Credit Unions, 6060	14,921	163,027	65
6080	Foreign Banking & Agencies Of Foreign Banks, 6080	656	33,830	1
6090	Functions Related To Depository Banking, 6090	5,820	68,711	85
6110	Federal & Federally-Sponsored Credit Agencies, 6110	1,333	22,884	67
6140	Personal Credit Institutions, 6140	18,996	183,249	6
6150	Business Credit Institutions, 6150	5,358	104,991	42
6160	Mortgage Bankers & Brokers, 6160	21,897	226,475	34
6210	Security Brokers, Dealers, & Flotation Companies, 6210	25,523	411,411	19
6220	Commodity Contracts Brokers & Dealers, 6220	1,623	13,185	19
6230	Security & Commodity Exchanges, 6230	117	7,650	62
6280	Services For The Exchange Of Securities Or Commodities	18,123	135,349	12
6310	Life Insurance, 6310	11,754	547,789	32
6320	Accident & Health Insurance & Medical Service Plans	3,337	306,420	114
6330	Fire, Marine, & Casulaty Insurance, 6330	20,361	594,733	83
6350	Surety Insurance, 6350	579	10,255	131
6360	Title Insurance, 6360	2,546	39,886	68
6370	Pensions, Health, & Welfare Funds, 6370	2,747	33,107	35
6390	Insurance Carriers Nec, 6390	292	4,018	72
6410	Insurance Agents, Brokers, & Service, 6410	127,278	695,139	28
6510	Real Estate Operators & Lessors, 6510	100,612	499,293	174
6530	Real Estate Agents & Managers, 6530	124,530	756,905	73
6540	Title Abstract Offices, 6540	5,195	35,417	32
6550	Land Subdividers & Developers, 6550	18,561	115,746	201
6710	Holding Offices, 6710	9,575	161,371	38
6720	Investment Offices, 6720	920	24,933	32

Table VIII-1: Estimated Number of Establishments and Employees and Estimated Annual Incidence of All MSD's, by 3-Digit SIC (Continued)

SIC	Industry	Total Number of Establishments	Total Number of Employees in all Establishments	Total MSD Incidence Rate (per 10,000 workers)
	6730 Trusts, 6730	8,841	57,282	56
	6790 Miscellaneous Investing, 6790	8,419	56,460	82
Services, Excluding 88				
	7010 Hotels & Motels, 7010	45,252	1,539,037	241
	7020 Rooming & Boarding Houses, 7020	1,624	9,302	285
	7030 Camps & Recreational Vehicle Parks, 7030	7,435	35,478	15
	7040 Organization Hotels & Lodging Houses, Memberships	2,410	12,891	40
	7210 Laundry, Cleaning, & Garment Services, 7210	56,704	443,179	200
	7220 Photographic Studios, Portrait, 7220	13,168	70,481	74
	7230 Beauty Shops, 7230	81,872	390,177	31
	7240 Barber Shops, 7240	4,499	14,506	190
	7250 Shoe Repair Shops & Shoeshine Parlors, 7250	2,216	5,807	134
	7260 Funeral Service & Crematories, 7260	15,784	99,027	65
	7290 Miscellaneous Personal Services, 7290	30,697	254,674	9
	7310 Advertising, 7310	19,664	242,468	49
	7320 Cons. Credit Reporting, Mercantile Rpt., & Collection	6,914	109,523	52
	7330 Mailing, Reproduction, Com. Art, Photography, Stenog.	35,058	285,511	118
	7340 Services To Dwellings & Other Buildings, 7342	65,559	916,370	165
	7350 Miscellaneous Equipment Rental & Leasing, 7350	24,814	229,196	142
	7360 Personnel Supply Services, 7360	37,374	2,778,419	48
	7370 Computer Program., Dataprocessing, & Other Services	88,911	1,266,890	33
	7380 Miscellaneous Business Services, 7380	85,634	1,366,526	70
	7510 Automotive Rental & Leasing, Without Drivers, 7510	10,643	149,154	93
	7520 Automobile Parking, 7520	8,892	65,390	57
	7530 Automotive Repair Shops, 7530	139,184	608,702	108
	7540 Automotive Services Except Repair, 7540	26,948	211,838	211
	7620 Electrical Repair Shops, 7620	19,328	144,758	53
	7630 Watch, Clock, & Jewelry Repair, 7630	1,805	5,705	1,346
	7640 Reupholstery & Furniture Repair, 7640	6,842	22,674	244
	7690 Miscellaneous Repair Shops & Related Services, 7690	39,008	262,495	160
	7810 Motion Picture Production & Allied Services, 7810	14,680	240,953	216
	7820 Motion Picture Distribution & Allied Services, 7820	1,456	21,899	498
	7830 Motion Picture Theaters, 7830	6,572	118,921	280
	7840 Video Tape Rental, 7840	20,816	129,258	270
	7910 Dance Studios, Schools, & Halls, 7910	5,719	27,063	18
	7920 Theatrical Producers, Bands, Orchestras, & Entertainers	16,839	161,158	94
	7930 Bowling Centers, 7930	5,735	90,614	50
	7940 Commercial Sports, 7940	4,763	101,728	218
	7990 Miscellaneous Amusement & Recreation Services, 7990	61,841	991,444	181
	8010 Offices & Clinics Of Doctors Of Medicine, 8010	186,994	1,688,823	78
	8020 Offices & Clinics Of Dentists, 8020	113,054	634,709	27
	8030 Offices & Clinics Of Doctors Of Osteopathy, 8030	9,105	53,700	182
	8040 Offices & Clinics Of Other Health Praactioners, 8040	84,667	353,204	166
	8050 Nursing & Personal Care Facilities, 8050	24,009	1,806,086	706
	8060 Hospitals, 806	7,282	5,067,349	327
	8070 Medical & Dental Laboratories, 8070	15,243	190,629	84
	8080 Home Health Care Services, 8080	16,106	779,365	285
	8090 Miscellaneous Health & Allied Services Nec, 8090	20,849	387,020	121
	8110 Legal Services, 8110	168,276	959,809	39
	8210 Elementaary & Secondary Schools, 8210	18,017	609,190	45
	8220 Colleges, Universities, Prof. Schools, & Junior Colleges	3,663	1,258,979	46
	8230 Libraries, 8230	2,252	22,343	73
	8240 Vocational Schools, 8240	6,816	79,561	22
	8290 Schools & Educational Services Nec, 8290	15,395	124,076	13
	8320 Individual & Family Social Services, 8320	43,047	596,191	190
	8330 Job Training & Vocational Rehabilitation Services, 8330	9,114	325,655	107
	8350 Child Day Care Services, 8350	53,592	553,897	80

Table VIII-1: Estimated Number of Establishments and Employees and Estimated Annual Incidence of All MSD's, by 3-Digit SIC (Continued)

SIC	Industry	Total Number of Establishments	Total Number of Employees in all Establishments	Total MSD Incidence Rate (per 10,000 workers)
8360	Residential Care, 8360	28,762	550,745	353
8390	Social Services Nec, 8390	15,702	216,649	87
8410	Museums & Art Galleries, 8410	4,520	63,818	129
8420	Arboreta & Botanical Or Zoological Gardens, 8420	585	16,044	172
8610	Business Associations, 8610	15,767	111,371	30
8620	Professional Membership Organizations, 8620	7,033	63,638	24
8630	Labor Unions & Similar Labor Organizations, 8630	19,536	169,366	16
8640	Civic, Social, & Fraternal Associations, 8640	36,944	369,808	70
8650	Political Organizations, 8650	2,579	10,719	95
8660	Religious Organizations, 8660	158,299	1,380,975	8
8690	Membership Organizations Nec, 8690	9,072	106,606	81
8710	Engineering, Architectural, & Surveying Services, 8710	78,815	910,439	38
8720	Accounting, Auditing, & Bookkeeping Services, 8720	84,175	639,896	59
8730	Research, Development, & Testing Services, 8730	19,471	458,980	113
8740	Management & Public Relations Services, 8740	95,033	985,335	69
8990	Services Nec, 8990	17,221	105,803	249
	Total	**5,904,039**	**92,725,578**	

Sources: Office of Regulatory Analysis, OSHA
Number of establishments is taken from "County Business Patterns", U.S. Bureau of Census (1996)
MSD rates are calculated by multiplying, for each industry, the number of lost workday MSDs reported by employers to the BLS by the ratio of all lost workday injuries and illnesses for that industry to all non-lost workday injuries and illnesses for that industry. OSHA used this approach because the BLS only reports the number of lost workday MSDs by industry.

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Table VIII–2 shows that about 2 million of the establishments in general industry (or about one-third of all establishments) will be covered by the standard (either by a basic or a full program) in the first year after the standard goes into effect (Table VIII–2). This table breaks these establishments out by those within the scope of the proposed standard because they have employees engaged in manufacturing operations, because they have employees engaged in manual handling, or have employees engaged in other activities that have caused a covered MSD. About 373,000 establishments are estimated to need a basic program as a result of having employees engaged in manufacturing operations, and a total of about 976,000 establishments will need a basic program because they have employees engaged in manual handling. In the first year of the standard's implementation, about 600,000 establishments whose employees engage in other general industry jobs (*i.e.,* have jobs that do not involve either manual handling or manufacturing operations) will need to fix jobs because they have an employee who has incurred a covered MSD. In the first year, approximately 7.7 million jobs will be fixed as a result of the ergonomics program standard. At the end of ten years, approximately 30 million problem jobs will have been fixed (see Chapter IV of the Preliminary Economic Analysis).

BILLING CODE 4510–26–P

Table VIII-2

NUMBER OF ESTABLISHMENTS ESTIMATED TO FALL WITHIN THE SCOPE OF THE STANDARD IN YEAR 1, BY 3-DIGIT SIC

SIC	Industry	Total Number of Establishments in SIC	Total Number of Establishments with Manufacturing Jobs	Total Number of Establishments With Manual Handling Jobs [a]	Total Number of Establishments Not Engaged in Manual Handling or Manufacturing, but incurring a Covered MSD	Total Number of Establishments in First Year in the Scope of the Standard
071	Soil prep. services	641	0	239	74	313
072	Crop services	4,133	0	1,538	986	2,524
074	Veterinary services	22,807	0	8,488	1,183	9,672
075	Animal serv., excpt vet.	10,369	0	3,859	189	4,048
078	Lndscape & hort. services	68,157	0	31,355	4,732	36,087
081	Timber tracts	862	0	321	83	404
083	Forest products	137	0	51	26	77
085	Forestry services	1,568	0	584	99	683
091	Commerical fishing	1,947	0	725	90	815
092	Fish hatcheries	95	0	35	14	49
097	Hunting & trapping	339	0	126	17	143
131	Crude petrol. & nat. gas	7,758	0	1,553	480	2,032
132	Natural gas liquids	560	0	112	100	212
138	Oil & gas field services	8,764	0	1,754	1,707	3,461
201	Meat products	3,080	3,080	0	0	3,080
202	Dairy products	1,881	1,881	0	0	1,881
203	Presrvd fruits & vegetables	2,016	2,016	0	0	2,016
204	Grain mill products	2,603	2,603	0	0	2,603
205	Bakery products	3,523	3,523	0	0	3,523
206	Sugar and confect. prods	1,098	1,098	0	0	1,098
207	Fats and oils	507	507	0	0	507
208	Beverages	2,286	2,286	0	0	2,286
209	Misc. food products	4,007	4,007	0	0	4,007
211	Cigarettes	15	15	0	0	15
212	Cigars	47	47	0	0	47
213	Chewing & smoking tobacco	26	26	0	0	26
214	Tobacco stemm. & redrying	32	32	0	0	32
221	Brdwven fab. mills, cotton	412	412	0	0	412
222	Broadwoven fabric mills	458	458	0	0	458
223	Brdwvn fab. mills, wool	99	99	0	0	99
224	Narrow fabric mills	277	277	0	0	277
225	Knitting mills	1,945	1,945	0	0	1,945
226	Tex. finishing, excpt wool	852	852	0	0	852
227	Carpets and rugs	484	484	0	0	484
228	Yarn and thread mills	588	588	0	0	588
229	Misc. textile goods	1,010	1,010	0	0	1,010
231	Men's & boys' suits & coats	293	293	0	0	293
232	Men's & boys' furnishings	2,112	2,112	0	0	2,112
233	Wm's & misses' outerwear	8,954	8,954	0	0	8,954
234	Wm's & chldrn's undergarmnts	372	372	0	0	372
235	Hats, caps, & millinery	381	381	0	0	381
236	Girls' & chldrn's outerwear	585	585	0	0	585
237	Fur goods	133	133	0	0	133
238	Misc. apparel & accessories	933	933	0	0	933
239	Misc. fab. textile prods	8,797	8,797	0	0	8,797
241	Logging	14,273	14,273	0	0	14,273
242	Sawmills & planing mills	6,103	6,103	0	0	6,103
243	Millwork & plywood	9,548	9,548	0	0	9,548
244	Wood containers	2,830	2,830	0	0	2,830
245	Wood bldings & mobile homes	1,044	1,044	0	0	1,044
249	Misc. wood products	3,536	3,536	0	0	3,536
251	Household furniture	5,500	5,500	0	0	5,500
252	Office furniture	1,033	1,033	0	0	1,033
253	Pub blding & related furn.	449	449	0	0	449
254	Partitions and fixtures	2,996	2,996	0	0	2,996
259	Misc furniture and fixtures	1,412	1,412	0	0	1,412
261	Pulp mills	62	62	0	0	62
262	Paper mills	344	344	0	0	344
263	Paperboard mills	228	228	0	0	228
265	Paperbrd containers & boxes	2,809	2,809	0	0	2,809
267	Misc. cnvrtd paper products	3,033	3,033	0	0	3,033
271	Newspapers	8,878	8,878	0	0	8,878
272	Periodicals	5,781	5,781	0	0	5,781
273	Books	3,559	3,559	0	0	3,559
274	Miscellaneous publishing	3,259	3,259	0	0	3,259

Table VIII-2

NUMBER OF ESTABLISHMENTS ESTIMATED TO FALL WITHIN THE SCOPE OF THE STANDARD IN YEAR 1, BY 3-DIGIT SIC

SIC	Industry	Total Number of Establishments in SIC	Total Number of Establishments with Manufacturing Jobs	Total Number of Establishments With Manual Handling Jobs [a]	Total Number of Establishments Not Engaged in Manual Handling or Manufacturing, but incurring a Covered MSD	Total Number of Establishments in First Year in the Scope of the Standard
275	Commercial printing	34,435	34,435	0	0	34,435
276	Manifold business forms	911	911	0	0	911
277	Greeting cards	143	143	0	0	143
278	Blankbooks & bookbinding	1,583	1,583	0	0	1,583
279	Printing trade services	3,436	3,436	0	0	3,436
281	Indust. inorganic chemicals	1,390	1,390	0	0	1,390
282	Plastics mat. & synthetics	876	876	0	0	876
283	Drugs	1,637	1,637	0	0	1,637
284	Soap, clnrs, & toilet goods	2,434	2,434	0	0	2,434
285	Paints & allied products	1,479	1,479	0	0	1,479
286	Indust. organic chemicals	946	946	0	0	946
287	Agricultural chemicals	938	938	0	0	938
289	Misc. chemical products	2,566	2,566	0	0	2,566
291	Petroleum refining	275	275	0	0	275
295	Asphlt pavng & roofng mat.	1,368	1,368	0	0	1,368
299	Misc. pet. & coal prods	466	466	0	0	466
301	Tires and inner tubes	171	171	0	0	171
302	Rubber & plastics footwear	61	61	0	0	61
305	Hose, bltng, and gaskets	826	826	0	0	826
306	Fab. rubber prod., n.e.c.	1,767	1,767	0	0	1,767
308	Misc plastics, n.e.c.	13,648	13,648	0	0	13,648
311	Leather tan. & finishing	343	343	0	0	343
313	Footwear cut stock	70	70	0	0	70
314	Footwear, except rubber	378	378	0	0	378
315	Leather gloves & mittens	69	69	0	0	69
316	Luggage	261	261	0	0	261
317	Hndbags & prsnal leathr gds.	343	343	0	0	343
319	Leather goods, n.e.c.	418	418	0	0	418
321	Flat glass	81	81	0	0	81
322	Glass, pressed or blown	589	589	0	0	589
323	Prod. of purchased glass	1,640	1,640	0	0	1,640
324	Cement, hydraulic	231	231	0	0	231
325	Structural clay products	593	593	0	0	593
326	Pottery & related prods	1,200	1,200	0	0	1,200
327	Concrete & plast. prdcts	9,498	9,498	0	0	9,498
328	Cut stone & stone prods	1,071	1,071	0	0	1,071
329	Misc. nonmet. mineral prods.	1,599	1,599	0	0	1,599
331	Basic steel products	1,284	1,284	0	0	1,284
332	Iron and steel foundries	1,160	1,160	0	0	1,160
333	Primary nonfer. metals	201	201	0	0	201
334	Secondary nonfer. metals	299	299	0	0	299
335	Nonfer. rolling & drawing	1,105	1,105	0	0	1,105
336	Nonfer. foundries (cstngs)	1,662	1,662	0	0	1,662
339	Misc. primary metal prdcts	947	947	0	0	947
341	Met. cans & ship. containers	435	435	0	0	435
342	Cutlery, hndtls, & hardware	2,446	2,446	0	0	2,446
343	Plumbing & heating fixtures	688	688	0	0	688
344	Fab. struct. metal prdcts	13,334	13,334	0	0	13,334
345	Screw machine products	2,602	2,602	0	0	2,602
346	Met. forgings & stampings	3,694	3,694	0	0	3,694
347	Metal services, n.e.c.	5,529	5,529	0	0	5,529
348	Ordnance and access., n.e.c.	438	438	0	0	438
349	Misc. fab. metal products	7,266	7,266	0	0	7,266
351	Engines and turbines	371	371	0	0	371
352	Farm & garden machinery	1,761	1,761	0	0	1,761
353	Construct. & related mach.	3,324	3,324	0	0	3,324
354	Metalworking machinery	11,811	11,811	0	0	11,811
355	Special industry mach.	4,790	4,790	0	0	4,790
356	General indust. mach.	4,378	4,378	0	0	4,378
357	Computer & office equip.	2,112	2,112	0	0	2,112
358	Refrig. & serv. indust mach.	2,246	2,246	0	0	2,246
359	Industrial mach., n.e.c.	25,875	25,875	0	0	25,875
361	Elect. dist. equipment	875	875	0	0	875
362	Elect. indust. apparatus	2,260	2,260	0	0	2,260
363	Household appliances	474	474	0	0	474

Table VIII-2

NUMBER OF ESTABLISHMENTS ESTIMATED TO FALL WITHIN THE SCOPE OF THE STANDARD IN YEAR 1, BY 3-DIGIT SIC

SIC	Industry	Total Number of Establishments in SIC	Total Number of Establishments with Manufacturing Jobs	Total Number of Establishments With Manual Handling Jobs [a]	Total Number of Establishments Not Engaged in Manual Handling or Manufacturing, but incurring a Covered MSD	Total Number of Establishments in First Year in the Scope of the Standard
364	Elct. lghtng & wire equip.	2,117	2,117	0	0	2,117
365	Household audio & vid. equip.	815	815	0	0	815
366	Communications equipment	2,110	2,110	0	0	2,110
367	Electrnic compnnts & access.	6,570	6,570	0	0	6,570
369	Misc. elect. equipment	1,788	1,788	0	0	1,788
371	Motor vehicles & equipt.	5,049	5,049	0	0	5,049
372	Aircraft and parts	1,693	1,693	0	0	1,693
373	Ship, boat blding and repair	2,676	2,676	0	0	2,676
374	Railroad equipment	213	213	0	0	213
375	Motorcycles & bicycles	370	370	0	0	370
376	Guided missiles	105	105	0	0	105
379	Misc. transportatión equip.	1,135	1,135	0	0	1,135
381	Srch & navigation equipment	696	696	0	0	696
382	Meas. & contrlling devices	4,755	4,755	0	0	4,755
384	Medical instrmnts & supplies	4,471	4,471	0	0	4,471
385	Ophthalmic goods	587	587	0	0	587
386	Photo. equip. & supplies	721	721	0	0	721
387	Watches, clocks, & parts	141	141	0	0	141
391	Jwlry, slvrwre, and plate	2,813	2,813	0	0	2,813
393	Musical instruments	550	550	0	0	550
394	Toys and sporting goods	3,515	3,515	0	0	3,515
395	Office and art supplies	1,038	1,038	0	0	1,038
396	Costume jewelry & notions	1,092	1,092	0	0	1,092
399	Misc. manufactures	8,803	8,803	0	0	8,803
411	Local & suburban trans.	9,536	0	0	5,555	5,555
412	Taxicabs	3,304	0	0	183	183
413	Intercty & rural bus trans.	481	0	0	346	346
414	Bus charter service	1,432	0	0	258	258
415	School buses	4,248	0	0	1,019	1,019
417	Bus terminals	57	0	0	20	20
421	Trking & Courier Service	116,861	0	0	37,262	37,262
422	Pub. warehousing & storage	11,856	0	0	4,384	4,384
423	Trucking terminal fac.	80	0	0	31	31
451	Air trans., scheduled	6,608	0	0	6,608	6,608
452	Air trans., nonsched.	1,831	0	0	445	445
458	Airports and services	4,014	0	0	2,303	2,303
461	Pipelines, excpt natural gas	963	0	193	393	586
472	Pass. trans. arrangements	33,106	0	9,025	438	9,463
473	Freight trans. arrangements	14,771	0	4,027	1,391	5,418
474	Rental of railroad cars	116	0	32	17	49
478	Misc. trans. services	2,681	0	731	680	1,411
481	Telephone communication	27,277	0	7,201	5,844	13,045
482	Telegrph & other comm.	466	0	123	30	153
483	Radio & TV broadcasting	8,833	0	2,332	604	2,936
484	Cable & othr pay TV services	4,786	0	1,263	1,623	2,886
489	Communication serv., n.e.c.	1,488	0	393	71	464
491	Electric services	6,278	0	1,657	3,156	4,814
492	Gas product. & distribution	3,941	0	1,040	1,548	2,589
493	Comb. utility services	1,871	0	494	1,016	1,510
494	Water supply	3,701	0	977	406	1,383
495	Sanitary services	6,491	0	1,714	3,182	4,896
496	Steam & air-cond. supplies	69	0	18	19	37
497	Irrigation systems	366	0	97	28	125
501	Motor vehicles	45,779	0	18,296	6,090	24,387
502	Furn. & homefurnishings	16,693	0	6,672	2,263	8,935
503	Lumber & construct. mat.	23,678	0	9,463	5,328	14,791
504	Prof. & commercial equip.	51,941	0	20,759	5,535	26,294
505	Met. & minerals, excpt pet.	11,416	0	4,563	2,294	6,856
506	Electrical goods	41,707	0	16,669	4,362	21,031
507	Hardware supplies	26,119	0	10,439	4,271	14,710
508	Mach., equipt, & supplies	76,249	0	30,474	9,232	39,706
509	Misc. durable goods	40,029	0	15,998	3,753	19,751
511	Paper and paper products	18,712	0	7,479	2,052	9,531
512	Drugs, propriet., & sundries	7,316	0	2,924	1,303	4,227
513	Apparel and notions	21,766	0	8,699	1,712	10,411

Table VIII-2

NUMBER OF ESTABLISHMENTS ESTIMATED TO FALL WITHIN THE SCOPE OF THE STANDARD IN YEAR 1, BY 3-DIGIT SIC

SIC	Industry	Total Number of Establishments in SIC	Total Number of Establishments with Manufacturing Jobs	Total Number of Establishments With Manual Handling Jobs [a]	Total Number of Establishments Not Engaged in Manual Handling or Manufacturing, but incurring a Covered MSD	Total Number of Establishments in First Year in the Scope of the Standard
514	Groceries & related products	43,314	0	17,311	13,980	31,291
515	Farm-prod. raw materials	10,680	0	4,268	467	4,736
516	Chemicals & allied prods	15,171	0	6,063	1,387	7,450
517	Petrol. & petrol. prods	13,177	0	5,266	1,365	6,632
518	Beer, wine, & dist. bev.	5,055	0	2,020	2,465	4,485
519	Misc. nondurable goods	54,335	0	21,716	5,793	27,509
521	Lumber & other blding mat.	24,266	0	5,835	10,168	16,003
523	Paint, glass, wallpaper strs	9,777	0	2,351	1,108	3,459
525	Hardware stores	14,282	0	3,434	1,871	5,305
526	Retail nurseries and gardens	11,258	0	2,707	1,441	4,148
527	Mobile home dealers	4,780	0	1,149	916	2,066
531	Department stores	10,824	0	2,603	8,210	10,813
533	Variety stores	10,848	0	2,609	2,987	5,596
539	Misc. gen. merchandise strs.	14,797	0	3,558	2,910	6,468
541	Grocery stores	129,150	0	30,304	44,308	74,612
542	Meat and fish markets	7,868	0	1,846	617	2,463
543	Fruit & vegetable markets	3,342	0	784	151	936
544	Candy, nut, & confctnry strs	4,742	0	1,113	190	1,302
545	Dairy products stores	2,550	0	598	76	674
546	Retail bakeries	20,156	0	4,729	1,309	6,038
549	Misc. food stores	9,904	0	2,324	368	2,692
551	New and used car dealers	24,639	0	5,925	10,556	16,482
552	Used car dealers	21,951	0	5,279	185	5,464
553	Auto & home supply stores	43,806	0	10,534	5,171	15,705
554	Gas service stations	96,236	0	23,143	5,732	28,875
555	Boat dealers	5,068	0	1,219	521	1,739
556	Rec. vehicle dealers	2,995	0	720	573	1,293
557	Motorcycle dealers	3,785	0	910	44	954
559	Auto dealers, n.e.c.	1,234	0	297	12	309
561	Men's & boys' clothing strs	13,844	0	3,329	461	3,790
562	Women's clothing stores	40,559	0	9,754	981	10,735
563	Wm's access.& specialty strs	8,647	0	2,079	154	2,234
564	Chldrn's & infants' wear strs	5,186	0	1,247	179	1,426
565	Family clothing stores	19,583	0	4,709	3,633	8,342
566	Shoe stores	31,737	0	7,632	909	8,541
569	Misc. apparel stores	10,161	0	2,443	125	2,568
571	Furnitre & homefurnishng strs	66,004	0	15,872	8,674	24,547
572	Household appliance strs	10,045	0	2,416	1,088	3,503
573	Radio, TV, & comptr strs	39,074	0	9,396	2,569	11,966
581	Eating & drinking places	466,386	0	112,155	41,754	153,909
591	Drug stores	43,221	0	10,394	3,207	13,600
592	Liquor stores	28,812	0	6,929	308	7,237
593	Used merchandise stores	23,524	0	5,657	1,097	6,754
594	Misc. shopping goods strs.	129,136	0	31,054	6,697	37,751
596	Nonstore retailers	29,947	0	7,202	6,307	13,508
598	Fuel dealers	11,317	0	2,721	1,060	3,782
599	Retail stores, n.e.c.	95,174	0	22,887	2,916	25,803
601	Central res. depository	102	0	9	92	101
602	Commercial banks	67,422	0	6,220	5,238	11,458
603	Savings institutions	16,131	0	1,488	799	2,287
606	Credit unions	14,921	0	1,377	932	2,309
608	Foreign banking	656	0	61	128	189
609	Banking-related functions	5,820	0	537	505	1,042
611	Federal credit agencies	1,333	0	123	30	153
614	Personal cred. institutions	18,996	0	1,753	177	1,929
615	Business cred. institutions	5,358	0	494	384	878
616	Mortgage bankers & brokers	21,897	0	2,020	693	2,713
621	Security brokers & dealers	25,523	0	2,355	682	3,037
622	Commodity contracts brokers	1,623	0	150	22	172
623	Security & commod. exchanges	117	0	11	36	46
628	Security & commod. services	18,123	0	1,672	152	1,824
631	Life insurance	11,754	0	1,084	1,501	2,586
632	Medical & health insur.	3,337	0	308	1,972	2,280
633	Fire, marine, & caslty ins.	20,361	0	1,878	3,976	5,855
635	Surety insurance	579	0	53	43	97

Table VIII-2

NUMBER OF ESTABLISHMENTS ESTIMATED TO FALL WITHIN THE SCOPE OF THE STANDARD IN YEAR 1, BY 3-DIGIT SIC

SIC	Industry	Total Number of Establishments in SIC	Total Number of Establishments with Manufacturing Jobs	Total Number of Establishments With Manual Handling Jobs [a]	Total Number of Establishments Not Engaged in Manual Handling or Manufacturing, but incurring a Covered MSD	Total Number of Establishments in First Year in the Scope of the Standard
636	Title insurance	2,546	0	235	328	563
637	Pension and health funds	2,747	0	253	123	376
639	Ins. carriers, n.e.c.	292	0	27	25	52
641	Insurance agents	127,278	0	11,743	1,785	13,527
651	Real estate operators	100,612	0	9,282	7,638	16,920
653	RE agents and managers	124,530	0	11,489	4,936	16,425
654	Title abstract offices	5,195	0	479	319	798
655	Subdividers & developrs	18,561	0	1,712	2,005	3,718
671	Holding offices	9,575	0	883	796	1,679
672	Investment offices	920	0	85	70	155
673	Trusts	8,841	0	816	288	1,103
679	Miscellaneous investing	8,419	0	777	216	992
701	Hotels and motels	45,252	0	2,242	24,234	26,477
702	Rooming & boarding houses	1,624	0	80	236	316
703	Camps and rec. vehicle parks	7,435	0	368	72	440
704	Membership-basis org. hotels	2,410	0	119	26	146
721	Laundry & garment srvices	56,704	0	9,420	6,906	16,325
722	Photo studios, portrait	13,168	0	653	485	1,137
723	Beauty shops	81,872	0	4,057	1,129	5,187
724	Barber shops	4,499	0	223	182	405
725	Shoe repair	2,216	0	110	73	183
726	Fun. service and crematories	15,784	0	782	599	1,381
729	Misc personal services.	30,697	0	1,521	226	1,748
731	Advertising	19,664	0	1,814	2,539	4,353
732	Credit report.& collection	6,914	0	638	494	1,132
733	Mailing, reprod, steno., serv	35,058	0	3,234	2,933	6,167
734	Services to buildings	65,559	0	6,048	12,373	18,422
735	Misc. equipt. rental	24,814	0	2,289	2,784	5,073
736	Pers. supply services	37,374	0	3,448	10,210	13,658
737	Comptr & data proc. services	88,911	0	8,203	3,680	11,883
738	Misc. business services	85,634	0	7,901	8,251	16,151
751	Auto rentals, no drivers	10,643	0	527	1,241	1,768
752	Automobile parking	8,892	0	441	347	788
753	Automotive repair shops	139,184	0	6,897	6,143	13,040
754	Automotive serv., exc repair	26,948	0	1,335	2,932	4,267
762	Electrical repair shops	19,328	0	958	1,754	2,711
763	Watch and jewelry repair	1,805	0	89	71	161
764	Reupholstery & furn. repair	6,842	0	1,137	179	1,316
769	Misc. repair shops	39,008	0	1,933	3,811	5,744
781	Motion picture production	14,680	0	727	4,736	5,464
782	Motion picture dist.	1,456	0	72	816	888
783	Motion picture theaters	6,572	0	326	2,802	3,127
784	Video tape rental	20,816	0	1,032	3,530	4,562
791	Dance studios & schools	5,719	0	283	503	787
792	Prducrs, orch., entertainers	16,839	0	834	1,389	2,223
793	Bowling centers	5,735	0	284	418	702
794	Commercial sports	4,763	0	236	1,702	1,938
799	Misc. recreation services	61,841	0	3,064	14,941	18,005
801	Offices of medical doctors	186,994	0	22,836	11,247	34,083
802	Dentists offices and clinics	113,054	0	13,806	2,775	16,582
803	Osteopathic physicians	9,105	0	1,112	133	1,245
804	Other health practitioners	84,667	0	10,340	5,001	15,340
805	Nursing & personal care fac.	24,009	0	10,629	13,326	23,955
806	Hospitals	7,282	0	3,224	4,058	7,282
807	Med. & dental labs	15,243	0	1,861	1,339	3,201
808	Home hlth care services	16,106	0	1,967	10,642	12,608
809	Hlth & allied serv., n.e.c.	20,849	0	2,546	3,693	6,240
811	Legal services	168,276	0	20,550	3,266	23,817
821	Elem. & secondary schools	18,017	0	2,200	2,243	4,443
822	Colleges & universities	3,663	0	447	2,566	3,013
823	Libraries	2,252	0	275	42	317
824	Vocational schools	6,816	0	832	158	991
829	Schools, n.e.c.	15,395	0	1,880	235	2,115
832	Individual & fam. services	43,047	0	5,257	8,814	14,071
833	Job train. & related serv.	9,114	0	1,113	2,556	3,669

Table VIII-2

NUMBER OF ESTABLISHMENTS ESTIMATED TO FALL WITHIN THE SCOPE OF THE STANDARD IN YEAR 1, BY 3-DIGIT SIC

SIC	Industry	Total Number of Establishments in SIC	Total Number of Establishments with Manufacturing Jobs	Total Number of Establishments With Manual Handling Jobs [a]	Total Number of Establishments Not Engaged in Manual Handling or Manufacturing, but incurring a Covered MSD	Total Number of Establishments in First Year in the Scope of the Standard
835	Child day care services	53,592	0	6,545	3,726	10,271
836	Residential care	28,762	0	3,512	12,565	16,077
839	Social services, n.e.c.	15,702	0	1,918	1,569	3,487
841	Museums & art galleries	4,520	0	552	663	1,215
842	Bot. & zoolog. gardens	585	0	71	194	265
861	Business associations	15,767	0	1,925	291	2,217
862	Prof. organizations	7,033	0	859	132	991
863	Labor organizations	19,536	0	2,386	238	2,623
864	Civic & social assoc.	36,944	0	4,512	2,192	6,704
865	Political organizations	2,579	0	315	88	403
866	Religious organizations	158,299	0	19,332	976	20,308
869	Membership orgs., n.e.c.	9,072	0	1,108	728	1,835
871	Eng. and arch. services	78,815	0	9,625	2,952	12,577
872	Accntng, auditng, & bkeeping	84,175	0	10,280	3,276	13,555
873	Research & testing services	19,471	0	2,378	4,032	6,410
874	Management & pub. relations	95,033	0	11,606	5,746	17,351
899	Services, n.e.c.	17,221	0	2,103	2,174	4,277
Total		**5,904,039**	**373,413**	**975,595**	**618,104**	**1,967,112**

[a] Establishments in SICs 20-39 are not counted in the column because they have already been determined to be in the scope of the rule.

Source: Office of Regulatory Analysis, OSHA, U.S. DOL, from data presented in Tables II-1 and II-4.

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C. Technological Feasibility (Chapter III)

Only a few of the proposed rule's provisions are related to technological feasibility; these are the job hazard analysis and control provisions in sections 1910.917 through 1910.922. These provisions require employers to analyze those jobs that have been linked to a covered MSD, as well as other jobs in the workplace that involve the same work activities and conditions as the job in which the covered MSD was reported. Once the job has been analyzed, employers must evaluate the risk factors identified by the job hazard analysis and implement controls to eliminate or materially reduce the MSD hazards in the job.

Employers are permitted by the proposed standard to use any combination of engineering, administrative, or work practice controls to achieve the required level of control. Engineering controls are always the control method of choice, because they eliminate the hazard at its source. However, the standard permits employers to use work practice and administrative controls to address MSD hazards as well. Personal protective equipment (PPE) may be used to supplement engineering, work practice, and/or administrative controls, but it may not be used as the only method of control unless other controls are not feasible. In addition, the proposed standard notes that back belts and wrist braces are not considered PPE under this standard because these devices do not provide an effective barrier between the MSD hazard and the employee. The standard also permits employers to implement an incremental abatement process, *i.e.*, to try a control that is reasonably anticipated to materially reduce the MSD hazard adequately and to try another such control if the first control fails.

The proposed rule also clearly states that the controls that must be applied to the problem job are limited to those that are feasible. The Technological Feasibility chapter of the analysis provides an extensive list exemplifying the control measures that employers have found effective in addressing the risk factors of concern: forceful exertion, repetitive motions, awkward postures, vibration, contact stress, static postures, and cold temperatures. These are discussed in connection with manual handling, manufacturing production, and other general industry jobs.

Chapter III includes lists of controls to address each of the relevant risk factors associated with these jobs. Numerous intervention studies have also shown that controls of these kinds work to reduce risk factors and MSDs among workers in the jobs targeted by this standard. In addition, thousands of employers have implemented successful ergonomics programs and have identified many feasible engineering, administrative, and work practice controls to reduce the number and severity of the MSDs occurring in their workplaces. In addition, OSHA's 1993 ergonomics survey showed that 50% of general industry employees worked in establishments that have ergonomics programs, and OSHA expects that this percentage has grown since that time. Based on this evidence, OSHA preliminarily concludes that the proposed standard is technologically feasible for general industry employers with problem jobs. Ergonomic controls, including engineering, work practice, and administrative controls, as demonstrated by the many published case studies (such as those captured by the scenarios in Appendix III–A to Chapter III), are widely available, well understood, and demonstrably effective in reducing MSD hazards in the workplace.

D. Benefits Analysis (Chapter IV)

In its analysis of both the benefits and costs of the proposed standard, OSHA has estimated MSD rates based on BLS data. As discussed in the Preliminary Risk Assessment section of the Preamble, there is extensive evidence that MSDs are underreported to the BLS, perhaps by as much as 50 percent. To the extent that those provisions of the standard that are designed to encourage reporting increase the number of MSDs reported, both the costs and benefits of the proposed standard would be affected. (See the Initial Regulatory Flexibility Analysis, Section VIII. H., for a discussion of possible impacts of increased reporting on both the benefits and costs of the proposed standard.) However, the proposed standard also creates incentives for employers to discourage employee reporting of MSDs, because the reporting of a covered MSD is the event under the standard that triggers the need to implement job controls and/or a full program. In this Preliminary Economic Analysis, OSHA has chosen to assume that these two effects will leave the current MSD reporting rate unaffected. However, OSHA welcomes data and comments on the extent of MSD underreporting, possible increases in the reporting of MSDs that may occur after employers implement an ergonomics program, and on the incentive effects of the proposed standard on employee reporting of MSDs.

Most of the benefits of the proposed standard will be generated when employers fix their problem jobs and thus reduce the number of covered MSDs these jobs cause. Hazard information, MSD management and work restriction protection will also generate benefits because they will ensure that MSDs are identified and treated early in their development, thus preventing progression of the MSD to a serious long-term disability. However, OSHA has not yet found ways to separately calculate the benefits of fixing problem jobs and the benefits of early detection, although the Agency is aware that early reporting and medical management have substantial benefits that are similar to those associated with preventive medicine in general. For example, Oxenburgh *et al.* (1985) compared two groups of VDU operators (Ex. 26–1041). In Group A, which did not report early or receive medical management early, 22% of cases were at the second or third stage by the time they sought medical attention, compared with 8% at these stages in Group B, which had been made aware of the need to report early and the value of prompt medical management. The mean period of absence for Group A workers was 33.9 days; only 25% of this group continued to work (*i.e.*, at alternate duty) throughout the period of recuperation. In Group B, however, the mean period of absence from work was only 3.4 days, and fully 80% of this group remained in alternate duty throughout. The mean number of alternate duty days was 91 days for Group A workers and 31.5 days for those in Group B. The total amount of time the average worker in Group A lost, either to days away or alternate duty, was 124.9 days; in Group B, this figure decreased by 72%, to 34.9 days. Thus the elements of the basic program plus medical management can have substantial benefits even in the absence of a full program. Most employers who have implemented ergonomics programs agree, and have included both hazard identification, early reporting, and medical management elements in their programs.

Most of the preventive, as against remedial, benefits of the proposed ergonomics program standard will stem, however, from the implementation of the full program, because the standard's most important preventive elements are job hazard analysis and control. The proposed standard (and therefore this economic analysis) is structured in such a way that the number of jobs fixed in any given year depends on the number of covered MSDs projected to occur and the number of workers OSHA estimates hold jobs that involve the same physical work activities as the job giving rise to the covered MSD. The number of workers holding the same job, as defined by the standard, varies by industry and job.

A review of 88 studies of ergonomics program interventions showed that they reduced MSDs by an average of 67 percent (the median effectiveness rate for these studies was 64 percent). (These case studies are largely pre- and post-intervention studies of control effectiveness, expressed in terms of reductions in the MSD rate.) Those studies from this group that provide information on reductions in lost workday case rates and reductions in the value of workers' compensation claims demonstrate that these programs are even more effective in reducing more serious MSDs than they are in reducing all types of MSDs. These intervention studies are, in turn, supported by the results of a large group of epidemiological studies of the work-related risk factors leading to MSDs (see the Preliminary Risk Assessment section of this preamble). That section describes the results of a large number of risk ratio studies reviewed by NIOSH (NIOSH 1997), which found that reducing the risk factors present in the jobs of the exposed populations (those who had experienced MSDs) to the risk factor levels found in the jobs of the control (non-exposed) populations in these studies would result in a 69% reduction in the number of MSDs of the neck or shoulder in the exposed population, a 57% to 86% reduction in the number of upper extremity disorders in this population, and a 56% reduction in the number of MSDs of the back. OSHA assumes, for the purpose of this benefits analysis, that the levels of risk factors present in the jobs of the workers in the control populations (*i.e.*, the exposures of the control group workers to forceful exertions, awkward or static posture, repetitive motions, etc.) are equivalent to the levels of these risk factors that would be present in jobs that have been controlled or ''fixed,'' as would be required by the proposed standard. Based on the data from these two sources (the intervention studies and the risk ratio studies), which report effectiveness rates that are strikingly consistent, OSHA estimates that the ergonomics program required by the proposed standard will prevent 50 percent of the covered MSDs that would otherwise have occurred in problem jobs. OSHA believes that this estimate of the effectiveness of the proposed standard is conservative, because many programs achieve substantially higher reductions and some eliminate MSD hazards entirely.

Determining the number of employees whose jobs will be fixed by the full ergonomics program required by the standard is unusually complicated because of the structure of the proposed standard itself. For example, the full program is applicable only to employees in a job in which a covered MSD has occurred and to other employees in the establishment in the same job, as defined by the standard.

Any analysis of the number of employees affected by the program envisioned by the proposed rule must consider: (1) That some MSDs initially reported to employers will turn out, on closer examination, not to be covered MSDs, and (2) that some MSDs will continue to occur in jobs that have already been fixed. To OSHA's knowledge, there are no data on either of these points.

Lacking such data, OSHA assumes, for analytical purposes, that all OSHA-recordable MSDs, rather than a portion of all OSHA-recordable MSDs, that occur in jobs that have not been fixed will require employers to implement a full program, and that all MSDs, rather than some MSDs, subsequently occurring in jobs that have already been fixed will not be covered MSDs and will thus not require employers to implement a full program. In other words, in terms of this analysis, OSHA treats these two factors as offsets of each other, *i.e.*, that the number of MSDs screened out will be equal to the number of MSDs subsequently occurring in controlled jobs. In actuality, some problem jobs that have been fixed will need further hazard control, and some covered MSDs will continue to occur in jobs that have not been fixed but will nevertheless not trigger implementation of the full program. The result of these simplifying assumptions is to overestimate the frequency with which a full program will be needed in the first years after the standard is implemented and to underestimate the frequency with which a full program will be needed in the out-years. Because this analysis only covers the first 10 years following the proposed standard's effective date, OSHA believes that these simplifying assumptions are likely to lead to an overestimate of both the benefits and costs. (In its cost analysis, OSHA assumes that employers will incur costs to investigate all MSDs that occur; thus, the simplifying assumptions used here are not carried forward into the cost analysis, which instead assumes that employers will assess the OSHA recordability and then the covered status of all MSDs occurring among their employees.)

OSHA estimates that employers will be required to fix approximately 7.7 million jobs in the first year the standard is in place, and a diminishing number every year thereafter. Over ten years, approximately 30 million jobs will be fixed. OSHA estimates that fixing these jobs will reduce the number of covered MSDs caused by these jobs by 50 percent per year (based on the effectiveness rate derived above) for the next ten years (the time horizon of this analysis). In the first 10 years, the proposed standard is therefore projected to avert approximately 3 million MSDs. By the tenth year the proposed standard is in place, it will have reduced the number of general industry MSDs by 26 percent, compared with the number of MSDs reported by the BLS for general industry in 1996.

OSHA estimates that the direct cost savings associated with each MSD, including the savings in lost productivity, lost tax payments, and administrative costs for workers' compensation claims, are $22,500 per MSD (1996 dollars). These direct cost savings do not attribute a value or assign a monetary cost to the pain and suffering of injured or ill workers, losses to their families, or losses of the worker's ability to contribute at home, and are thus conservative estimates of these savings. Based on this estimate of the direct cost savings associated with each covered MSD avoided, the annualized benefits (using a discount rate of 7%) accruing in the first ten years the standard is in effect are estimated to be $9.1 billion per year.

E. Costs of Compliance (Chapter V)

This chapter presents OSHA's estimates of the costs employers would incur to comply with the proposed ergonomics program rule. The costs reported are annualized costs measured in 1996 real dollars for the first 10 years the rule is in effect. To calculate annualized costs, non-recurring costs have been annualized using a discount rate of 7 percent for an estimated life of 10 years. The cost analysis does not account for any changes in the economy over time, or for possible adjustments in the demand and supply of goods, changes in production methods, investment effects, or macroeconomic effects of the standard. Taking account of all of these effects could increase or decrease the cost or benefit estimates presented here, although the macroeconomic effects of any rule whose costs are less than 0.05 percent of GNP are likely to be minimal. OSHA believes that its approach, *i.e.*, of determining the benefits and costs of the standard for industry as it is today, is the least speculative and least controversial way of presenting the benefits and costs of the proposed standard.

OSHA relied on responses to a 1993 ergonomics survey (see Appendix II–A to Chapter II of the Preliminary Economic Analysis) of thousands of general industry employers to estimate the extent to which establishments within the scope of the standard already have implemented ergonomics programs involving the control of jobs. This current industry baseline was taken into account in calculating industry-by-industry and size-of-establishment cost estimates, *i.e.*, any costs employers have already incurred, and any benefits they have already accrued, to voluntarily implement such programs have not been attributed to the proposed rule.

Costs were calculated separately at the three-digit SIC code level for all industries. These industry-by-industry cost estimates account for differences among industries in terms of wage rates, turnover, baseline rates of compliance, and the MSD rate for the industry. To facilitate analysis of the impacts of the proposed rule on small businesses, costs were calculated separately for each of three size classes of establishments. The Initial Regulatory Flexibility Analysis (Section VIII. H. of this Preamble) provides a detailed summary of OSHA's unit cost estimates for each element of the standard.

Table VIII–3 presents the annualized costs of the proposed ergonomics program standard. As this table shows, the total annualized costs to society are $3.4 billion, and the costs to employers are $4.2 billion. (The difference in these cost estimates is accounted for by the fact that an annualized cost of $875 million represents a shift in the costs employees are currently paying in the form of lost wages to costs that employers would be required to incur in the form of work restriction protection costs, *i.e.*, a shift in costs from employees to employers.) The job control provisions of the standard account for $2.3 billion, or 54 percent of the standard's total costs, and the work restriction protection provision accounts for $875 million, or 21 percent of this total.

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TABLE VIII-3

Total Cost of Compliance, by Provision of the Proposed Rule and 3-Digit SIC

SIC	Industry	Familiarization and MSD Coverage Costs	Basic Program	Full Program	Job Fixes	SUBTOTAL (cost to society)	Work Restriction Protection	TOTAL (cost to employers)
710	Soil preparation services	$4,987	$6,476	$35,359	$103,643	$150,466	$91,498	$241,964
720	Crop services	$57,711	$89,037	$715,647	$3,286,507	$4,148,901	$1,048,170	$5,197,071
740	Veterinary services	$111,426	$188,129	$1,502,747	$3,183,834	$4,986,135	$1,281,099	$6,267,235
750	Animal serv., excpt vet.	$33,281	$24,234	$242,781	$662,335	$962,631	$203,076	$1,165,707
780	Lndscape & hort. services	$446,243	$626,152	$5,231,530	$19,503,388	$25,807,313	$4,574,059	$30,381,372
810	Timber tracts	$9,390	$12,725	$92,334	$391,031	$505,480	$83,579	$589,058
830	Forest products	$2,388	$3,203	$24,391	$143,886	$173,867	$27,082	$200,949
850	Forestry services	$14,054	$20,593	$144,287	$377,313	$556,247	$103,784	$660,032
910	Commerical fishing	$14,682	$13,140	$103,663	$443,819	$575,304	$86,987	$662,291
920	Fish hatcheries	$1,380	$2,298	$15,665	$77,790	$97,133	$14,251	$111,384
970	Hunting & trapping	$2,701	$3,093	$22,698	$65,615	$94,107	$5,217	$99,324
1310	Crude petrol. & nat. gas	$99,996	$102,963	$721,594	$1,559,647	$2,484,199	$117,997	$2,602,196
1320	Natural gas liquids	$9,477	$22,565	$120,806	$181,518	$334,366	$64,327	$398,693
1380	Oil & gas field services	$141,424	$194,504	$1,444,641	$6,607,716	$8,388,285	$1,025,762	$9,414,047
2010	Meat products	$1,292,571	$232,815	$5,124,746	$13,849,717	$20,499,849	$14,352,079	$34,851,928
2020	Dairy products	$290,536	$123,080	$1,551,056	$3,414,123	$5,378,795	$2,829,232	$8,208,027
2030	Presrvd fruits & vegetables	$336,169	$132,309	$1,699,103	$4,655,532	$6,823,112	$3,202,193	$10,025,305
2040	Grain mill products	$268,330	$139,496	$1,477,950	$2,513,364	$4,399,140	$2,435,618	$6,834,758
2050	Bakery products	$431,082	$187,666	$2,300,855	$5,604,584	$8,524,186	$3,963,402	$12,487,588
2060	Sugar and confect. prods	$169,220	$73,894	$873,773	$2,094,901	$3,211,788	$1,337,722	$4,549,510
2070	Fats and oils	$42,723	$32,268	$271,343	$506,720	$853,054	$367,900	$1,220,954
2080	Beverages	$476,309	$145,324	$2,231,090	$4,033,755	$6,886,479	$2,166,275	$9,052,754
2090	Misc. food products	$352,217	$166,901	$1,814,634	$4,149,049	$6,482,800	$1,661,026	$8,143,826
2110	Cigarettes	$36,621	$15,330	$351,977	$273,762	$677,690	$138,508	$816,198
2120	Cigars	$2,016	$1,973	$16,353	$41,198	$61,540	$7,674	$69,214
2130	Chewing & smoking tobacco	$3,871	$2,366	$25,837	$19,294	$51,368	$15,987	$67,355
2140	Tobacco stemm. & redrying	$8,889	$4,812	$56,852	$115,984	$186,538	$37,215	$223,753
2210	Brdwven fab. mills, cotton	$153,345	$38,532	$727,340	$1,511,011	$2,430,229	$837,360	$3,267,589
2220	Broadwoven fabric mills	$84,935	$56,779	$680,047	$1,770,076	$2,591,837	$439,326	$3,031,163
2230	Brdwvn fab. mills, wool	$12,264	$10,808	$106,391	$240,228	$369,691	$66,897	$436,588
2240	Narrow fabric mills	$38,341	$22,978	$239,283	$404,408	$705,011	$275,322	$980,333
2250	Knitting mills	$227,250	$161,420	$1,697,598	$4,460,433	$6,546,701	$1,803,827	$8,350,528
2260	Tex. finishing, excpt wool	$74,571	$49,105	$560,822	$1,323,802	$2,008,301	$569,439	$2,577,740
2270	Carpets and rugs	$49,156	$36,546	$418,296	$1,297,526	$1,801,523	$377,969	$2,179,492
2280	Yarn and thread mills	$90,869	$68,818	$744,477	$1,990,103	$2,894,267	$766,120	$3,660,386
2290	Misc. textile goods	$76,312	$73,124	$644,138	$1,366,090	$2,159,665	$531,245	$2,690,910
2310	Men's & boys' suits & coats	$33,934	$17,453	$222,330	$373,337	$647,054	$302,359	$949,413
2320	Men's & boys' furnishings	$352,945	$146,504	$1,883,609	$3,050,871	$5,433,930	$2,804,240	$8,238,170
2330	Wm's & misses' outerwear	$222,143	$222,773	$1,787,931	$2,328,675	$4,561,521	$1,631,513	$6,193,035
2340	Wm's & chldrn's undergarmnts	$40,659	$21,666	$265,909	$645,985	$974,219	$509,425	$1,483,644
2350	Hats, caps, & millinery	$20,727	$15,636	$142,928	$173,942	$353,233	$208,095	$561,328
2360	Girls' & chldrn's outerwear	$22,136	$20,520	$209,489	$436,384	$688,529	$299,964	$988,493
2370	Fur goods	$1,228	$1,022	$7,788	$703	$10,741	$5,621	$16,361
2380	Misc. apparel & accessories	$39,652	$30,119	$274,268	$491,478	$835,516	$341,331	$1,176,847
2390	Misc. fab. textile prods	$295,417	$218,575	$2,042,306	$4,008,768	$6,565,067	$2,378,172	$8,943,239
2410	Logging	$93,363	$58,983	$462,751	$402,670	$1,017,767	$224,823	$1,242,590
2420	Sawmills & planing mills	$287,000	$261,566	$2,529,980	$3,763,949	$6,842,496	$2,360,422	$9,202,918
2430	Millwork & plywood	$583,281	$404,204	$4,528,356	$7,012,486	$12,528,327	$4,814,627	$17,342,953
2440	Wood containers	$56,634	$62,609	$672,815	$832,834	$1,624,892	$700,480	$2,325,372
2450	Wood bldings & mobile homes	$226,958	$84,492	$1,380,386	$3,153,345	$4,845,181	$1,838,941	$6,684,122
2490	Misc. wood products	$146,568	$130,027	$1,323,917	$1,831,541	$3,432,054	$1,776,602	$5,208,656
2510	Household furniture	$459,522	$213,129	$3,133,991	$6,229,989	$10,036,630	$6,212,126	$16,248,756
2520	Office furniture	$174,209	$69,795	$979,383	$1,966,554	$3,189,942	$1,818,118	$5,008,060
2530	Pub blding & related furn.	$189,745	$34,318	$758,473	$1,216,464	$2,199,001	$2,400,525	$4,599,526
2540	Partitions and fixtures	$161,634	$103,211	$1,242,244	$1,825,077	$3,332,165	$2,132,627	$5,464,792
2590	Misc furniture and fixtures	$72,016	$50,833	$527,579	$848,365	$1,498,794	$774,678	$2,273,471
2610	Pulp mills	$11,424	$13,148	$107,993	$280,466	$413,031	$111,883	$524,915
2620	Paper mills	$247,924	$131,832	$1,765,412	$3,765,953	$5,911,121	$2,140,699	$8,051,820
2630	Paperboard mills	$52,638	$75,395	$492,099	$1,034,327	$1,654,459	$444,921	$2,099,380
2650	Paperbrd containers & boxes	$341,820	$321,545	$2,823,669	$4,842,285	$8,329,319	$3,480,788	$11,810,106
2670	Misc. cnvrtd paper products	$401,244	$340,300	$3,008,784	$5,519,766	$9,270,094	$3,520,132	$12,790,226
2710	Newspapers	$438,601	$509,171	$4,174,010	$8,718,626	$13,840,408	$4,002,609	$17,843,017

TABLE VIII-3

Total Cost of Compliance, by Provision of the Proposed Rule and 3-Digit SIC

SIC	Industry	Familiarization and MSD Coverage Costs	Basic Program	Full Program	Job Fixes	SUBTOTAL (cost to society)	Work Restriction Protection	TOTAL (cost to employers)
2720	Periodicals	$86,785	$111,521	$916,865	$956,982	$2,072,152	$753,383	$2,825,535
2730	Books	$146,049	$140,449	$1,402,595	$2,307,355	$3,996,448	$1,448,385	$5,444,833
2740	Miscellaneous publishing	$58,441	$74,584	$543,443	$601,677	$1,278,144	$299,529	$1,577,673
2750	Commercial printing	$789,771	$1,023,042	$8,174,710	$7,189,782	$17,177,305	$5,137,479	$22,314,783
2760	Manifold business forms	$76,103	$84,852	$761,960	$751,585	$1,674.499	$603,556	$2,278,055
2770	Greeting cards	$39,944	$19,323	$265,013	$907,814	$1,232,094	$291,705	$1,523,799
2780	Blankbooks & bookbinding	$89,296	$100,845	$869,426	$1,511,860	$2,571,427	$748,404	$3,319,832
2790	Printing trade services	$59,889	$91,017	$582,268	$211,823	$944,996	$258,745	$1,203,741
2810	Indust. inorganic chemicals	$96,797	$64,914	$582,743	$1,294,714	$2,039,168	$535,798	$2,574,966
2820	Plastics mat. & synthetics	$122,740	$82,151	$746,510	$1,417,255	$2,368,656	$739,988	$3,108,644
2830	Drugs	$260,684	$130,084	$1,426,144	$3,175,181	$4,992,093	$2,457,923	$7,450,017
2840	Soap, clnrs, & toilet goods	$173,485	$88,316	$895,079	$2,111,037	$3,267,917	$1,773,632	$5,041,549
2850	Paints & allied products	$72,281	$46,848	$432,646	$682,993	$1,234,768	$867,025	$2,101,792
2860	Indust. organic chemicals	$125,520	$105,823	$751,671	$1,303,483	$2,286,496	$574,433	$2,860,929
2870	Agricultural chemicals	$40,787	$31,766	$256,873	$452,629	$782,056	$241,451	$1,023,507
2890	Misc. chemical products	$138,254	$97,315	$801,899	$1,128,929	$2,166,396	$880,254	$3,046,650
2910	Petroleum refining	$59,716	$112,893	$594,464	$1,805,294	$2,572,368	$269,676	$2,842,044
2950	Asphlt pavng & roofng mat.	$40,114	$56,241	$375,983	$968,332	$1,440,671	$254,541	$1,695,212
2990	Misc. pet. & coal prods	$9,003	$22,223	$112,739	$289,620	$433,585	$32,399	$465,984
3010	Tires and inner tubes	$219,488	$44,629	$1,163,243	$1,424,982	$2,852,341	$955,426	$3,807,767
3020	Rubber & plastics footwear	$24,725	$4,774	$98,357	$223,485	$351,341	$137,126	$488,467
3050	Hose, bltng, and gaskets	$143,626	$52,078	$679,979	$1,450,210	$2,325,894	$741,890	$3,067,784
3060	Fab. rubber prod., n.e.c.	$266,659	$101,107	$1,271,163	$2,672,038	$4,310,967	$1,383,253	$5,694,221
3080	Misc plastics, n.e.c.	$1,347,716	$699,349	$7,471,653	$15,672,256	$25,190,974	$6,999,315	$32,190,288
3110	Leather tan. & finishing	$33,820	$21,464	$221,025	$589,913	$866,222	$168,574	$1,034,796
3130	Footwear cut stock	$3,110	$3,303	$25,830	$58,823	$91,066	$36,998	$128,064
3140	Footwear, except rubber	$65,979	$31,564	$418,497	$1,624,062	$2,140,102	$884,439	$3,024,541
3150	Leather gloves & mittens	$6,700	$4,470	$43,163	$42,981	$97,313	$84,666	$181,979
3160	Luggage	$8,752	$10,570	$86,370	$187,250	$292,942	$121,747	$414,688
3170	Hndbags & prsnal leathr gds.	$9,358	$7,710	$92,339	$304,038	$413,446	$179,967	$593,413
3190	Leather goods, n.e.c.	$14,962	$12,730	$121,977	$260,087	$409,755	$237,434	$647,189
3210	Flat glass	$47,351	$13,129	$250,688	$493,156	$804,324	$462,291	$1,266,615
3220	Glass, pressed or blown	$211,449	$59,113	$940,301	$2,051,162	$3,262,024	$1,633,864	$4,895,889
3230	Prod. of purchased glass	$148,964	$80,706	$789,277	$2,146,211	$3,165,157	$1,497,315	$4,662,472
3240	Cement, hydraulic	$28,128	$21,979	$212,609	$442,401	$705,117	$163,609	$868,727
3250	Structural clay products	$72,612	$43,294	$425,866	$918,782	$1,460,555	$478,468	$1,939,023
3260	Pottery & related prods	$105,087	$49,343	$531,420	$1,344,773	$2,030,623	$736,348	$2,766,970
3270	Concrete & plast. prdcts	$349,702	$385,906	$2,892,656	$5,057,981	$8,686,245	$2,255,193	$10,941,438
3280	Cut stone & stone prods	$29,602	$31,314	$235,326	$338,425	$634,667	$180,071	$814,738
3290	Misc. nonmet. mineral prods.	$131,038	$98,700	$860,158	$2,155,367	$3,245,263	$886,282	$4,131,545
3310	Basic steel products	$539,361	$189,531	$3,525,180	$6,436,770	$10,690,842	$2,995,612	$13,686,455
3320	Iron and steel foundries	$436,536	$112,336	$2,068,240	$3,432,151	$6,049,263	$3,302,185	$9,351,449
3330	Primary nonfer. metals	$73,026	$24,048	$416,124	$879,707	$1,392,905	$482,769	$1,875,674
3340	Secondary nonfer. metals	$36,839	$18,922	$201,335	$417,990	$675,086	$261,597	$936,683
3350	Nonfer. rolling & drawing	$389,851	$135,054	$1,889,475	$3,935,671	$6,350,051	$2,425,542	$8,775,592
3360	Nonfer. foundries (cstngs)	$235,885	$96,561	$1,101,117	$2,164,493	$3,598,057	$1,773,747	$5,371,804
3390	Misc. primary metal prdcts	$38,664	$43,266	$295,634	$557,634	$935,198	$249,554	$1,184,752
3410	Met. cans & ship. containers	$78,724	$49,208	$586,664	$919,556	$1,634,152	$501,141	$2,135,293
3420	Cutlery, hndtls, & hardware	$297,616	$173,932	$2,011,168	$3,877,717	$6,360,433	$2,061,445	$8,421,878
3430	Plumbing & heating fixtures	$167,692	$53,896	$855,720	$1,660,249	$2,737,557	$1,311,106	$4,048,663
3440	Fab. struct. metal prdcts	$849,767	$693,151	$6,855,786	$11,168,871	$19,567,575	$6,439,798	$26,007,372
3450	Screw machine products	$219,273	$170,580	$1,715,235	$2,116,672	$4,221,759	$1,618,903	$5,840,663
3460	Met. forgings & stampings	$824,129	$376,377	$4,746,165	$8,679,062	$14,625,734	$5,659,519	$20,285,253
3470	Metal services, n.e.c.	$218,656	$222,471	$1,942,865	$2,174,274	$4,558,266	$1,638,394	$6,196,660
3480	Ordnance and access., n.e.c.	$73,076	$36,879	$478,676	$1,033,571	$1,622,202	$436,551	$2,058,754
3490	Misc. fab. metal products	$589,495	$415,675	$4,465,584	$7,479,527	$12,950,281	$4,425,629	$17,375,910
3510	Engines and turbines	$220,541	$69,347	$1,165,957	$1,991,508	$3,447,353	$1,320,904	$4,768,256
3520	Farm & garden machinery	$267,611	$130,767	$1,503,677	$3,108,824	$5,010,879	$1,577,971	$6,588,850
3530	Construct. & related mach.	$454,768	$241,864	$2,880,890	$5,709,236	$9,286,758	$3,209,034	$12,495,792
3540	Metalworking machinery	$582,437	$508,638	$4,655,183	$5,752,420	$11,498,678	$2,612,411	$14,111,089
3550	Special industry mach.	$345,325	$268,298	$2,598,591	$3,898,661	$7,110,875	$1,545,567	$8,656,442
3560	General indust. mach.	$520,063	$326,287	$3,621,951	$6,141,371	$10,609,672	$2,466,064	$13,075,736

TABLE VIII-3

Total Cost of Compliance, by Provision of the Proposed Rule and 3-Digit SIC

SIC	Industry	Familiarization and MSD Coverage Costs	Basic Program	Full Program	Job Fixes	SUBTOTAL (cost to society)	Work Restriction Protection	TOTAL (cost to employers)
3570	Computer & office equip.	$289,582	$179,785	$1,910,387	$4,544,423	$6,924,177	$1,103,833	$8,028,010
3580	Refrig. & serv. indust mach.	$518,937	$201,047	$2,811,471	$6,359,093	$9,890,548	$2,472,817	$12,363,365
3590	Industrial mach., n.e.c.	$674,379	$693,223	$5,692,592	$4,820,735	$11,880,930	$2,779,177	$14,660,107
3610	Elect. dist. equipment	$131,116	$40,529	$594,404	$1,066,571	$1,832,620	$605,637	$2,438,256
3620	Elect. indust. apparatus	$392,662	$101,438	$1,589,553	$2,503,770	$4,587,423	$1,695,903	$6,283,325
3630	Household appliances	$358,851	$41,165	$1,235,281	$2,306,060	$3,941,356	$994,665	$4,936,022
3640	Elct. lghtng & wire equip.	$361,387	$95,196	$1,550,582	$2,567,937	$4,575,103	$1,036,538	$5,611,641
3650	Household audio & vid. equip.	$104,773	$26,313	$436,041	$774,993	$1,342,120	$295,878	$1,637,998
3660	Communications equipment	$268,372	$114,798	$1,354,173	$2,971,302	$4,708,645	$632,236	$5,340,881
3670	Electrnic compnnts & access.	$636,637	$297,328	$3,325,890	$6,451,029	$10,710,884	$1,707,180	$12,418,064
3690	Misc. elect. equipment	$377,907	$91,648	$1,595,343	$2,597,975	$4,662,873	$1,073,328	$5,736,202
3710	Motor vehicles & equipt.	$6,110,272	$106,665	$19,067,888	$9,225,657	$34,510,482	$13,808,384	$48,318,866
3720	Aircraft and parts	$1,059,333	$126,318	$4,943,403	$3,879,273	$10,008,327	$3,949,190	$13,957,517
3730	Ship, boat blding and repair	$190,463	$34,962	$566,210	$586,265	$1,377,901	$928,782	$2,306,682
3740	Railroad equipment	$113,000	$12,212	$400,980	$448,930	$975,122	$613,205	$1,588,327
3750	Motorcycles & bicycles	$62,338	$8,460	$198,199	$183,295	$452,292	$279,135	$731,427
3760	Guided missiles	$71,402	$21,997	$434,354	$517,715	$1,045,467	$309,889	$1,355,357
3790	Misc. transportation equip.	$147,968	$23,286	$464,301	$661,711	$1,297,267	$852,981	$2,150,247
3810	Srch & navigation equipment	$144,859	$96,191	$982,575	$2,171,092	$3,394,716	$619,321	$4,014,037
3820	Meas. & contrlling devices	$388,984	$218,685	$2,165,034	$3,934,262	$6,706,966	$1,845,100	$8,552,066
3840	Medical instrmnts & supplies	$339,754	$182,368	$1,903,998	$4,394,382	$6,820,501	$1,612,150	$8,432,651
3850	Ophthalmic goods	$40,265	$18,210	$207,936	$421,516	$687,927	$221,269	$909,196
3860	Photo. equip. & supplies	$114,816	$36,190	$776,989	$1,282,619	$2,210,613	$600,797	$2,811,411
3870	Watches, clocks, & parts	$4,192	$2,796	$27,259	$77,368	$111,616	$23,271	$134,887
3910	Jwlry, slvrwre, and plate	$58,762	$48,592	$424,219	$878,379	$1,409,952	$607,505	$2,017,457
3930	Musical instruments	$30,303	$15,592	$161,092	$429,830	$636,816	$383,710	$1,020,526
3940	Toys and sporting goods	$253,054	$127,950	$1,322,435	$3,039,197	$4,742,635	$2,971,917	$7,714,553
3950	Office and art supplies	$39,717	$32,649	$276,576	$547,987	$896,930	$373,807	$1,270,737
3960	Costume jewelry & notions	$21,488	$18,643	$166,935	$364,354	$571,419	$248,010	$819,428
3990	Misc. manufactures	$259,336	$210,687	$1,920,586	$3,892,492	$6,283,101	$3,200,145	$9,483,246
4110	Local & suburban trans.	$270,438	$477,130	$3,177,413	$16,349,789	$20,274,770	$3,743,337	$24,018,108
4120	Taxicabs	$14,951	$18,710	$155,751	$927,276	$1,116,687	$106,769	$1,223,456
4130	Intercty & rural bus trans.	$23,248	$40,727	$247,503	$2,189,167	$2,500,645	$286,125	$2,786,770
4140	Bus charter service	$14,224	$38,954	$229,616	$1,010,765	$1,293,558	$161,236	$1,454,794
4150	School buses	$43,496	$158,402	$827,641	$5,623,426	$6,652,965	$653,889	$7,306,855
4170	Bus terminals	$1,151	$2,084	$12,486	$18,547	$34,268	$11,598	$45,866
4210	Trking & Courier Service	$1,991,571	$3,193,985	$20,696,026	$157,727,668	$183,609,250	$19,927,167	$203,536,417
4220	Pub. warehousing & storage	$252,812	$429,735	$2,707,392	$7,580,477	$10,970,415	$2,911,025	$13,881,441
4230	Trucking terminal fac.	$1,879	$2,786	$19,845	$60,210	$84,719	$20,769	$105,488
4510	Air trans., scheduled	$3,141,829	$1,654,817	na	$45,899,440	$50,696,087	$34,383,061	$85,079,148
4520	Air trans., nonsched.	$28,911	$50,403	na	$834,207	$913,521	$306,469	$1,219,990
4580	Airports and services	$151,961	$228,651	na	$5,711,186	$6,091,798	$1,857,214	$7,949,012
4610	Pipelines, excpt natural gas	$43,291	$71,575	$430,575	$779,380	$1,324,821	$371,508	$1,696,329
4720	Pass. trans. arrangements	$130,767	$80,858	$675,387	$1,180,784	$2,067,796	$433,400	$2,501,195
4730	Freight trans. arrangements	$148,131	$273,075	$1,912,863	$4,538,363	$6,872,431	$1,346,468	$8,218,900
4740	Rental of railroad cars	$1,637	$2,506	$19,417	$47,391	$70,951	$16,151	$87,102
4780	Misc. trans. services	$58,293	$116,336	$761,558	$2,239,613	$3,175,800	$687,512	$3,863,312
4810	Telephone communication	$736,341	$687,065	$5,141,577	$15,471,865	$22,036,849	$6,357,405	$28,394,255
4820	Telegrph & other comm.	$4,403	$3,520	$26,693	$54,733	$89,349	$30,420	$119,769
4830	Radio & TV broadcasting	$89,118	$114,740	$598,802	$713,401	$1,516,060	$612,917	$2,128,977
4840	Cable & othr pay TV services	$150,488	$140,247	$1,085,772	$3,365,180	$4,741,687	$1,944,488	$6,686,176
4890	Communication serv., n.e.c.	$8,823	$7,231	$57,693	$130,585	$204,333	$71,041	$275,374
4910	Electric services	$484,291	$402,785	$3,164,075	$7,285,459	$11,336,610	$4,684,979	$16,021,589
4920	Gas product. & distribution	$209,739	$161,388	$1,260,935	$2,777,015	$4,409,076	$1,957,335	$6,366,411
4930	Comb. utility services	$157,931	$174,209	$1,289,606	$3,645,897	$5,267,643	$1,647,225	$6,914,868
4940	Water supply	$47,828	$31,445	$279,398	$365,967	$724,638	$398,715	$1,123,354
4950	Sanitary services	$369,617	$192,723	$1,681,523	$3,905,228	$6,149,092	$4,356,458	$10,505,550
4960	Steam & air-cond. supplies	$1,981	$1,889	$13,831	$18,099	$35,800	$21,137	$56,936
4970	Irrigation systems	$3,846	$2,313	$20,862	$23,444	$50,465	$27,529	$77,993
5010	Motor vehicles	$670,124	$1,119,295	$7,372,540	$17,544,541	$26,706,500	$7,340,983	$34,047,483
5020	Furn. & homefurnishings	$270,260	$420,597	$2,778,495	$5,450,047	$8,919,399	$2,891,441	$11,810,839
5030	Lumber & construct. mat.	$529,424	$868,999	$5,701,892	$12,053,857	$19,154,171	$7,166,477	$26,320,648

TABLE VIII-3

Total Cost of Compliance, by Provision of the Proposed Rule and 3-Digit SIC

SIC	Industry	Familiarization and MSD Coverage Costs	Basic Program	Full Program	Job Fixes	SUBTOTAL (cost to society)	Work Restriction Protection	TOTAL (cost to employers)
5040	Prof. & commercial equip.	$767,460	$1,199,428	$8,149,284	$19,071,169	$29,187,341	$7,035,788	$36,223,129
5050	Met. & minerals, excpt pet.	$250,863	$415,216	$2,702,977	$6,224,460	$9,593,516	$3,061,582	$12,655,098
5060	Electrical goods	$478,477	$801,277	$5,716,175	$12,036,297	$19,032,226	$5,580,786	$24,613,012
5070	Hardware supplies	$470,424	$801,425	$5,195,989	$9,143,776	$15,611,615	$5,546,127	$21,157,742
5080	Mach., equipt, & supplies	$1,169,252	$1,952,553	$12,787,599	$22,207,577	$38,116,981	$11,848,377	$49,965,358
5090	Misc. durable goods	$465,035	$651,528	$4,491,872	$10,424,284	$16,032,719	$4,680,988	$20,713,707
5110	Paper and paper products	$240,016	$372,882	$2,427,331	$8,007,675	$11,047,904	$1,832,530	$12,880,434
5120	Drugs, propriet., & sundries	$195,812	$263,578	$1,750,403	$5,626,906	$7,836,699	$1,208,244	$9,044,943
5130	Apparel and notions	$268,799	$326,789	$2,208,296	$4,405,641	$7,209,526	$1,503,877	$8,713,403
5140	Groceries & related products	$1,527,746	$1,801,204	$12,216,331	$42,961,160	$58,506,441	$14,326,055	$72,832,496
5150	Farm-prod. raw materials	$66,736	$82,303	$596,285	$1,078,621	$1,823,945	$424,401	$2,248,346
5160	Chemicals & allied prods	$208,707	$302,167	$1,991,680	$3,603,976	$6,106,530	$1,250,754	$7,357,284
5170	Petrol. & petrol. prods	$166,173	$263,520	$1,716,782	$3,996,954	$6,143,429	$1,239,897	$7,383,326
5180	Beer, wine, & dist. bev.	$367,763	$389,064	$2,616,453	$8,440,158	$11,813,438	$4,961,044	$16,774,482
5190	Misc. nondurable goods	$693,384	$912,518	$6,127,581	$15,953,876	$23,687,359	$7,234,035	$30,921,394
5210	Lumber & other blding mat.	$699,520	$1,437,405	$8,503,116	$32,098,003	$42,738,044	$11,288,080	$54,026,123
5230	Paint, glass, wallpaper strs	$66,022	$133,922	$1,051,264	$1,847,081	$3,098,289	$1,048,571	$4,146,859
5250	Hardware stores	$116,198	$263,783	$1,748,911	$3,515,909	$5,644,801	$1,797,909	$7,442,710
5260	Retail nurseries and gardens	$98,921	$211,193	$1,384,171	$4,074,662	$5,768,946	$1,366,958	$7,135,904
5270	Mobile home dealers	$75,960	$183,892	$962,173	$2,286,762	$3,508,786	$864,884	$4,373,670
5310	Department stores	$1,456,112	$2,579,222	$18,543,511	$86,647,527	$109,226,373	$39,736,507	$148,962,880
5330	Variety stores	$148,025	$363,875	$1,991,237	$2,637,282	$5,140,419	$2,864,574	$8,004,993
5390	Misc. gen. merchandise strs.	$202,970	$468,617	$2,836,343	$8,674,125	$12,182,055	$2,975,324	$15,157,380
5410	Grocery stores	$2,935,417	$4,233,564	$26,283,328	$113,882,170	$147,334,478	$47,341,032	$194,675,511
5420	Meat and fish markets	$69,086	$90,323	$561,701	$1,239,539	$1,960,649	$585,028	$2,545,677
5430	Fruit & vegetable markets	$23,636	$22,499	$156,467	$266,400	$469,001	$147,343	$616,344
5440	Candy, nut, & confctnry strs	$32,298	$31,179	$216,748	$264,010	$544,235	$187,128	$731,363
5450	Dairy products stores	$15,944	$12,657	$90,534	$122,416	$241,552	$75,394	$316,946
5460	Retail bakeries	$162,972	$207,986	$1,345,909	$1,811,860	$3,528,727	$1,287,555	$4,816,282
5490	Misc. food stores	$65,862	$58,657	$414,300	$521,922	$1,060,742	$362,575	$1,423,316
5510	New and used car dealers	$895,819	$3,214,783	$13,666,384	$61,678,633	$79,455,619	$8,931,247	$88,386,866
5520	Used car dealers	$112,022	$39,914	$323,147	$464,113	$939,196	$187,272	$1,126,468
5530	Auto & home supply stores	$382,532	$846,125	$5,571,912	$15,653,650	$22,454,218	$5,007,197	$27,461,415
5540	Gas service stations	$550,926	$915,746	$6,601,353	$12,641,485	$20,709,510	$5,664,091	$26,373,601
5550	Boat dealers	$53,560	$107,649	$672,657	$1,384,860	$2,218,725	$497,866	$2,716,592
5560	Rec. vehicle dealers	$47,080	$111,721	$616,395	$1,644,332	$2,419,529	$547,481	$2,967,010
5570	Motorcycle dealers	$20,053	$11,011	$77,519	$156,348	$264,931	$44,384	$309,316
5590	Auto dealers, n.e.c.	$6,423	$2,738	$21,672	$41,515	$72,348	$12,298	$84,647
5610	Men's & boys' clothing strs	$57,123	$69,153	$561,816	$763,952	$1,452,045	$249,329	$1,701,374
5620	Women's clothing stores	$232,823	$213,332	$1,480,170	$1,757,782	$3,684,107	$536,675	$4,220,782
5630	Wm's access.& specialty strs	$48,236	$33,257	$242,898	$231,625	$556,017	$84,389	$640,405
5640	Chldrn's & infants' wear strs	$33,654	$40,250	$267,092	$542,086	$883,082	$96,966	$980,049
5650	Family clothing stores	$268,162	$658,432	$3,646,772	$8,852,053	$13,425,419	$1,946,312	$15,371,732
5660	Shoe stores	$228,146	$221,430	$1,508,850	$1,444,254	$3,402,680	$492,592	$3,895,272
5690	Misc. apparel stores	$49,834	$24,788	$190,112	$194,717	$459,451	$68,416	$527,866
5710	Furnitre & homefurnishng strs	$699,700	$1,473,531	$9,311,645	$22,284,325	$33,769,201	$4,439,257	$38,208,458
5720	Household appliance strs	$126,596	$237,972	$1,369,086	$3,324,919	$5,058,573	$545,741	$5,604,314
5730	Radio, TV, & comptr strs	$322,158	$528,607	$3,541,892	$7,962,991	$12,355,649	$1,355,193	$13,710,842
5810	Eating & drinking places	$4,248,762	$7,266,370	$42,553,440	$70,883,331	$124,951,904	$22,914,838	$147,866,742
5910	Drug stores	$372,398	$796,948	$4,612,042	$10,215,051	$15,996,439	$1,743,740	$17,740,179
5920	Liquor stores	$91,255	$42,835	$392,767	$301,406	$828,263	$168,944	$997,207
5930	Used merchandise stores	$162,168	$204,697	$1,409,967	$2,404,560	$4,181,392	$577,048	$4,758,441
5940	Misc. shopping goods strs.	$887,324	$1,250,591	$8,597,085	$14,732,139	$25,467,139	$3,547,251	$29,014,390
5960	Nonstore retailers	$503,122	$825,565	$4,963,604	$24,029,191	$30,321,482	$3,109,435	$33,430,917
5980	Fuel dealers	$87,883	$181,195	$1,268,193	$4,122,069	$5,659,339	$560,282	$6,219,621
5990	Retail stores, n.e.c.	$535,805	$538,601	$4,091,752	$6,973,613	$12,139,771	$1,567,049	$13,706,820
6010	Central res. depository	$19,144	$24,128	$165,488	$372,874	$581,634	$158,978	$740,611
6020	Commercial banks	$620,662	$835,361	$4,935,074	$8,888,205	$15,279,302	$2,394,004	$17,673,306
6030	Savings institutions	$128,150	$141,972	$843,489	$1,035,567	$2,149,177	$366,166	$2,515,343
6060	Credit unions	$100,628	$120,393	$810,520	$885,011	$1,916,553	$422,449	$2,339,002
6080	Foreign banking	$15,270	$34,485	$145,489	$229,772	$425,016	$61,800	$486,815
6090	Banking-related functions	$56,144	$49,863	$375,814	$645,549	$1,127,371	$217,934	$1,345,305

TABLE VIII-3

Total Cost of Compliance, by Provision of the Proposed Rule and 3-Digit SIC

SIC	Industry	Familiarization and MSD Coverage Costs	Basic Program	Full Program	Job Fixes	SUBTOTAL (cost to society)	Work Restriction Protection	TOTAL (cost to employers)
6110	Federal credit agencies	$8,492	$5,013	$34,195	$49,581	$97,282	$13,935	$111,216
6140	Personal cred. institutions	$112,035	$27,803	$207,198	$263,851	$610,888	$81,123	$692,011
6150	Business cred. institutions	$57,056	$59,231	$396,646	$724,486	$1,237,419	$171,496	$1,408,915
6160	Mortgage bankers & brokers	$157,167	$110,887	$777,704	$879,280	$1,925,038	$313,295	$2,238,332
6210	Security brokers & dealers	$159,455	$131,439	$860,678	$1,452,879	$2,604,451	$311,818	$2,916,269
6220	Commodity contracts brokers	$7,261	$3,252	$26,627	$44,464	$81,605	$13,277	$94,882
6230	Security & commod. exchanges	$3,025	$5,276	$36,921	$69,316	$114,538	$24,167	$138,705
6280	Security & commod. services	$123,175	$28,186	$224,831	$355,502	$731,694	$91,630	$823,324
6310	Life insurance	$187,677	$235,235	$1,407,818	$3,429,444	$5,260,175	$931,857	$6,192,032
6320	Medical & health insur.	$191,754	$195,434	$1,653,638	$4,601,419	$6,642,246	$2,281,161	$8,923,407
6330	Fire, marine, & caslty ins.	$414,568	$332,119	$3,059,917	$4,652,261	$8,458,865	$2,435,612	$10,894,478
6350	Surety insurance	$6,499	$5,635	$38,479	$72,517	$123,129	$25,498	$148,627
6360	Title insurance	$29,427	$34,115	$231,572	$301,887	$597,001	$199,132	$796,133
6370	Pension and health funds	$22,958	$15,827	$111,956	$129,160	$279,902	$73,601	$353,503
6390	Ins. carriers, n.e.c.	$2,789	$2,925	$19,629	$24,678	$50,022	$15,114	$65,136
6410	Insurance agents	$757,305	$322,150	$2,557,541	$2,192,452	$5,829,448	$1,074,351	$6,903,799
6510	Real estate operators	$745,191	$872,979	$7,055,751	$12,868,326	$21,542,247	$3,265,756	$24,808,003
6530	RE agents and managers	$815,824	$690,631	$5,574,350	$11,897,961	$18,978,767	$2,169,868	$21,148,635
6540	Title abstract offices	$37,586	$48,876	$364,140	$235,700	$686,302	$143,450	$829,752
6550	Subdividers & developrs	$164,809	$211,960	$1,651,162	$4,537,840	$6,565,771	$844,484	$7,410,254
6710	Holding offices	$109,973	$116,620	$813,320	$2,127,896	$3,167,810	$353,154	$3,520,964
6720	Investment offices	$8,167	$5,938	$69,362	$383,912	$467,380	$31,101	$498,481
6730	Trusts	$59,082	$38,007	$303,743	$482,252	$883,084	$128,345	$1,011,429
6790	Miscellaneous investing	$53,744	$29,185	$237,240	$515,830	$835,999	$96,823	$932,823
7010	Hotels and motels	$1,252,550	$1,765,915	$12,608,058	$42,680,891	$58,307,415	$16,348,430	$74,655,845
7020	Rooming & boarding houses	$17,330	$25,809	$154,750	$172,712	$370,601	$126,581	$497,181
7030	Camps and rec. vehicle parks	$16,921	$5,171	$54,269	$129,092	$205,454	$41,783	$247,237
7040	Membership-basis org. hotels	$12,231	$3,629	$28,094	$27,747	$71,701	$15,167	$86,868
7210	Laundry & garment srvices	$468,255	$789,972	$6,846,313	$10,450,279	$18,554,820	$4,352,819	$22,907,639
7220	Photo studios, portrait	$50,880	$42,265	$378,061	$944,847	$1,416,052	$361,206	$1,777,258
7230	Beauty shops	$224,867	$107,624	$1,030,277	$1,373,722	$2,736,490	$654,226	$3,390,716
7240	Barber shops	$28,636	$26,634	$196,420	$163,675	$415,365	$102,219	$517,584
7250	Shoe repair	$13,392	$10,468	$80,069	$106,671	$210,599	$41,254	$251,854
7260	Fun. service and crematories	$88,972	$87,960	$640,687	$1,060,634	$1,878,252	$341,909	$2,220,161
7290	Misc personal services.	$137,183	$35,970	$266,366	$920,342	$1,359,861	$131,568	$1,491,429
7310	Advertising	$235,413	$239,994	$1,886,567	$4,375,182	$6,737,157	$1,472,713	$8,209,870
7320	Credit report.& collection	$69,094	$74,800	$456,050	$591,161	$1,191,105	$297,398	$1,488,503
7330	Mailing, reprod, steno., serv	$281,025	$257,467	$1,933,844	$4,658,495	$7,130,831	$1,697,626	$8,828,457
7340	Services to buildings	$628,043	$634,021	$5,033,478	$5,364,864	$11,660,407	$7,187,708	$18,848,115
7350	Misc. equipt. rental	$215,210	$259,345	$1,847,785	$5,712,640	$8,034,980	$1,649,167	$9,684,148
7360	Pers. supply services	$640,818	$1,623,943	$7,848,843	$59,345,512	$69,459,117	$6,215,022	$75,674,139
7370	Comptr & data proc. services	$718,770	$559,503	$4,167,141	$9,421,916	$14,867,330	$2,016,630	$16,883,961
7380	Misc. business services	$590,380	$587,373	$4,843,727	$17,179,287	$23,200,768	$4,444,159	$27,644,927
7510	Auto rentals, no drivers	$124,728	$205,961	$1,300,782	$4,846,224	$6,477,696	$641,664	$7,119,360
7520	Automobile parking	$41,040	$42,374	$326,895	$1,339,248	$1,749,556	$106,678	$1,856,234
7530	Automotive repair shops	$886,925	$978,950	$7,413,679	$15,186,779	$24,466,334	$1,863,043	$26,329,376
7540	Automotive serv., exc repair	$183,481	$335,697	$2,372,396	$6,070,140	$8,961,714	$1,495,848	$10,457,562
7620	Electrical repair shops	$158,028	$243,078	$1,761,339	$5,467,305	$7,629,750	$892,065	$8,521,815
7630	Watch and jewelry repair	$11,782	$11,285	$88,236	$126,849	$238,152	$36,642	$274,794
7640	Reupholstery & furn. repair	$41,646	$32,828	na	$326,022	$400,496	$107,400	$507,897
7690	Misc. repair shops	$317,624	$511,068	$3,682,545	$10,337,609	$14,848,846	$1,916,580	$16,765,426
7810	Motion picture production	$336,437	$295,610	$4,360,858	$10,643,414	$15,636,318	$2,155,898	$17,792,216
7820	Motion picture dist.	$50,910	$70,707	$441,887	$776,095	$1,339,599	$467,747	$1,807,346
7830	Motion picture theaters	$127,253	$314,744	$1,984,981	$2,170,895	$4,597,873	$1,616,051	$6,213,923
7840	Video tape rental	$204,854	$418,048	$2,346,539	$713,797	$3,683,238	$1,745,730	$5,428,968
7910	Dance studios & schools	$48,181	$71,072	$460,552	$451,053	$1,030,858	$252,972	$1,283,830
7920	Prducrs, orch., entertainers	$115,309	$136,276	$1,071,893	$3,415,871	$4,739,349	$709,114	$5,448,464
7930	Bowling centers	$44,678	$76,822	$445,225	$704,821	$1,271,546	$224,639	$1,496,184
7940	Commercial sports	$117,673	$143,715	$1,056,575	$3,759,981	$5,077,943	$909,627	$5,987,571
7990	Misc. recreation services	$762,471	$1,283,504	$8,739,338	$34,654,985	$45,440,298	$7,594,554	$53,034,852
8010	Offices of medical doctors	$1,393,281	$1,355,048	$10,068,080	$26,817,760	$39,634,170	$6,350,341	$45,984,511
8020	Dentists offices and clinics	$847,573	$488,588	$3,512,703	$2,970,314	$7,819,178	$1,606,642	$9,425,820

TABLE VIII-3

Total Cost of Compliance, by Provision of the Proposed Rule and 3-Digit SIC

SIC	Industry	Familiarization and MSD Coverage Costs	Basic Program	Full Program	Job Fixes	SUBTOTAL (cost to society)	Work Restriction Protection	TOTAL (cost to employers)
8030	Osteopathic physicians	$35,075	$15,032	$128,267	$179,195	$357,570	$77,167	$434,736
8040	Other health practitioners	$536,674	$481,334	$3,987,147	$5,847,699	$10,852,854	$2,800,602	$13,653,456
8050	Nursing & personal care fac.	$3,759,898	$2,114,261	$24,074,294	$77,752,250	$107,700,702	$51,294,314	$158,995,016
8060	Hospitals	$7,239,105	$4,890,903	$55,115,077	$209,521,909	$276,766,994	$68,404,131	$345,171,125
8070	Med. & dental labs	$152,323	$155,108	$1,123,088	$4,132,142	$5,562,660	$748,539	$6,311,199
8080	Home hlth care services	$815,588	$990,964	$6,851,537	$33,742,269	$42,400,358	$9,114,120	$51,514,478
8090	Hlth & allied serv., n.e.c.	$290,769	$448,678	$2,834,519	$9,416,424	$12,990,390	$2,145,692	$15,136,082
8110	Legal services	$1,078,509	$636,931	$4,975,954	$6,296,553	$12,987,947	$1,839,321	$14,827,269
8210	Elem. & secondary schools	$252,669	$536,448	$2,408,558	$7,409,246	$10,606,920	$1,315,740	$11,922,661
8220	Colleges & universities	$297,420	$845,008	$5,562,216	$27,745,022	$34,449,666	$2,500,587	$36,950,253
8230	Libraries	$12,931	$6,340	$47,050	$57,024	$123,346	$24,182	$147,528
8240	Vocational schools	$39,821	$24,899	$173,999	$329,784	$568,502	$90,754	$659,256
8290	Schools, n.e.c.	$83,539	$33,915	$262,448	$372,197	$752,100	$249,057	$1,001,157
8320	Individual & fam. services	$501,092	$942,073	$5,686,199	$24,515,841	$31,645,206	$8,689,296	$40,334,501
8330	Job train. & related serv.	$127,353	$321,339	$1,760,324	$13,721,380	$15,930,395	$2,714,343	$18,644,738
8350	Child day care services	$294,739	$474,979	$3,338,656	$5,616,982	$9,725,355	$3,936,218	$13,661,574
8360	Residential care	$603,128	$1,135,315	$6,226,790	$29,787,259	$37,752,492	$13,687,890	$51,440,382
8390	Social services, n.e.c.	$119,886	$201,304	$1,338,684	$5,819,126	$7,479,000	$1,566,723	$9,045,724
8410	Museums & art galleries	$47,270	$66,558	$440,174	$1,239,604	$1,793,606	$632,280	$2,425,886
8420	Bot. & zoolog. gardens	$11,271	$17,193	$115,067	$821,371	$964,903	$199,648	$1,164,551
8610	Business associations	$101,194	$59,901	$453,625	$593,807	$1,208,527	$303,599	$1,512,126
8620	Prof. organizations	$42,146	$28,169	$203,430	$346,495	$620,240	$138,569	$758,809
8630	Labor organizations	$70,138	$41,336	$320,476	$539,511	$971,460	$252,578	$1,224,039
8640	Civic & social assoc.	$213,175	$314,542	$2,421,858	$5,697,880	$8,647,454	$2,230,603	$10,878,058
8650	Political organizations	$16,951	$13,249	$108,296	$114,082	$252,577	$87,849	$340,427
8660	Religious organizations	$718,771	$209,759	$1,548,569	$2,986,046	$5,463,144	$1,043,032	$6,506,177
8690	Membership orgs., n.e.c.	$62,510	$99,111	$750,596	$3,132,955	$4,045,172	$717,630	$4,762,801
8710	Eng. and arch. services	$640,764	$610,807	$4,228,773	$10,162,590	$15,642,934	$3,020,533	$18,663,467
8720	Accntng, auditng, & bkeeping	$680,660	$487,522	$3,690,408	$9,984,888	$14,843,479	$3,180,317	$18,023,796
8730	Research & testing services	$347,366	$558,510	$3,817,933	$15,079,435	$19,803,244	$3,906,451	$23,709,695
8740	Management & pub. relations	$753,839	$712,697	$5,792,697	$25,689,167	$32,948,400	$5,564,929	$38,513,329
8990	Services, n.e.c.	$206,385	$286,962	$2,199,863	$2,763,293	$5,456,503	$2,157,591	$7,614,094
	TOTAL	$108,632,674	$106,997,692	$823,597,643	$2,317,443,741	$3,356,671,750	$875,526,111	$4,232,197,861

Source: Office of Regulatory Analysis, OSHA, U.S. DOL

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Estimates of the costs of job control are presented as net costs, because OSHA has taken the benefits employers often accrue from productivity improvements associated with job controls as offsets to the costs of job control. OSHA estimates that the labor savings (productivity improvements) provided by the job controls the standard will require will amount to approximately $1.3 billion per year in annualized savings.[6] OSHA believes that many ergonomic interventions improve productivity, either because they reduce employee fatigue and relieve muscle pain (which means that the employee will do more work in less time), or because they involve automating portions of jobs in ways that can be expected to improve productivity. In addition to such direct effects on productivity, ergonomic interventions frequently offset the employers' cost for controls by:

• Reducing absenteeism because a worker is less likely to take time off to recover from muscle soreness, fatigue, etc.;

• Reducing turnover, particularly since new hires are more likely to find an ergonomically designed job within their physical capacity;

• Improving product quality because fewer errors are made when processes are more automated and demand less physical effort.

These positive productivity impacts are attested to by the experience of many employers (see the productivity tables in Chapter V of the Preliminary Economic Analysis). OSHA's 1993 ergonomics survey of general industry employers found that 30 percent of those employers who had implemented ergonomics controls reported that their ergonomics programs had had measurable positive impacts on productivity. On average, these employers (including the few employers who reported that their controls had negative impacts on productivity) reported a weighted average productivity improvement of 7 percent per intervention. A review of the case studies of ergonomics programs discussed in Chapter IV found that one program in four reported having produced an increase in productivity.

F. Economic Feasibility (Chapter VI)

The OSH Act requires the Agency to set standards for toxic materials and harmful physical agents (such as musculoskeletal risk factors) that are feasible, both technologically and economically. To demonstrate that a standard is feasible, the courts have held that OSHA must ''construct a reasonable estimate of compliance costs and demonstrate a reasonable likelihood that these costs will not threaten the existence or competitive structure of an industry, even if it does portend disaster for some marginal firms'' [*United Steelworkers of America, AFL–CIO–CLC* v. *Marshall* (the ''Lead'' decision)].

OSHA's analysis of economic feasibility is conducted on an establishment basis. For each affected industry, estimates of per-establishment annualized compliance costs are compared with per-establishment estimates of revenues and per-establishment estimates of profits, using two worst-case assumptions about the ability of employers to pass the costs of compliance through to their customers: the no cost passthrough assumption and the full cost passthrough assumption. Based on the results of these comparisons, which bound the universe of potential impacts of the proposed standard, OSHA then assesses the proposed standard's economic feasibility for establishments in all covered industries.

OSHA assumed that the establishments falling within the scope of the proposed standard had the same average sales and profits as other establishments in their industries. This assumption is reasonable because there is no evidence suggesting that the financial characteristics of those firms whose employees experience covered MSDs are different from firms that do not have covered MSDs among their workforce. Absent such evidence, OSHA relied on the best available financial data (those from the Bureau of the Census (Ex. 28–6) and Robert Morris Associates), used commonly accepted methodology to calculate industry averages, and based its analysis of the significance of the projected economic impacts and the feasibility of compliance on these data.

The analysis of the potential impacts of the proposed standard on before-tax profits and sales shown in Table VIII–4 is a screening analysis because it simply measures costs as a percentage of pre-tax profits and sales under the worst-case assumptions discussed above, but does not predict impacts on these before-tax profits or sales. The screening analysis is used to determine whether the compliance costs potentially associated with the proposed standard could lead to significant impacts on affected establishments. The actual impact of the proposed standard on the profit and sales of establishments in a given industry will depend on the price elasticity of demand for the products or services of establishments in that industry.

Table VIII–4 shows that the potential impacts of the proposed standard on average industry profits are small, even under the worst-case scenario of no cost passthrough. For all industries as a whole, annualized compliance costs are 0.6 percent of profits. Compliance costs potentially exceed 5 percent of profits only for 10 industry groups, and they exceed 10 percent of profits only in one industry (SIC 561, Men's and boy's clothing stores). This potential impact is accounted for in this industry by the fact that, as reported by Robert Morris Associates (RMA), this industry's profits are extremely small—0.1 percent of sales (compared with an average profit of 4.89 percent for all industries).

Based on the data for establishments in all industries shown in Table VIII–4, OSHA preliminarily concludes that the proposed ergonomics program standard is economically feasible for the industries covered by the standard. OSHA reaches this conclusion based on the fact that, even under the worst case scenarios of full cost passthrough and no cost passthrough, respectively, impacts on average industry revenues are only 0.03 percent, and impacts on average profits are only 0.6 percent. In only one industry, SIC 561, do worst-case profit impacts exceed 10 percent and, as discussed above, this industry's profits are abnormally low (only 0.1 percent of sales). The average annual profit per establishment for the establishments in SIC 561 is $721, by far the lowest profit for any of the approximately 300 industries shown in Table VIII–4.

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[6] OSHA estimated productivity impacts by determining the average percentage reduction from gross costs caused by productivity in a set of examples of ergonomic interventions. Please see the Preliminary Economic Analysis, particularly Tables V–17 through V–19, for details.

Table VIII-4 Estimated Economic Impact of the Proposed Ergonomics Standard on All Industries and all Affected Establishments

						For All Establishments			For Affected Establishments (Those with MSDs)			
SIC	Industry	Annualized Compliance Costs for all Establishments	Revenues for all Establishments ($1,000s)	Profits as a Percentage of Revenues	Profits ($1,000s)	Annualized Compliance Costs as a Percentage of Revenues	Annualized Compliance Costs as a Percentage of Profits	Compliance Cost per Establishment	Total Number of Affected Establishments over 10 years	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits	Annualized Cost per Affected Establishment
710	Soil prep. services	$241,964	$932,972	6.0%	$55,698	0.03	0.0	$377	268	0.06	1.04	$902
720	Crop services	$5,197,071	$5,966,617	7.9%	$471,363	0.09	1.1	$1,257	1,848	0.19	2.47	$2,812
740	Veterinary services	$6,267,235	$7,693,839	8.7%	$669,364	0.08	0.9	$275	8,982	0.21	2.38	$698
750	Animal serv., excpt vet.	$1,165,707	$1,821,371	6.0%	$108,736	0.06	1.1	$112	1,704	0.39	6.52	$684
780	Lndscape & hort. services	$30,381,372	$19,389,342	4.4%	$853,131	0.16	3.6	$446	22,430	0.48	10.82	$1,355
810	Timber tracts	$589,058	$851,843	3.1%	$26,322	0.07	2.2	$683	260	0.23	7.42	$2,266
830	Forest products	$200,949	$247,111	3.1%	$7,636	0.08	2.6	$1,467	45	0.25	8.04	$4,484
850	Forestry services	$660,032	$1,069,094	3.1%	$33,035	0.06	2.0	$421	469	0.21	6.68	$1,407
910	Commerical fishing	$662,291	$1,343,245	5.0%	$67,162	0.05	1.0	$340	347	0.28	5.54	$1,910
920	Fish hatcheries	$111,384	$62,473	5.0%	$3,124	0.18	3.6	$1,172	31	0.54	10.80	$3,552
970	Hunting & trapping	$99,324	$167,605	5.0%	$8,380	0.06	1.2	$293	67	0.30	5.97	$1,475
1310	Crude petrol. & nat. gas	$2,602,196	$59,652,592	5.7%	$3,406,163	0.00	0.1	$335	1,369	0.02	0.43	$1,901
1320	Natural gas liquids	$398,693	$41,021,720	4.8%	$1,977,247	0.00	0.0	$712	239	0.00	0.05	$1,667
1380	Oil & gas field services	$9,414,047	$9,630,581	2.0%	$188,759	0.10	5.0	$1,074	1,917	0.45	22.80	$4,911
2010	Meat products	$34,851,928	$117,204,932	2.3%	$2,695,713	0.03	1.3	$11,316	824	0.11	4.84	$42,320
2020	Dairy products	$8,208,027	$59,676,113	2.2%	$1,312,874	0.01	0.6	$4,364	518	0.05	2.27	$15,860
2030	Presrvd fruits & vegetables	$10,025,305	$47,486,808	4.2%	$1,994,446	0.02	0.5	$4,973	523	0.08	1.94	$19,174
2040	Grain mill products	$6,834,758	$55,960,493	2.7%	$1,510,933	0.01	0.5	$2,626	726	0.04	1.62	$9,412
2050	Bakery products	$12,487,588	$31,963,430	2.2%	$703,195	0.04	1.8	$3,545	874	0.16	7.16	$14,291
2060	Sugar and confect. prods	$4,549,510	$22,593,884	4.6%	$1,039,319	0.02	0.4	$4,143	278	0.08	1.73	$16,367
2070	Fats and oils	$1,220,954	$21,732,140	2.9%	$630,232	0.01	0.2	$2,408	146	0.02	0.67	$8,388
2080	Beverages	$9,052,754	$64,480,420	4.5%	$2,901,619	0.01	0.3	$3,960	596	0.05	1.20	$15,192
2090	Misc. food products	$8,143,826	$37,957,910	2.9%	$1,100,779	0.02	0.7	$2,032	1,001	0.09	2.96	$8,138
2110	Cigarettes	$816,198	$25,695,548	3.9%	$1,002,126	0.00	0.1	$54,413	4	0.01	0.31	$204,270
2120	Cigars	$69,214	$315,743	3.9%	$12,314	0.02	0.6	$1,473	8	0.13	3.42	$8,964
2130	Chewing & smoking tobacco	$67,355	$1,544,972	3.9%	$60,254	0.00	0.1	$2,591	6	0.02	0.46	$10,572
2140	Tobacco stemm. & redrying	$223,753	$3,104,375	3.9%	$121,071	0.01	0.2	$6,992	9	0.02	0.64	$24,180
2210	Brdwven fab. mills, cotton	$3,267,589	$6,018,357	3.6%	$216,661	0.05	1.5	$7,931	154	0.15	4.04	$21,270
2220	Broadwoven fabric mills	$3,031,163	$9,703,013	2.4%	$232,872	0.03	1.3	$6,618	170	0.08	3.51	$17,823
2230	Brdwvn fab. mills, wool	$436,588	$1,720,695	2.4%	$41,297	0.03	1.1	$4,410	38	0.07	2.78	$11,606
2240	Narrow fabric mills	$980,333	$1,485,068	1.3%	$19,306	0.07	5.1	$3,539	117	0.16	12.05	$8,401
2250	Knitting mills	$8,350,528	$17,214,105	2.7%	$464,781	0.05	1.8	$4,293	767	0.12	4.56	$10,891
2260	Tex. finishing, excpt wool	$2,577,740	$7,498,188	1.2%	$89,978	0.03	2.9	$3,026	285	0.10	8.57	$9,045
2270	Carpets and rugs	$2,179,492	$12,446,310	1.7%	$211,587	0.02	1.0	$4,503	168	0.05	6.97	$12,956
2280	Yarn and thread mills	$3,660,386	$12,173,797	4.0%	$486,952	0.03	0.8	$6,225	252	0.07	4.04	$14,548
2290	Misc. textile goods	$2,690,910	$8,817,910	2.4%	$211,630	0.03	1.3	$2,664	380	0.08	3.38	$7,074
2310	Men's & boys' suits & coats	$949,413	$1,906,167	4.0%	$76,247	0.05	1.2	$3,240	87	0.17	1.52	$10,959
2320	Men's & boys' furnishings	$8,238,170	$15,125,809	3.2%	$484,026	0.05	1.7	$3,901	665	0.17	5.40	$12,386
2330	Wm's & misses' outerwear	$6,193,035	$19,500,842	2.0%	$390,017	0.03	1.6	$692	2,390	0.12	5.95	$2,591
2340	Wm's & chldrn's undergarmnts	$1,483,644	$2,918,268	2.2%	$64,202	0.05	2.3	$3,988	116	0.16	7.43	$12,821
2350	Hats, caps, & millinery	$561,328	$1,098,786	4.3%	$47,248	0.05	1.2	$1,473	106	0.18	4.27	$5,293
2360	Girls' & chldrn's outerwear	$988,493	$2,258,886	1.4%	$31,624	0.04	3.1	$1,690	174	0.15	10.51	$5,682
2370	Fur goods	$16,361	$142,828	2.4%	$3,428	0.01	0.5	$123	28	0.06	2.30	$594
2380	Misc. apparel & accessories	$1,176,847	$2,244,834	2.4%	$53,876	0.05	2.2	$1,261	262	0.19	7.77	$4,489
2390	Misc. fab. textile prods	$8,943,239	$22,070,600	2.4%	$529,694	0.04	1.7	$1,017	2,469	0.14	6.02	$3,623
2410	Logging	$1,242,590	$15,538,413	3.9%	$605,998	0.01	0.2	$87	2,002	0.06	1.46	$621
2420	Sawmills & planing mills	$9,202,918	$25,776,399	3.8%	$979,503	0.04	0.9	$1,508	2,260	0.10	2.54	$4,072
2430	Millwork & plywood	$17,342,953	$31,414,582	3.7%	$1,162,340	0.06	1.5	$1,816	3,534	0.15	4.03	$4,908
2440	Wood containers	$2,325,372	$4,006,433	3.6%	$144,232	0.06	1.6	$822	1,076	0.15	4.24	$2,160
2450	Wood bldings & mobile homes	$6,684,122	$12,663,722	3.7%	$468,558	0.05	1.4	$6,402	388	0.14	3.84	$17,215

Table VIII-4 Estimated Economic Impact of the Proposed Ergonomics Standard on All Industries and all Affected Establishments

						For All Establishments			For Affected Establishments (Those with MSDs)			
SIC	Industry	Annualized Compliance Costs for all Establishments	Revenues for all Establishments ($1,000s)	Profits as a Percentage of Revenues	Profits ($1,000s)	Annualized Compliance Costs as a Percentage of Revenues	Annualized Compliance Costs as a Percentage of Profits	Compliance Cost per Establishment	Total Number of Affected Establishments over 10 years	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits	Annualized Cost per Affected Establishment
2490	Misc. wood products	$5,208,656	$13,133,205	2.8%	$367,730	0.04	1.4	$1,473	1,153	0.12	4.35	$4,519
2510	Household furniture	$16,248,756	$24,242,412	2.9%	$703,030	0.07	2.3	$2,954	1,585	0.23	8.02	$10,249
2520	Office furniture	$5,008,060	$9,836,788	3.9%	$383,635	0.05	1.3	$4,848	316	0.17	4.27	$15,843
2530	Pub blding & related furn.	$4,599,526	$6,139,247	3.0%	$184,177	0.07	2.5	$10,244	151	0.22	7.44	$30,520
2540	Partitions and fixtures	$5,464,792	$8,109,037	3.0%	$243,271	0.07	2.2	$1,824	931	0.22	7.23	$5,871
2590	Misc furniture and fixtures	$2,273,471	$4,857,016	3.0%	$145,710	0.05	1.6	$1,610	436	0.15	5.05	$5,216
2610	Pulp mills	$524,915	$5,810,924	3.8%	$220,815	0.01	0.2	$8,466	23	0.02	0.64	$22,716
2620	Paper mills	$8,051,820	$35,582,333	4.7%	$1,672,370	0.02	0.5	$23,406	142	0.05	1.17	$56,681
2630	Paperboard mills	$2,099,380	$19,899,897	4.7%	$935,295	0.01	0.2	$9,208	98	0.02	0.52	$21,519
2650	Paperbrd containers & boxes	$11,810,106	$40,019,006	4.0%	$1,600,760	0.03	0.7	$4,204	1,196	0.07	1.73	$9,878
2670	Misc. cnvrtd paper products	$12,790,226	$49,954,537	2.7%	$1,348,772	0.03	0.9	$4,217	1,247	0.06	2.31	$10,258
2710	Newspapers	$17,843,017	$37,006,756	6.0%	$2,220,405	0.05	0.8	$2,010	3,294	0.13	2.17	$5,418
2720	Periodicals	$2,825,535	$26,525,283	3.7%	$981,435	0.01	0.3	$489	1,501	0.04	1.11	$1,882
2730	Books	$5,444,833	$26,774,751	4.0%	$1,070,990	0.02	0.5	$1,530	1,105	0.07	1.64	$4,925
2740	Miscellaneous publishing	$1,577,673	$10,624,468	5.1%	$541,848	0.01	0.3	$484	866	0.06	1.10	$1,821
2750	Commercial printing	$22,314,783	$66,006,851	3.3%	$2,178,226	0.03	1.0	$648	12,615	0.09	2.80	$1,769
2760	Manifold business forms	$2,278,055	$7,941,418	2.7%	$214,418	0.03	1.1	$2,501	432	0.06	2.24	$5,268
2770	Greeting cards	$1,523,799	$4,434,535	3.8%	$168,512	0.03	0.9	$10,656	55	0.09	2.33	$27,512
2780	Blankbooks & bookbinding	$3,319,832	$5,222,155	3.8%	$198,442	0.06	1.7	$2,097	706	0.14	3.75	$4,703
2790	Printing trade services	$1,203,741	$4,984,730	3.0%	$149,542	0.02	0.8	$350	803	0.10	3.44	$1,499
2810	Indust. inorganic chemicals	$2,574,966	$30,002,480	4.1%	$1,230,102	0.01	0.2	$1,852	245	0.05	1.19	$10,511
2820	Plastics mat. & synthetics	$3,108,644	$57,333,971	5.0%	$2,866,699	0.01	0.1	$3,549	177	0.03	0.54	$17,558
2830	Drugs	$7,450,017	$98,347,315	5.5%	$5,409,102	0.01	0.1	$4,551	310	0.04	0.73	$24,025
2840	Soap, clnrs, & toilet goods	$5,041,549	$48,294,820	2.9%	$1,400,550	0.01	0.4	$2,071	447	0.06	1.96	$11,277
2850	Paints & allied products	$2,101,792	$17,587,225	2.8%	$492,442	0.01	0.4	$1,421	299	0.06	2.11	$7,018
2860	Indust. organic chemicals	$2,860,929	$79,254,515	3.3%	$2,615,399	0.00	0.1	$3,024	193	0.02	0.54	$14,814
2870	Agricultural chemicals	$1,023,507	$22,569,700	3.4%	$767,370	0.00	0.1	$1,091	173	0.02	0.72	$5,905
2890	Misc. chemical products	$3,046,650	$27,864,576	3.8%	$1,058,854	0.01	0.3	$1,187	764	0.04	0.97	$3,989
2910	Petroleum refining	$2,842,044	$145,808,878	3.1%	$4,520,075	0.00	0.1	$10,335	121	0.00	0.14	$23,466
2950	Asphlt pavng & roofng mat.	$1,695,212	$9,765,070	3.3%	$322,247	0.02	0.5	$1,239	535	0.04	1.35	$3,170
2990	Misc. pet. & coal prods	$465,984	$6,900,468	3.7%	$255,317	0.01	0.2	$1,000	160	0.02	0.53	$2,908
3010	Tires and inner tubes	$3,807,767	$12,649,425	3.9%	$493,328	0.03	0.8	$22,268	47	0.11	2.82	$81,275
3020	Rubber & plastics footwear	$488,467	$688,879	4.2%	$28,933	0.07	1.7	$8,008	16	0.26	6.27	$29,753
3050	Hose, bltng, and gaskets	$3,067,784	$8,004,186	4.4%	$352,184	0.04	0.9	$3,714	228	0.14	3.16	$13,480
3060	Fab. rubber prod., n.e.c.	$5,694,221	$13,765,033	3.9%	$536,836	0.04	1.1	$3,223	483	0.15	3.88	$11,792
3080	Misc plastics, n.e.c.	$32,190,288	$106,907,067	3.4%	$3,634,840	0.03	0.9	$2,359	4,168	0.10	2.90	$7,723
3110	Leather tan. & finishing	$1,034,796	$2,738,038	1.7%	$46,547	0.04	2.2	$3,017	129	0.10	5.90	$8,004
3130	Footwear cut stock	$128,064	$213,944	1.8%	$3,851	0.06	3.3	$1,829	27	0.15	8.52	$4,687
3140	Footwear, except rubber	$3,024,541	$3,634,490	1.9%	$69,055	0.08	4.4	$8,001	148	0.21	11.22	$20,489
3150	Leather gloves & mittens	$181,979	$149,789	1.8%	$2,696	0.12	6.7	$2,637	29	0.29	16.19	$6,325
3160	Luggage	$414,688	$1,007,874	1.8%	$18,142	0.04	2.3	$1,589	93	0.12	6.39	$4,445
3170	Hndbags & prsnal leathr gds.	$593,413	$848,276	1.8%	$15,269	0.07	3.9	$1,730	114	0.21	11.70	$5,206
3190	Leather goods, n.e.c.	$647,189	$651,426	1.8%	$11,726	0.10	5.5	$1,548	148	0.28	15.63	$4,386
3210	Flat glass	$1,266,615	$2,709,081	4.5%	$121,909	0.05	1.0	$15,637	27	0.14	3.10	$46,637
3220	Glass, pressed or blown	$4,895,889	$9,244,687	6.8%	$628,639	0.05	0.8	$8,312	168	0.19	2.74	$29,227
3230	Prod. of purchased glass	$4,662,472	$9,109,494	4.4%	$400,818	0.05	1.2	$2,843	479	0.18	3.99	$9,741
3240	Cement, hydraulic	$868,727	$4,720,190	4.5%	$212,409	0.02	0.4	$3,761	80	0.05	1.18	$10,878
3250	Structural clay products	$1,939,023	$3,232,723	6.0%	$193,963	0.06	1.0	$3,270	208	0.17	2.85	$9,317
3260	Pottery & related prods	$2,766,970	$3,370,197	4.5%	$151,659	0.08	1.8	$2,306	339	0.29	6.45	$8,151
3270	Concrete & plast. prdcts	$10,941,438	$29,948,845	4.3%	$1,287,800	0.04	0.8	$1,152	3,309	0.10	2.44	$3,307

Table VIII-4 Estimated Economic Impact of the Proposed Ergonomics Standard on All Industries and all Affected Establishments

						For All Establishments			For Affected Establishments (Those with MSDs)			
SIC	Industry	Annualized Compliance Costs for all Establishments	Revenues for all Establishments ($1,000s)	Profits as a Percentage of Revenues	Profits ($1,000s)	Annualized Compliance Costs as a Percentage of Revenues	Annualized Compliance Costs as a Percentage of Profits	Compliance Cost per Establishment	Total Number of Affected Establishments over 10 years	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits	Annualized Cost per Affected Establishment
3280	Cut stone & stone prods	$814,738	$1,218,989	4.2%	$51,198	0.07	1.6	$761	348	0.21	4.90	$2,341
3290	Misc. nonmet. mineral prods.	$4,131,545	$12,831,147	5.7%	$731,375	0.03	0.6	$2,584	507	0.10	1.78	$8,144
3310	Basic steel products	$13,686,455	$69,010,676	4.7%	$3,243,502	0.02	0.4	$10,659	337	0.08	1.61	$40,584
3320	Iron and steel foundries	$9,351,449	$15,484,686	4.7%	$727,780	0.06	1.3	$8,062	347	0.20	4.30	$26,976
3330	Primary nonfer. metals	$1,875,674	$17,465,720	4.5%	$785,957	0.01	0.2	$9,332	52	0.04	0.93	$36,275
3340	Secondary nonfer. metals	$936,683	$7,521,366	3.6%	$270,769	0.01	0.3	$3,133	87	0.04	1.19	$10,761
3350	Nonfer. rolling & drawing	$8,775,592	$45,476,554	5.6%	$2,546,687	0.02	0.3	$7,942	320	0.07	1.19	$27,412
3360	Nonfer. foundries (cstngs)	$5,371,804	$9,611,068	3.7%	$355,610	0.06	1.5	$3,232	476	0.20	5.27	$11,278
3390	Misc. primary metal prdcts	$1,184,752	$4,169,927	0.5%	$21,267	0.03	5.6	$1,251	283	0.09	18.62	$4,181
3410	Met. cans & ship. containers	$2,135,293	$13,004,892	2.8%	$364,137	0.02	0.6	$4,909	166	0.04	1.54	$12,850
3420	Cutlery, hndtls, & hardware	$8,421,878	$17,122,208	4.7%	$804,744	0.05	1.0	$3,443	876	0.14	2.92	$9,611
3430	Plumbing & heating fixtures	$4,048,663	$7,375,857	3.8%	$280,283	0.05	1.4	$5,885	257	0.15	3.87	$15,746
3440	Fab. struct. metal prdcts	$26,007,372	$56,840,749	4.0%	$2,273,630	0.05	1.1	$1,950	4,927	0.12	3.10	$5,279
3450	Screw machine products	$5,840,663	$11,596,795	3.9%	$452,275	0.05	1.3	$2,245	1,012	0.13	3.32	$5,772
3460	Met. forgings & stampings	$20,285,253	$40,752,728	4.5%	$1,833,873	0.05	1.1	$5,491	1,417	0.13	2.88	$14,315
3470	Metal services, n.e.c.	$6,196,660	$12,900,758	5.7%	$735,343	0.05	0.8	$1,121	2,013	0.13	2.31	$3,079
3480	Ordnance and access., n.e.c.	$2,058,754	$4,686,212	4.4%	$206,193	0.04	1.0	$4,700	132	0.15	3.31	$15,584
3490	Misc. fab. metal products	$17,375,910	$38,754,246	4.8%	$1,860,204	0.04	0.9	$2,391	2,571	0.13	2.64	$6,758
3510	Engines and turbines	$4,768,256	$16,985,636	4.4%	$747,368	0.03	0.6	$12,852	125	0.08	1.90	$38,286
3520	Farm & garden machinery	$6,588,850	$17,677,144	4.1%	$724,763	0.04	0.9	$3,742	570	0.12	2.81	$11,555
3530	Construct. & related mach.	$12,495,792	$33,857,157	5.0%	$1,692,858	0.04	0.7	$3,759	1,127	0.11	2.18	$11,092
3540	Metalworking machinery	$14,111,089	$34,863,234	4.6%	$1,603,709	0.04	0.9	$1,195	3,901	0.12	2.66	$3,617
3550	Special industry mach.	$8,656,442	$29,950,693	4.5%	$1,347,781	0.03	0.6	$1,807	1,544	0.09	1.99	$5,607
3560	General indust. mach.	$13,075,736	$38,890,135	4.5%	$1,750,056	0.03	0.7	$2,987	1,492	0.10	2.19	$8,761
3570	Computer & office equip.	$8,028,010	$72,679,343	3.3%	$2,398,418	0.01	0.3	$3,801	554	0.04	1.28	$14,499
3580	Refrig. & serv. indust mach.	$12,363,365	$36,688,548	2.0%	$733,771	0.03	1.7	$5,505	746	0.10	5.07	$16,564
3590	Industrial mach., n.e.c.	$14,660,107	$35,100,649	5.5%	$1,930,536	0.04	0.8	$567	5,982	0.18	3.28	$2,451
3610	Elect. dist. equipment	$2,438,256	$11,273,986	4.0%	$450,959	0.02	0.5	$2,787	164	0.12	2.88	$14,831
3620	Elect. indust. apparatus	$6,283,325	$21,854,697	4.0%	$874,188	0.03	0.7	$2,780	416	0.16	3.90	$15,101
3630	Household appliances	$4,936,022	$21,300,973	3.4%	$724,233	0.02	0.7	$10,414	87	0.13	3.70	$56,599
3640	Elct. lghtng & wire equip.	$5,611,641	$23,289,566	4.6%	$1,071,320	0.02	0.5	$2,651	400	0.13	2.77	$14,014
3650	Household audio & vid. equip.	$1,637,998	$13,716,113	5.9%	$809,251	0.01	0.2	$2,010	136	0.07	1.21	$12,018
3660	Communications equipment	$5,340,881	$57,675,808	5.4%	$3,114,494	0.01	0.2	$2,531	337	0.06	1.07	$15,840
3670	Electrnic compnnts & access.	$12,418,064	$103,870,202	5.4%	$5,608,991	0.01	0.2	$1,890	1,115	0.07	1.30	$11,137
3690	Misc. elect. equipment	$5,736,202	$26,674,704	5.0%	$1,333,735	0.02	0.4	$3,208	296	0.13	2.60	$19,407
3710	Motor vehicles & equipt.	$48,318,866	$339,576,992	3.9%	$13,243,503	0.01	0.4	$9,570	630	0.11	2.92	$76,717
3720	Aircraft and parts	$13,957,517	$93,016,989	4.3%	$3,999,731	0.02	0.3	$8,244	169	0.15	3.50	$82,754
3730	Ship, boat blding and repair	$2,306,682	$6,028,640	3.6%	$217,031	0.04	1.1	$862	406	0.25	7.01	$5,686
3740	Railroad equipment	$1,588,327	$6,654,526	2.8%	$186,327	0.02	0.9	$7,457	25	0.20	7.13	$62,329
3750	Motorcycles & bicycles	$731,427	$3,336,172	3.8%	$126,775	0.02	0.6	$1,977	39	0.21	5.54	$18,976
3760	Guided missiles	$1,355,357	$18,052,173	3.8%	$685,983	0.01	0.2	$12,908	11	0.07	1.82	$118,636
3790	Misc. transportation equip.	$2,150,247	$8,420,402	3.8%	$319,975	0.03	0.7	$1,894	186	0.16	4.09	$11,541
3810	Srch & navigation equipment	$4,014,037	$30,132,161	4.7%	$1,416,212	0.01	0.3	$5,767	134	0.07	1.47	$29,875
3820	Meas. & contrlling devices	$8,552,066	$39,725,944	5.3%	$2,105,475	0.02	0.4	$1,799	1,022	0.10	1.89	$8,364
3840	Medical instrmnts & supplies	$8,432,651	$49,607,297	6.2%	$3,075,652	0.02	0.3	$1,886	892	0.09	1.37	$9,458
3850	Ophthalmic goods	$909,196	$2,850,267	4.2%	$119,711	0.03	0.8	$1,549	120	0.16	3.70	$7,551
3860	Photo. equip. & supplies	$2,811,411	$19,103,716	5.3%	$1,012,497	0.01	0.3	$3,899	129	0.08	1.56	$21,876
3870	Watches, clocks, & parts	$134,887	$768,223	5.6%	$43,020	0.02	0.3	$957	27	0.09	1.66	$5,069
3910	Jwlry, slvrwre, and plate	$2,017,457	$6,261,321	2.8%	$175,317	0.03	1.2	$717	641	0.14	5.05	$3,147
3930	Musical instruments	$1,020,526	$1,313,948	3.3%	$43,360	0.08	2.4	$1,856	138	0.31	9.36	$7,383

Table VIII-4 Estimated Economic Impact of the Proposed Ergonomics Standard on All Industries and all Affected Establishments

						For All Establishments			For Affected Establishments (Those with MSDs)			
SIC	Industry	Annualized Compliance Costs for all Establishments	Revenues for all Establishments ($1,000s)	Profits as a Percentage of Revenues	Profits ($1,000s)	Annualized Compliance Costs as a Percentage of Revenues	Annualized Compliance Costs as a Percentage of Profits	Compliance Cost per Establishment	Total Number of Affected Establishments over 10 years	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits	Annualized Cost per Affected Establishment
3940	Toys and sporting goods	$7,714,553	$14,422,948	3.5%	$504,803	0.05	1.5	$2,195	948	0.20	5.66	$8,136
3950	Office and art supplies	$1,270,737	$3,683,197	3.3%	$121,546	0.03	1.0	$1,224	268	0.13	4.05	$4,747
3960	Costume jewelry & notions	$819,428	$2,246,891	3.3%	$74,147	0.04	1.1	$750	244	0.16	4.95	$3,360
3990	Misc. manufactures	$9,483,246	$19,008,990	3.4%	$646,306	0.05	1.5	$1,077	4,174	0.11	3.09	$2,272
4110	Local & suburban trans.	$24,018,108	$8,742,145	6.2%	$542,013	0.27	4.4	$2,519	5,338	0.49	7.92	$4,499
4120	Taxicabs	$1,223,456	$1,286,889	5.9%	$75,926	0.10	1.6	$370	714	0.44	7.45	$1,713
4130	Intercty & rural bus trans.	$2,786,770	$1,610,701	7.0%	$112,749	0.17	2.5	$5,794	246	0.34	4.83	$11,310
4140	Bus charter service	$1,454,794	$1,653,193	3.8%	$62,821	0.09	2.3	$1,016	668	0.19	4.96	$2,178
4150	School buses	$7,306,855	$4,192,484	5.9%	$247,357	0.17	3.0	$1,720	2,090	0.35	6.00	$3,495
4170	Bus terminals	$45,866	$44,464	5.9%	$2,623	0.10	1.7	$805	29	0.20	3.39	$1,560
4210	Trking & Courier Service	$203,536,417	$169,408,687	3.2%	$5,421,078	0.12	3.8	$1,742	38,171	0.37	11.49	$5,332
4220	Pub. warehousing & storage	$13,881,441	$11,696,021	9.4%	$1,099,426	0.12	1.3	$1,171	5,717	0.25	2.62	$2,428
4230	Trucking terminal fac.	$105,488	na	4.2%	na	na	na	$1,319	37	na	na	$2,890
4510	Air trans., scheduled	$85,079,148	$139,896,879	4.0%	$5,595,875	0.06	1.5	$12,875	4,757	0.08	2.11	$17,886
4520	Air trans., nonsched.	$1,219,990	$4,596,451	6.0%	$275,787	0.03	0.4	$666	698	0.07	1.16	$1,747
4580	Airports and services	$7,949,012	$9,429,735	4.6%	$433,768	0.08	1.8	$1,980	1,791	0.19	4.11	$4,439
4610	Pipelines, excpt natural gas	$1,696,329	$8,949,097	4.9%	$438,506	0.02	0.4	$1,762	587	0.03	0.63	$2,890
4720	Pass. trans. arrangements	$2,501,195	$14,855,776	2.7%	$401,106	0.02	0.6	$76	3,772	0.15	5.47	$663
4730	Freight trans. arrangements	$8,218,900	$13,557,555	3.7%	$501,630	0.06	1.6	$556	5,923	0.15	4.09	$1,388
4740	Rental of railroad cars	$87,102	$2,475,148	3.4%	$84,155	0.00	0.1	$751	34	0.01	0.35	$2,572
4780	Misc. trans. services	$3,863,312	$3,112,064	3.4%	$105,810	0.12	3.7	$1,441	952	0.35	10.28	$4,056
4810	Telephone communication	$28,394,255	$208,432,617	7.7%	$16,049,312	0.01	0.2	$1,041	4,532	0.08	1.06	$6,266
4820	Telegrph & other comm.	$119,769	$1,436,935	5.7%	$81,905	0.01	0.1	$257	59	0.07	1.16	$2,037
4830	Radio & TV broadcasting	$2,128,977	$35,250,634	2.4%	$846,015	0.01	0.3	$241	1,336	0.04	1.66	$1,594
4840	Cable & othr pay TV services	$6,686,176	$43,809,951	5.4%	$2,365,737	0.02	0.3	$1,397	1,050	0.07	1.29	$6,368
4890	Communication serv., n.e.c.	$275,374	$5,631,490	5.7%	$320,995	0.00	0.1	$185	141	0.05	0.91	$1,957
4910	Electric services	$16,021,589	$162,448,596	10.8%	$17,544,448	0.01	0.1	$2,552	1,389	0.04	0.41	$11,534
4920	Gas product. & distribution	$6,366,411	$89,523,533	6.7%	$5,998,077	0.01	0.1	$1,615	848	0.03	0.49	$7,508
4930	Comb. utility services	$6,914,868	$71,542,818	8.3%	$5,938,054	0.01	0.1	$3,696	401	0.05	0.54	$17,263
4940	Water supply	$1,123,354	$4,130,669	10.6%	$437,851	0.03	0.3	$304	577	0.17	1.65	$1,946
4950	Sanitary services	$10,505,550	$24,057,028	7.6%	$1,828,334	0.04	0.6	$1,618	1,363	0.21	2.74	$7,710
4960	Steam & air-cond. supplies	$56,936	$434,948	8.3%	$36,101	0.01	0.2	$825	15	0.06	0.73	$3,843
4970	Irrigation systems	$77,993	$167,025	8.3%	$13,863	0.05	0.6	$213	98	0.17	2.10	$795
5010	Motor vehicles	$34,047,483	$510,238,863	2.0%	$10,204,777	0.01	0.3	$744	18,333	0.02	0.83	$1,857
5020	Furn. & homefurnishings	$11,810,839	$68,862,490	2.0%	$1,377,250	0.02	0.9	$708	6,229	0.05	2.30	$1,896
5030	Lumber & construct. mat.	$26,320,648	$117,970,381	1.9%	$2,241,437	0.02	1.2	$1,112	11,317	0.05	2.46	$2,326
5040	Prof. & commercial equip.	$36,223,129	$329,207,483	2.5%	$8,230,187	0.01	0.4	$697	16,158	0.04	1.41	$2,242
5050	Met. & minerals, excpt pet.	$12,655,098	$151,787,907	2.8%	$4,250,061	0.01	0.3	$1,109	4,929	0.02	0.69	$2,567
5060	Electrical goods	$24,613,012	$337,183,776	2.2%	$7,418,043	0.01	0.3	$590	14,621	0.02	0.95	$1,683
5070	Hardware supplies	$21,157,742	$95,859,741	2.2%	$2,108,914	0.02	1.0	$810	11,803	0.05	2.22	$1,793
5080	Mach., equipt, & supplies	$49,965,358	$293,593,950	2.9%	$8,514,225	0.02	0.6	$655	30,491	0.04	1.47	$1,639
5090	Misc. durable goods	$20,713,707	$183,194,901	3.2%	$5,862,237	0.01	0.4	$517	11,575	0.04	1.22	$1,790
5110	Paper and paper products	$12,880,434	$132,104,428	1.6%	$2,113,671	0.01	0.6	$688	5,481	0.03	2.08	$2,350
5120	Drugs, propriet., & sundries	$9,044,943	$194,538,527	2.9%	$5,641,617	0.00	0.2	$1,236	2,055	0.02	0.57	$4,400
5130	Apparel and notions	$8,713,403	$125,178,134	2.1%	$2,628,741	0.01	0.3	$400	5,359	0.03	1.35	$1,626
5140	Groceries & related products	$72,832,496	$587,575,642	1.4%	$8,226,059	0.01	0.9	$1,682	15,954	0.03	2.40	$4,565
5150	Farm-prod. raw materials	$2,248,346	$141,454,588	1.7%	$2,404,728	0.00	0.1	$211	2,702	0.01	0.37	$832
5160	Chemicals & allied prods	$7,357,284	$170,707,220	3.2%	$5,462,631	0.00	0.1	$485	4,682	0.01	0.44	$1,571
5170	Petrol. & petrol. prods	$7,383,326	$315,300,716	1.2%	$3,783,609	0.00	0.2	$560	4,605	0.01	0.56	$1,603
5180	Beer, wine, & dist. bev.	$16,774,482	$70,906,318	2.3%	$1,630,845	0.02	1.0	$3,318	2,313	0.05	2.25	$7,253

Table VIII-4 Estimated Economic Impact of the Proposed Ergonomics Standard on All Industries and all Affected Establishments

						For All Establishments			For Affected Establishments (Those with MSDs)			
SIC	Industry	Annualized Compliance Costs for all Establishments	Revenues for all Establishments ($1,000s)	Profits as a Percentage of Revenues	Profits ($1,000s)	Annualized Compliance Costs as a Percentage of Revenues	Annualized Compliance Costs as a Percentage of Profits	Compliance Cost per Establishment	Total Number of Affected Establishments over 10 years	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits	Annualized Cost per Affected Establishment
5190	Misc. nondurable goods	$30,921,394	$218,636,094	1.9%	$4,154,086	0.01	0.7	$569	22,236	0.03	1.82	$1,391
5210	Lumber & other blding mat.	$54,026,123	$94,882,400	1.9%	$1,802,766	0.06	3.0	$2,226	16,009	0.09	4.54	$3,375
5230	Paint, glass, wallpaper strs	$4,146,859	$7,137,672	0.9%	$64,239	0.06	6.5	$424	5,611	0.10	11.25	$739
5250	Hardware stores	$7,442,710	$11,768,982	2.3%	$270,687	0.06	2.7	$521	7,771	0.12	5.05	$958
5260	Retail nurseries and gardens	$7,135,904	$8,246,165	2.2%	$181,416	0.09	3.9	$634	5,839	0.17	7.58	$1,222
5270	Mobile home dealers	$4,373,670	$12,128,180	2.9%	$351,717	0.04	1.2	$915	2,953	0.06	2.01	$1,481
5310	Department stores	$148,962,880	$212,202,049	2.6%	$5,517,253	0.07	2.7	$13,762	9,514	0.08	3.07	$15,657
5330	Variety stores	$8,004,993	$7,801,344	2.7%	$210,636	0.10	3.8	$738	7,517	0.15	5.48	$1,065
5390	Misc. gen. merchandise strs.	$15,157,380	$73,078,703	1.6%	$1,169,259	0.02	1.3	$1,024	6,319	0.05	3.04	$2,399
5410	Grocery stores	$194,675,511	$413,038,161	1.2%	$4,956,458	0.05	3.9	$1,507	45,877	0.13	11.06	$4,243
5420	Meat and fish markets	$2,545,677	$5,620,494	1.3%	$73,066	0.05	3.5	$324	2,272	0.16	12.07	$1,121
5430	Fruit & vegetable markets	$616,344	$2,467,380	1.3%	$32,076	0.02	1.9	$184	638	0.13	10.07	$966
5440	Candy, nut, & confctnry strs	$731,363	$1,508,092	1.3%	$19,605	0.05	3.7	$154	1,097	0.21	16.12	$667
5450	Dairy products stores	$316,946	$746,400	1.3%	$9,703	0.04	3.3	$124	488	0.22	17.08	$650
5460	Retail bakeries	$4,816,282	$5,837,642	3.0%	$175,129	0.08	2.8	$239	5,704	0.29	9.72	$844
5490	Misc. food stores	$1,423,316	$4,903,987	1.8%	$88,272	0.03	1.6	$144	2,708	0.11	5.90	$526
5510	New and used car dealers	$88,386,866	$473,713,203	1.1%	$5,210,845	0.02	1.7	$3,587	18,989	0.02	2.20	$4,655
5520	Used car dealers	$1,126,468	$26,046,018	2.5%	$651,150	0.00	0.2	$51	1,964	0.05	1.93	$574
5530	Auto & home supply stores	$27,461,415	$41,415,750	1.9%	$786,899	0.07	3.5	$627	24,438	0.12	6.26	$1,124
5540	Gas service stations	$26,373,601	$154,592,503	1.6%	$2,473,480	0.02	1.1	$274	39,526	0.04	2.60	$667
5550	Boat dealers	$2,716,592	$7,697,095	2.2%	$169,336	0.04	1.6	$536	2,493	0.07	3.26	$1,090
5560	Rec. vehicle dealers	$2,967,010	$9,355,689	1.7%	$159,047	0.03	1.9	$991	1,757	0.05	3.18	$1,689
5570	Motorcycle dealers	$309,316	$6,487,093	3.1%	$201,100	0.00	0.2	$82	468	0.04	1.24	$660
5590	Auto dealers, n.e.c.	$84,647	$1,290,175	2.6%	$33,545	0.01	0.3	$69	126	0.06	2.47	$672
5610	Men's & boys' clothing strs	$1,701,374	$9,985,692	0.1%	$9,986	0.02	17.0	$123	3,814	0.06	61.85	$446
5620	Women's clothing stores	$4,220,782	$29,323,315	4.0%	$1,172,933	0.01	0.4	$104	8,885	0.07	1.64	$475
5630	Wm's access & specialty strs	$640,405	$4,417,649	4.5%	$198,794	0.01	0.3	$74	1,531	0.08	1.82	$418
5640	Chldrn's & infants' wear strs	$980,049	$4,249,583	1.2%	$50,995	0.02	1.9	$189	1,402	0.09	7.11	$699
5650	Family clothing stores	$15,371,732	$40,135,206	1.3%	$521,758	0.04	2.9	$785	10,597	0.07	5.44	$1,451
5660	Shoe stores	$3,895,272	$18,686,566	2.6%	$485,851	0.02	0.8	$123	8,210	0.08	3.10	$474
5690	Misc. apparel stores	$527,866	$4,848,422	1.2%	$58,181	0.01	0.9	$52	1,273	0.09	7.24	$415
5710	Furnitre & homefurnishng strs	$38,208,458	$63,978,206	2.3%	$1,471,499	0.06	2.6	$579	34,538	0.11	4.96	$1,106
5720	Household appliance strs	$5,604,314	$10,491,658	2.3%	$241,308	0.05	2.3	$558	4,546	0.12	5.13	$1,233
5730	Radio, TV, & comptr strs	$13,710,842	$59,843,357	2.3%	$1,376,397	0.02	1.0	$351	11,044	0.08	3.52	$1,241
5810	Eating & drinking places	$147,866,742	$253,760,234	3.0%	$7,612,807	0.06	1.9	$317	166,985	0.16	5.42	$886
5910	Drug stores	$17,740,179	$91,701,331	2.5%	$2,292,533	0.02	0.8	$410	19,584	0.04	1.71	$906
5920	Liquor stores	$997,207	$21,457,553	1.4%	$300,406	0.00	0.3	$35	3,267	0.04	2.93	$305
5930	Used merchandise stores	$4,758,441	$7,863,561	4.6%	$361,724	0.06	1.3	$202	7,083	0.20	4.37	$672
5940	Misc. shopping goods strs.	$29,014,390	$86,940,718	2.2%	$1,912,696	0.03	1.5	$225	41,973	0.10	4.67	$691
5960	Nonstore retailers	$33,430,917	$71,726,499	2.0%	$1,434,530	0.05	2.3	$1,116	11,107	0.13	6.28	$3,010
5980	Fuel dealers	$6,219,621	$17,012,865	0.8%	$136,103	0.04	4.6	$550	5,417	0.08	9.55	$1,148
5990	Retail stores, n.e.c.	$13,706,820	$39,343,051	2.6%	$1,022,919	0.03	1.3	$144	17,648	0.19	7.23	$777
6010	Central res. depository	$740,611	$34,398,950	12.7%	$4,368,667	0.00	0.0	$7,261	51	0.00	0.03	$14,419
6020	Commercial banks	$17,673,306	$362,240,850	12.7%	$46,004,588	0.00	0.0	$262	15,433	0.02	0.17	$1,145
6030	Savings institutions	$2,515,343	$86,099,788	12.7%	$10,934,673	0.00	0.0	$156	3,147	0.01	0.12	$799
6060	Credit unions	$2,339,002	$28,386,945	12.7%	$3,605,142	0.01	0.1	$157	3,281	0.04	0.30	$713
6080	Foreign banking	$486,815	$85,523,610	12.7%	$10,861,498	0.00	0.0	$742	234	0.00	0.01	$2,078
6090	Banking-related functions	$1,345,305	$17,268,075	12.7%	$2,193,046	0.01	0.1	$231	928	0.05	0.38	$1,449
6110	Federal credit agencies	$111,216	$27,976,840	14.6%	$4,084,619	0.00	0.0	$83	97	0.01	0.04	$1,150
6140	Personal cred. institutions	$692,011	$69,321,834	18.1%	$12,547,252	0.00	0.0	$36	839	0.02	0.12	$824

Table VIII-4 Estimated Economic Impact of the Proposed Ergonomics Standard on All Industries and all Affected Establishments

SIC	Industry	Annualized Compliance Costs for all Establishments	Revenues for all Establishments ($1,000s)	Profits as a Percentage of Revenues	Profits ($1,000s)	For All Establishments: Annualized Compliance Costs as a Percentage of Revenues	For All Establishments: Annualized Compliance Costs as a Percentage of Profits	For All Establishments: Compliance Cost per Establishment	For Affected Establishments (Those with MSDs): Total Number of Affected Establishments over 10 years	For Affected Establishments (Those with MSDs): Annualized Costs as a Percent of Revenues	For Affected Establishments (Those with MSDs): Annualized Costs as a Percent of Profits	For Affected Establishments (Those with MSDs): Annualized Cost per Affected Establishment
6150	Business cred. institutions	$1,408,915	$54,425,294	15.5%	$8,435,921	0.00	0.0	$263	747	0.02	0.12	$1,886
6160	Mortgage bankers & brokers	$2,238,332	$28,664,554	9.6%	$2,751,797	0.01	0.1	$102	2,576	0.07	0.69	$869
6210	Security brokers & dealers	$2,916,269	$136,415,141	10.5%	$14,323,590	0.00	0.0	$114	2,497	0.02	0.21	$1,168
6220	Commodity contracts brokers	$94,882	$2,902,031	11.7%	$339,538	0.00	0.0	$58	103	0.05	0.44	$921
6230	Security & commod. exchanges	$138,705	$1,424,656	11.7%	$166,685	0.01	0.1	$1,186	24	0.05	0.40	$5,715
6280	Security & commod. services	$823,324	$30,330,543	14.1%	$4,276,607	0.00	0.0	$45	572	0.09	0.61	$1,439
6310	Life insurance	$6,192,032	$402,471,102	12.7%	$51,113,830	0.00	0.0	$527	1,775	0.01	0.08	$3,488
6320	Medical & health insur.	$8,923,407	$225,866,321	12.7%	$28,685,023	0.00	0.0	$2,674	705	0.02	0.15	$12,653
6330	Fire, marine, & caslty ins.	$10,894,478	$304,968,860	12.7%	$38,731,045	0.00	0.0	$535	2,315	0.03	0.25	$4,706
6350	Surety insurance	$148,627	$5,184,734	12.7%	$658,461	0.00	0.0	$257	64	0.03	0.21	$2,337
6360	Title insurance	$796,133	$5,360,463	12.7%	$680,779	0.01	0.1	$313	472	0.08	0.63	$1,685
6370	Pension and health funds	$353,503	$1,884,439	12.7%	$239,324	0.02	0.1	$129	275	0.19	1.48	$1,286
6390	Ins. carriers, n.e.c.	$65,136	$810,377	12.7%	$102,918	0.01	0.1	$223	58	0.04	0.32	$1,128
6410	Insurance agents	$6,903,799	$67,001,357	6.8%	$4,556,092	0.01	0.2	$54	10,770	0.12	1.79	$641
6510	Real estate operators	$24,808,003	$89,035,697	15.4%	$13,711,497	0.03	0.2	$247	25,646	0.11	0.71	$967
6530	RE agents and managers	$21,148,635	$72,786,929	12.1%	$8,807,218	0.03	0.2	$170	19,365	0.19	1.54	$1,092
6540	Title abstract offices	$829,752	$2,702,283	12.1%	$326,976	0.03	0.3	$160	1,425	0.11	0.93	$582
6550	Subdividers & developrs	$7,410,254	$17,073,624	9.1%	$1,553,700	0.04	0.5	$399	4,091	0.20	2.16	$1,811
6710	Holding offices	$3,520,964	$49,468,775	17.5%	$8,657,036	0.01	0.0	$368	1,401	0.05	0.28	$2,514
6720	Investment offices	$498,481	$12,829,710	17.5%	$2,245,199	0.00	0.0	$542	73	0.05	0.28	$6,833
6730	Trusts	$1,011,429	$12,102,680	17.5%	$2,117,969	0.01	0.0	$114	987	0.07	0.43	$1,025
6790	Miscellaneous investing	$932,823	$23,366,830	17.5%	$4,089,195	0.00	0.0	$111	869	0.04	0.22	$1,074
7010	Hotels and motels	$74,655,845	$85,827,743	7.0%	$6,007,942	0.09	1.2	$1,650	17,848	0.22	3.15	$4,183
7020	Rooming & boarding houses	$497,181	$427,076	7.0%	$29,895	0.12	1.7	$306	542	0.21	4.99	$918
7030	Camps and rec. vehicle parks	$247,237	$2,820,658	7.0%	$197,446	0.01	0.1	$33	454	0.14	2.05	$545
7040	Membership-basis org. hotels	$86,868	$762,685	7.0%	$53,388	0.01	0.2	$36	182	0.15	2.16	$478
7210	Laundry & garment srvices	$22,907,639	$19,968,307	3.8%	$758,796	0.11	3.0	$404	22,113	0.29	7.74	$1,036
7220	Photo studios, portrait	$1,777,258	$4,360,841	3.9%	$170,073	0.04	1.0	$135	2,301	0.23	5.98	$772
7230	Beauty shops	$3,390,716	$11,597,696	4.6%	$533,494	0.03	0.6	$41	8,870	0.27	5.87	$382
7240	Barber shops	$517,584	$488,787	4.6%	$22,484	0.11	2.3	$115	1,072	0.44	9.66	$483
7250	Shoe repair	$251,854	$280,028	4.6%	$12,881	0.09	2.0	$114	450	0.44	9.63	$560
7260	Fun. service and crematories	$2,220,161	$8,817,707	7.9%	$696,599	0.03	0.3	$141	3,747	0.11	1.34	$593
7290	Misc personal services.	$1,491,429	$6,849,595	4.6%	$315,081	0.02	0.5	$49	1,285	0.52	11.31	$1,161
7310	Advertising	$8,209,870	$28,132,776	3.8%	$1,069,045	0.03	0.8	$418	3,504	0.16	4.31	$2,343
7320	Credit report.& collection	$1,488,503	$8,373,157	7.0%	$586,121	0.02	0.3	$215	1,208	0.10	1.45	$1,233
7330	Mailing, reprod, steno., serv	$8,828,457	$26,231,013	4.6%	$1,206,627	0.03	0.7	$252	5,754	0.21	4.46	$1,534
7340	Services to buildings	$18,848,115	$24,230,046	3.7%	$896,512	0.08	2.1	$287	12,793	0.40	10.77	$1,473
7350	Misc. equipt. rental	$9,684,148	$30,369,885	9.2%	$2,794,029	0.03	0.3	$390	6,024	0.13	1.43	$1,608
7360	Pers. supply services	$75,674,139	$71,832,848	3.0%	$2,154,985	0.11	3.5	$2,025	9,268	0.42	14.16	$8,165
7370	Comptr & data proc. services	$16,883,961	$181,997,360	5.2%	$9,463,863	0.01	0.2	$190	8,304	0.10	1.91	$2,033
7380	Misc. business services	$27,644,927	$71,061,254	3.4%	$2,416,083	0.04	1.1	$323	16,228	0.21	6.04	$1,704
7510	Auto rentals, no drivers	$7,119,360	$28,628,943	5.7%	$1,631,850	0.02	0.4	$669	3,441	0.08	1.35	$2,069
7520	Automobile parking	$1,856,234	$4,810,800	4.8%	$230,918	0.04	0.8	$209	1,854	0.19	3.86	$1,001
7530	Automotive repair shops	$26,329,376	$52,456,660	3.9%	$2,045,810	0.05	1.3	$189	38,478	0.18	4.66	$684
7540	Automotive serv., exc repair	$10,457,562	$9,160,104	6.5%	$595,407	0.11	1.8	$388	10,766	0.29	4.40	$971
7620	Electrical repair shops	$8,521,815	$12,355,727	2.6%	$321,249	0.07	2.7	$441	6,191	0.22	8.28	$1,376
7630	Watch and jewelry repair	$274,794	$374,160	3.4%	$12,721	0.07	2.2	$152	444	0.30	8.77	$618
7640	Reupholstery & furn. repair	$507,897	$1,276,653	3.4%	$43,406	0.04	1.2	$74	1,422	0.19	5.63	$357
7690	Misc. repair shops	$16,765,426	$24,393,605	5.9%	$1,439,223	0.07	1.2	$430	12,871	0.21	3.53	$1,303
7810	Motion picture production	$17,792,216	$28,310,206	5.4%	$1,528,751	0.06	1.2	$1,212	2,546	0.36	6.71	$6,988

Table VIII-4 Estimated Economic Impact of the Proposed Ergonomics Standard on All Industries

						For All Establishments			For Affected Establishments (Those with MSDs)			
SIC	Industry	Annualized Compliance Costs for all Establishments	Revenues for all Establishments ($1,000s)	Profits as a Percentage of Revenues	Profits ($1,000s)	Annualized Compliance Costs as a Percentage of Revenues	Annualized Compliance Costs as a Percentage of Profits	Compliance Cost per Establishment	Total Number of Affected Establishments over 10 years	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits	Annualized Cost per Affected Establishment
7820	Motion picture dist.	$1,807,346	$18,051,508	5.8%	$1,046,987	0.01	0.2	$1,241	687	0.02	0.37	$2,631
7830	Motion picture theaters	$6,213,923	$7,023,730	5.8%	$407,376	0.09	1.5	$946	4,168	0.14	2.40	$1,491
7840	Video tape rental	$5,428,968	$6,459,177	7.2%	$465,061	0.08	1.2	$261	10,396	0.17	2.34	$522
7910	Dance studios & schools	$1,283,830	$863,722	4.1%	$35,413	0.15	3.6	$224	2,062	0.41	10.05	$623
7920	Prducrs, orch., entertainers	$5,448,464	$16,444,890	3.6%	$592,016	0.03	0.9	$324	3,468	0.16	4.47	$1,571
7930	Bowling centers	$1,496,184	$2,944,692	4.2%	$123,677	0.05	1.2	$261	2,050	0.14	3.38	$730
7940	Commercial sports	$5,987,571	$12,089,744	3.6%	$435,231	0.05	1.4	$1,257	1,464	0.16	4.48	$4,091
7990	Misc. recreation services	$53,034,852	$55,776,035	4.2%	$2,342,593	0.10	2.3	$858	18,362	0.32	7.62	$2,888
8010	Offices of medical doctors	$45,984,511	$186,598,097	6.3%	$11,755,680	0.02	0.4	$246	34,137	0.13	2.14	$1,347
8020	Dentists offices and clinics	$9,425,820	$46,131,244	11.3%	$5,212,831	0.02	0.2	$83	16,155	0.14	1.27	$583
8030	Osteopathic physicians	$434,736	$4,582,835	5.4%	$247,473	0.01	0.2	$48	810	0.11	1.98	$537
8040	Other health practitioners	$13,653,456	$25,053,745	6.5%	$1,628,493	0.05	0.8	$161	18,219	0.25	3.90	$749
8050	Nursing & personal care fac.	$158,995,016	$63,625,522	4.3%	$2,735,897	0.25	5.8	$6,622	11,190	0.54	12.47	$14,209
8060	Hospitals	$345,171,125	$343,314,509	5.1%	$17,509,040	0.10	2.0	$47,401	3,634	0.20	3.95	$94,988
8070	Med. & dental labs	$6,311,199	$16,543,625	7.9%	$1,306,946	0.04	0.5	$414	2,625	0.22	2.80	$2,404
8080	Home hlth care services	$51,514,478	$27,690,537	3.5%	$969,169	0.19	5.3	$3,198	5,961	0.50	14.36	$8,643
8090	Hlth & allied serv., n.e.c.	$15,136,082	$26,036,633	11.0%	$2,864,030	0.06	0.5	$726	6,841	0.18	1.61	$2,213
8110	Legal services	$14,827,269	$116,202,122	5.0%	$5,810,106	0.01	0.3	$88	14,399	0.15	2.98	$1,030
8210	Elem. & secondary schools	$11,922,661	$30,967,943	5.9%	$1,827,109	0.04	0.7	$662	4,535	0.15	2.59	$2,629
8220	Colleges & universities	$36,950,253	$73,194,239	6.2%	$4,538,043	0.05	0.8	$10,087	975	0.19	3.06	$37,888
8230	Libraries	$147,528	$846,367	5.9%	$49,936	0.02	0.3	$66	170	0.23	3.91	$868
8240	Vocational schools	$659,256	$6,322,931	5.9%	$373,053	0.01	0.2	$97	590	0.12	2.04	$1,118
8290	Schools, n.e.c.	$1,001,157	$7,437,108	5.0%	$371,855	0.01	0.3	$65	1,335	0.16	3.11	$750
8320	Individual & fam. services	$40,334,501	$25,266,265	4.1%	$1,035,917	0.16	3.9	$937	16,130	0.43	10.39	$2,501
8330	Job train. & related serv.	$18,644,738	$8,830,464	2.5%	$220,762	0.21	8.4	$2,046	3,793	0.51	20.29	$4,915
8350	Child day care services	$13,661,574	$12,459,047	3.8%	$473,444	0.11	2.9	$255	17,990	0.33	8.60	$759
8360	Residential care	$51,440,382	$20,174,955	2.6%	$524,549	0.25	9.8	$1,788	14,449	0.51	19.52	$3,560
8390	Social services, n.e.c.	$9,045,724	$22,170,593	3.4%	$753,800	0.04	1.2	$576	4,098	0.16	4.60	$2,207
8410	Museums & art galleries	$2,425,886	$3,660,267	6.1%	$223,276	0.07	1.1	$537	1,040	0.29	4.72	$2,332
8420	Bot. & zoolog. gardens	$1,164,551	$906,476	6.1%	$55,295	0.13	2.1	$1,991	174	0.43	7.09	$6,700
8610	Business associations	$1,512,126	$14,242,520	3.3%	$470,003	0.01	0.3	$96	1,703	0.10	2.98	$888
8620	Prof. organizations	$758,809	$7,845,620	4.8%	$376,590	0.01	0.2	$108	734	0.09	1.93	$1,033
8630	Labor organizations	$1,224,039	$11,731,332	6.4%	$750,805	0.01	0.2	$63	1,714	0.12	1.86	$714
8640	Civic & social assoc.	$10,878,058	$15,241,892	3.4%	$518,224	0.07	2.1	$294	8,286	0.32	9.36	$1,313
8650	Political organizations	$340,427	$1,093,341	6.4%	$69,974	0.03	0.5	$132	381	0.21	3.30	$895
8660	Religious organizations	$6,506,177	$57,709,235	9.1%	$5,251,540	0.01	0.1	$41	7,763	0.23	2.53	$838
8690	Membership orgs., n.e.c.	$4,762,801	$8,262,479	6.4%	$528,799	0.06	0.9	$525	2,020	0.26	4.05	$2,358
8710	Eng. and arch. services	$18,663,467	$98,926,133	4.2%	$4,154,898	0.02	0.4	$237	11,110	0.13	3.19	$1,680
8720	Accntng, auditng, & bkeeping	$18,023,796	$49,834,103	12.0%	$5,980,092	0.04	0.3	$214	10,055	0.30	2.52	$1,792
8730	Research & testing services	$23,709,695	$47,185,349	3.4%	$1,604,302	0.05	1.5	$1,218	4,780	0.20	6.02	$4,960
8740	Management & pub. relations	$38,513,329	$96,714,846	6.2%	$5,996,320	0.04	0.6	$405	13,819	0.27	4.42	$2,787
8990	Services, n.e.c.	$7,614,094	$13,388,980	5.0%	$669,449	0.06	1.1	$442	6,328	0.15	3.10	$1,203
Total		$4,232,197,861	$15,802,862,958		$766,327,987	0.03	0.6	$717	1,585,552	0.10	2.06	$2,669

Source: Office of Regulatory Analysis.
Revenue data is from U.S. Dept. of Commerce, Bureau of Census. Compliance costs are from Chapter 5 of this Preliminary Economic Analysis. Profit Rates are from, in most instances, Robert Morris Associates' "RMA Studies."

[a] Excludes SIC 3731

[b] A profit rate of 5 percent of revenues (the average rate for all establishments) was estimated for SICs 910,920,970,8110, and 8990; a profit rate of 4 percent was estimated for SICs 2280, 2310, and 5620, since they are recognized as industries with lower than average margins.

Table VIII-4 Estimated Economic Impact of the Proposed Ergonomics Standard on All Industries and all Affected Establishments

SIC	Industry	Annualized Compliance Costs for all Establishments	Revenues for all Establishments ($1,000s)	Profits as a Percentage of Revenues	Profits ($1,000s)	For All Establishments: Annualized Compliance Costs as a Percentage of Revenues	For All Establishments: Annualized Compliance Costs as a Percentage of Profits	Compliance Cost per Establishment	For Affected Establishments (Those with MSDs): Total Number of Affected Establishments over 10 years	For Affected Establishments (Those with MSDs): Annualized Costs as a Percent of Revenues	For Affected Establishments (Those with MSDs): Annualized Costs as a Percent of Profits	Annualized Cost per Affected Establishment
7820	Motion picture dist.	$1,807,346	$18,051,508	5.8%	$1,046,987	0.01	0.2	$1,241	687	0.02	0.37	$2,631
7830	Motion picture theaters	$6,213,923	$7,023,730	5.8%	$407,376	0.09	1.5	$946	4,168	0.14	2.40	$1,491
7840	Video tape rental	$5,428,968	$6,459,177	7.2%	$465,061	0.08	1.2	$261	10,396	0.17	2.34	$522
7910	Dance studios & schools	$1,283,830	$863,722	4.1%	$35,413	0.15	3.6	$224	2,062	0.41	10.05	$623
7920	Prducrs, orch., entertainers	$5,448,464	$16,444,890	3.6%	$592,016	0.03	0.9	$324	3,468	0.16	4.47	$1,571
7930	Bowling centers	$1,496,184	$2,944,692	4.2%	$123,677	0.05	1.2	$261	2,050	0.14	3.38	$730
7940	Commercial sports	$5,987,571	$12,089,744	3.6%	$435,231	0.05	1.4	$1,257	1,464	0.16	4.48	$4,091
7990	Misc. recreation services	$53,034,852	$55,776,035	4.2%	$2,342,593	0.10	2.3	$858	18,362	0.32	7.62	$2,888
8010	Offices of medical doctors	$45,984,511	$186,598,097	6.3%	$11,755,680	0.02	0.4	$246	34,137	0.13	2.14	$1,347
8020	Dentists offices and clinics	$9,425,820	$46,131,244	11.3%	$5,212,831	0.02	0.2	$83	16,155	0.14	1.27	$583
8030	Osteopathic physicians	$434,736	$4,582,835	5.4%	$247,473	0.01	0.2	$48	810	0.11	1.98	$537
8040	Other health practitioners	$13,653,456	$25,053,745	6.5%	$1,628,493	0.05	0.8	$161	18,219	0.25	3.90	$749
8050	Nursing & personal care fac.	$158,995,016	$63,625,522	4.3%	$2,735,897	0.25	5.8	$6,622	11,190	0.54	12.47	$14,209
8060	Hospitals	$345,171,125	$343,314,509	5.1%	$17,509,040	0.10	2.0	$47,401	3,634	0.20	3.95	$94,988
8070	Med. & dental labs	$6,311,199	$16,543,625	7.9%	$1,306,946	0.04	0.5	$414	2,625	0.22	2.80	$2,404
8080	Home hlth care services	$51,514,478	$27,690,537	3.5%	$969,169	0.19	5.3	$3,198	5,961	0.50	14.36	$8,643
8090	Hlth & allied serv., n.e.c.	$15,136,082	$26,036,633	11.0%	$2,864,030	0.06	0.5	$726	6,841	0.18	1.61	$2,213
8110	Legal services	$14,827,269	$116,202,122	5.0%	$5,810,106	0.01	0.3	$88	14,399	0.15	2.98	$1,030
8210	Elem. & secondary schools	$11,922,661	$30,967,943	5.9%	$1,827,109	0.04	0.7	$662	4,535	0.15	2.59	$2,629
8220	Colleges & universities	$36,950,253	$73,194,239	6.2%	$4,538,043	0.05	0.8	$10,087	975	0.19	3.06	$37,888
8230	Libraries	$147,528	$846,367	5.9%	$49,936	0.02	0.3	$66	170	0.23	3.91	$868
8240	Vocational schools	$659,256	$6,322,931	5.9%	$373,053	0.01	0.2	$97	590	0.12	2.04	$1,118
8290	Schools, n.e.c.	$1,001,157	$7,437,108	5.0%	$371,855	0.01	0.3	$65	1,335	0.16	3.11	$750
8320	Individual & fam. services	$40,334,501	$25,266,265	4.1%	$1,035,917	0.16	3.9	$937	16,130	0.43	10.39	$2,501
8330	Job train. & related serv.	$18,644,738	$8,830,464	2.5%	$220,762	0.21	8.4	$2,046	3,793	0.51	20.29	$4,915
8350	Child day care services	$13,661,574	$12,459,047	3.8%	$473,444	0.11	2.9	$255	17,990	0.33	8.60	$759
8360	Residential care	$51,440,382	$20,174,955	2.6%	$524,549	0.25	9.8	$1,788	14,449	0.51	19.52	$3,560
8390	Social services, n.e.c.	$9,045,724	$22,170,593	3.4%	$753,800	0.04	1.2	$576	4,098	0.16	4.60	$2,207
8410	Museums & art galleries	$2,425,886	$3,660,267	6.1%	$223,276	0.07	1.1	$537	1,040	0.29	4.72	$2,332
8420	Bot. & zoolog. gardens	$1,164,551	$906,476	6.1%	$55,295	0.13	2.1	$1,991	174	0.43	7.09	$6,700
8610	Business associations	$1,512,126	$14,242,520	3.3%	$470,003	0.01	0.3	$96	1,703	0.10	2.98	$888
8620	Prof. organizations	$758,809	$7,845,620	4.8%	$376,590	0.01	0.2	$108	734	0.09	1.93	$1,033
8630	Labor organizations	$1,224,039	$11,731,332	6.4%	$750,805	0.01	0.2	$63	1,714	0.12	1.86	$714
8640	Civic & social assoc.	$10,878,058	$15,241,892	3.4%	$518,224	0.07	2.1	$294	8,286	0.32	9.36	$1,313
8650	Political organizations	$340,427	$1,093,341	6.4%	$69,974	0.03	0.5	$132	381	0.21	3.30	$895
8660	Religious organizations	$6,506,177	$57,709,235	9.1%	$5,251,540	0.01	0.1	$41	7,763	0.23	2.53	$838
8690	Membership orgs., n.e.c.	$4,762,801	$8,262,479	6.4%	$528,799	0.06	0.9	$525	2,020	0.26	4.05	$2,358
8710	Eng. and arch. services	$18,663,467	$98,926,133	4.2%	$4,154,898	0.02	0.4	$237	11,110	0.13	3.19	$1,680
8720	Accntng, auditng, & bkeeping	$18,023,796	$49,834,103	12.0%	$5,980,092	0.04	0.3	$214	10,055	0.30	2.52	$1,792
8730	Research & testing services	$23,709,695	$47,185,349	3.4%	$1,604,302	0.05	1.5	$1,218	4,780	0.20	6.02	$4,960
8740	Management & pub. relations	$38,513,329	$96,714,846	6.2%	$5,996,320	0.04	0.6	$405	13,819	0.27	4.42	$2,787
8990	Services, n.e.c.	$7,614,094	$13,388,980	5.0%	$669,449	0.06	1.1	$442	6,328	0.15	3.10	$1,203
Total		$4,232,197,861	$15,802,862,958		$766,327,987	0.03	0.6	$717	1,585,552	0.10	2.06	$2,669

Source: Office of Regulatory Analysis.
Revenue data is from U.S. Dept. of Commerce, Bureau of Census. Compliance costs are from Chapter 5 of this Preliminary Economic Analysis. Profit rates are from, in most cases, Robert Morris Associates' "RMA Studies."

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However, because Table VIII–4 also shows that the proposed standard's worst-case impacts are potentially concentrated in a few industries, OSHA analyzed potential impacts on establishments in these industries, termed ''affected industry establishments'' in this analysis. Affected establishments are defined for this analysis as those without an ergonomics program and whose employees are projected to incur a covered MSD in the next 10 years. OSHA's analysis of affected establishments thus looks at the potential for adverse impacts on those firms likely to experience the greatest impacts under the two worst-case scenarios described above.

• The results of this analysis are presented in Table VIII–4, which shows:

• Data on the number of affected establishments potentially affected over 10 years;

• Annualized costs of compliance per affected establishment; and

• Annualized costs of compliance as a percentage of establishment revenues and establishment profits.

Although Table VIII–4 projects, as would be expected, potentially greater impacts on the profits and revenues of affected establishments than was the case for all establishments, the proposed standard's worst-case impacts overall are only 0.1 percent of revenues and 2.1 percent of profits even for these affected establishments. Table VIII–4 shows that impacts do not exceed 1 percent of revenues for affected establishments in any affected industry, even using these worst-case assumptions.

However, under the worst-case no cost passthrough scenario, Table VIII–4 projects profit impacts exceeding 20 percent on affected establishments in three industry groups: SIC 138 (Oil and gas field services), SIC 561 (Men's and boy's clothing stores), and SIC 833 (Job training and related services). As discussed above, SIC 561's annual profit of $721 is lower by a factor of 5 than the profit for affected establishments in any other industry shown on Table VIII–4, and establishments in SICs 138 and 833 have average profits of only 2.0 percent and 2.5 percent, respectively, approximately one-half the average profit rate for firms in all industries.

Nevertheless, OSHA analyzed the impacts of the proposed standard on these four industries more extensively to determine what factors might account for these potential worst-case effects on profits. As discussed above, establishments in SIC 561, Men's and boy's clothing, have profits that are lower, by a factor of 5, than those for any other industry shown on Table VIII–4. In an industry such as this, even the very small per-establishment cost of the ergonomics standard—$404—represents a large share of annual profits. Establishments in this industry are already experiencing serious problems, but the compliance costs of the standard are not the source of these problems.

In the oil and gas field services (SIC 138) and job training and related services (SIC 833) industries, establishments are likely to be able to raise their prices without losing business, because both of these services serve local markets and/or occupy a specialized niche. For job training establishments, a price increase of only 0.5 percent would totally restore profits, even under this worst-case scenario. For oil and gas field services establishments, the story is the same: a price increase of 0.45 percent would restore profits. Even if establishments in these industries were completely unable to pass any costs through, a highly unlikely event, as the Court pointed out in *ADA* v. *Secretary of Labor*, the profits of these industries would only decline to 2.25 percent, compared with the current 2.5 percent rate for SIC 833, and to 1.8 percent, compared with the current 2.0 percent profit rate for SIC 138. These kinds of changes in profit rates are within the range of normal fluctuations in profits in most industries.

Thus, OSHA preliminarily finds, even for the potentially most impacted industries, and even assuming absolutely no cost passthrough, that the viability of affected firms will not be adversely impacted by the compliance costs associated with the proposed standard. OSHA has therefore preliminarily concluded that the proposed standard is economically feasible for all affected industries. OSHA has shown that, in the words of the *Lead* decision, the costs of compliance associated with the standard ''will not threaten the existence or competitive structure'' of any affected industry.

G. Economic Impacts

To identify possible economic impacts, OSHA compared annualized costs to revenues and profits for all covered establishments, for all establishments defined as small using Small Business Administration (SBA) size criteria, and for all establishments with 1–19 employees (Ex. 28–3). The comparison was made for establishments in each of these three size classes, for all establishments, and for affected establishments alone (affected establishments are defined as those without programs in place and whose employees will experience at least one covered MSD in the 10 years after the standard is promulgated). Costs were annualized over ten years, including the costs of controlling all of the MSDs projected to occur in the facility over that time period.

OSHA analyzed the impacts of the proposed standard's annualized compliance costs on establishments in each 3-digit SIC industry. The results of this analysis are shown in Tables VIII–5 and VIII–6. OSHA's procedures call for the agency to conduct an Initial Regulatory Flexibility Analysis if, in any affected sector, the impact of the annualized compliance costs exceed 1 percent of revenues or 5 percent of profits for a substantial number of small entities. As Table VIII–5 shows, in no 3-digit industry do the expected costs of compliance exceed 1 percent of revenues. However, the impact of the compliance costs exceeds 5 percent of profits for 27 industries.

Table VIII–5 shows that, across all small business firms in all 3-digit industries, costs as a percentage of revenues average 0.04 percent. Focusing more narrowly on affected establishments (*i.e.*, those whose employees will experience a covered MSD), Table VIII–5 shows that, even in this extreme case, costs are not estimated to exceed 1.5 percent of revenues in any 3-digit industry. Table VIII–5 does show that costs in 27 industries exceed 5 percent of profits, and do so in approximately one-third of all 3-digit SICs, when impacts are considered only for affected establishments.

Table VIII–6 shows a similar pattern of impacts for employers with fewer than 20 employees: costs do not exceed one percent of revenues for very small establishments in any industry. Focusing only on affected establishments, Table VIII–6 shows that no 3-digit industry has estimated costs that exceed one percent of average revenues. The costs of compliance do, however, have higher impacts on the estimated profits of very small affected establishments. In almost half of all industry sectors, costs exceed 5 percent of profits for very small affected establishments.

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Table VIII-5 Estimated Economic Impact Under Worst-Case Scenarios, of the Proposed Ergonomics Standard on Firms Meeting SBA Size Criteria

SIC	Industry	SBA size (Number of Employees)*	Average Revenue per Firm (SBA)	Profits as a Percentage of Revenues [b]	Average Profit per Firm (SBA) ($)	Average Cost per Firm (SBA) ($)	For all small firms: Annualized Compliance Costs as a Percentage of Revenues--SBA (percent)	For all small firms: Annualized Compliance Costs as a Percentage of Profits--SBA (percent)	For small affected firms (Those with MSDs): Number of Affected Small Firms Over 10 years	For small affected firms (Those with MSDs): Annualized Costs per Affected Small Firms	For small affected firms (Those with MSDs): Annualized Costs as a Percent of Revenues	For small affected firms (Those with MSDs): Annualized Costs as a Percent of Profits
710	Soil prep. services	100	$827,563	6.0%	$49,406	$232	0.00	0.5	261	$569	0.07	1.15
720	Crop services	100	$920,171	7.9%	$72,694	$823	0.10	1.2	1,618	$2,060	0.22	2.83
740	Veterinary services	100	$323,809	8.7%	$28,171	$259	0.08	0.9	8,885	$663	0.20	2.35
750	Animal serv., excpt vet.	100	$130,385	6.0%	$7,784	$99	0.08	1.3	1,686	$608	0.47	7.81
780	Lndscape & hort. services	500	$224,169	4.4%	$9,863	$411	0.19	4.2	22,191	$1,264	0.56	12.81
810	Timber tracts	100	$655,119	3.1%	$20,243	$433	0.09	3.0	183	$2,029	0.31	10.02
830	Forest products	1000	na [c]	3.1%	na	$1,936	na	na	34	$7,822	na	na
850	Forestry services	500	$651,017	3.1%	$20,116	$393	0.08	2.6	341	$1,804	0.28	8.97
910	Commercial fishing	100	$467,143	5.0%	$23,357	$206	0.06	1.2	255	$1,567	0.34	6.71
920	Fish hatcheries	100	$263,926	5.0%	$13,196	$691	0.33	6.6	21	$3,004	1.14	22.76
970	Hunting & trapping	100	$221,182	5.0%	$11,059	$258	0.15	3.1	49	$1,766	0.80	15.97
1310	Crude petrol. & nat. gas	500	$3,965,915	5.7%	$226,454	$308	0.01	0.1	1,239	$1,930	0.05	0.85
1320	Natural gas liquids	500	$48,139,333	4.8%	$2,320,316	$842	0.01	0.3	26	$18,379	0.04	0.79
1380	Oil & gas field services	500	$626,980	2.0%	$12,289	$828	0.14	7.1	1,730	$4,175	0.67	33.97
2010	Meat products	500	$8,956,331	2.3%	$205,996	$2,623	0.03	1.4	642	$11,427	0.13	5.55
2020	Dairy products	500	$15,094,385	2.2%	$332,076	$3,388	0.03	1.4	348	$18,122	0.12	5.46
2030	Presrvd fruits & vegetables	500	$9,121,313	4.2%	$383,095	$2,397	0.03	0.8	375	$12,416	0.14	3.24
2040	Grain mill products	500	$9,680,093	2.7%	$261,363	$2,053	0.03	1.2	439	$12,065	0.12	4.62
2050	Bakery products	500	$2,270,290	2.2%	$49,946	$2,042	0.10	4.7	735	$9,530	0.42	19.08
2060	Sugar and confect. prods	500	$6,274,334	4.6%	$288,619	$2,413	0.04	1.0	227	$11,253	0.18	3.90
2070	Fats and oils	500	$17,798,517	2.9%	$516,157	$2,250	0.02	0.8	67	$16,977	0.10	3.29
2080	Beverages	500	$10,514,066	4.5%	$473,133	$3,163	0.04	0.8	462	$15,407	0.15	3.26
2090	Misc. food products	500	$4,590,098	2.9%	$133,113	$1,808	0.04	1.5	853	$8,404	0.18	6.31
2110	Cigarettes	1000	na [c]	3.9%	na	$58,343	na	na	3	$328,533	na	na
2120	Cigars	500	$1,804,300 [c]	3.9%	$70,368	$1,115	0.07	1.8	6	$7,955	0.44	11.31
2130	Chewing & smoking tobacco	500	$21,752,278	3.9%	$848,339	$2,309	0.02	0.4	4	$13,614	0.06	1.60
2140	Tobacco stemm. & redrying	500	na [c]	3.9%	na	$4,760	na	na	5	$26,690	na	na
2210	Brdwven fab. mills, cotton	1000	$15,713,726	3.6%	$565,694	$7,087	0.04	1.2	143	$20,446	0.13	3.61
2220	Broadwoven fabric mills	500	$5,404,147	2.4%	$129,700	$3,382	0.09	3.5	108	$13,015	0.24	10.03
2230	Brdwvn fab. mills, wool	500	$5,776,513	2.4%	$138,636	$1,624	0.03	1.3	30	$4,932	0.09	3.56
2240	Narrow fabric mills	500	$3,448,690	1.3%	$44,833	$2,554	0.08	6.4	98	$7,170	0.21	15.99
2250	Knitting mills	500	$3,597,430	2.7%	$97,131	$2,354	0.07	2.6	658	$6,714	0.19	6.91
2260	Tex. finishing, excpt wool	500	$4,235,317	1.2%	$50,824	$1,923	0.05	4.1	253	$6,375	0.15	12.54
2270	Carpets and rugs	500	$5,177,762	1.7%	$88,022	$2,040	0.04	2.5	135	$6,824	0.13	7.75
2280	Yarn and thread mills	500	$8,354,331	4.0%	$334,173	$4,622	0.10	2.5	125	$21,020	0.25	6.29
2290	Misc. textile goods	500	$4,445,480	2.4%	$106,692	$1,868	0.05	2.0	316	$5,877	0.13	5.51
2310	Men's & boys' suits & coats	500	$2,881,376	4.0%	$115,255	$1,863	0.07	1.8	72	$7,232	0.25	6.27
2320	Men's & boys' furnishings	500	$3,171,012	3.2%	$101,472	$2,590	0.10	3.0	504	$10,478	0.33	10.33
2330	Wm's & misses' outerwear	500	$1,569,746	2.0%	$31,395	$510	0.03	1.6	2,430	$1,870	0.12	5.96
2340	Wm's & chldrn's undergarmnts	500	$3,775,503	2.2%	$83,061	$2,613	0.08	3.6	91	$10,338	0.27	12.45
2350	Hats, caps, & millinery	500	$1,649,005	4.3%	$70,907	$881	0.05	1.2	104	$3,208	0.19	4.52
2360	Girls' & chldrn's outerwear	500	$2,669,747	1.4%	$37,376	$1,263	0.05	3.6	154	$4,752	0.18	12.71
2370	Fur goods	500	$1,027,540 [c]	2.4%	$24,661	$88	0.01	0.3	29	$409	0.04	1.66
2380	Misc. apparel & accessories	500	$1,580,292	2.4%	$37,927	$944	0.06	2.4	263	$3,333	0.21	8.79
2390	Misc. fab. textile prods	500	$1,304,873	2.4%	$31,317	$705	0.05	2.2	2,525	$2,442	0.19	7.80
2410	Logging	500	$929,614	3.9%	$36,255	$75	0.01	0.2	1,998	$539	0.06	1.49
2420	Sawmills & planing mills	500	$2,910,249	3.8%	$110,589	$1,332	0.05	1.3	2,028	$4,004	0.14	3.62
2430	Millwork & plywood	500	$1,826,529	3.7%	$67,582	$1,344	0.08	2.1	3,340	$3,829	0.21	5.67
2440	Wood containers	500	$1,369,020	3.6%	$49,285	$706	0.05	1.4	1,041	$1,918	0.14	3.89
2450	Wood bldings & mobile homes	500	$4,950,488	3.7%	$183,168	$4,995	0.13	3.5	290	$17,727	0.36	9.68
2490	Misc. wood products	500	$2,178,297	2.8%	$60,992	$1,033	0.05	1.8	1,040	$3,502	0.16	5.74

Table VIII-5 Estimated Economic Impact Under Worst-Case Scenarios, of the Proposed Ergonomics Standard on Firms Meeting SBA Size Criteria

							For all small firms		For small affected firms (Those with MSDs)			
SIC	Industry	SBA size (Number of Employees)*	Average Revenue per Firm (SBA)	Profits as a Percentage of Revenues [b]	Average Profit per Firm (SBA) ($)	Average Cost per Firm (SBA) ($)	Annualized Compliance Costs as a Percentage of Revenues--SBA (percent)	Annualized Compliance Costs as a Percentage of Profits--SBA (percent)	Number of Affected Small Firms Over 10 years	Annualized Costs per Affected Small Firms	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits
2510	Household furniture	500	$2,073,124	2.9%	$60,121	$1,595	0.08	2.7	1,498	$5,763	0.28	9.59
2520	Office furniture	500	$3,012,350	3.9%	$117,482	$2,455	0.09	2.3	277	$8,986	0.30	7.65
2530	Pub blding & related furn.	500	$5,819,938	3.0%	$174,598	$5,263	0.10	3.4	130	$17,683	0.30	10.13
2540	Partitions and fixtures	500	$2,089,272	3.0%	$62,678	$1,216	0.06	1.9	940	$3,867	0.19	6.17
2590	Misc furniture and fixtures	500	$2,117,271	3.0%	$63,518	$1,025	0.05	1.7	414	$3,475	0.16	5.47
2610	Pulp mills	750	$134,667,674 [c]	3.8%	$5,117,372	$10,469	0.01	0.2	16	$40,502	0.03	0.79
2620	Paper mills	750	$191,302,866	4.7%	$8,991,235	$35,806	0.02	0.4	77	$160,361	0.08	1.78
2630	Paperboard mills	750	$196,732,297 [c]	4.7%	$9,246,418	$17,393	0.01	0.2	43	$91,758	0.05	0.99
2650	Paperbrd containers & boxes	500	$8,670,479	4.0%	$346,819	$3,672	0.07	1.7	688	$14,915	0.17	4.30
2670	Misc. cnvrtd paper products	500	$6,820,292	2.7%	$184,148	$3,055	0.06	2.0	937	$9,692	0.14	5.26
2710	Newspapers	500	$1,125,756	6.0%	$67,545	$1,195	0.12	2.1	2,564	$4,079	0.36	6.04
2720	Periodicals	500	$2,200,657	3.7%	$81,424	$326	0.02	0.4	1,407	$1,332	0.06	1.64
2730	Books	500	$2,457,053	4.0%	$98,282	$816	0.03	0.9	1,021	$2,798	0.11	2.85
2740	Miscellaneous publishing	500	$1,795,050	5.1%	$91,548	$407	0.02	0.5	783	$1,691	0.09	1.85
2750	Commercial printing	500	$1,315,823	3.3%	$43,422	$539	0.04	1.2	12,442	$1,488	0.11	3.43
2760	Manifold business forms	500	$5,561,192	2.7%	$150,152	$2,493	0.05	2.0	308	$7,334	0.13	4.88
2770	Greeting cards	500	$6,967,041	3.8%	$264,748	$3,783	0.06	1.6	46	$10,909	0.16	4.12
2780	Blankbooks & bookbinding	500	$1,749,401	3.8%	$66,477	$1,752	0.11	2.8	645	$4,271	0.24	6.42
2790	Printing trade services	500	$1,124,497	3.0%	$33,735	$306	0.03	0.9	776	$1,352	0.12	4.01
2810	Indust. inorganic chemicals	1000	$50,087,613	4.1%	$2,053,592	$3,489	0.01	0.2	106	$45,940	0.09	2.24
2820	Plastics mat. & synthetics	750	$100,234,215	5.0%	$5,011,711	$4,326	0.00	0.1	116	$32,782	0.03	0.65
2830	Drugs	500	$11,576,143	5.5%	$636,688	$1,450	0.02	0.3	230	$9,702	0.08	1.52
2840	Soap, clnrs, & toilet goods	500	$6,619,474	2.9%	$191,965	$1,083	0.02	0.6	385	$6,751	0.10	3.52
2850	Paints & allied products	500	$6,147,975	2.8%	$172,143	$947	0.02	0.7	228	$6,116	0.10	3.55
2860	Indust. organic chemicals	500	$18,842,994	3.3%	$621,819	$1,554	0.01	0.4	95	$14,701	0.08	2.36
2870	Agricultural chemicals	500	$7,976,028	3.4%	$271,185	$688	0.01	0.3	117	$5,456	0.07	2.01
2890	Misc. chemical products	500	$6,784,471	3.8%	$257,810	$939	0.02	0.5	494	$4,860	0.07	1.89
2910	Petroleum refining	1500	$836,868,684 [c]	3.1%	$25,942,929	$15,004	0.00	0.1	77	$53,844	0.01	0.21
2950	Asphlt pavng & roofng mat.	500	$7,498,719	3.3%	$247,458	$1,614	0.04	1.1	234	$9,441	0.13	3.82
2990	Misc. pet. & coal prods	500	$10,440,575 [c]	3.7%	$386,301	$1,111	0.01	0.4	112	$4,603	0.04	1.19
3010	Tires and inner tubes	1000	$110,959,868	3.9%	$4,327,435	$27,946	0.03	0.6	31	$153,001	0.14	3.54
3020	Rubber & plastics footwear	1000	$14,058,755	4.2%	$590,468	$9,891	0.07	1.6	13	$45,753	0.33	7.75
3050	Hose, bltng, and gaskets	500	$3,876,049	4.4%	$170,546	$2,773	0.09	2.0	168	$13,254	0.34	7.77
3060	Fab. rubber prod., n.e.c.	500	$4,274,557	3.9%	$166,708	$2,682	0.08	1.9	369	$12,622	0.30	7.57
3080	Misc plastics, n.e.c.	500	$4,687,853	3.4%	$159,387	$2,109	0.05	1.6	3,269	$8,723	0.19	5.47
3110	Leather tan. & finishing	500	$3,171,214	1.7%	$53,911	$2,123	0.07	4.3	114	$6,300	0.20	11.69
3130	Footwear cut stock	500	na [c]	1.8%	na	$1,350	na	na	26	$3,668	na	na
3140	Footwear, except rubber	500	$3,351,889	1.9%	$63,686	$4,214	0.15	7.9	115	$13,237	0.39	20.79
3150	Leather gloves & mittens	500	na [c]	1.8%	na	$1,829	na	na	22	$5,820	na	na
3160	Luggage	500	$2,550,508 [c]	1.8%	$45,909	$1,023	0.04	2.3	89	$2,979	0.12	6.49
3170	Hndbags & prsnal leathr gds.	500	$1,514,988 [c]	1.8%	$27,270	$967	0.06	3.5	114	$2,888	0.19	10.59
3190	Leather goods, n.e.c.	500	$1,368,278	1.8%	$24,629	$991	0.07	4.0	143	$2,885	0.21	11.71
3210	Flat glass	1000	$44,411,164	4.5%	$1,998,502	$16,902	0.04	0.8	20	$66,938	0.15	3.35
3220	Glass, pressed or blown	750	$18,905,290	6.8%	$1,285,560	$8,125	0.04	0.6	139	$34,412	0.18	2.68
3230	Prod. of purchased glass	500	$1,988,946	4.4%	$87,514	$1,948	0.11	2.5	422	$7,500	0.38	8.57
3240	Cement, hydraulic	750	$32,779,097	4.5%	$1,475,059	$5,681	0.02	0.4	50	$26,357	0.08	1.79
3250	Structural clay products	500	$3,234,269	6.0%	$194,056	$3,422	0.15	2.4	137	$14,805	0.46	7.63
3260	Pottery & related prods	500	$1,082,204	4.5%	$48,699	$1,792	0.17	3.8	317	$6,711	0.62	13.78
3270	Concrete & plast. prdcts	500	$3,222,724	4.3%	$138,577	$1,376	0.05	1.2	2,133	$6,124	0.19	4.42
3280	Cut stone & stone prods	500	$965,036	4.2%	$40,532	$703	0.07	1.7	342	$2,200	0.23	5.43
3290	Misc. nonmet. mineral prods.	500	$3,852,558	5.7%	$219,596	$2,286	0.07	1.3	372	$9,758	0.25	4.44

Table VIII-5 Estimated Economic Impact Under Worst-Case Scenarios, of the Proposed Ergonomics Standard on Firms Meeting SBA Size Criteria

							For all small firms		For small affected firms (Those with MSDs)			
SIC	Industry	SBA size (Number of Employees)*	Average Revenue per Firm (SBA)	Profits as a Percentage of Revenues [b]	Average Profit per Firm (SBA) ($)	Average Cost per Firm (SBA) ($)	Annualized Compliance Costs as a Percentage of Revenues--SBA (percent)	Annualized Compliance Costs as a Percentage of Profits--SBA (percent)	Number of Affected Small Firms Over 10 years	Annualized Costs per Affected Small Firms	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits
3310	Basic steel products	750	$71,587,838	4.7%	$3,364,628	$10,440	0.01	0.3	253	$52,946	0.07	1.57
3320	Iron and steel foundries	500	$5,316,943	4.7%	$249,896	$4,038	0.09	1.9	272	$16,348	0.31	6.54
3330	Primary nonfer. metals	750	$104,585,150	4.5%	$4,706,332	$8,632	0.01	0.2	43	$40,387	0.04	0.86
3340	Secondary nonfer. metals	500	$19,152,945	3.6%	$689,506	$2,661	0.02	0.5	63	$12,500	0.07	1.81
3350	Nonfer. rolling & drawing	750	$58,983,857	5.6%	$3,303,096	$8,858	0.01	0.3	223	$43,822	0.07	1.33
3360	Nonfer. foundries (cstngs)	500	$3,491,201	3.7%	$129,174	$2,284	0.07	1.9	425	$8,841	0.25	6.84
3390	Misc. primary metal prdcts	750	$5,066,740	0.5%	$25,840	$1,177	0.02	4.5	246	$4,525	0.09	17.51
3410	Met. cans & ship. containers	500	$8,487,749	2.8%	$237,657	$4,197	0.10	3.7	73	$24,972	0.29	10.51
3420	Cutlery, hndtls, & hardware	500	$3,168,148	4.7%	$148,903	$2,157	0.07	1.6	754	$6,859	0.22	4.61
3430	Plumbing & heating fixtures	500	$5,500,578	3.8%	$209,022	$3,724	0.08	2.0	214	$11,696	0.21	5.60
3440	Fab. struct. metal prdcts	500	$3,142,031	4.0%	$125,681	$1,523	0.05	1.3	4,464	$4,533	0.14	3.61
3450	Screw machine products	500	$3,399,471	3.9%	$132,579	$1,750	0.05	1.4	925	$4,903	0.14	3.70
3460	Met. forgings & stampings	500	$5,900,679	4.5%	$265,531	$3,484	0.06	1.4	1,216	$10,429	0.18	3.93
3470	Metal services, n.e.c.	500	$1,930,459	5.7%	$110,036	$925	0.05	0.9	1,885	$2,712	0.14	2.46
3480	Ordnance and access., n.e.c.	500	$1,916,047	4.4%	$84,306	$1,632	0.09	2.1	113	$6,002	0.31	7.12
3490	Misc. fab. metal products	500	$3,139,004	4.8%	$150,672	$1,779	0.06	1.3	2,269	$5,655	0.18	3.75
3510	Engines and turbines	1000	$56,430,684	4.4%	$2,482,950	$12,325	0.02	0.5	101	$45,252	0.08	1.82
3520	Farm & garden machinery	500	$3,024,716	4.1%	$124,013	$1,768	0.06	1.5	514	$5,917	0.20	4.77
3530	Construct. & related mach.	500	$4,366,578	5.0%	$218,329	$2,252	0.06	1.1	974	$7,547	0.17	3.46
3540	Metalworking machinery	500	$1,923,153	4.6%	$88,465	$925	0.05	1.1	3,687	$2,951	0.15	3.34
3550	Special industry mach.	500	$3,696,115	4.5%	$166,325	$1,339	0.04	0.9	1,392	$4,575	0.12	2.75
3560	General indust. mach.	500	$4,271,460	4.5%	$192,216	$2,206	0.06	1.3	1,204	$7,894	0.18	4.11
3570	Computer & office equip.	500	$6,625,168	3.3%	$218,631	$1,234	0.02	0.6	475	$5,265	0.08	2.41
3580	Refrig. & serv. indust mach.	500	$4,721,613	2.0%	$94,432	$2,869	0.07	3.5	611	$10,155	0.22	10.75
3590	Industrial mach., n.e.c.	500	$1,086,294	5.5%	$59,746	$459	0.04	0.8	5,890	$2,016	0.19	3.37
3610	Elect. dist. equipment	750	$14,873,332	4.0%	$594,933	$2,500	0.02	0.4	142	$15,357	0.10	2.58
3620	Elect. indust. apparatus	500	$3,392,834	4.0%	$135,713	$1,478	0.05	1.3	340	$9,541	0.28	7.03
3630	Household appliances	500	$5,756,270	3.4%	$195,713	$2,815	0.06	1.8	60	$19,679	0.34	10.05
3640	Elct. lghtng & wire equip.	500	$4,355,541	4.6%	$200,355	5	0.04	0.9	328	$10,265	0.24	5.12
3650	Household audio & vid. equip.	750	$17,721,076	5.9%	$1,045,543	5	0.01	0.2	129	$11,620	0.07	1.11
3660	Communications equipment	750	$30,039,483	5.4%	$1,622,132	0	0.01	0.1	307	$16,296	0.05	1.00
3670	Electrnic compnnts & access.	500	$4,279,984	5.4%	$231,119	$931	0.02	0.4	942	$6,289	0.15	2.72
3690	Misc. elect. equipment	500	$4,403,609	5.0%	$220,180	$1,758	0.05	0.9	240	$12,642	0.29	5.74
3710	Motor vehicles & equipt.	500	$5,821,819	3.9%	$227,051	$1,935	0.04	1.0	490	$18,774	0.32	8.27
3720	Aircraft and parts	1000	$64,238,252	4.3%	$2,762,245	$4,463	0.01	0.2	144	$52,379	0.08	1.90
3730	Ship, boat blding and repair [a]	500	$1,358,254	3.6%	$48,897	$433	0.03	0.9	261	$4,423	0.33	9.05
3740	Railroad equipment	1000	$43,644,454 [c]	2.8%	$1,222,045	$5,496	0.01	0.4	18	$64,378	0.15	5.27
3750	Motorcycles & bicycles	500	$2,531,479	3.8%	$96,196	$531	0.02	0.6	36	$5,329	0.21	5.54
3760	Guided missiles	1000	$228,855,179 [c]	3.8%	$8,696,497	$9,485	0.00	0.1	8	$117,349	0.05	1.35
3790	Misc. transportation equip.	500	$3,063,312	3.8%	$116,406	$795	0.03	0.7	170	$5,240	0.17	4.50
3810	Srch & navigation equipment	750	$51,158,168	4.7%	$2,404,434	$5,279	0.01	0.2	114	$32,312	0.06	1.34
3820	Meas. & contrlling devices	500	$3,508,984	5.3%	$185,976	$1,013	0.03	0.6	878	$5,387	0.15	2.90
3840	Medical instrmnts & supplies	500	$3,717,069	6.2%	$230,458	$1,031	0.03	0.5	757	$5,937	0.16	2.58
3850	Ophthalmic goods	500	$1,524,020	4.2%	$64,009	$803	0.06	1.4	104	$4,461	0.29	6.97
3860	Photo. equip. & supplies	500	$3,934,531	5.3%	$208,530	$1,085	0.03	0.6	112	$6,869	0.17	3.29
3870	Watches, clocks, & parts	500	$2,121,654	5.6%	$118,813	$552	0.03	0.5	25	$3,065	0.14	2.58
3910	Jwlry, slvrwre, and plate	500	$1,704,571	2.8%	$47,728	$432	0.02	0.9	648	$1,870	0.11	3.92
3930	Musical instruments	500	$1,432,933	3.3%	$47,287	$1,273	0.09	2.7	134	$5,206	0.36	11.01
3940	Toys and sporting goods	500	$2,141,491	3.5%	$74,952	$1,126	0.05	1.5	918	$4,277	0.20	5.71
3950	Office and art supplies	500	$1,910,943	3.3%	$63,061	$700	0.04	1.1	255	$2,829	0.15	4.49
3960	Costume jewelry & notions	500	$1,192,271	3.3%	$39,345	$437	0.04	1.1	243	$1,953	0.16	4.96

Table VIII-5 Estimated Economic Impact Under Worst-Case Scenarios, of the Proposed Ergonomics Standard on Firms Meeting SBA Size Criteria

SIC	Industry	SBA size (Number of Employees)*	Average Revenue per Firm (SBA)	Profits as a Percentage of Revenues [b]	Average Profit per Firm (SBA) ($)	Average Cost per Firm (SBA) ($)	For all small firms: Annualized Compliance Costs as a Percentage of Revenues--SBA (percent)	For all small firms: Annualized Compliance Costs as a Percentage of Profits--SBA (percent)	For small affected firms (Those with MSDs): Number of Affected Small Firms Over 10 years	For small affected firms (Those with MSDs): Annualized Costs per Affected Small Firms	For small affected firms (Those with MSDs): Annualized Costs as a Percent of Revenues	For small affected firms (Those with MSDs): Annualized Costs as a Percent of Profits
3990	Misc. manufactures	500	$1,443,695	3.4%	$49,086	$676	0.05	1.4	4,123	$1,439	0.10	2.93
4110	Local & suburban trans.	500	$693,674	6.2%	$43,008	$2,341	0.36	5.7	4,738	$4,702	0.68	10.93
4120	Taxicabs	500	$334,160	5.9%	$19,715	$341	0.10	1.7	715	$1,574	0.47	7.98
4130	Intercty & rural bus trans.	500	$2,047,822	7.0%	$143,348	$4,431	0.29	4.2	146	$14,516	0.71	10.13
4140	Bus charter service	500	$1,112,257	3.8%	$42,266	$1,055	0.10	2.5	611	$2,472	0.22	5.85
4150	School buses	500	$655,154	5.9%	$38,654	$1,663	0.31	5.3	1,601	$4,401	0.67	11.38
4170	Bus terminals	100	$178,250	5.9%	$10,517	$520	0.31	5.3	26	$1,099	0.62	10.45
4210	Trking & Courier Service	100	$682,252	3.2%	$21,832	$952	0.15	4.8	32,512	$3,359	0.49	15.38
4220	Pub. warehousing & storage	1000	$645,103	9.4%	$60,640	$1,452	0.22	2.4	4,289	$4,015	0.62	6.62
4230	Trucking terminal fac.	500	$528,972 [c]	4.2%	$22,217	$1,215	0.26	6.1	33	$2,959	0.56	13.32
4510	Air trans., scheduled	1500	$84,888,883	4.0%	$3,395,555	$18,711	0.02	0.5	1,186	$104,226	0.12	3.07
4520	Air trans., nonsched.	1500	$2,785,728	6.0%	$167,144	$172	0.01	0.1	629	$500	0.02	0.30
4580	Airports and services	100	$815,921	4.6%	$37,532	$200	0.03	0.6	1,326	$574	0.07	1.53
4610	Pipelines, excpt natural gas	1500	$85,999,109 [c]	4.9%	$4,213,956	$13,744	0.02	0.3	62	$214,972	0.25	5.10
4720	Pass. trans. arrangements	100	$291,573	2.7%	$7,872	$61	0.02	0.9	2,944	$681	0.23	8.65
4730	Freight trans. arrangements	1000	$1,127,447	3.7%	$41,716	$650	0.06	1.5	4,822	$1,992	0.18	4.78
4740	Rental of railroad cars	20	$3,112,041	3.4%	$105,809	$151	0.01	0.2	16	$987	0.03	0.93
4780	Misc. trans. services	100	$597,838	3.4%	$20,326	$978	0.20	6.0	679	$3,744	0.63	18.42
4810	Telephone communication	1500	$30,966,070	7.7%	$2,384,387	$3,508	0.01	0.1	1,118	$85,583	0.28	3.59
4820	Telegrph & other comm.	100	$1,587,993	5.7%	$90,516	$169	0.01	0.2	49	$1,564	0.10	1.73
4830	Radio & TV broadcasting	100	$828,013	2.4%	$19,872	$143	0.02	0.8	994	$1,212	0.15	6.10
4840	Cable & othr pay TV services	100	$2,309,048	5.4%	$124,689	$638	0.06	1.1	405	$6,908	0.30	5.54
4890	Communication serv., n.e.c.	100	$1,476,773	5.7%	$84,176	$95	0.01	0.1	120	$1,144	0.08	1.36
4910	Electric services	100	$10,459,747	10.8%	$1,129,653	$1,057	0.03	0.3	257	$22,613	0.22	2.00
4920	Gas product. & distribution	10	$5,639,801	6.7%	$377,867	$184	0.01	0.2	67	$5,196	0.09	1.38
4930	Comb. utility services	20	$1,749,337	8.3%	$145,195	$227	0.06	0.8	23	$8,823	0.50	6.08
4940	Water supply	100	$417,626	10.6%	$44,268	$189	0.05	0.5	527	$1,314	0.31	2.97
4950	Sanitary services	100	$1,250,569	7.6%	$95,043	$865	0.09	1.1	987	$5,476	0.44	5.76
4960	Steam & air-cond. supplies	100	$1,091,696	8.3%	$90,611	$587	0.07	0.9	10	$4,026	0.37	4.44
4970	Irrigation systems	100	$176,445 [c]	8.3%	$14,645	$149	0.09	1.0	95	$572	0.32	3.91
5010	Motor vehicles	100	$7,338,706	2.0%	$146,774	$636	0.01	0.5	13,204	$2,181	0.03	1.49
5020	Furn. & homefurnishings	100	$3,107,868	2.0%	$62,157	$563	0.02	1.0	5,429	$1,715	0.06	2.76
5030	Lumber & construct. mat.	100	$3,956,240	1.9%	$75,169	$953	0.03	1.6	8,570	$2,610	0.07	3.47
5040	Prof. & commercial equip.	100	$2,865,424	2.5%	$71,636	$456	0.02	0.8	12,520	$1,851	0.06	2.58
5050	Met. & minerals, excpt pet.	100	$10,345,693	2.8%	$289,679	$880	0.01	0.4	3,648	$2,712	0.03	0.94
5060	Electrical goods	100	$5,334,184	2.2%	$117,352	$461	0.01	0.5	9,925	$1,913	0.04	1.63
5070	Hardware supplies	100	$3,243,960	2.2%	$71,367	$718	0.03	1.3	8,258	$2,254	0.07	3.16
5080	Mach., equipt, & supplies	100	$3,120,491	2.9%	$90,494	$567	0.02	0.7	23,717	$1,809	0.06	2.00
5090	Misc. durable goods	100	$3,072,234	3.2%	$98,311	$389	0.01	0.4	10,654	$1,450	0.05	1.47
5110	Paper and paper products	100	$4,200,691	1.6%	$67,211	$519	0.02	1.0	3,765	$2,540	0.06	3.78
5120	Drugs, propriet., & sundries	100	$6,828,751	2.9%	$198,034	$566	0.01	0.4	1,457	$2,708	0.04	1.37
5130	Apparel and notions	100	$3,898,982	2.1%	$81,879	$297	0.01	0.4	4,780	$1,336	0.03	1.63
5140	Groceries & related products	100	$6,267,970	1.4%	$87,752	$1,003	0.02	1.3	12,569	$3,326	0.05	3.79
5150	Farm-prod. raw materials	100	$13,088,804	1.7%	$222,510	$233	0.00	0.1	1,829	$1,356	0.01	0.61
5160	Chemicals & allied prods	100	$6,688,714	3.2%	$214,039	$417	0.01	0.3	3,212	$1,950	0.03	0.91
5170	Petrol. & petrol. prods	100	$18,899,169	1.2%	$226,790	$537	0.00	0.3	2,938	$2,388	0.01	1.05
5180	Beer, wine, & dist. bev.	100	$7,805,539	2.3%	$179,527	$2,003	0.03	1.3	1,630	$5,786	0.07	3.22
5190	Misc. nondurable goods	100	$2,420,357	1.9%	$45,987	$422	0.02	1.1	18,050	$1,257	0.05	2.73
5210	Lumber & other blding mat.	100	$2,041,155	1.9%	$38,782	$1,480	0.09	4.8	10,952	$3,113	0.15	8.03
5230	Paint, glass, wallpaper strs	100	$746,327	0.9%	$6,717	$449	0.09	10.5	3,228	$1,361	0.18	20.27
5250	Hardware stores	100	$747,354	2.3%	$17,189	$514	0.08	3.3	6,760	$1,085	0.15	6.31

Table VIII-5 Estimated Economic Impact Under Worst-Case Scenarios, of the Proposed Ergonomics Standard on Firms Meeting SBA Size Criteria

							For all small firms			For small affected firms (Those with MSDs)			
SIC	Industry	SBA size (Number of Employees)*	Average Revenue per Firm (SBA)	Profits as a Percentage of Revenues [b]	Average Profit per Firm (SBA) ($)	Average Cost per Firm (SBA) ($)	Annualized Compliance Costs as a Percentage of Revenues--SBA (percent)	Annualized Compliance Costs as a Percentage of Profits--SBA (percent)	Number of Affected Small Firms Over 10 years	Annualized Costs per Affected Small Firms	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits
5260	Retail nurseries and gardens	100	$685,629	2.2%	$15,084	$616	0.10	4.4	5,227	$1,325	0.19	8.78
5270	Mobile home dealers	100	$2,506,918	2.9%	$72,701	$949	0.04	1.5	2,293	$1,976	0.08	2.72
5310	Department stores	500	$90,424,242	2.6%	$2,351,030	$13,243	0.90	34.6	145	$976,462	1.08	41.53
5330	Variety stores	500	$518,168	2.7%	$13,991	$782	0.37	13.8	2,693	$3,151	0.61	22.52
5390	Misc. gen. merchandise strs.	100	$867,314	1.6%	$13,877	$620	0.13	8.4	2,834	$3,055	0.35	22.01
5410	Grocery stores	500	$1,354,669	1.2%	$16,256	$1,395	0.14	11.4	31,006	$5,803	0.43	35.70
5420	Meat and fish markets	500	$698,037	1.3%	$9,074	$280	0.04	3.1	2,197	$1,003	0.14	11.05
5430	Fruit & vegetable markets	500	$670,436	1.3%	$8,716	$161	0.02	1.9	614	$877	0.13	10.06
5440	Candy, nut, & confctnry strs	500	$356,630	1.3%	$4,636	$153	0.06	4.3	698	$1,043	0.29	22.49
5450	Dairy products stores	500	$357,975	1.3%	$4,654	$111	0.05	3.7	297	$950	0.27	20.42
5460	Retail bakeries	500	$310,632	3.0%	$9,319	$216	0.08	2.5	4,795	$910	0.29	9.76
5490	Misc. food stores	100	$485,584	1.8%	$8,741	$122	0.03	1.8	2,047	$588	0.12	6.72
5510	New and used car dealers	100	$14,022,797	1.1%	$154,251	$2,830	0.02	2.0	15,764	$4,068	0.03	2.64
5520	Used car dealers	1000	$1,204,329	2.5%	$30,108	$50	0.00	0.2	1,935	$573	0.05	1.90
5530	Auto & home supply stores	100	$734,699	1.9%	$13,959	$643	0.13	6.9	15,128	$1,860	0.25	13.32
5540	Gas service stations	100	$1,661,818	1.6%	$26,589	$298	0.03	1.7	22,903	$1,250	0.08	4.70
5550	Boat dealers	100	$1,497,285	2.2%	$32,940	$529	0.04	1.7	2,280	$1,176	0.08	3.57
5560	Rec. vehicle dealers	20	$1,564,906	1.7%	$26,603	$595	0.04	2.4	1,298	$1,201	0.08	4.51
5570	Motorcycle dealers	100	$1,722,849	3.1%	$53,408	$80	0.00	0.2	456	$668	0.04	1.25
5590	Auto dealers, n.e.c.	500	$1,054,926	2.6%	$27,428	$67	0.01	0.2	125	$665	0.06	2.42
5610	Men's & boys' clothing strs	100	$734,468	0.1%	$734	$146	0.04	39.4	1,695	$1,188	0.16	161.69
5620	Women's clothing stores	100	$521,388	4.0%	$20,856	$117	0.05	1.2	3,610	$1,307	0.25	6.27
5630	Wm's access.& specialty strs	100	$424,294	4.5%	$19,093	$86	0.04	0.9	705	$1,049	0.25	5.49
5640	Chldrn's & infants' wear strs	100	$442,743	1.2%	$5,313	$205	0.07	6.2	822	$1,289	0.29	24.27
5650	Family clothing stores	100	$811,771	1.3%	$10,553	$774	0.23	17.5	3,914	$3,824	0.47	36.23
5660	Shoe stores	100	$720,198	2.6%	$18,725	$159	0.08	2.9	1,931	$2,614	0.36	13.96
5690	Misc. apparel stores	500	$486,401	1.2%	$5,837	$62	0.02	1.3	956	$659	0.14	11.30
5710	Furnitre & homefurnishng strs	100	$837,185	2.3%	$19,255	$623	0.09	3.9	26,271	$1,560	0.19	8.10
5720	Household appliance strs	100	$851,037	2.3%	$19,574	$552	0.07	3.0	4,005	$1,380	0.16	7.05
5730	Radio, TV, & comptr strs	100	$1,073,328	2.3%	$24,687	$329	0.05	2.0	6,675	$1,907	0.18	7.72
5810	Eating & drinking places	500	$469,053	3.0%	$14,072	$328	0.08	2.8	128,415	$1,190	0.25	8.46
5910	Drug stores	100	$1,276,589	2.5%	$31,915	$450	0.06	2.4	10,658	$1,821	0.14	5.71
5920	Liquor stores	1000	$803,413	1.4%	$11,248	$45	0.01	0.4	3,029	$423	0.05	3.76
5930	Used merchandise stores	500	$327,184	4.6%	$15,050	$237	0.08	1.7	5,829	$955	0.29	6.35
5940	Misc. shopping goods strs.	100	$506,822	2.2%	$11,150	$243	0.06	2.8	29,906	$1,049	0.21	9.40
5960	Nonstore retailers	100	$831,934	2.0%	$16,639	$664	0.09	4.4	9,386	$2,081	0.25	12.51
5980	Fuel dealers	100	$1,502,002	0.8%	$12,016	$590	0.05	6.8	3,581	$1,859	0.12	15.47
5990	Retail stores, n.e.c.	100	$392,251	2.6%	$10,199	$158	0.05	1.8	14,159	$1,063	0.27	10.43
6010	Central res. depository	10	na [c]	12.7%	na	$233	na	na	1	$3,130	na	na
6020	Commercial banks	10	$1,727,898	12.7%	$219,443	$67	0.14	1.1	112	$20,574	1.19	9.38
6030	Savings institutions	10	$1,974,399	12.7%	$250,749	$55	0.08	0.6	33	$15,956	0.81	6.36
6060	Credit unions	10	$494,582	12.7%	$62,812	$52	0.02	0.1	937	$587	0.12	0.93
6080	Foreign banking	10	$6,126,893	12.7%	$778,115	$74	0.00	0.0	6	$2,180	0.04	0.28
6090	Banking-related functions	100	$918,459	12.7%	$116,644	$131	0.02	0.2	486	$1,547	0.17	1.33
6110	Federal credit agencies	20	$1,722,770	14.6%	$251,524	$27	0.02	0.2	3	$9,859	0.57	3.92
6140	Personal cred. institutions	20	$856,550	18.1%	$155,036	$19	0.01	0.1	128	$2,706	0.32	1.75
6150	Business cred. institutions	20	$1,814,771	15.5%	$281,290	$55	0.01	0.0	219	$1,151	0.06	0.41
6160	Mortgage bankers & brokers	100	$695,722	9.6%	$66,789	$68	0.01	0.2	1,549	$949	0.14	1.42
6210	Security brokers & dealers	20	$842,572	10.5%	$88,470	$31	0.01	0.1	370	$1,764	0.21	1.99
6220	Commodity contracts brokers	100	$1,061,365	11.7%	$124,180	$37	0.00	0.0	85	$709	0.07	0.57
6230	Security & commod. exchanges	100	$1,600,957	11.7%	$187,312	$165	0.02	0.1	11	$1,573	0.10	0.84

Table VIII-5 Estimated Economic Impact Under Worst-Case Scenarios, of the Proposed Ergonomics Standard on Firms Meeting SBA Size Criteria

SIC	Industry	SBA size (Number of Employees)*	Average Revenue per Firm (SBA)	Profits as a Percentage of Revenues [b]	Average Profit per Firm (SBA) ($)	Average Cost per Firm (SBA) ($)	For all small firms: Annualized Compliance Costs as a Percentage of Revenues--SBA (percent)	For all small firms: Annualized Compliance Costs as a Percentage of Profits--SBA (percent)	For small affected firms (Those with MSDs): Number of Affected Small Firms Over 10 years	For small affected firms (Those with MSDs): Annualized Costs per Affected Small Firms	For small affected firms (Those with MSDs): Annualized Costs as a Percent of Revenues	For small affected firms (Those with MSDs): Annualized Costs as a Percent of Profits
6280	Security & commod. services	100	$731,044	14.1%	$103,077	$26	0.00	0.0	437	$1,062	0.15	1.03
6310	Life insurance	100	$7,739,146	12.7%	$982,872	$176	0.02	0.2	135	$14,390	0.19	1.46
6320	Medical & health insur.	20	$4,637,512	12.7%	$588,964	$134	0.01	0.1	67	$4,124	0.09	0.70
6330	Fire, marine, & caslty ins.	1500	$140,086,752	12.7%	$17,791,018	$3,452	0.00	0.0	248	$283,937	0.20	1.60
6350	Surety insurance	20	$2,086,520	12.7%	$264,988	$56	0.01	0.0	13	$2,014	0.10	0.76
6360	Title insurance	100	$628,048	12.7%	$79,762	$189	0.12	0.9	109	$4,292	0.68	5.38
6370	Pension and health funds	1000	$758,021	12.7%	$96,269	$108	0.01	0.1	249	$1,193	0.16	1.24
6390	Ins. carriers, n.e.c.	100	$1,836,789	12.7%	$233,272	$141	0.01	0.1	46	$878	0.05	0.38
6410	Insurance agents	100	$376,269	6.8%	$25,586	$42	0.01	0.2	9,495	$557	0.15	2.18
6510	Real estate operators	100	$723,466	15.4%	$111,414	$203	0.03	0.2	23,947	$850	0.12	0.76
6530	RE agents and managers	100	$452,717	12.1%	$54,779	$127	0.03	0.2	17,090	$919	0.20	1.68
6540	Title abstract offices	100	$450,454	12.1%	$54,505	$146	0.04	0.3	1,204	$629	0.14	1.15
6550	Subdividers & developers	100	$686,118	9.1%	$62,437	$314	0.05	0.5	3,755	$1,543	0.22	2.47
6710	Holding offices	100	$1,458,012	17.5%	$255,152	$161	0.02	0.1	846	$1,759	0.12	0.69
6720	Investment offices	20	$2,504,933	17.5%	$438,363	$63	0.00	0.0	32	$1,656	0.07	0.38
6730	Trusts	100	$964,611	17.5%	$168,807	$80	0.01	0.0	907	$771	0.08	0.46
6790	Miscellaneous investing	20	$1,309,443	17.5%	$229,152	$48	0.00	0.0	575	$656	0.05	0.29
7010	Hotels and motels	100	$562,982	7.0%	$39,409	$639	0.13	1.9	13,478	$2,010	0.36	5.10
7020	Rooming & boarding houses	1000	$274,294	7.0%	$19,201	$285	0.10	1.5	519	$890	0.32	4.64
7030	Camps and rec. vehicle parks	1000	$403,297	7.0%	$28,231	$33	0.01	0.1	427	$576	0.14	2.04
7040	Membership-basis org. hotels	100	$216,959	7.0%	$15,187	$29	0.01	0.2	167	$414	0.19	2.72
7210	Laundry & garment srvices	100	$247,311	3.8%	$9,398	$365	0.15	4.1	19,329	$1,062	0.43	11.30
7220	Photo studios, portrait	500	$278,014	3.9%	$10,843	$114	0.06	1.5	1,511	$995	0.36	9.18
7230	Beauty shops	500	$142,666	4.6%	$6,563	$42	0.03	0.7	7,931	$430	0.30	6.55
7240	Barber shops	100	$82,197	4.6%	$3,781	$108	0.14	2.9	1,016	$478	0.58	12.63
7250	Shoe repair	100	$101,726	4.6%	$4,679	$113	0.11	2.4	418	$596	0.59	12.74
7260	Fun. service and crematories	100	$590,431	7.9%	$46,644	$150	0.03	0.4	2,838	$834	0.14	1.79
7290	Misc personal services.	500	$212,827	4.6%	$9,790	$50	0.03	0.6	1,091	$1,420	0.67	14.51
7310	Advertising	100	$765,849	3.8%	$29,102	$217	0.03	0.8	3,055	$1,373	0.18	4.72
7320	Credit report.& collection	100	$674,626	7.0%	$47,224	$133	0.02	0.3	966	$930	0.14	1.97
7330	Mailing, reprod, steno., serv	100	$500,227	4.6%	$23,010	$163	0.03	0.7	5,396	$1,048	0.21	4.55
7340	Services to buildings	500	$258,731	3.7%	$9,573	$176	0.07	1.9	12,290	$935	0.36	9.76
7350	Misc. equipt. rental	100	$985,159	9.2%	$90,635	$327	0.04	0.5	4,016	$2,010	0.20	2.22
7360	Pers. supply services	500	$1,103,842	3.0%	$33,115	$1,381	0.17	5.8	6,019	$8,402	0.76	25.37
7370	Comptr & data proc. services	500	$1,097,682	5.2%	$57,079	$138	0.01	0.3	7,146	$1,711	0.16	3.00
7380	Misc. business services	500	$557,848	3.4%	$18,967	$242	0.05	1.4	14,724	$1,402	0.25	7.39
7510	Auto rentals, no drivers	100	$1,154,193	5.7%	$65,789	$427	0.07	1.1	1,671	$2,651	0.23	4.03
7520	Automobile parking	100	$682,842	4.8%	$32,776	$254	0.12	2.5	414	$5,421	0.79	16.54
7530	Automotive repair shops	500	$374,580	3.9%	$14,609	$198	0.05	1.4	36,758	$751	0.20	5.14
7540	Automotive serv., exc repair	500	$349,680	6.5%	$22,729	$408	0.12	1.9	9,281	$1,186	0.34	5.22
7620	Electrical repair shops	100	$384,314	2.6%	$9,992	$363	0.10	4.0	5,382	$1,293	0.34	12.94
7630	Watch and jewelry repair	100	$156,483	3.4%	$5,320	$151	0.10	3.1	398	$684	0.44	12.86
7640	Reupholstery & furn. repair	100	$149,960	3.4%	$5,099	$112	0.07	2.1	1,452	$528	0.35	10.36
7690	Misc. repair shops	100	$456,359	5.9%	$26,925	$376	0.08	1.4	12,308	$1,186	0.26	4.41
7810	Motion picture production	500	$990,868	5.4%	$53,507	$418	0.04	0.8	2,454	$2,492	0.25	4.66
7820	Motion picture dist.	20	$1,444,490	5.8%	$83,780	$365	0.03	0.5	445	$1,005	0.07	1.20
7830	Motion picture theaters	100	$652,241	5.8%	$37,830	$958	0.33	5.7	1,580	$3,958	0.61	10.46
7840	Video tape rental	500	$297,050	7.2%	$21,388	$275	0.11	1.6	7,203	$795	0.27	3.72
7910	Dance studios & schools	100	$147,902	4.1%	$6,064	$210	0.14	3.4	2,061	$582	0.39	9.59
7920	Prducrs, orch., entertainers	100	$713,474	3.6%	$25,685	$191	0.03	0.7	3,228	$977	0.14	3.80
7930	Bowling centers	500	$480,995	4.2%	$20,202	$258	0.06	1.4	1,830	$809	0.17	4.00

Table VIII-5 Estimated Economic Impact Under Worst-Case Scenarios, of the Proposed Ergonomics Standard on Firms Meeting SBA Size Criteria

							For all small firms		For small affected firms (Those with MSDs)			
SIC	Industry	SBA size (Number of Employees)*	Average Revenue per Firm (SBA)	Profits as a Percentage of Revenues [b]	Average Profit per Firm (SBA) ($)	Average Cost per Firm (SBA) ($)	Annualized Compliance Costs as a Percentage of Revenues--SBA (percent)	Annualized Compliance Costs as a Percentage of Profits--SBA (percent)	Number of Affected Small Firms Over 10 years	Annualized Costs per Affected Small Firms	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits
7940	Commercial sports	100	$1,064,778	3.6%	$38,332	$416	0.04	1.1	1,259	$1,498	0.14	3.91
7990	Misc. recreation services	500	$602,501	4.2%	$25,305	$681	0.12	2.8	17,198	$2,443	0.41	9.65
8010	Offices of medical doctors	100	$775,789	6.3%	$48,875	$184	0.02	0.4	30,591	$1,113	0.14	2.28
8020	Dentists offices and clinics	500	$413,582	11.3%	$46,735	$75	0.02	0.2	15,864	$531	0.13	1.14
8030	Osteopathic physicians	500	$501,172	5.4%	$27,063	$43	0.01	0.2	786	$500	0.10	1.85
8040	Other health practitioners	500	$289,816	6.5%	$18,838	$145	0.05	0.8	17,520	$703	0.24	3.73
8050	Nursing & personal care fac.	500	$2,533,384	4.3%	$108,936	$5,958	0.35	8.2	6,066	$23,504	0.93	21.58
8060	Hospitals	100	$2,933,028	5.1%	$149,584	$3,119	0.17	3.4	329	$12,379	0.42	8.28
8070	Med. & dental labs	100	$567,385	7.9%	$44,823	$236	0.05	0.6	2,039	$1,725	0.30	3.85
8080	Home hlth care services	500	$1,352,121	3.5%	$47,324	$2,695	0.30	8.6	3,534	$12,169	0.90	25.71
8090	Hlth & allied serv., n.e.c.	500	$1,242,429	11.0%	$136,667	$794	0.08	0.7	4,121	$4,012	0.32	2.94
8110	Legal services	100	$499,601	5.0%	$24,980	$69	0.01	0.3	13,330	$864	0.17	3.46
8210	Elem. & secondary schools	100	$1,176,073	5.9%	$69,388	$420	0.04	0.7	3,421	$2,066	0.18	2.98
8220	Colleges & universities	100	$1,325,665	6.2%	$82,191	$632	0.07	1.1	260	$5,624	0.42	6.84
8230	Libraries	1000	$390,031	5.9%	$23,012	$62	0.01	0.2	164	$852	0.22	3.70
8240	Vocational schools	100	$557,312	5.9%	$32,881	$68	0.01	0.2	481	$944	0.17	2.87
8290	Schools, n.e.c.	1000	$500,377	5.0%	$25,019	$53	0.01	0.2	1,288	$636	0.13	2.54
8320	Individual & fam. services	500	$609,148	4.1%	$24,975	$944	0.16	3.8	12,854	$3,159	0.52	12.65
8330	Job train. & related serv.	500	$1,095,666	2.5%	$27,392	$2,250	0.23	9.2	2,477	$8,240	0.75	30.08
8350	Child day care services	1000	$266,652	3.8%	$10,133	$250	0.09	2.3	15,684	$854	0.32	8.42
8360	Residential care	500	$860,750	2.6%	$22,380	$2,038	0.26	9.9	9,280	$6,310	0.73	28.20
8390	Social services, n.e.c.	100	$982,940	3.4%	$33,420	$376	0.05	1.3	2,944	$1,958	0.20	5.86
8410	Museums & art galleries	100	$413,094	6.1%	$25,199	$258	0.06	1.1	906	$1,255	0.30	4.98
8420	Bot. & zoology gardens	100	$580,625	6.1%	$35,418	$713	0.13	2.2	133	$2,921	0.50	8.25
8610	Business associations	100	$658,954	3.3%	$21,745	$67	0.01	0.3	1,566	$669	0.10	3.08
8620	Prof. organizations	100	$732,835	4.8%	$35,176	$67	0.01	0.2	642	$730	0.10	2.07
8630	Labor organizations	100	$432,735	6.4%	$27,695	$45	0.01	0.2	1,557	$561	0.13	2.03
8640	Civic & social assoc.	500	$382,131	3.4%	$12,992	$252	0.07	2.0	7,826	$1,187	0.31	9.14
8650	Political organizations	100	$362,243	6.4%	$23,184	$89	0.02	0.4	371	$615	0.17	2.65
8660	Religious organizations	500	$328,231	9.1%	$29,869	$34	0.01	0.1	7,712	$695	0.21	2.33
8690	Membership orgs., n.e.c.	100	$482,414	6.4%	$30,874	$325	0.08	1.2	1,571	$1,843	0.38	5.97
8710	Eng. and arch. services	100	$647,979	4.2%	$27,215	$140	0.02	0.6	9,322	$1,164	0.18	4.28
8720	Accntng, auditng, & bkeeping	100	$324,342	12.0%	$38,921	$120	0.04	0.3	9,288	$1,075	0.33	2.76
8730	Research & testing services	100	$976,053	3.4%	$33,186	$504	0.06	1.8	3,434	$2,742	0.28	8.26
8740	Management & pub. relations	100	$540,229	6.2%	$33,494	$194	0.04	0.6	11,955	$1,516	0.28	4.53
8990	Services, n.e.c.	100	$470,966	5.0%	$23,548	$285	0.06	1.3	5,755	$848	0.18	3.60
	Total						**0.04**	**0.1**				
	Average (unweighted)		**$11,070,190**	**4.9%**	**$481,756**	**$1,898**			1,210,067	$13,666	0.23	6.67

Source: Office of Regulatory Analysis.
Revenue data is from U.S. Dept. of Commerce, Bureau of Census. Compliance costs are from Chapter 5 of this Preliminary Economic Analysis. Profit rates are from, in most cases, Robert Morris Associates ' "RMA Studies."

* Approximated, to make use of available firm revenue data.

[a] Excludes SIC 3731

[b] A profit rate of 5 percent of revenues was estimated for SICs 910,920,970,8110, and 8990; a profit rate of 4 percent. was estimated for SICs 2280, 2310, and 5620.

[c] Revenue data was wholly or partially suppressed by the Census Bureau for the SBA small entity size category. Any projected economic impacts are therefore overestimated for these industries Where estimated costs as a percent of profits would be in excess of 20 percent in those industries for which the Bureau suppressed the data, OSHA reported profit impacts as "na."

Table VIII-6 Estimated Economic Impact of the Proposed Ergonomics Standard on All Very Small Firms and All Very Small Affected Firms (Those with MSDs)*

						For all very small firms			For very small affected firms (those with MSDs)			
SIC	Industry	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues	Profits ($1,000s)	Average Profits per firm ($)	Annualized Costs per Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits	Total Number of Affected Firms over 10 years	Annualized Costs per Affected Very Small Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits
710	Soil prep. services	$354,118	6.0%	$12,346	$21,141	$108	0.03	0.5	230	$275	0.08	1.3
720	Crop services	$363,704	7.9%	$95,938	$28,733	$295	0.08	1.0	1,321	$746	0.21	2.6
740	Veterinary services	$147,753	8.7%	$273,531	$12,855	$228	0.15	1.8	7,875	$616	0.42	4.8
750	Animal serv., excpt vet.	$77,543	6.0%	$46,742	$4,629	$69	0.09	1.5	1,519	$461	0.59	10.0
780	Lndscape & hort. services	$109,792	4.4%	$313,231	$4,831	$167	0.15	3.5	19,881	$545	0.50	11.3
810	Timber tracts	$241,574	3.1%	$4,307	$7,465	$186	0.08	2.5	153	$703	0.29	9.4
830	Forest products	$508,094	3.1%	$1,335	$15,700	$204	0.04	1.3	23	$769	0.15	4.9
850	Forestry services	$203,723	3.1%	$6,389	$6,295	$167	0.08	2.7	247	$687	0.34	10.9
910	Commerical fishing	$260,772	5.0%	$18,541	$13,039	$90	0.03	0.7	225	$568	0.22	4.4
920	Fish hatcheries	$147,276	5.0%	$427	$7,364	$195	0.13	2.7	13	$888	0.60	12.1
970	Hunting & trapping	$157,738	5.0%	$1,893	$7,887	$48	0.03	0.6	40	$288	0.18	3.7
1310	Crude petrol. & nat. gas	$1,063,503	5.7%	$398,241	$60,726	$77	0.01	0.1	874	$580	0.05	1.0
1320	Natural gas liquids	$6,478,211	4.8%	$11,865	$312,250	$165	0.00	0.1	12	$537	0.01	0.2
1380	Oil & gas field services	$321,483	2.0%	$43,862	$6,301	$129	0.04	2.0	984	$912	0.28	14.5
2010	Meat products	$588,374	2.3%	$22,207	$13,533	$240	0.04	1.8	379	$1,036	0.18	7.7
2020	Dairy products	$770,743	2.2%	$12,955	$16,956	$294	0.04	1.7	175	$1,282	0.17	7.6
2030	Presrvd fruits & vegetables	$510,610	4.2%	$19,730	$21,446	$176	0.03	0.8	191	$848	0.17	4.0
2040	Grain mill products	$964,208	2.7%	$28,481	$26,034	$355	0.04	1.4	279	$1,391	0.14	5.3
2050	Bakery products	$217,705	2.2%	$10,087	$4,790	$233	0.11	4.9	435	$1,127	0.52	23.5
2060	Sugar and confect. prods	$511,272	4.6%	$13,758	$23,519	$237	0.05	1.0	120	$1,155	0.23	4.9
2070	Fats and oils	$1,433,935	2.9%	$5,739	$41,584	$278	0.02	0.7	34	$1,127	0.08	2.7
2080	Beverages	$2,376,764	4.5%	$129,415	$106,954	$330	0.01	0.3	268	$1,490	0.06	1.4
2090	Misc. food products	$525,021	2.9%	$36,359	$15,226	$262	0.05	1.7	515	$1,212	0.23	8.0
2110	Cigarettes	na [c]	3.9%	na	na	$128	na	na	na	na	na	na
2120	Cigars	na [c]	3.9%	na	na	$51	na	na	2	$671	na	na
2130	Chewing & smoking tobacco	$1,063,083 [c]	3.9%	$498	$41,460	$104	0.01	0.3	2	$816	0.08	2.0
2140	Tobacco stemm. & redrying	na [c]	3.9%	na	na	$83	na	na	na	na	na	na
2210	Brdwven fab. mills, cotton	$267,223	3.6%	$2,799	$9,620	$275	0.10	2.9	94	$855	0.32	8.9
2220	Broadwoven fabric mills	$190,505	2.4%	$933	$4,572	$139	0.07	3.0	48	$586	0.31	12.8
2230	Brdwvn fab. mills, wool	$458,913	2.4%	$507	$11,014	$68	0.01	0.6	12	$263	0.06	2.4
2240	Narrow fabric mills	$324,956	1.3%	$570	$4,224	$306	0.09	7.2	49	$843	0.26	20.0
2250	Knitting mills	$371,512	2.7%	$9,439	$10,031	$203	0.05	2.0	286	$668	0.18	6.7
2260	Tex. finishing, excpt wool	$369,584	1.2%	$2,302	$4,435	$162	0.04	3.7	127	$664	0.18	15.0
2270	Carpets and rugs	$458,882	1.7%	$2,317	$7,801	$150	0.03	1.9	78	$572	0.12	7.3
2280	Yarn and thread mills	$380,590	4.0%	$2,375	$15,224	$194	0.05	1.3	47	$649	0.17	4.3
2290	Misc. textile goods	$376,255	2.4%	$4,632	$9,030	$240	0.06	2.7	145	$845	0.22	9.4
2310	Men's & boys' suits & coats	$247,145	4.0%	$1,433	$9,886	$165	0.07	1.7	33	$724	0.29	7.3
2320	Men's & boys' furnishings	$303,121	3.2%	$7,828	$9,700	$203	0.07	2.1	191	$857	0.28	8.8
2330	Wm's & misses' outerwear	$235,611	2.0%	$29,847	$4,712	$129	0.05	2.7	1,401	$582	0.25	12.3
2340	Wm's & chldrn's undergarmn	$509,612	2.2%	$1,704	$11,211	$190	0.04	1.7	37	$787	0.15	7.0
2350	Hats, caps, & millinery	$172,675	4.3%	$1,693	$7,425	$130	0.08	1.8	47	$628	0.36	8.5
2360	Girls' & chldrn's outerwear	$425,055	1.4%	$1,613	$5,951	$124	0.03	2.1	60	$558	0.13	9.4
2370	Fur goods	$660,448	2.4%	$2,124	$15,851	$69	0.01	0.4	27	$342	0.05	2.2
2380	Misc. apparel & accessories	$216,937	2.4%	$3,389	$5,206	$178	0.08	3.4	156	$741	0.34	14.2
2390	Misc. fab. textile prods	$194,512	2.4%	$34,167	$4,668	$165	0.08	3.5	1,889	$641	0.33	13.7
2410	Logging	$421,274	3.9%	$223,050	$16,430	$60	0.01	0.4	1,721	$473	0.11	2.9

Table VIII-6 Estimated Economic Impact of the Proposed Ergonomics Standard on All Very Small Firms and All Very Small Affected Firms (Those with MSDs)*

						For all very small firms			For very small affected firms (those with MSDs)			
SIC	Industry	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues	Profits ($1,000s)	Average Profits per firm ($)	Annualized Costs per Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits	Total Number of Affected Firms over 10 years	Annualized Costs per Affected Very Small Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits
2420	Sawmills & planing mills	$262,325	3.8%	$39,774	$9,968	$314	0.12	3.2	1,365	$918	0.35	9.2
2430	Millwork & plywood	$245,373	3.7%	$64,469	$9,079	$346	0.14	3.8	2,492	$987	0.40	10.9
2440	Wood containers	$215,651	3.6%	$15,837	$7,763	$295	0.14	3.8	741	$813	0.38	10.5
2450	Wood bldings & mobile hom	$365,286	3.7%	$6,758	$13,516	$339	0.09	2.5	159	$1,065	0.29	7.9
2490	Misc. wood products	$273,903	2.8%	$19,012	$7,669	$267	0.10	3.5	713	$929	0.34	12.1
2510	Household furniture	$203,804	2.9%	$23,257	$5,910	$245	0.12	4.2	1,028	$940	0.46	15.9
2520	Office furniture	$259,145	3.9%	$6,115	$10,107	$320	0.12	3.2	167	$1,164	0.45	11.5
2530	Pub blding & related furn.	$332,258	3.0%	$2,203	$9,968	$664	0.20	6.7	71	$2,059	0.62	20.7
2540	Partitions and fixtures	$245,147	3.0%	$15,996	$7,354	$327	0.13	4.4	640	$1,112	0.45	15.1
2590	Misc furniture and fixtures	$251,255	3.0%	$7,402	$7,538	$219	0.09	2.9	286	$751	0.30	10.0
2610	Pulp mills	na [c]	3.8%	na	na	$95	na	na	na	na	na	na
2620	Paper mills	$442,060	4.7%	$1,039	$20,777	$218	0.05	1.0	12	$913	0.21	4.4
2630	Paperboard mills	na [c]	4.7%	na	na	$174	na	na	5	$678	na	na
2650	Paperbrd containers & boxes	$514,381	4.0%	$13,394	$20,575	$369	0.07	1.8	239	$1,006	0.20	4.9
2670	Misc. cnvrtd paper products	$498,582	2.7%	$16,154	$13,462	$310	0.06	2.3	436	$852	0.17	6.3
2710	Newspapers	$171,876	6.0%	$58,111	$10,313	$191	0.11	1.9	1,716	$627	0.36	6.1
2720	Periodicals	$372,480	3.7%	$64,788	$13,782	$90	0.02	0.7	964	$440	0.12	3.2
2730	Books	$399,819	4.0%	$43,740	$15,993	$137	0.03	0.9	671	$558	0.14	3.5
2740	Miscellaneous publishing	$386,448	5.1%	$49,390	$19,709	$101	0.03	0.5	511	$496	0.13	2.5
2750	Commercial printing	$234,077	3.3%	$223,687	$7,725	$200	0.09	2.6	9,661	$600	0.26	7.8
2760	Manifold business forms	$369,381	2.7%	$3,690	$9,973	$323	0.09	3.2	150	$794	0.21	8.0
2770	Greeting cards	$299,953	3.8%	$969	$11,398	$254	0.08	2.2	24	$885	0.29	7.8
2780	Blankbooks & bookbinding	$156,867	3.8%	$5,705	$5,961	$294	0.19	4.9	371	$758	0.48	12.7
2790	Printing trade services	$189,836	3.0%	$15,445	$5,695	$112	0.06	2.0	414	$734	0.39	12.9
2810	Indust. inorganic chemicals	$1,240,983	4.1%	$15,061	$50,880	$116	0.01	0.2	38	$904	0.07	1.8
2820	Plastics mat. & synthetics	$1,246,308	5.0%	$18,819	$62,315	$107	0.01	0.2	38	$864	0.07	1.4
2830	Drugs	$938,460	5.5%	$40,312	$51,615	$127	0.01	0.2	101	$975	0.10	1.9
2840	Soap, clnrs, & toilet goods	$892,064	2.9%	$40,331	$25,870	$154	0.02	0.6	234	$1,029	0.12	4.0
2850	Paints & allied products	$670,834	2.8%	$15,064	$18,783	$165	0.02	0.9	137	$966	0.14	5.1
2860	Indust. organic chemicals	$1,226,195	3.3%	$10,561	$40,464	$104	0.01	0.3	32	$850	0.07	2.1
2870	Agricultural chemicals	$1,005,313	3.4%	$15,723	$34,181	$122	0.01	0.4	68	$818	0.08	2.4
2890	Misc. chemical products	$932,634	3.8%	$39,728	$35,440	$204	0.02	0.6	367	$624	0.07	1.8
2910	Petroleum refining	$2,321,552 [c]	3.1%	$4,822	$71,968	$119	0.01	0.2	11	$709	0.03	1.0
2950	Asphlt pavng & roofng mat.	$1,955,981	3.3%	$24,012	$64,547	$297	0.02	0.5	128	$858	0.04	1.3
2990	Misc. pet. & coal prods	$238,135 [c]	3.7%	$1,894	$8,811	$146	0.06	1.7	42	$754	0.32	8.6
3010	Tires and inner tubes	$449,894	3.9%	$1,158	$17,546	$334	0.07	1.9	16	$1,416	0.31	8.1
3020	Rubber & plastics footwear	$231,682	4.2%	$214	$9,731	$268	0.12	2.8	5	$1,302	0.56	13.4
3050	Hose, bltng, and gaskets	$334,264	4.4%	$5,236	$14,708	$331	0.10	2.2	87	$1,352	0.40	9.2
3060	Fab. rubber prod., n.e.c.	$294,956	3.9%	$8,812	$11,503	$313	0.11	2.7	183	$1,308	0.44	11.4
3080	Misc plastics, n.e.c.	$360,366	3.4%	$74,960	$12,252	$252	0.07	2.1	1,872	$823	0.23	6.7
3110	Leather tan. & finishing	$329,655	1.7%	$1,233	$5,604	$295	0.09	5.3	71	$910	0.28	16.2
3130	Footwear cut stock	na [c]	1.8%	na	na	$272	na	na	15	$796	na	na
3140	Footwear, except rubber	$335,179	1.9%	$1,210	$6,368	$247	0.07	3.9	57	$819	0.24	12.9
3150	Leather gloves & mittens	na [c]	1.8%	na	na	$391	na	na	10	$1,090	na	na
3160	Luggage	na [c]	1.8%	na	na	$143	na	na	44	$519	na	na
3170	Hndbags & prsnal leathr gds.	na [c]	1.8%	na	na	$178	na	na	78	$618	na	na

Table VIII-6 Estimated Economic Impact of the Proposed Ergonomics Standard on All Very Small Firms and All Very Small Affected Firms (Those with MSDs)*

SIC	Industry	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues	Profits ($1,000s)	For all very small firms: Average Profits per firm ($)	Annualized Costs per Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits	For very small affected firms (those with MSDs): Total Number of Affected Firms over 10 years	Annualized Costs per Affected Very Small Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits
3190	Leather goods, n.e.c.	$192,370	1.8%	$1,115	$3,463	$276	0.14	8.0	102	$870	0.45	25.1
3210	Flat glass	$207,842	4.5%	$355	$9,353	$347	0.17	3.7	10	$1,324	0.64	14.2
3220	Glass, pressed or blown	$301,159	6.8%	$8,089	$20,479	$326	0.11	1.6	91	$1,419	0.47	6.9
3230	Prod. of purchased glass	$230,435	4.4%	$11,619	$10,139	$300	0.13	3.0	284	$1,208	0.52	11.9
3240	Cement, hydraulic	$1,050,298	4.5%	$3,970	$47,263	$298	0.03	0.6	23	$1,070	0.10	2.3
3250	Structural clay products	$256,304	6.0%	$3,645	$15,378	$375	0.15	2.4	69	$1,278	0.50	8.3
3260	Pottery & related prods	$132,403	4.5%	$5,386	$5,958	$296	0.22	5.0	221	$1,211	0.91	20.3
3270	Concrete & plast. prdcts	$413,581	4.3%	$73,804	$17,784	$417	0.10	2.3	1,353	$1,277	0.31	7.2
3280	Cut stone & stone prods	$247,993	4.2%	$9,103	$10,416	$358	0.14	3.4	271	$1,156	0.47	11.1
3290	Misc. nonmet. mineral prods.	$407,792	5.7%	$17,526	$23,244	$341	0.08	1.5	196	$1,313	0.32	5.6
3310	Basic steel products	$797,017	4.7%	$17,943	$37,460	$182	0.02	0.5	84	$1,043	0.13	2.8
3320	Iron and steel foundries	$337,456	4.7%	$6,265	$15,860	$304	0.09	1.9	98	$1,222	0.36	7.7
3330	Primary nonfer. metals	$970,958	4.5%	$4,195	$43,693	$194	0.02	0.4	18	$1,048	0.11	2.4
3340	Secondary nonfer. metals	$1,072,780	3.6%	$4,557	$38,620	$294	0.03	0.8	29	$1,186	0.11	3.1
3350	Nonfer. rolling & drawing	$625,461	5.6%	$10,333	$35,026	$237	0.04	0.7	61	$1,154	0.18	3.3
3360	Nonfer. foundries (cstngs)	$240,793	3.7%	$7,617	$8,909	$303	0.13	3.4	214	$1,208	0.50	13.6
3390	Misc. primary metal prdcts	$286,519	0.5%	$617	$1,461	$189	0.07	13.0	115	$693	0.24	47.4
3410	Met. cans & ship. containers	$655,041	2.8%	$2,256	$18,341	$314	0.05	1.7	40	$977	0.15	5.3
3420	Cutlery, hndtls, & hardware	$278,801	4.7%	$18,542	$13,104	$315	0.11	2.4	456	$978	0.35	7.5
3430	Plumbing & heating fixtures	$367,613	3.8%	$5,266	$13,969	$438	0.12	3.1	130	$1,272	0.35	9.1
3440	Fab. struct. metal prdcts	$321,458	4.0%	$101,362	$12,858	$338	0.11	2.6	2,702	$986	0.31	7.7
3450	Screw machine products	$240,690	3.9%	$13,029	$9,387	$392	0.16	4.2	513	$1,063	0.44	11.3
3460	Met. forgings & stampings	$337,019	4.5%	$24,538	$15,166	$433	0.13	2.9	565	$1,240	0.37	8.2
3470	Metal services, n.e.c.	$225,866	5.7%	$46,489	$12,874	$301	0.13	2.3	1,230	$885	0.39	6.9
3480	Ordnance and access., n.e.c.	$167,856	4.4%	$2,208	$7,386	$205	0.12	2.8	75	$817	0.49	11.1
3490	Misc. fab. metal products	$312,038	4.8%	$65,453	$14,978	$312	0.10	2.1	1,391	$979	0.31	6.5
3510	Engines and turbines	$413,304	4.4%	$2,928	$18,185	$228	0.06	1.3	45	$815	0.20	4.5
3520	Farm & garden machinery	$326,580	4.1%	$15,023	$13,390	$214	0.07	1.6	328	$733	0.22	5.5
3530	Construct. & related mach.	$394,130	5.0%	$34,940	$19,707	$320	0.08	1.6	538	$1,057	0.27	5.4
3540	Metalworking machinery	$232,627	4.6%	$88,956	$10,701	$288	0.12	2.7	2,572	$932	0.40	8.7
3550	Special industry mach.	$344,630	4.5%	$44,711	$15,508	$250	0.07	1.6	822	$876	0.25	5.6
3560	General indust. mach.	$356,137	4.5%	$34,857	$16,026	$291	0.08	1.8	659	$961	0.27	6.0
3570	Computer & office equip.	$621,373	3.3%	$26,452	$20,505	$137	0.02	0.7	246	$719	0.12	3.5
3580	Refrig. & serv. indust mach.	$334,315	2.0%	$7,796	$6,686	$316	0.09	4.7	336	$1,096	0.33	16.4
3590	Industrial mach., n.e.c.	$193,735	5.5%	$224,595	$10,655	$225	0.12	2.1	4,172	$1,137	0.59	10.7
3610	Elect. dist. equipment	$394,178	4.0%	$7,174	$15,767	$197	0.05	1.2	75	$1,187	0.30	7.5
3620	Elect. indust. apparatus	$389,434	4.0%	$19,643	$15,577	$216	0.06	1.4	205	$1,335	0.34	8.6
3630	Household appliances	$421,725	3.4%	$3,284	$14,339	$250	0.06	1.7	35	$1,636	0.39	11.4
3640	Elct. lghtng & wire equip.	$338,127	4.6%	$17,374	$15,554	$222	0.07	1.4	188	$1,323	0.39	8.5
3650	Household audio & vid. equi	$569,616	5.9%	$18,383	$33,607	$170	0.03	0.5	80	$1,168	0.21	3.5
3660	Communications equipment	$496,670	5.4%	$29,985	$26,820	$97	0.02	0.4	129	$842	0.17	3.1
3670	Electrnic compnnts & access.	$381,138	5.4%	$68,104	$20,581	$105	0.03	0.5	423	$821	0.22	4.0
3690	Misc. elect. equipment	$380,068	5.0%	$16,799	$19,003	$221	0.06	1.2	106	$1,837	0.48	9.7
3710	Motor vehicles & equipt.	$418,128	3.9%	$42,659	$16,307	$104	0.02	0.6	313	$868	0.21	5.3
3720	Aircraft and parts	$351,923	4.3%	$13,317	$15,133	$135	0.04	0.9	64	$1,855	0.53	12.3
3730	Ship, boat blding and repair[a	$188,726	3.6%	$17,685	$6,794	$176	0.09	2.6	367	$1,247	0.66	18.3

Table VIII-6 Estimated Economic Impact of the Proposed Ergonomics Standard on All Very Small Firms and All Very Small Affected Firms (Those with MSDs)*

SIC	Industry	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues	Profits ($1,000s)	Average Profits per firm ($)	For all very small firms: Annualized Costs per Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits	For very small affected firms (those with MSDs): Total Number of Affected Firms over 10 years	Annualized Costs per Affected Very Small Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits
3740	Railroad equipment	na [c]	2.8%	na	na	$175	na	na	6	$1,754	na	na
3750	Motorcycles & bicycles	$364,505	3.8%	$3,864	$13,851	$192	0.05	1.4	27	$2,009	0.55	14.5
3760	Guided missiles	na [c]	3.8%	na	na	$51	na	na	na	na	na	na
3790	Misc. transportation equip.	$355,671	3.8%	$9,745	$13,516	$180	0.05	1.3	131	$990	0.28	7.3
3810	Srch & navigation equipment	$309,297	4.7%	$4,797	$14,537	$78	0.03	0.5	37	$698	0.23	4.8
3820	Meas. & contrlling devices	$352,337	5.3%	$51,951	$18,674	$151	0.04	0.8	491	$853	0.24	4.6
3840	Medical instrmnts & supplies	$514,868	6.2%	$88,264	$31,922	$128	0.02	0.4	436	$815	0.16	2.6
3850	Ophthalmic goods	$253,881	4.2%	$4,223	$10,663	$155	0.06	1.5	70	$874	0.34	8.2
3860	Photo. equip. & supplies	$442,828	5.3%	$11,054	$23,470	$126	0.03	0.5	62	$952	0.21	4.1
3870	Watches, clocks, & parts	$260,379	5.6%	$1,385	$14,581	$76	0.03	0.5	15	$496	0.19	3.4
3910	Jwlry, slvrwre, and plate	$309,642	2.8%	$21,302	$8,670	$127	0.04	1.5	503	$623	0.20	7.2
3930	Musical instruments	$183,232	3.3%	$2,763	$6,047	$195	0.11	3.2	102	$869	0.47	14.4
3940	Toys and sporting goods	$260,558	3.5%	$24,696	$9,120	$221	0.08	2.4	651	$919	0.35	10.1
3950	Office and art supplies	$229,779	3.3%	$5,945	$7,583	$160	0.07	2.1	177	$711	0.31	9.4
3960	Costume jewelry & notions	$243,748	3.3%	$7,280	$8,044	$104	0.04	1.3	172	$551	0.23	6.9
3990	Misc. manufactures	$227,598	3.4%	$55,097	$7,738	$182	0.08	2.3	3,571	$362	0.16	4.7
4110	Local & suburban trans.	$131,754	6.2%	$54,200	$8,169	$441	0.33	5.4	3,061	$957	0.73	11.7
4120	Taxicabs	$108,596	5.9%	$19,298	$6,407	$96	0.09	1.5	479	$601	0.55	9.4
4130	Intercty & rural bus trans.	$209,955	7.0%	$2,939	$14,697	$274	0.13	1.9	64	$854	0.41	5.8
4140	Bus charter service	$190,309	3.8%	$6,726	$7,232	$224	0.12	3.1	276	$755	0.40	10.4
4150	School buses	$92,169	5.9%	$12,709	$5,438	$182	0.20	3.4	606	$703	0.76	12.9
4170	Bus terminals	$165,896	5.9%	$470	$9,788	$384	0.23	3.9	23	$798	0.48	8.2
4210	Trking & Courier Service	$256,899	3.2%	$768,001	$8,221	$189	0.07	2.3	23,128	$762	0.30	9.3
4220	Pub. warehousing & storage	$284,511	9.4%	$205,020	$26,744	$379	0.13	1.4	3,321	$874	0.31	3.3
4230	Trucking terminal fac.	$172,967 [c]	4.2%	$436	$7,265	$328	0.19	4.5	24	$806	0.47	11.1
4510	Air trans., scheduled	$753,374	4.0%	$37,819	$30,135	$756	0.10	2.5	805	$1,178	0.16	3.9
4520	Air trans., nonsched.	$469,131	6.0%	$37,155	$28,148	$94	0.02	0.3	402	$308	0.07	1.1
4580	Airports and services	$250,033	4.6%	$31,825	$11,502	$161	0.06	1.4	937	$476	0.19	4.1
4610	Pipelines, excpt natural gas	na [c]	4.9%	na	na	$510	na	na	19	$869	na	na
4720	Pass. trans. arrangements	$147,833	2.7%	$102,597	$3,991	$35	0.02	0.9	2,283	$397	0.27	9.9
4730	Freight trans. arrangements	$305,924	3.7%	$122,564	$11,319	$230	0.08	2.0	3,725	$668	0.22	5.9
4740	Rental of railroad cars	$2,541,068	3.4%	$6,307	$86,396	$95	0.00	0.1	16	$446	0.02	0.5
4780	Misc. trans. services	$214,235	3.4%	$12,936	$7,284	$332	0.15	4.6	395	$1,493	0.70	20.5
4810	Telephone communication	$469,144	7.7%	$202,620	$36,124	$92	0.02	0.3	638	$810	0.17	2.2
4820	Telegrph & other comm.	$502,591	5.7%	$10,428	$28,648	$62	0.01	0.2	35	$651	0.13	2.3
4830	Radio & TV broadcasting	$160,378	2.4%	$20,951	$3,849	$43	0.03	1.1	481	$489	0.30	12.7
4840	Cable & othr pay TV services	$739,240	5.4%	$67,663	$39,919	$154	0.02	0.4	290	$900	0.12	2.3
4890	Communication serv., n.e.c.	$454,817	5.7%	$31,498	$25,925	$32	0.01	0.1	70	$551	0.12	2.1
4910	Electric services	$1,047,530	10.8%	$61,318	$113,133	$179	0.02	0.2	87	$1,117	0.11	1.0
4920	Gas product. & distribution	$4,870,258	6.7%	$174,574	$326,307	$223	0.00	0.1	97	$1,231	0.03	0.4
4930	Comb. utility services	$1,059,789	8.3%	$15,393	$87,962	$118	0.01	0.1	23	$907	0.09	1.0
4940	Water supply	$227,639	10.6%	$80,087	$24,130	$137	0.06	0.6	494	$919	0.40	3.8
4950	Sanitary services	$339,686	7.6%	$108,712	$25,816	$320	0.09	1.2	791	$1,707	0.50	6.6
4960	Steam & air-cond. supplies	$734,972	8.3%	$2,196	$61,003	$193	0.03	0.3	7	$1,049	0.14	1.7
4970	Irrigation systems	$102,303	8.3%	$2,938	$8,491	$79	0.08	0.9	92	$296	0.29	3.5
5010	Motor vehicles	$997,216	2.0%	$577,727	$19,944	$279	0.03	1.4	10,574	$764	0.08	3.8

Table VIII-6 Estimated Economic Impact of the Proposed Ergonomics Standard on All Very Small Firms and All Very Small Affected Firms (Those with MSDs)*

						For all very small firms			For very small affected firms (those with MSDs)			
SIC	Industry	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues	Profits ($1,000s)	Average Profits per firm ($)	Annualized Costs per Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits	Total Number of Affected Firms over 10 years	Annualized Costs per Affected Very Small Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits
5020	Furn. & homefurnishings	$1,337,006	2.0%	$346,900	$26,740	$252	0.02	0.9	4,333	$753	0.06	2.8
5030	Lumber & construct. mat.	$1,364,186	1.9%	$399,109	$25,920	$453	0.03	1.7	6,888	$1,013	0.07	3.9
5040	Prof. & commercial equip.	$990,766	2.5%	$910,291	$24,769	$163	0.02	0.7	9,285	$645	0.07	2.6
5050	Met. & minerals, excpt pet.	$4,613,645	2.8%	$934,761	$129,182	$332	0.01	0.3	2,775	$864	0.02	0.7
5060	Electrical goods	$2,078,746	2.2%	$1,153,646	$45,732	$192	0.01	0.4	7,613	$635	0.03	1.4
5070	Hardware supplies	$1,182,468	2.2%	$415,032	$26,014	$374	0.03	1.4	6,787	$879	0.07	3.4
5080	Mach., equipt, & supplies	$1,192,421	2.9%	$1,811,001	$34,580	$288	0.02	0.8	19,167	$787	0.07	2.3
5090	Misc. durable goods	$1,312,292	3.2%	$1,435,207	$41,993	$176	0.01	0.4	8,590	$701	0.05	1.7
5110	Paper and paper products	$1,719,729	1.6%	$318,686	$27,516	$140	0.01	0.5	2,557	$635	0.04	2.3
5120	Drugs, propriet., & sundries	$1,559,160	2.9%	$217,713	$45,216	$154	0.01	0.3	997	$745	0.05	1.6
5130	Apparel and notions	$1,737,426	2.1%	$656,309	$36,486	$133	0.01	0.4	3,755	$637	0.04	1.7
5140	Groceries & related products	$2,200,655	1.4%	$926,401	$30,809	$306	0.01	1.0	9,429	$976	0.04	3.2
5150	Farm-prod. raw materials	$4,082,308	1.7%	$416,951	$69,399	$124	0.00	0.2	1,277	$583	0.01	0.8
5160	Chemicals & allied prods	$2,415,490	3.2%	$724,570	$77,296	$195	0.01	0.3	2,518	$727	0.03	0.9
5170	Petrol. & petrol. prods	$5,853,007	1.2%	$451,407	$70,236	$242	0.00	0.3	2,002	$776	0.01	1.1
5180	Beer, wine, & dist. bev.	$1,901,134	2.3%	$107,741	$43,726	$490	0.03	1.1	948	$1,272	0.07	2.9
5190	Misc. nondurable goods	$991,448	1.9%	$761,695	$18,838	$194	0.02	1.0	15,860	$495	0.05	2.6
5210	Lumber & other blding mat.	$546,349	1.9%	$150,831	$10,381	$534	0.10	5.1	8,461	$917	0.17	8.8
5230	Paint, glass, wallpaper strs	$405,055	0.9%	$19,598	$3,645	$376	0.09	10.3	3,046	$663	0.16	18.2
5250	Hardware stores	$300,058	2.3%	$77,950	$6,901	$296	0.10	4.3	5,681	$588	0.20	8.5
5260	Retail nurseries and gardens	$353,082	2.2%	$73,204	$7,768	$366	0.10	4.7	4,567	$755	0.21	9.7
5270	Mobile home dealers	$1,016,599	2.9%	$97,642	$29,481	$578	0.06	2.0	1,960	$977	0.10	3.3
5310	Department stores	$1,124,000	2.6%	$3,507	$29,224	$55	0.00	0.2	12	$534	0.05	1.8
5330	Variety stores	$232,711	2.7%	$22,883	$6,283	$483	0.21	7.7	2,440	$720	0.31	11.5
5390	Misc. gen. merchandise strs.	$326,089	1.6%	$34,320	$5,217	$186	0.06	3.6	1,829	$668	0.20	12.8
5410	Grocery stores	$372,487	1.2%	$341,608	$4,470	$217	0.06	4.9	21,284	$780	0.21	17.4
5420	Meat and fish markets	$379,841	1.3%	$34,886	$4,938	$207	0.05	4.2	1,924	$759	0.20	15.4
5430	Fruit & vegetable markets	$344,048	1.3%	$13,396	$4,473	$98	0.03	2.2	487	$603	0.18	13.5
5440	Candy, nut, & confctnry strs	$160,161	1.3%	$5,801	$2,082	$126	0.08	6.0	612	$571	0.36	27.4
5450	Dairy products stores	$209,840	1.3%	$4,035	$2,728	$98	0.05	3.6	263	$549	0.26	20.1
5460	Retail bakeries	$130,643	3.0%	$59,557	$3,919	$163	0.12	4.1	3,873	$638	0.49	16.3
5490	Misc. food stores	$271,747	1.8%	$34,539	$4,891	$99	0.04	2.0	1,829	$384	0.14	7.9
5510	New and used car dealers	$1,181,684	1.1%	$106,783	$12,999	$449	0.04	3.5	4,042	$913	0.08	7.0
5520	Used car dealers	$746,731	2.5%	$391,380	$18,668	$37	0.00	0.2	1,655	$472	0.06	2.5
5530	Auto & home supply stores	$365,409	1.9%	$178,596	$6,943	$424	0.12	6.1	13,673	$798	0.22	11.5
5540	Gas service stations	$807,554	1.6%	$661,858	$12,921	$203	0.03	1.6	19,900	$522	0.06	4.0
5550	Boat dealers	$659,731	2.2%	$62,846	$14,514	$356	0.05	2.5	2,017	$765	0.12	5.3
5560	Rec. vehicle dealers	$780,614	1.7%	$32,022	$13,270	$475	0.06	3.6	1,298	$883	0.11	6.7
5570	Motorcycle dealers	$619,849	3.1%	$64,602	$19,215	$52	0.01	0.3	332	$524	0.08	2.7
5590	Auto dealers, n.e.c.	$590,677	2.6%	$17,922	$15,358	$44	0.01	0.3	99	$522	0.09	3.4
5610	Men's & boys' clothing strs	$357,954	0.1%	$2,081	$358	$104	0.03	29.0	1,469	$411	0.11	114.7
5620	Women's clothing stores	$252,774	4.0%	$160,612	$10,111	$80	0.03	0.8	3,065	$412	0.16	4.1
5630	Wm's access.& specialty strs	$211,468	4.5%	$36,751	$9,516	$68	0.03	0.7	631	$414	0.20	4.4
5640	Chldrn's & infants' wear strs	$207,560	1.2%	$7,335	$2,491	$102	0.05	4.1	599	$501	0.24	20.1
5650	Family clothing stores	$282,179	1.3%	$24,651	$3,668	$239	0.08	6.5	2,818	$571	0.20	15.6
5660	Shoe stores	$339,604	2.6%	$62,117	$8,830	$124	0.04	1.4	1,739	$503	0.15	5.7

Table VIII-6 Estimated Economic Impact of the Proposed Ergonomics Standard on All Very Small Firms and All Very Small Affected Firms (Those with MSDs)*

						For all very small firms			For very small affected firms (those with MSDs)			
SIC	Industry	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues	Profits ($1,000s)	Average Profits per firm ($)	Annualized Costs per Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits	Total Number of Affected Firms over 10 years	Annualized Costs per Affected Very Small Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits
5690	Misc. apparel stores	$239,857	1.2%	$20,798	$2,878	$43	0.02	1.5	795	$392	0.16	13.6
5710	Furnitre & homefurnishng str	$391,573	2.3%	$426,227	$9,006	$369	0.09	4.1	23,388	$747	0.19	8.3
5720	Household appliance strs	$399,872	2.3%	$78,000	$9,197	$323	0.08	3.5	3,630	$755	0.19	8.2
5730	Radio, TV, & comptr strs	$473,892	2.3%	$250,852	$10,900	$156	0.03	1.4	5,301	$675	0.14	6.2
5810	Eating & drinking places	$127,704	3.0%	$1,120,186	$3,831	$114	0.09	3.0	75,111	$444	0.35	11.6
5910	Drug stores	$534,247	2.5%	$287,745	$13,356	$192	0.04	1.4	7,500	$551	0.10	4.1
5920	Liquor stores	$457,765	1.4%	$159,493	$6,409	$34	0.01	0.5	2,612	$320	0.07	5.0
5930	Used merchandise stores	$186,153	4.6%	$158,330	$8,563	$138	0.07	1.6	5,139	$495	0.27	5.8
5940	Misc. shopping goods strs.	$257,537	2.2%	$500,200	$5,666	$144	0.06	2.5	25,859	$493	0.19	8.7
5960	Nonstore retailers	$327,931	2.0%	$158,214	$6,559	$220	0.07	3.4	7,510	$707	0.22	10.8
5980	Fuel dealers	$574,269	0.8%	$30,776	$4,594	$349	0.06	7.6	2,987	$783	0.14	17.0
5990	Retail stores, n.e.c.	$231,538	2.6%	$444,991	$6,020	$114	0.05	1.9	12,187	$689	0.30	11.4
6010	Central res. depository	na [c]	12.7%	na	na	$161	na	na	na	na	na	na
6020	Commercial banks	$600,009	12.7%	$206,276	$76,201	$67	0.01	0.1	449	$402	0.07	0.5
6030	Savings institutions	$977,677	12.7%	$77,231	$124,165	$64	0.01	0.1	90	$444	0.05	0.4
6060	Credit unions	$420,849	12.7%	$445,274	$53,448	$67	0.02	0.1	1,438	$387	0.09	0.7
6080	Foreign banking	$3,363,784	12.7%	$43,574	$427,201	$74	0.00	0.0	18	$408	0.01	0.1
6090	Banking-related functions	$289,839	12.7%	$109,656	$36,810	$61	0.02	0.2	394	$463	0.16	1.3
6110	Federal credit agencies	$896,270	14.6%	$9,683	$130,855	$20	0.00	0.0	3	$435	0.05	0.3
6140	Personal cred. institutions	$595,983	18.1%	$439,043	$107,873	$15	0.00	0.0	128	$490	0.08	0.5
6150	Business cred. institutions	$1,193,070	15.5%	$504,108	$184,926	$37	0.00	0.0	219	$458	0.04	0.2
6160	Mortgage bankers & brokers	$271,298	9.6%	$331,913	$26,045	$34	0.01	0.1	1,057	$414	0.15	1.6
6210	Security brokers & dealers	$552,911	10.5%	$455,621	$58,056	$21	0.00	0.0	370	$455	0.08	0.8
6220	Commodity contracts brokers	$451,741	11.7%	$72,674	$52,854	$9	0.00	0.0	52	$230	0.05	0.4
6230	Security & commod. exchang	$239,233	11.7%	$1,679	$27,990	$44	0.02	0.2	6	$449	0.19	1.6
6280	Security & commod. services	$321,210	14.1%	$726,734	$45,291	$14	0.00	0.0	265	$861	0.27	1.9
6310	Life insurance	$1,834,300	12.7%	$193,354	$232,956	$40	0.00	0.0	61	$540	0.03	0.2
6320	Medical & health insur.	$3,241,956	12.7%	$250,743	$411,728	$75	0.00	0.0	67	$685	0.02	0.2
6330	Fire, marine, & caslty ins.	$1,049,008	12.7%	$202,900	$133,224	$42	0.00	0.0	95	$677	0.06	0.5
6350	Surety insurance	$1,478,721	12.7%	$38,311	$187,798	$38	0.00	0.0	13	$584	0.04	0.3
6360	Title insurance	$272,718	12.7%	$19,292	$34,635	$78	0.03	0.2	79	$553	0.20	1.6
6370	Pension and health funds	$265,760	12.7%	$73,207	$33,751	$34	0.01	0.1	141	$523	0.20	1.5
6390	Ins. carriers, n.e.c.	$469,706	12.7%	$11,990	$59,653	$28	0.01	0.0	32	$179	0.04	0.3
6410	Insurance agents	$208,917	6.8%	$1,594,937	$14,206	$27	0.01	0.2	7,411	$409	0.20	2.9
6510	Real estate operators	$437,952	15.4%	$6,147,986	$67,445	$119	0.03	0.2	21,631	$500	0.11	0.7
6530	RE agents and managers	$276,237	12.1%	$3,597,325	$33,425	$58	0.02	0.2	13,824	$455	0.16	1.4
6540	Title abstract offices	$199,511	12.1%	$98,615	$24,141	$99	0.05	0.4	999	$404	0.20	1.7
6550	Subdividers & developrs	$350,225	9.1%	$525,289	$31,870	$130	0.04	0.4	3,086	$692	0.20	2.2
6710	Holding offices	$769,686	17.5%	$705,264	$134,695	$46	0.01	0.0	455	$535	0.07	0.4
6720	Investment offices	$2,142,997	17.5%	$257,267	$375,024	$24	0.00	0.0	32	$502	0.02	0.1
6730	Trusts	$409,627	17.5%	$568,317	$71,685	$41	0.01	0.1	688	$470	0.11	0.7
6790	Miscellaneous investing	$932,853	17.5%	$1,187,475	$163,249	$34	0.00	0.0	575	$426	0.05	0.3
7010	Hotels and motels	$172,236	7.0%	$353,593	$12,057	$232	0.13	1.9	8,390	$811	0.47	6.7
7020	Rooming & boarding houses	$128,762	7.0%	$13,250	$9,013	$98	0.08	1.1	462	$312	0.24	3.5
7030	Camps and rec. vehicle parks	$202,714	7.0%	$90,929	$14,190	$21	0.01	0.1	289	$457	0.23	3.2
7040	Membership-basis org. hotels	$171,197	7.0%	$27,023	$11,984	$25	0.01	0.2	143	$401	0.23	3.3

Table VIII-6 Estimated Economic Impact of the Proposed Ergonomics Standard on All Very Small Firms and All Very Small Affected Firms (Those with MSDs)*

SIC	Industry	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues	Profits ($1,000s)	Average Profits per firm ($)	For all very small firms: Annualized Costs per Firm	For all very small firms: Annualized Costs as a Percent of Revenues	For all very small firms: Annualized Costs as a Percent of Profits	For very small affected firms (those with MSDs): Total Number of Affected Firms over 10 years	For very small affected firms (those with MSDs): Annualized Costs per Affected Very Small Firm	For very small affected firms (those with MSDs): Annualized Costs as a Percent of Revenues	For very small affected firms (those with MSDs): Annualized Costs as a Percent of Profits
7210	Laundry & garment srvices	$115,139	3.8%	$204,426	$4,375	$241	0.21	5.5	16,575	$681	0.59	15.6
7220	Photo studios, portrait	$163,990	3.9%	$53,621	$6,396	$63	0.04	1.0	1,339	$394	0.24	6.2
7230	Beauty shops	$77,387	4.6%	$252,237	$3,560	$38	0.05	1.1	6,869	$388	0.50	10.9
7240	Barber shops	$72,648	4.6%	$14,032	$3,342	$106	0.15	3.2	964	$463	0.64	13.9
7250	Shoe repair	$94,046	4.6%	$8,830	$4,326	$40	0.04	0.9	394	$206	0.22	4.8
7260	Fun. service and crematories	$346,624	7.9%	$312,991	$27,383	$124	0.04	0.5	2,484	$569	0.16	2.1
7290	Misc personal services.	$101,738	4.6%	$116,165	$4,680	$17	0.02	0.4	537	$790	0.78	16.9
7310	Advertising	$328,643	3.8%	$203,861	$12,488	$84	0.03	0.7	2,329	$592	0.18	4.7
7320	Credit report.& collection	$190,234	7.0%	$65,610	$13,316	$52	0.03	0.4	560	$457	0.24	3.4
7330	Mailing, reprod, steno., serv	$249,443	4.6%	$361,741	$11,474	$72	0.03	0.6	4,282	$531	0.21	4.6
7340	Services to buildings	$96,644	3.7%	$204,859	$3,576	$68	0.07	1.9	9,067	$429	0.44	12.0
7350	Misc. equipt. rental	$319,788	9.2%	$435,895	$29,421	$154	0.05	0.5	3,217	$711	0.22	2.4
7360	Pers. supply services	$259,712	3.0%	$134,401	$7,791	$42	0.02	0.5	1,333	$538	0.21	6.9
7370	Comptr & data proc. services	$273,544	5.2%	$1,005,842	$14,224	$28	0.01	0.2	3,539	$553	0.20	3.9
7380	Misc. business services	$214,709	3.4%	$514,432	$7,300	$40	0.02	0.6	10,487	$271	0.13	3.7
7510	Auto rentals, no drivers	$449,841	5.7%	$125,281	$25,641	$176	0.04	0.7	1,200	$717	0.16	2.8
7520	Automobile parking	$282,968	4.8%	$24,313	$13,582	$114	0.04	0.8	286	$717	0.25	5.3
7530	Automotive repair shops	$228,541	3.9%	$1,153,160	$8,913	$177	0.08	2.0	34,183	$671	0.29	7.5
7540	Automotive serv., exc repair	$145,592	6.5%	$196,339	$9,463	$239	0.16	2.5	7,235	$686	0.47	7.2
7620	Electrical repair shops	$185,528	2.6%	$78,622	$4,824	$206	0.11	4.3	4,478	$752	0.41	15.6
7630	Watch and jewelry repair	$133,127	3.4%	$7,219	$4,526	$132	0.10	2.9	378	$556	0.42	12.3
7640	Reupholstery & furn. repair	$125,164	3.4%	$29,334	$4,256	$80	0.06	1.9	1,376	$398	0.32	9.4
7690	Misc. repair shops	$210,042	5.9%	$440,862	$12,392	$241	0.11	1.9	10,395	$823	0.39	6.6
7810	Motion picture production	$440,712	5.4%	$319,685	$23,798	$88	0.02	0.4	1,763	$667	0.15	2.8
7820	Motion picture dist.	$802,155	5.8%	$50,340	$46,525	$366	0.05	0.8	445	$889	0.11	1.9
7830	Motion picture theaters	$206,221	5.8%	$25,178	$11,961	$530	0.26	4.4	1,167	$957	0.46	8.0
7840	Video tape rental	$123,805	7.2%	$120,891	$8,914	$257	0.21	2.9	6,646	$524	0.42	5.9
7910	Dance studios & schools	$95,808	4.1%	$21,868	$3,928	$207	0.22	5.3	1,950	$591	0.62	15.0
7920	Prducrs, orch., entertainers	$451,723	3.6%	$250,988	$16,262	$88	0.02	0.5	2,375	$571	0.13	3.5
7930	Bowling centers	$118,745	4.2%	$18,842	$4,987	$137	0.12	2.7	871	$594	0.50	11.9
7940	Commercial sports	$398,365	3.6%	$58,354	$14,341	$121	0.03	0.8	954	$516	0.13	3.6
7990	Misc. recreation services	$179,978	4.2%	$372,239	$7,559	$173	0.10	2.3	9,692	$879	0.49	11.6
8010	Offices of medical doctors	$375,838	6.3%	$3,750,538	$23,678	$83	0.02	0.4	24,491	$539	0.14	2.3
8020	Dentists offices and clinics	$275,329	11.3%	$3,386,315	$31,112	$74	0.03	0.2	15,010	$535	0.19	1.7
8030	Osteopathic physicians	$300,717	5.4%	$137,639	$16,239	$35	0.01	0.2	674	$437	0.15	2.7
8040	Other health practitioners	$198,218	6.5%	$1,025,567	$12,884	$112	0.06	0.9	16,647	$538	0.27	4.2
8050	Nursing & personal care fac.	$186,764	4.3%	$37,536	$8,031	$322	0.17	4.0	1,701	$884	0.47	11.0
8060	Hospitals	$1,960,099	5.1%	$24,192	$99,965	$165	0.01	0.2	54	$735	0.04	0.7
8070	Med. & dental labs	$227,997	7.9%	$206,649	$18,012	$75	0.03	0.4	1,519	$563	0.25	3.1
8080	Home hlth care services	$178,999	3.5%	$35,823	$6,265	$190	0.11	3.0	1,323	$821	0.46	13.1
8090	Hlth & allied serv., n.e.c.	$241,346	11.0%	$253,746	$26,548	$134	0.06	0.5	2,631	$486	0.20	1.8
8110	Legal services	$248,616	5.0%	$1,937,821	$12,431	$36	0.01	0.3	9,243	$601	0.24	4.8
8210	Elem. & secondary schools	$124,855	5.9%	$53,841	$7,366	$66	0.05	0.9	890	$538	0.43	7.3
8220	Colleges & universities	$250,072	6.2%	$15,706	$15,504	$35	0.01	0.2	59	$608	0.24	3.9
8230	Libraries	$76,904	5.9%	$8,585	$4,537	$22	0.03	0.5	92	$454	0.59	10.0
8240	Vocational schools	$176,678	5.9%	$55,685	$10,424	$24	0.01	0.2	262	$480	0.27	4.6

Table VIII-6 Estimated Economic Impact of the Proposed Ergonomics Standard on All Very Small Firms and All Very Small Affected Firms (Those with MSDs)*

					For all very small firms				For very small affected firms (those with MSDs)			
SIC	Industry	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues	Profits ($1,000s)	Average Profits per firm ($)	Annualized Costs per Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits	Total Number of Affected Firms over 10 years	Annualized Costs per Affected Very Small Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits
8290	Schools, n.e.c.	$161,333	5.0%	$108,319	$8,067	$22	0.01	0.3	880	$331	0.21	4.1
8320	Individual & fam. services	$112,044	4.1%	$127,896	$4,594	$150	0.13	3.3	8,322	$504	0.45	11.0
8330	Job train. & related serv.	$141,082	2.5%	$11,869	$3,527	$107	0.08	3.0	798	$452	0.32	12.8
8350	Child day care services	$55,578	3.8%	$84,369	$2,112	$99	0.18	4.7	10,835	$366	0.66	17.4
8360	Residential care	$90,977	2.6%	$30,048	$2,365	$261	0.29	11.0	5,376	$616	0.68	26.1
8390	Social services, n.e.c.	$261,374	3.4%	$89,525	$8,887	$78	0.03	0.9	1,770	$444	0.17	5.0
8410	Museums & art galleries	$124,048	6.1%	$27,687	$7,567	$72	0.06	0.9	601	$437	0.35	5.8
8420	Bot. & zoolog. gardens	$157,533	6.1%	$3,892	$9,610	$97	0.06	1.0	76	$518	0.33	5.4
8610	Business associations	$253,725	3.3%	$118,577	$8,373	$31	0.01	0.4	1,116	$399	0.16	4.8
8620	Prof. organizations	$274,989	4.8%	$82,233	$13,199	$26	0.01	0.2	408	$397	0.14	3.0
8630	Labor organizations	$188,674	6.4%	$208,586	$12,075	$21	0.01	0.2	1,072	$335	0.18	2.8
8640	Civic & social assoc.	$153,214	3.4%	$165,103	$5,209	$63	0.04	1.2	5,320	$378	0.25	7.3
8650	Political organizations	$221,265	6.4%	$35,162	$14,161	$27	0.01	0.2	316	$213	0.10	1.5
8660	Religious organizations	$121,886	9.1%	$1,594,072	$11,092	$13	0.01	0.1	4,244	$435	0.36	3.9
8690	Membership orgs., n.e.c.	$162,338	6.4%	$69,746	$10,390	$74	0.05	0.7	1,042	$474	0.29	4.6
8710	Eng. and arch. services	$230,441	4.2%	$626,839	$9,679	$42	0.02	0.4	5,884	$457	0.20	4.7
8720	Accntng, auditng, & bkeepin	$166,295	12.0%	$1,552,730	$19,955	$45	0.03	0.2	7,513	$463	0.28	2.3
8730	Research & testing services	$294,370	3.4%	$128,680	$10,009	$82	0.03	0.8	1,900	$553	0.19	5.5
8740	Management & pub. relations	$256,909	6.2%	$1,310,442	$15,928	$44	0.02	0.3	8,543	$426	0.17	2.7
8990	Services, n.e.c.	$246,015	5.0%	$185,496	$12,301	$153	0.06	1.2	5,099	$452	0.18	3.7
Average		$537,098	4.9%		$26,997	$183	0.06	1.80		$740	0.24	6.96
Total				$69,586,551					896,908			

Source: Office of Regulatory Analysis.
Revenue data are from U.S. Dept. of Commerce, Bureau of Census. Compliance costs are from Chapter V of this Preliminary Economic Analysis. Profit rates are from, in most cases, Robert Morris Associates ("RMA Studies")

* "Very small firm" refers to firms with 1-19 employees.
[a] Excludes SIC 3731 (not in the scope of proposed standard)
[b] A profit rate of 5 percent of revenues was estimated for SICs 910,920,970,8110, and 8990; a profit rate of 4 percent. was estimated for SICs 2280, 2310, and 5620.
[c] Revenue data was wholly or partially suppressed by the Census Bureau for the 1-19 employee entity size category. Any projected economic impacts are therefore overestimated for these industries. Where estimated costs as a percent of profits would be in excess of 20 percent in those industries for which the Bureau suppressed the data, OSHA reported profit impacts as "na."

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Based on these findings, OSHA convened a Small Business Regulatory Enforcement Fairness Act (SBREFA) Panel (the report of the Panel is in the docket of this rulemaking as Ex. 23) and an Initial Regulatory Flexibility Analysis, which is presented in the next section.

H. Initial Regulatory Flexibility Analysis

The Regulatory Flexibility Act, as amended in 1996, requires that an Initial Regulatory Flexibility Analysis (IRFA) contain the following elements:

(1) A description of the reasons why action by the Agency is being considered;

(2) A succinct statement of the objectives of, and legal basis for, the proposed rule;

(3) A description of and, where feasible, an estimate of the number of small entities to which the proposed rule will apply;

(4) A description of the projected reporting, recordkeeping and other compliance requirements of the proposed rule, including an estimate of the classes of small entities that will be subject to the requirements and the type of professional skills necessary for preparation of the report or record; and

(5) An identification, to the extent practicable, of all relevant Federal rules that may duplicate, overlap or conflict with the proposed rule.

In addition, a Regulatory Flexibility Analysis must contain a description of any significant alternatives to the proposed rule that accomplish the stated objectives of the applicable statute (in this case the OSH Act) and that minimize any significant economic impact of the proposed rule on small entities.[5]

1. Description of the Reasons for Agency Action

As discussed in detail in section H.2, below, OSHA has determined that it is appropriate to propose an ergonomics program standard to ensure that general industry employers whose employees have experienced an MSD covered by the standard are afforded the protection provided by the quick fix option or the full ergonomics program. Employers are required by the full program to perform a job hazard analysis of the job and to implement controls that are reasonably anticipated to eliminate or materially reduce the risk factors giving rise to the ergonomics injury or illness.

Musculoskeletal disorders have continued to occur in the workplace in large numbers: in 1996, 647,000 lost workday MSDs were reported by employers to the Bureau of Labor Statistics, and OSHA estimates that the number of non-lost workday MSDs (*i.e.*, restricted work MSDs and non-lost workday MSDs) occurring in the same year brings this total to about 1.8 million MSDs in that year.

OSHA establishes that workplace risk factors pose a significant risk of material impairment of health or functional capacity to workers in general industries in Sections VI and VII of this preamble, the Preliminary Risk Assessment and Significance of Risk sections, respectively. The OSH Act, as explained below, requires OSHA to act when the risk of harm posed to workers is significant and feasible means of reducing that risk exist. As demonstrated in Chapter III (Technological Feasibility) of the economic analysis, employers have many choices of controls available to address these risks. Further, because the standard allows employers to choose among several control approaches—engineering, work practice, or administrative controls—employers will have an even larger range of control choices. Thus, OSHA is considering regulatory action because workers in the industries covered by the rule are at significant risk of material health impairment and feasible methods of reducing this risk substantially are available.

2. Legal Basis and Objectives of the Proposed Rule

OSHA's authority to issue an ergonomics program standard derives from sections 2(b), 6(b)(5), 8(c)(1), and 8(g)(2) of the OSH Act. The objective of the proposed rule is to reduce the risk of occupational musculoskeletal disorders in exposed working populations through the use of an ergonomics program that includes management leadership and employee participation, hazard identification and reporting, job hazard control and analysis, training, MSD management, and program evaluation. Implementation of ergonomics programs incorporating these elements has been shown to substantially reduce the risk of MSDs among workers.

In developing the proposed standard, OSHA will be guided by eight principles: (1) The proposed standard should focus on operations where the risk of MSDs is the greatest and solutions are known; (2) it should maximize worker protection and cost-effectiveness; (3) it should include those program elements that best practices have shown to be effective; (4) it should be written in plain language; (5) it should recognize the unique needs of small businesses; (6) it should be performance-oriented and flexible; (7) it should recognize employers who already have effective ergonomics programs; and (8) it should include a tiered approach that does not require employers whose establishments do not have problem jobs to implement a full program.

OSHA standards must also be supported by substantial evidence in the record as a whole. OSHA has collected and analyzed thousands of scientific studies and articles on MSDs, successful interventions to control them, and ergonomic programs. Other government agencies have also found such programs to be effective. In August of 1997, for example, the Government Accounting Office (GAO) issued a report of its investigation of ergonomics programs. The GAO report, ''Private Sector Ergonomics Programs Yield Results,'' is a detailed review of the ergonomics programs of five major corporations that shows that these companies have implemented programs that successfully address serious ergonomic problems (Ex. 26–5). A NIOSH publication entitled ''Elements of Ergonomics Program'' (1998) also identified the elements included in the program envisioned by the proposed standard as essential to program success (Ex. 26–2).

NIOSH (1997) also recently published a critical review of the large body of epidemiologic evidence on work-related MSDs and exposure to workplace risk factors. NIOSH identified more than 2,000 studies for this project and conducted a detailed review of over 600 of those studies (Ex. 26–1). NIOSH found that, for most combinations of MSDs and risk factors, the human evidence for causality was either sufficient or strong. NIOSH found the evidence convincing based on the strength of the associations, the lack of ambiguity in temporal relationships from projected studies, the consistency of the results of these studies, and these studies' use of adequate controls or adjustment for likely confounders. Similarly, a recent (1998) National Research Council (NRC) panel of 66 scientists considered the evidence for the work-relatedness of musculoskeletal

[5] The Regulatory Flexibility Act states that a Regulatory Flexibility Analysis need not contain all of the above elements *in toto* if these elements are presented elsewhere in the documentation and analysis of the rule. The Regulatory Flexibility Analysis should, however, summarize where these elements can be found elsewhere in the rulemaking record.

disorders. The most significant finding of the NRC report concerned the work-relatedness of MSDs: ''there is a higher incidence of reported pain, injury, loss of work, and disability among individuals who are employed in occupations where there is a high level of exposure to physical loading than for those employed in occupations with lower levels of exposure.'' (Ex. 26–37)

3. Description of the Number of Small Entities

Determining the number of small entities falling within the scope of various provisions of the proposed standard at any given time is complicated, because all small entities in general industry are potentially affected by the rule in the sense that if a covered MSD occurs, the establishment will have at least to determine if the MSD is covered by the standard. (For the purpose of this economic analysis, a covered MSD is one that meets the criteria for an OSHA recordable injury or illness and additionally meets the screening criteria in section 1910.902.) The first step in the description of affected small entities for this IRFA is therefore to determine the number of small entities in general industry. However, in a typical year, most small entities will not in fact be within the scope of the standard, because only those small entities that have employees engaged in manual handling or manufacturing operations, or whose employee(s) experience a covered MSD, will be covered by the standard. Further, only establishments whose employee(s) experience a covered MSD will need to have a full program. Thus, to be within the scope of the standard, a small entity must have employees: (1) Engaged in manufacturing operations; (2) engaged in manual handling operations, or (3) who have experienced a covered MSD.

This analysis has been carried out in terms of small establishments rather than small entities. This was necessary because of the complexity of the probability calculation involving small entities owning multiple establishments. As a result, this economic analysis tends to overestimate the number of affected small entities, because some small establishments are owned by large entities. OSHA estimates that there are 5.8 million small establishments in general industry potentially affected by the rule. Of these, an estimated 1.45 million small establishment would be required by the proposed standard to maintain a basic ergonomics program at all times because they have employees engaged in manual handling or manufacturing operations. Over the course of 10 years, 1.5 million small establishments would need to initiate a full program at least once because an employee in the establishment had a covered MSD.

The proposed standard potentially covers an estimated 5.1 million very small entities (*i.e.*, those employing fewer than 20 employees). Of these, OSHA estimates that 1.27 million very small entities would be required to maintain a basic ergonomics program at all times. Over the course of 10 years, 1.1 million very small establishments would need to initiate a full program at least once because an employee in the establishment had a covered MSD.

4. Description of Proposed Reporting, Recordkeeping and Other Compliance Requirements

Compliance Requirements

There is widespread agreement that successful ergonomics programs include the following elements in some form:

- Management leadership and employee participation
- Hazard information and reporting
- MSD management
- Job hazard analysis and control
- Training
- Program evaluation.

OSHA is proposing a tiered approach to program implementation in this standard. This would mean that general industry establishments with a somewhat lower probability of incurring a covered MSD (*i.e.*, general industry establishments that do not engage in manual handling or manufacturing operations) would not be required to take action until an MSD has occurred. Moreover, further action would only be triggered if the MSD is determined by the employer to be one that is recordable under the OSHA recordkeeping standard, and, in addition, is determined by the employer to be a covered MSD. Establishments with a higher probability of incurring a covered MSD, *i.e.*, those whose employees engage in manufacturing operations or manual handling, would be required to implement a basic ergonomics program that emphasizes employer leadership and employee participation and hazard information and reporting, even in the absence of a covered MSD.

If no covered MSD occurs for three years in a job that has been controlled under the program required by the standard, the establishment is permitted by the proposed standard to drop back to the lesser program for that job (if the establishment had employees who were engaged in manufacturing or manual handling operations) or to a program consisting essentially only of maintaining the controls in the problem job and any associated employee training (if the establishment did not have employees engaged in manufacturing operations or manual handling).

The basic program includes those elements listed above that are appropriate to workplaces where covered MSDs and problem jobs have not yet been identified. The proposed standard includes the following elements in the basic program:

- Management leadership, including allocation of resources, information and training for responsible managers or supervisors, and assignment of program responsibilities;
- Establishment of an employee reporting system and protection against discrimination for employees participating in the program or reporting hazards;
- Providing employees with the information they need to recognize the signs and symptoms of MSDs and MSD hazards;
- Review of safety and health records the employer already keeps;
- Employee participation in the basic program; and
- Determination of the recordability and then covered status of reported MSDs.

Once a covered MSD has been identified, a full ergonomics program is required. However, even the full program may not be necessary in some circumstances when an MSD is identified. For example, if the means of controlling a job are obvious and completely effective, such as eliminating the need for lifting by installing automated equipment, then a detailed job hazard analysis is unnecessary because the employer will be able to use the proposed standard's quick fix option.

Table VIII–7 shows the requirements of the rule, the circumstances that trigger these requirements, the hours or costs involved, and the level of expertise required. These are estimates made by OSHA and its ergonomics consultants, and they are based on experience in implementing such programs in a variety of workplaces. To further ensure that OSHA's estimates reflect real experience in actual workplaces, OSHA reviewed its estimates of the costs of controlling jobs with an Expert Ergonomics Panel made up of ergonomists with experience in controlling jobs in general industry settings. These estimates have been significantly modified from the estimates provided to the SBREFA Panel in February 1999. The most significant modifications to the economic analysis in response to the recommendations of the SBREFA panel are:

- OSHA has added ''familiarization'' costs for all general industry employers to read and understand the proposed rule to determine whether it:

(1) Applies to their establishment, and

(2) Would allow their program to be grandfathered in.

- OSHA has significantly increased its estimates of the costs of the analysis necessary to identify appropriate controls for problem jobs;
- OSHA has added costs for employers to assess whether a given MSD is in fact a covered MSD;
- OSHA has increased its estimates both of the amount of time consultants would be needed and the cost of consultant services.

The following table (Table VIII–7) shows the assumption OSHA used to develop the costs estimates used in this Preliminary Economic Analysis.

Table VIII–7.—Assumptions Used To Develop Costs for Provisions of the Proposed Rule

PROVISION	WHEN REQUIRED	HOURS OR COSTS INVOLVED	LEVEL OF STAFF OR EXPERTISE REQUIRED
Familiarization Costs to Review Standard to Determine Applicability to Establishment and Ability to Grandfather In (Cost to All General Industry Firms)	Initially for all establishments in general industry	1 Hour	Manager
Cost to Investigate whether an MSD or Persistent Symptoms are Covered by the Standard (Cost to All General Industry Firms)	All establishments with manufacturing or manual handling jobs; for other general industry establishments, only when an MSD occurs	0.25 hour of managerial time and 0.25 hour of employee time per recordable MSD	Manager who has received initial training
Cost to Implement Initial Program (designating responsible persons, providing resources, etc.) (Basic Program)	Establishments with basic programs: all with manual handling or manufacturing jobs; otherwise, only if MSD occurs	1 hour	Manager with initial training
Cost to Provide Managerial Training as Part of Management Leadership (Basic Program)	Establishments with basic programs: all with manual handling or manufacturing jobs; otherwise, only if MSD occurs	2 Hours	Manager
Cost to Set up Reporting System (Basic Program)	Establishments with basic programs: all with manual handling or manufacturing jobs; otherwise, only if MSD occurs	1 hour	Manager with initial training
Cost to Provide Employee Information (Basic Program)	Establishments with basic programs: all with manual handling or manufacturing jobs; otherwise, only if MSD occurs	0.5 hour per employee plus 0.5 hour managerial time	Manager with initial training
Cost to Provide Managerial Training in Establishments with Full Program	If persistent symptoms or an MSD occurs in manufacturing or manual handling establishments; otherwise, only where an MSD occurs	16 hours of managerial time	Manager with initial training

Table VIII–7.—Assumptions Used To Develop Costs for Provisions of the Proposed Rule—Continued

PROVISION	WHEN REQUIRED	HOURS OR COSTS INVOLVED	LEVEL OF STAFF OR EXPERTISE REQUIRED
Cost to Train Employees in Establishments with Full Programs	All establishments having problem jobs	1 hour of employee time per affected employee, 2 hours of managerial time per problem job to provide training; 25% of employers able to use quick fix option and do not need to conduct employee training	Manager with training required for the full program
Cost of Job Hazard Analysis (Full Program)	All establishments with problem jobs	1 hour of managerial time plus 1 hour employee time per problem job	Manager with full program training
Cost to Evaluate Job Controls (Full Program)	All establishments with problem jobs	2–16 hours of employee and 2–32 hours managerial time, depending on problem job; in 15% of cases, $2,000 for consulting ergonomist's time is assumed to be required	In 85% of cases, manager with full program training; in 15% of cases, consultant ergonomist
Cost to Administer MSD Management (Full Program)	All establishments with problem jobs	1 hour of managerial time per MSD	Manager with full program training, health care professional, or ergonomist
Cost to Do Record-keeping (Full Program)	All establishments with an MSD or persistent symptoms	0.25 hours of supervisory time per MSD	Supervisor
Cost to Conduct Program Evaluation (Full Program)	All establishments with full programs	4 hours of managerial time in the three years following occurrence of covered MSD. For 25% of problem jobs able to use quick fix option, no program evaluation is conducted	Manager with full program training
Cost To Implement Job Controls— Engineering, work practice, or administrative controls	Job control costs: all establishments with problem jobs	Costs per job intervention per affected employee vary by industry and occupational groups and are presented in detail in Chapter V of the Preliminary Economic Impact Analysis (affected employees include the employee incurring the covered MSD and all other employees in the establishment with the same job)	Covered under costs calculated for evaluating and implementing controls (above)
Cost to Provide Work Restriction Protection	All establishments with problem jobs	$946 per MSD	Covered in costs for administering MSD management, above

Benefits of the Proposed Standard

OSHA estimates that the proposed standard would, within 10 years, lower the current (1996) general industry rate of MSDs by 26 percent and produce direct cost savings of $9.1 billion per year; direct cost savings are defined as the value of lost production, medical costs, administrative costs of insurance, and indirect costs to employers. Direct cost savings do not include any quantitative benefits for the pain and suffering of workers and their families, and thus do not represent a full measure of the economic benefits of the proposed standard.

OSHA's benefits estimates are based on the following key assumptions, data, and estimates:

• Estimates of MSD rates are based on the BLS data on MSD rates for lost workday MSDs, multiplied by the ratio of lost workday injuries to all injuries and illnesses in an industry to arrive at the total number of MSDs for an industry (see Industrial Profile, Chapter II, for a table showing MSD rates by industry);

- When a job is fixed, the MSD rate in that job is assumed to be reduced by 50% (the basis for this estimate is discussed in the Benefits chapter of this Preliminary Economic Analysis and in the Preliminary Risk Assessment section of the Preamble); and
- Establishments already having ergonomics programs are assumed already to have achieved a 50% reduction in their rates of MSDs.

Key Assumptions of the Preliminary Economic Analysis

OSHA's analysis of the benefits, costs and economic impacts of the proposed standard uses a variety of data and estimates from a number of sources. These data and estimates have been outlined in detail in the Industrial Profile, Costs of Compliance, and Benefit chapters of the Preliminary Economic Analysis (Chapters II, V, and IV, respectively). There are, however, certain issues for which data are lacking, and OSHA has had to make reasonable assumptions to bridge the data gaps in these cases. This section outlines certain key assumptions that OSHA has made, and solicits information and data that could be used to refine these assumptions.

1. BLS maintains data distinguishing MSDs from other types of occupational injuries and illnesses only for MSDs involving days away from work. This means that MSDs that involve restricted work (assignment of the injured worker to ''light duty'' work) or that involve time off only on the day of the injury are not counted by the BLS. Lacking any other information, OSHA has assumed that the ratio of all MSDs to MSDs with days away from work is the same for each industry as the ratio in that industry of total injuries and illnesses to all injuries and illnesses involving days away from work. The average value of this ratio is three, but the value varies greatly by industry. OSHA solicits information concerning the actual experience of employers with respect to the number of MSDs involving days away from work and the number of OSHA recordable MSDs that do not involve lost time.

2. OSHA does not have information concerning how many MSDs meet the proposed standard's test for covered MSDs (*i.e.,* the number of MSDs that would ''pass'' the screening criteria in section 1910.902) and thus would require the implementation of a full program. In the absence of such information, OSHA has assumed that all jobs that have already been controlled will not subsequently give rise to a covered MSD, while all jobs that have not been controlled will have covered MSDs that require the implementation of a full program. This assumption is discussed in detail in the Benefits chapter (Chapter IV), but it affects both the benefits and costs estimates for this proposed standard. OSHA welcomes any information concerning the frequency with which covered MSDs and non-covered MSDs occur, both in previously controlled and in uncontrolled jobs.

3. Lacking more detailed information, OSHA has assumed that MSD rates within an industry are determined by whether or not establishments have ergonomics programs. Many SERs were concerned that the proposed standard would result in significantly increased reporting of MSDs. OSHA examined this possibility by conducting a sensitivity analysis of the direct cost savings (benefits) and costs that would occur if the number of MSDs reported increased by 50 percent. OSHA found that, if the new MSDs reported had the same severity as those currently being covered by workers' compensation, the new reporting would increase the costs of the proposed standard to employers only by 24 percent but would increase the direct cost savings (benefits) associated with the proposed standard by 66 percent. This disproportion between the costs and benefits would be the case unless the new MSDs being reported were only 20% as severe as those being reported today. Further, based on the NCCI's estimate that employee-perpetrated fraud accounts for less than 2 percent of all workers' compensation fraud, and on the fact that the work restriction protection provision of the standard is triggered only when the employer—not the employee—makes the determination that WRP is necessary, OSHA does not believe that the proposed standard will encourage an increase in employee perpetrated fraud or that such fraud will affect the standard's costs or benefits.

Recordkeeping Requirements

Firms with fewer than 10 employees do not have to keep any records under this proposed standard. Firms that do not meet this condition must keep the following records:

- Employee reports and responses to those reports;
- Results of job hazard analyses;
- Hazard control records;
- Quick fix control records
- Evaluations of the program; and
- MSD management records.

5. Federal and State Rules That May Duplicate, Overlap or Conflict With the Proposed Rule

There are no existing Federal regulations requiring ergonomics programs of employers in general industry. OSHA published voluntary guidelines for ergonomics program management in meatpacking plants in 1990 to assist employers in that industry voluntarily to establish and maintain ergonomics programs. Only one state, California, currently has an ergonomics program standard in effect. The California program requirement is triggered by two or more MSDs of any type occurring in the same job. If OSHA were to adopt a similar approach, fewer full programs would be required than is the case with the proposed rule; however, the California rule requires a program if there are two MSDs of *any* kind, even if they do not meet OSHA's criteria for a covered MSD. (For a more detailed discussion of alternative triggers, see the last section of this chapter.) Several other States—Washington, Rhode Island, Minnesota, North Carolina—are currently developing enforceable ergonomics standards.

Currently, employers are required to correct some ergonomic hazards (*i.e.,* those posing a risk of death or serious physical harm) under the General Duty Clause of the OSH Act. OSHA's draft safety and health program rule (once in effect) would provide a framework requiring employers to address those ergonomic hazards citable under the General Duty Clause. OSHA has reviewed the current drafts of both the safety and health program rule and the ergonomics program standard and found that the ergonomics program required by the ergonomics program rule is consistent with and could easily be made a part of a safety and health program set up to comply with the draft safety and health program rule (once in effect). Indeed, the ergonomics program standard could be viewed as augmenting the safety and health program rule in three ways: (1) By expanding the coverage of the safety and health program rule to cover ergonomic hazards not covered by the General Duty Clause, (2) by providing additional detail concerning how MSD hazards should be addressed, and (3) by requiring MSD management, including work restriction protection, for workers experiencing job-related musculoskeletal disorders.

Small entity representatives (SERs) who participated in the SBREFA process expressed concern that the proposed ergonomics standard might present conflicts with the National Labor Relations Act (NLRA) and with the Americans with Disabilities Act (ADA) and other equal opportunity legislation. These possible conflicts are discussed in detail in the Preamble to the proposed rule, along with a discussion of the perception among some SERs that the proposed standard may provide incentives to violate these statutes, *e.g.*, by encouraging selective hiring.

6. Alternatives to the Proposed Standard

Regulatory Flexibility Elements Already Incorporated Into the Proposed Rule

OSHA's proposed rule already incorporates a variety of regulatory flexibility features. First, the proposed rule has many performance-oriented aspects and is designed to provide all firms with flexibility in meeting the rule's core requirements. For example, the core requirement for employee participation states only that employees must have ways to report problems, get responses, and be involved in developing, implementing, and evaluating the ergonomics program. Employers have great flexibility in how to establish such systems and ensure such participation. Some employers may use formal mechanisms, such as employee surveys and joint employee-management committees. Others may find it more effective simply to designate a person who can receive employee reports and discuss problems with affected employees. The choice is up to the employer.

In addition to these general flexibility features, OSHA's proposed rule has been tailored to recognize the special problems potentially faced by employers with fewer than 10 employees in complying with the new rule. Although these employers cannot be exempted from the rule under the mandate of the OSH Act, the requirements for these employers have been reduced in some instances. For example, OSHA has tailored the proposed rule to very small employers by exempting them from all documentation requirements.

However, the most important regulatory flexibility features incorporated into the proposed standard are those related to tiering and the use of triggers. Tiering refers to the two levels of ergonomics program embedded in the standard: a ''basic'' program with few requirements for establishments without covered MSDs, and a ''full'' program with additional requirements for establishments with such MSDs. Triggers, on the other hand, are events occurring in the workplace that require certain employer actions under the standard. These mechanisms are designed to address the range in risk encountered by employees potentially within the scope of the standard.

Figures 1 and 2 show the distribution and cumulative distributions of the general industry population by level of risk of incurring a lost-workday MSD. The average risk of incurring such an MSD for all general industry employees covered by the BLS statistics is 7.1 per thousand employees per year (using 1996 data). As the table shows, less than 20 percent of the population is subject to levels of risk more than twice this average. Almost all employees experience a risk that is greater than 1 per 1,000 per year. Thus, employees in general industry are almost universally subject to a significant annual risk of incurring a lost workday MSD; however, portions of the employee population are subject to unusually high risks. OSHA has preliminarily rejected the alternative of exempting some employers in general industry from the scope of the standard because significant risk exists for all employees in general industry and the Act does not envision the exemption of employers whose employees face such risks.

Recognizing the need to provide protection for employees subject to significant risk but wishing to minimize the burden associated with a full ergonomics program, OSHA has tried in the proposed rule to provide flexibility through a system of tiering and triggers, as discussed above. The proposed standard uses two types of triggers: (1) Whether a general industry employer has employees engaged in manufacturing operations or manual handling, and (2) whether or not an employee in a general industry facility has had a job-related MSD.

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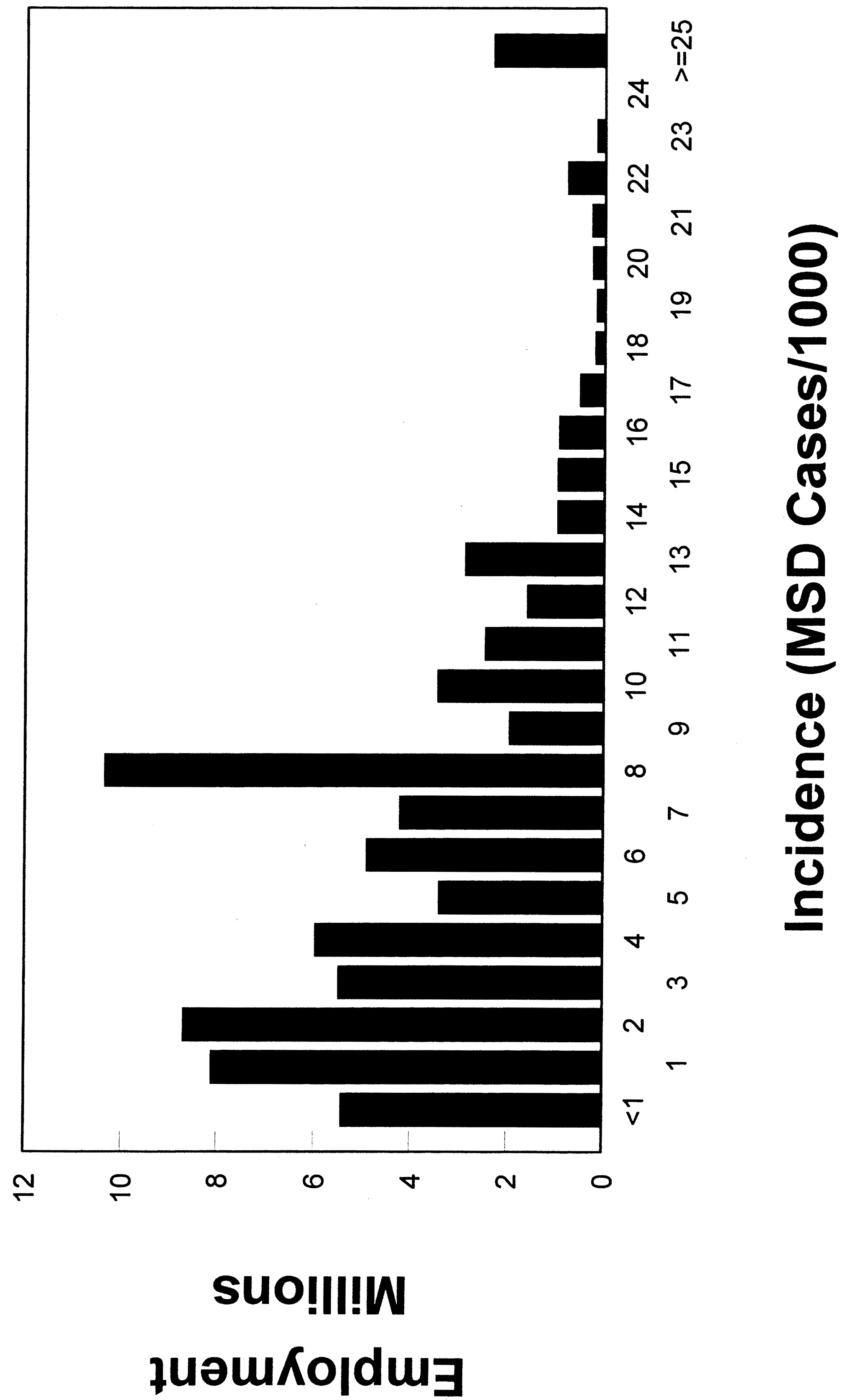
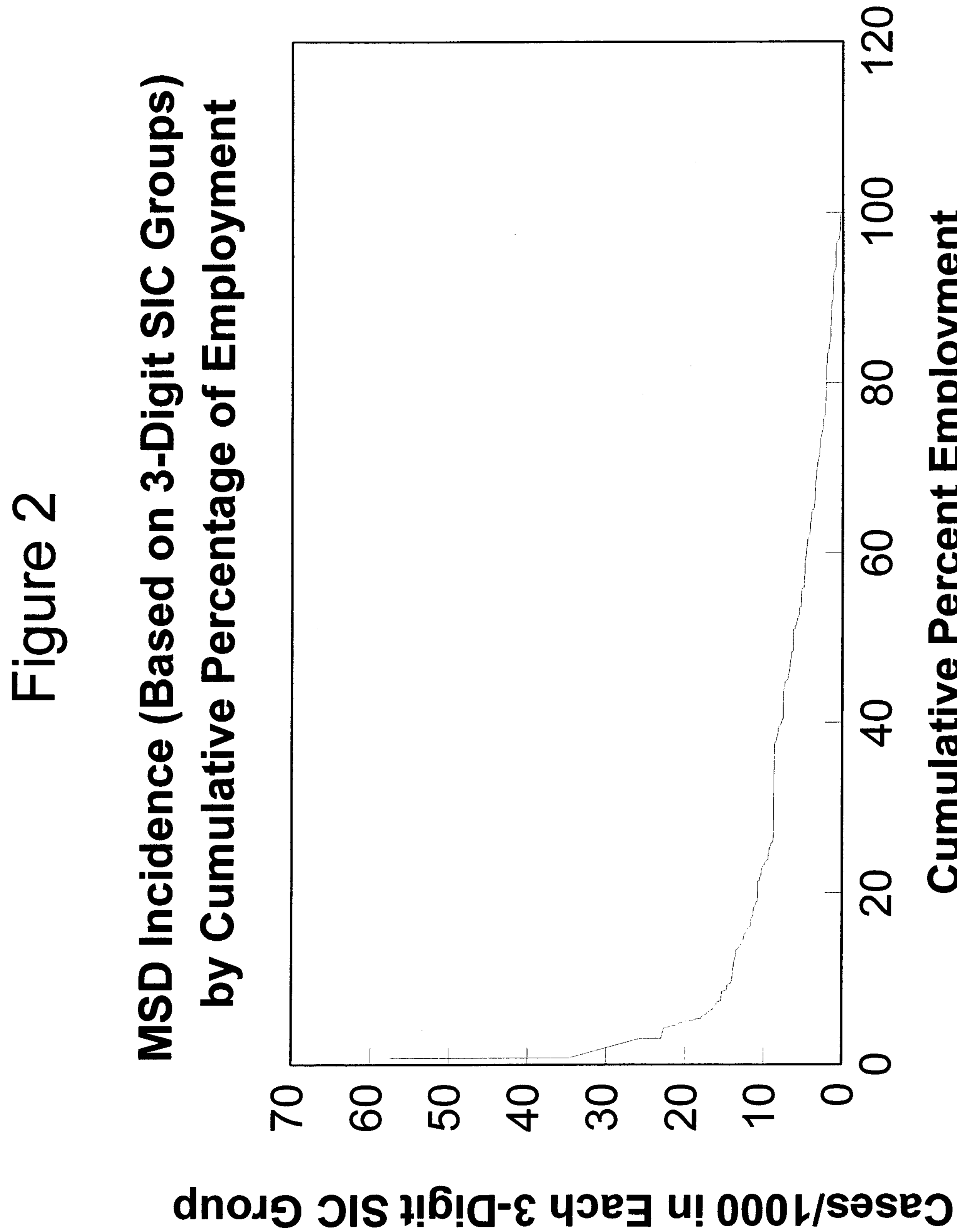
Figure 1

Employment by MSD Incidence From 1996 BLS Data (3-digit SIC)





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Employers with employees engaged in manufacturing operations or manual handling are treated differently from other general industry employers because employees engaged in these activities account for 60 percent of all lost workday MSDs while accounting for only 28% of all employees in general industry. Firms with employees engaged in these two activities are required to set up a basic ergonomics program with management leadership, employee participation, and hazard identification and information even if no MSD has occurred at the facility. Approximately 25 percent of all general industry employers will need to set up a basic program for their employees engaged in manufacturing operations or manual handling as a result of this requirement. (The basic program need not be applied to other employees in the facility.) Other employers do not need to set up a basic program unless an MSD occurs. However, firms with employees engaged in manufacturing operations or manual handling are not required to have the full program elements of job hazard analysis and hazard control; training; MSD management; and program evaluation unless a covered MSD occurs. In other words, general industry employers who do not have any employees engaged in manufacturing operations or manual handling do not need to have any ergonomics program until a covered MSD occurs. Thus most program elements are only required in firms clearly demonstrated to have an MSD hazard, as evidenced by the fact that a covered MSD has occurred.

Approximately 75% percent of all employers will not need to respond to this standard in any way unless an MSD occurs in their facility. Even when an MSD occurs, the full program applies only to the injured employee (at his or her job) and to employees with the same job (with respect to physical work activities) as that of the employee who incurred the MSD. There is no need for the employer to set up a program for other employees (*i.e.*, those who are not in the problem job or a job judged to be the same as that job) in the facility.

The triggers used for additional program elements in the proposed standard are the presence of employees engaged in manufacturing or manual handling, and the presence of a covered MSD. A covered MSD is defined as one that meets the following criteria:

- It is, or would be, recordable on an OSHA 200 log;
- It occurred in a job where workplace conditions and physical work activities are reasonably likely to cause or contribute to the type of MSD reported; and
- The workplace conditions and physical work activities are a core element and/or make up a significant amount of the employee's worktime.

This multi-level trigger serves to eliminate many MSDs that may occur as a result of unusual activities on the job or that are not the result of routine exposure to risk factors of a kind known to cause or contribute to MSDs.

OSHA will respond to the need expressed by many small business stakeholders for guidance and outreach by providing extensive outreach materials when the rule is published in final form. For example, OSHA may develop one or more checklists that can be used to aid in determining if an MSD is covered and to aid in job analysis. OSHA solicits comments on the best ways to focus its outreach efforts and the best means for providing compliance assistance to small entities.

Presented below are a number of alternatives that OSHA has considered in developing the proposed standard. OSHA solicits comment on all of the alternatives discussed below.

Alternative 1: No Rule: Continue To Rely Only on Existing OSHA Programs and Policies. Some small entity stakeholders urged OSHA to continue to rely on outreach efforts to encourage employers to adopt ergonomics programs voluntarily, *i.e.*, to continue to urge employers to voluntarily adopt the Agency's meatpacking guidelines, or a variant on these guidelines designed for all firms, rather than issuing a rule. OSHA has made the voluntary adoption of ergonomics programs a cornerstone of many of its injury prevention efforts for years. The Agency also has had regional ergonomics coordinators to provide technical assistance to OSHA area offices, consultation programs and state programs since 1987. OSHA issued the ergonomics program management guidelines for meatpacking plants in 1990 (Ex. 26–3). Since 1991, OSHA has also published a series of booklets designed to raise awareness and provide solutions to ergonomics problems. Since 1996, OSHA has had a formal four-pronged strategy for ergonomics, including outreach and education; research; and enforcement under the General Duty Clause, in addition to development of this proposed rule. As part of this strategy, starting in 1997, OSHA has held a series of national and regional ''Best Practices'' conferences on ergonomics. Such conferences have made a special effort to assure participation by small businesses. Starting in 1997, OSHA also has maintained an ergonomics page on its web site. This page provides access to OSHA publications on ergonomics, news about opportunities to participate in ergonomics conferences, and links to websites with ergonomics information.

Despite these efforts and the fact that many firms have found ergonomics programs cost-effective, only one-third of establishments surveyed by OSHA (OSHA survey, 1993) reported having done any risk analysis of ergonomic hazards in their workplaces. Even fewer have actually attempted to fix jobs that have ergonomic hazards. Firms that have begun to implement ergonomics programs cannot be distinguished by industry, SIC code, or other obvious factor from those that have not done so, *i.e.*, some firms have implemented such programs, while other firms that face similar musculoskeletal problems and belong to the same industry have not.

Although the Agency's efforts to encourage the voluntary adoption of ergonomics programs, backed by enforcement efforts involving the General Duty Clause (which have often led to corporate settlements), have resulted in thousands of employers and employees receiving the benefits of ergonomics programs, the majority of employers still have not adopted such programs. OSHA's experience also shows that outreach without enforcement is unlikely to be successful. The industries that have been most successful in adopting ergonomics programs and reducing MSDs—the automobile and meatpacking industries—both did so as a result of an OSHA strategy combining strong enforcement and outreach. At this stage, the additional incentive provided by a rule, in addition to targeted enforcement of the General Duty Clause and continued outreach, is needed if a majority of employers are to adopt ergonomics programs. OSHA will continue, and indeed plans to intensify, its outreach efforts in this area. Publication of a rule does not mean that OSHA is abandoning outreach, or choosing only to rely on this rule; instead, the Agency is adding a rule to all of its other efforts to encourage employers to adopt ergonomics programs. The ergonomics program rule thus supplements the Agency's other efforts and brings to bear the only major tool at the Agency's command that has not to date been employed in the effort to encourage employers to adopt these programs.

Some small entity stakeholders argued that because ergonomics programs are cost effective, there should be no need for regulation. Although OSHA agrees that ergonomics programs are cost effective for most small businesses, OSHA does not agree that cost effectiveness represents a sufficient motive for many small businesses to implement ergonomics programs. There are two major reasons for this.

First, many of the benefits of ergonomics programs do not accrue directly to smaller employers. Research has shown that workers' compensation costs do not, on the average, cover all income losses to injured workers, and do not attempt to account for their pain and suffering. Further, MSDs are significantly underreported to the workers' compensation system. One study found that the percent of medically diagnosed MSDs reported to the workers' compensation system ranged only from less than 1 percent to about 14 percent (Fine, Silverstein, Armstrong, Anderson and Sugano 1986 (Ex. 26–920)). An occupational safety and health professional participating in an ergonomics workshop sponsored by the Canadian Centre for Occupational Health and Safety (CCOHS) (1988) reported the same finding, stating that, ''Many workers are afraid to report RSIs [repetitive strain injuries] * * *. Many seek private benefits and try to avoid any contact with workers' compensation because of the [bad] experience of other workers trying to get claims accepted.'' Another workshop participant was of the same opinion: ''the vast majority of RSIs never reach the * * * workers' compensation system at all. The costs [of these injuries] are in the medical system * * *.'' Other studies (Cannon, Bernacki, and Walter 1981 (Ex. 26–1212); Silverstein, Stetson, Keyserling, and Fine (1994) provide plant-specific evidence of this tendency (Ex. 26–28). For an analysis of the underreporting and underfiling issue as it relates to occupational injuries and illnesses generally and to MSDs in particular, see Section VII of the preamble, Significance of Risk.

The social burden of adverse health effects is also shared by taxpayer-supported programs such as welfare, social security disability payments, and Medicare. Employers therefore have less incentive to avoid such losses than they would if they were directly liable for, or even aware of, all such claims. This combination of problems not reported to employers and the transfer of risk to others is another reason why the market fails to internalize the social costs of occupationally related injuries and illnesses such as musculoskeletal disorders. If workers do not recognize a risk as work-related or do not report the problem to employers, it will not be adequately addressed by employers.

In addition, smaller employers typically are not experience-rated, so that they do not directly pay a significant share of the costs of workers' compensation claims. This is particularly true of smaller firms with fewer hazards. Economic analysis principles suggest that regulations should consider costs and benefits to all parties, not just to employers. When a substantial portion of all benefits go to parties other than employers, employers cannot be counted on to implement ergonomics programs to the extent that such programs are cost beneficial.

Second, small businesses typically take the very understandable approach of not fixing what isn't perceived to be broken. Because ergonomic injuries and illnesses are relatively rare events in small firms, and are paid for in part by workers' compensation insurance, many small employers, especially in lower hazard industries, often neglect ergonomic problems. This does not mean that ergonomics programs are not cost effective. Aggregate statistics show that small firms have a significant number of MSDs, and studies show that these MSDs can be reduced by ergonomics programs. However, because MSDs are rare events for an individual small employer, the need for ergonomics programs may not come to the attention of busy small business employers as often as is the case for larger employers. As a result, ergonomics programs are less likely to be adopted by employers with few employees. (See discussion below.) This is unfortunate, because ergonomics programs are one of the best ways to lower workers' compensation costs for small businesses over the long run.

The threat of higher workers' compensation premiums and the presence of a substantial number of ergonomics injuries and illnesses do provide economic incentives for larger firms, because these firms are aware of and internalize a larger proportion of the true costs of the job-related injuries incurred by their workers. Thus larger firms can be expected to have done more about musculoskeletal hazards than smaller firms. Results from OSHA's ergonomics survey (OSHA survey, 1993) bear out this theoretical proposition: they show that only 28 percent of firms with fewer than 20 employees have analyzed their jobs for risk factors, while fully 80 percent of establishments with 250 or more employees, *i.e.*, the largest firms and those most likely to self-insure, have done so. The same pattern holds for following through on these job analyses: 76 percent of the largest establishments have implemented at least some engineering controls to reduce risk factors, while only 23 percent of firms with fewer than 20 employees have done so. These data suggest that, where adequate awareness and economic incentives are present, firms find it in their interest to address the risk factors responsible for musculoskeletal disorders.

Alternatives 2 and 3: Tiering Approaches

Alternative 2: Eliminate the Basic Program Requirement for Employers in Manufacturing or Manual Handling. The advantages of a basic program are that it assures that MSDs will be reported as soon as they occur and that a system is in place to address problems as they occur. Many stakeholders who have initiated a basic program have found that having a reporting system, conducting some basic hazard identification, and providing information on MSDs to employees increases the number of reported MSDs and thus the number of cases where early intervention is possible. OSHA has been unable to demonstrate that a ''reporting blip'' in fact follows increased awareness of MSDs. OSHA's survey of employers with ergonomics programs (1993) would suggest that this is not the case. Even in the absence of a full ergonomics program, the early and complete reporting of MSDs can actually serve to lower the costs of MSDs because early reporting means that simple corrective action may take care of the problem and avoid extensive lost work time. Many employers and insurers feel that awareness and MSD management alone can significantly reduce the costs of MSDs. The proposed standard's requirements for a basic program for employers with employees in manufacturing or manual handling operations result in costs of $36 million per year for all businesses. Eliminating the basic program in manufacturing and manual handling, as this alternative would require, would lead to fewer reported MSDs and to a greater likelihood that MSDs will not receive attention until they become very expensive in terms of lost time and the costs of medical care. On the other hand, dropping the basic program requirement would eliminate the need for any program in facilities that have no covered MSDs.

Alternative 3: Extend the Basic Program Requirement to All of General Industry. Because OSHA believes that having a basic program is of value to all employers whose employees are at risk of experiencing MSDs, OSHA considered extending the basic program to all employers in general industry. Because many general industry employers whose employees do not engage in manual handling or manufacturing operations generally have lower rates of injuries and illnesses, in addition to lower rates of MSDs, many of these general industry employers are not required even to maintain an injury and illness log under OSHA's recordkeeping requirements. However, employers who are not required to maintain an OSHA 200 Log or to have a basic program would be forced to rely primarily on workers' compensation claims for information about ergonomics hazards in their workplaces, and such claims have been shown to be an inadequate source of such information. Based on one study in the state of Wisconsin (NAS 1987), workers' compensation claims represented only 70% of all OSHA reportable injuries (Ex. 28–4). In the absence of a basic program with a formal reporting system, this means that 30 percent of MSDs might go unreported and uninvestigated. Extending the basic program to employers in all of general industry would result in additional initial costs of $318 million and in significant additions to the number of MSDs reported and corrected, as well as providing employees additional protection by encouraging reporting before MSDs become workers' compensation claims. The proposed standard does not extend the basic program requirement to general industry because the Agency is committed to targeting the standard to those facilities that have been shown to have the greatest MSD hazards.

Alternatives 4 through 8: Use Different Triggers

General Discussion. One of the key features of the proposed standard is that a full program is only triggered by a covered MSD, and then only for employees with the same job as the employee who incurred the MSD. OSHA found that the average job had three persons per job and that the average uncontrolled job has an MSD rate of 5 percent per year. Under the proposed trigger, it would be 5 years before 50% of all of the uncontrolled jobs covered by the scope of the standard are controlled, and 15 years before 90% of such jobs are controlled. Some stakeholders were concerned that this trigger was insufficiently proactive, and, as a result, OSHA examined alternatives that would result in more rapid efforts to control currently uncontrolled jobs. Alternative 4 reflects a more proactive trigger, *i.e.*, that the signs and symptoms of MSDs be used as a trigger, and Alternative 5 is similarly proactive, because it would require a job hazard analysis of all jobs, without regard to whether MSDs have occurred to employees in them.

Other stakeholders were concerned that reliance on a trigger of one covered MSD would impose major expenses on employers to investigate and even control jobs that do not need controls, either because the job has already been controlled or because the MSD is one that has little or nothing to do with the kinds of risk factors a full ergonomics program can address. The OSHA proposal recognizes this potential problem by allowing, in section 1910.902, employers to rule out OSHA-recordable MSDs that are not related to the physical work activities and conditions in the job or do not constitute a core element or significant portion of the job. In the typical controlled job, where the average MSD rate is 2.5 percent per year, 50% of firms will incur an MSD within 9 years, and thus will have to determine if the MSD is one that will trigger a full program. Nevertheless, OSHA investigated the consequences of the use of alterative triggers involving more than one covered MSD. Alternative 6 is such an alternative: it would require a full program only when an establishment has had two covered MSDs; Alternative 7 also reflects a more stringent trigger and would require a full program only when two MSDs have occurred in the same job within one year; Alternative 8 would require a full program only when two MSDs have occurred within two years in the same job; Alternative 9 would require a full program only when two MSDs have occurred within three years in the same job; and Alternative 10 would require a full program only when an MSD involving days away from work occurs. The analysis of alternatives 6 through 10 assumes that work restriction protection would continue to be triggered by a single MSD of any kind.

Alternative 4: Use Signs and Symptoms to Trigger the Program. OSHA's proposed standard uses the occurrence of a covered MSD to trigger the full ergonomics program. The use of this trigger is particularly advantageous to smaller firms, because the smaller the firm, the less likely it is to incur an MSD and thus to need a full program. The typical firm with 1 to 20 employees, for example, will need to initiate a full program only once every ten years. The majority of very small firms, those, for example, with only two or three employees, will go 10 years without ever having to initiate a full program. However, because use of this trigger also means that corrective measures will not be implemented for years even in some high risk jobs, OSHA considered other, more proactive triggers. If a more proactive trigger such as the signs or symptoms of MSDs were used to trigger the full program, the number of MSDs reported would increase by 2 to 7 times, and a substantially larger number of employers would be required to implement a formal reporting system.

Alternative 5: Use the Results of Job Hazard Analysis to Trigger the Program. OSHA also considered requiring employers to implement job hazard analyses for all jobs in their establishments and to implement a full program if the analysis identified any high risk jobs. OSHA has not proposed this approach because it would require substantial effort by all employers, even those whose employees do not have a high probability of incurring an MSD or have not yet incurred an MSD. In addition, such an approach would increase the first-year costs of the ergonomics program standard by a factor of at least 10.

Alternative 6: Use a Trigger of Two MSDs per Establishment. The SBREFA Panel recommended that OSHA consider as an alternative trigger the occurrence of two MSDs at an establishment in a one year period, rather than the proposed trigger of one MSD in a job. To analyze this alternative trigger, OSHA assumed that the two MSDs would be covered MSDs, as they are under the proposed standard. The chief advantage of the alternative two-MSD trigger is that it would eliminate the need for the employer to investigate the first MSD to occur in an establishment. This alternative trigger would therefore have little effect on larger firms. Indeed, the typical establishment with more than 100 employees and typical rates of MSDs for either controlled or uncontrolled jobs can expect to have two MSDs every year and would thus, under the two-MSD trigger, need a full program. Indeed, if two MSDs in an establishment trigger a full program for the entire establishment, larger establishments would permanently need to have a full program for all employees. For smaller establishments, however, this alternative would greatly extend the time necessary to ensure that uncontrolled jobs are controlled. For a five-employee establishment, the requirement of a two MSD per establishment trigger would mean that it would be 30 years before 50% of such establishments would have controlled any jobs. During this time period, over 3.5 potentially controllable MSDs would have occurred in each such establishment.

Alternative 7: Use a Trigger of Two Covered MSDs in the Same Job Within One Year. To limit the number of situations in which employers would have to establish a full program when a full program might not be needed, many stakeholders expressed interest in alternatives involving more than one MSD. The SBREFA Panel also recommended that OSHA examine such alternatives. This section examines the alternative of using a trigger of two covered MSDs in the same job within one year.

If this trigger were adopted, it would be 95 years before 50% of all typical uncontrolled jobs (where ''typical'' is defined as a job with a 5% MSD rate and three persons in the job) were controlled, and 325 years before 90% of such jobs were controlled. In this typical situation, use of this trigger would mean that more than 14 preventable MSDs would occur in an uncontrolled job before a full program to control that job would be required. For situations in which there is only one employee holding a job, a full program would almost never be triggered under this alternative. On the other hand, in the typical controlled job (MSD rate of 2.5%, 3 persons per job), 50% of firms would incur 2 MSDs in a year only once every 400 years, at which time they would have to determine if the two MSDs were covered. Thus use of this alternative trigger would ensure that employers would only rarely have to address MSD problems occurring in controlled jobs; however, this alternative achieves this by allowing many preventable MSDs to occur in uncontrolled jobs.

Under this alternative, economic costs would decline to $0.85 billion per year, while costs to employers would decline to $1.85 billion per year. Significantly fewer employers would need to control jobs or initiate full programs; however, the costs of WRP (the proposed rule's Work Restriction Protection provision) would be higher because the standard would prevent significantly fewer MSDs but many workers would continue to need time off to recuperate. This alternative would reduce the number of establishments subject to full programs, but would do nothing to mitigate the effect of a full program on those employers required to have a full program. Thus the economic impact on affected facilities would be virtually unchanged. Direct cost savings (benefits) would decline to $2.18 billion per year under this alternative.

This alternative also would not significantly decrease employers' costs for determining the covered status of MSDs or for recordkeeping because, for this alternative to work, employers would need to keep records of all MSDs, and the records would need to contain sufficient investigative information for employers to determine, when a second MSD occurred, what control approach to adopt to address the risk factors present in the jobs giving rise to both MSDs.

Alternative 8: Use a Trigger of Two MSDs within Two Years in the Same Job. Both the SBREFA Panel and OSHA stakeholders recommended that OSHA evaluate an alternative trigger of two covered MSDs in the same job occurring within a two year period. If this trigger were adopted, it would be 35 years before 50% of typical (where ''typical'' is defined as a 5% MSD rate and three persons in the job) uncontrolled jobs were controlled, and 100 years before 90% of such jobs were controlled. In this typical situation, use of this trigger would mean that more than four MSDs would occur in an uncontrolled job before the employer would be required to implement a full program. On the other hand, in the typical controlled job (MSD rate of 2.5%, 3 persons per job), 50% of firms would incur 2 MSDs within two years only once in 130 years (and thus would have to determine whether the second MSD triggers a full program only once in the same period). Thus this alternative would mean that employers would only rarely have to investigate problems in controlled jobs, but it would do so by allowing many preventable MSDs to occur in uncontrolled jobs.

Under this alternative, economic costs would decline to $1.40 billion per year, while costs to employers would decline to $2.33 billion per year. Very few employers would need to control jobs or initiate full programs; however, the costs of WRP would be higher because the standard would prevent very few MSDs but many workers would still need time off to recuperate. This alternative would reduce the number of establishments subject to full programs, but would do nothing to mitigate the effect of a full program on those employers required to have such a program. Direct cost savings (benefits) would decline to $4.24 billion per year under this alternative.

In OSHA's view, this alternative would also not significantly decrease an employer's costs for investigating MSDs or for recordkeeping. For this alternative to work, employers would need to keep records of all MSDs, and the records would need to contain sufficient investigative information for the employer to determine, if a second MSD occurred, what kinds of controls would be appropriate to address the risk factors associated with the two MSDs.

Alternative 9: Use a Trigger of Two MSDs within Three Years in the Same Job. OSHA also analyzed a trigger alternative of 2 MSDs in three years in the same job. If this trigger were adopted, it would be 10 years before 50% of typical uncontrolled jobs (where ''typical'' is defined as a 5% MSD rate and three persons in the job) were controlled, and 30 years before 90% of such jobs were controlled. Use of this trigger would thus mean that more than four MSDs would occur in an uncontrolled job before a full program to control that job would be required. On the other hand, in the typical controlled job (MSD rate of 2.5%, 3 persons per job), 50% of firms would incur 2 MSDs within two years only once in 80 years (and would then have to determine if the MSD is covered.) Thus this alternative would also ensure that employers would rarely have to investigate problems in controlled jobs, but the alternative achieves this by allowing many preventable MSDs to occur in uncontrolled jobs.

Under this alternative, economic costs would decline to $1.70 billion per year, while costs to employers would decline to $2.61 billion per year. Significantly fewer employers would need to control jobs or initiate full programs under this alternative; however, the costs of WRP would be higher because the standard would prevent significantly fewer MSDs but many workers would still need time off to recuperate. This alternative would thus reduce the number of establishments subject to full programs, but would do nothing to mitigate the effect of a full program on those employers required to have a full program. Direct cost savings (benefits) would decline to $5.05 billion per year under this alternative.

Alternative 10: Use a Trigger of One Lost Workday MSD. The SBREFA Panel urged OSHA to consider an alternative trigger of one lost workday MSD, *i.e.*, one MSD involving days away from work. This alternative would have the effect of reducing the probability of triggering a full program by approximately 66 percent. If this trigger were adopted, it would be 14 years before 50% of typical uncontrolled jobs (where ''typical'' is defined as a 5% MSD rate and three persons in the job) were controlled, and 50 years before 90%

of such jobs were controlled. On the other hand, in the typical controlled job (MSD rate of 2.5%, 3 persons per job), 50% of firms would incur 2 MSDs within two years only once in 30 years (and thus have to determine if the MSD would trigger a full program). Thus this alternative would also ensure that employers would rarely have to investigate problems in controlled jobs, but the alternative would achieve this by allowing many preventable MSDs to occur in uncontrolled jobs.

Under this alternative, economic costs would decline to $1.64 billion per year, while costs to employers would decline to $2.49 billion per year. This alternative would reduce the number of establishments subject to full programs, but would do nothing to mitigate the effect of a full program on those employers required to have a full program. Direct cost savings (benefits) would decline to $5.24 billion per year under this alternative.

Alternative 11: Use a Trigger of One Lost Workday MSD or 2 MSDs. This alternative would provide two triggers. An employer would have to fix a job and/or implement a full program if *either* of two conditions occurred: (1) There was a lost workday MSD; or (2) There were two MSDs in that job. This alternative would remove an incentive that employers might have with the single lost workday MSD trigger, *i.e.*, to urge employee to be on restricted duty rather than away from the workplace to avoid the lost workday that would trigger the standard's job hazard analysis and control requirements. This approach would somewhat increase both the costs and direct cost savings as compared to alternative 10.

OSHA's Preliminary Conclusions With Respect to Alternative Triggers

OSHA has examined a number of alternative triggers, including triggers that are more and less proactive than the trigger included in the proposed standard. OSHA believes that the choice of trigger it has made in the proposal—reliance on the occurrence of a single covered MSD in a job to trigger the full program for that job and all jobs in the establishments that are the same with respect to physical work activities—represents a reasonable compromise between the need to protect workers from MSDs, on the one hand, and the need, on the other, to target the standard to situations where the risk is greatest. OSHA believes that use of a trigger involving more than one MSD or a single lost workday MSD would inevitably mean that many workers will be injured, *i.e.*, that many preventable MSDs will occur before action is taken. OSHA also believes that the provisions of the proposed standard that are designed to ensure that only covered (and thus job-related) MSDs trigger the full program are sufficient to ensure that full programs will not be required except where they are needed. OSHA solicits comment both on triggers and the use of more than one MSD as a trigger.

Alternatives 12,13, 14, and 15: Alternatives Related to Work Restriction Protection

General Discussion. Many stakeholders objected to the work restriction protection (WRP) provisions (called medical removal protection, or MRP in the draft standard reviewed by the SBREFA Panel) of the proposed standard. The SBREFA Panel recommended that OSHA re-examine the need for WRP and explore possible alternatives to WRP. In order to do this, it is first necessary to understand that OSHA believes WRP is necessary because, absent WRP, the proposed standard provides employers and employees with significant incentives to avoid recognizing and reporting workplace MSDs. First, employees may be reluctant to report MSDs if reporting them could cause the employee to suffer financial loss. In the hearing on OSHA's arsenic standard, for example, OSHA heard testimony to the effect that fully 42% of employees had chosen not to participate in a medical surveillance program that would potentially cause them to lose money or risk their jobs, and the rulemaking records in several other OSHA health standards (*e.g.*, lead, cadmium) also support the need for MRP on the ground that it is needed if employees are to participate fully in medical programs. Two aspects of the proposed standard are especially relevant in this connection: first, the prompt reporting of MSDs is important because MSDs reported early are less likely to lead to long-term disability. One study (see Section VIII. D.) found that the severity of MSDs could be reduced by 75 percent or more through early reporting alone. Second, the proposed standard is designed specifically so that, if no covered MSD is reported, the employer need not implement the full program. Thus, employers covered by the standard have significant new incentives to discourage the reporting of MSDs and, absent WRP, employees have a significant incentive not to report them. Three examples, which are discussed separately below, highlight the range of employee disincentives to reporting and employer policies that could be invoked in the absence of WRP: (1) MSDs involving lost worktime and not covered by workers' compensation; (2) MSDs involving lost worktime that are covered by workers' compensation; (3) and assignment to light duty (''restricted work'') involving no lost worktime.

MSD Not Covered by Workers' Compensation. There are two common reasons why a particular work-related MSDs may not be covered by workers' compensation: first, the length of the worker's absence from work may be shorter than the workers' compensation waiting period for that state. States have waiting periods of from one to seven days before the indemnity portion of workers' compensation comes into effect. This means that an employee who reports an MSD could be out of work for one to seven days without receiving pay for this period. The likelihood of receiving no pay during this interval is particularly important for employees in the 50% of small firms that provide their employees with no sick leave (BLS 1995). Thus employees in this situation clearly have an incentive to avoid reporting an MSD, particularly when, under the proposed standard, the employer or health care professional could recommend that the employee stay home for a few days to recuperate. In addition, in the absence of WRP, employers could greatly increase the disincentive for employees to report MSDs by instituting a policy requiring any employee who reports an MSD to take from one to 5 days off from work. Such a policy would, in many cases, cost the employer nothing, and might even seem like a good way of avoiding the worsening of the MSD. However, such a policy would also ensure that employees would be extremely reluctant to report MSDs. There are also situations where many types of work-related MSDs, *e.g.*, rotator cuff tendinitis in Virginia, are not covered by workers' compensation no matter how long the absence from work. In this case, the employee could lose his or her job and all pay and benefits for an unlimited duration as a result of the MSD. Since an employee can never be certain that an MSD will be covered by workers' compensation (some employers routinely question all workers' compensation claims related to MSDs), this possibility is likely to be in the employee's mind whenever he or she reports an MSD.

MSD Covered by Workers' Compensation. When an MSD is covered by workers' compensation, the potential disincentives to underreporting are smaller. For example, many States retrospectively pay indemnity for the waiting period once the claim is accepted and the waiting period is exceeded. However, workers' compensation does not address either tangible or intangible benefits other than salary. As a result, a worker out on workers' compensation could lose both tangible benefits (such as health insurance for himself/herself and his/her family) and intangible benefits, such as seniority and even the right to return to the job when able. These potential losses represent a serious threat to the income and job security of an employee and are therefore likely to lead to a reluctance to report.

Worker with MSD Placed on Restricted Work. When a worker is placed on restricted work within the employer's establishment, workers' compensation temporary disability payments do not come into play. In this situation, the chief disincentive to reporting is the possibility that the employer will cut pay because the available restricted work job involves lower pay, or that the employer will cut tangible or intangible benefits, such as seniority rights.

Nevertheless, to respond to the recommendation of the SBREFA Panel, OSHA examined a number of alternatives to the proposed work restriction protection provisions, which are discussed in detail below. For comparison, it should be noted that OSHA's proposed WRP provision has annualized costs of $875 million per year. Twenty-four percent of these costs are associated with lost worktime that does not exceed the waiting limit for workers' compensation; 18 percent is associated with supplementing workers' compensation payments with additional pay and benefits; and 58 percent is associated with covered MSDs that would not be covered as workers' compensation claims at all. Alternatives 12 through 14 assume that a worker would receive 90 percent of take-home pay and full benefits when away from work.

Alternative 12: Do Not Require Work Restriction Protection. Work restriction protection accounts for approximately 22% of the costs of the rule to employers, or about $875 million per year. All of these costs to employers could be saved by eliminating the WRP provision from the proposed rule. This approach would, however, provide employees with disincentives to report in any situation where either the employee's medical situation or the employer's policies would require the injured employee to spend time away from work. This approach would essentially enable the least conscientious employers to avoid the intent of the standard almost completely by adopting policies designed to discourage reporting; even employees of employers who do not intend to be punitive toward employees reporting MSDs would be somewhat discouraged from reporting because they would fear the economic loss potentially associated with reporting.

Relatively few of the SERs favored removing the WRP provision completely; many, if not most, of the objections to WRP focused on those situations where an employee would be paid for being absent from work, rather than on workers on restricted work or the loss of intangible benefits after the employee returns to work. In response, OSHA has revised the WRP provision in the proposal to differentiate somewhat between those injured workers who are out of work entirely and those who are on restricted work.

Alternative 13: Require Worker Restriction Protection for Only Three or Seven Days. Limiting WRP to 3 days with full pay and benefits would address the problem that the workers' compensation system in many States does not cover short term absences. This approach would reduce the costs of WRP by 76 percent, to $210 million per year. However, this approach would still leave workers in some States subject to losses even for cases otherwise eligible for workers' compensation because some States have waiting periods that are longer than three days. More importantly, this alternative would provide injured employees with no pay beyond three days if the MSD turned out not to be covered by workers' compensation. Since whether an MSD is covered by workers' compensation cannot be known in advance, adoption of this alternative would, OSHA believes, have a chilling effect on MSD reporting.

Increasing the coverage to seven days would assure that workers eligible for workers' compensation would be covered in all states. This approach would have costs of $320 million per year.

Alternative 14: Do Not Start WRP Until the Worker Has Been Absent Three Days. This alternative would be designed to avoid requiring the employer to cover the expenses of an injured employee who would not be eligible for workers' compensation (because of the waiting period) by providing that the first three days of absence with an MSD would not be covered by WRP. This alternative would reduce the costs of WRP by 24 percent, to $667 million per year. However, this alternative would do nothing to deter employers from setting up policies requiring, for example, that any employee reporting an MSD take three days off without pay; such policies would, needless to say, have a chilling effect on reporting. This alternative would also mean that minor MSDs, *i.e.*, those requiring a day or two away from work, could result in loss of pay for the worker. As a result, this alternative would have the perverse effect of encouraging employees to wait until an MSD is serious enough to warrant more than three days away from work before reporting the MSD.

Alternative 15: Limit WRP to 3 Months. This alternative would be designed to limit the employer's costs of WRP by limiting the length of time that WRP is in effect. It would lower the costs to employers of WRP by 24 percent, to $668 million per year. OSHA is concerned that this alternative will have a chilling effect on the reporting of MSDs that could be serious enough to lead to longer term disabilities.

Alternative 16: Provide WRP at the Level of 100% of Take Home Pay. This alternative would ensure that the worker suffers no economic loss as a result of reporting an MSD. This alternative would increase the costs to employers of WRP by 36%, to $1.2 billion per year. This 36% increase in costs to employers represents a transfer in costs to employers from employees, who now bear these economic losses themselves.

Alternatives 17, 18, 19, and 20: Different Scope Provisions

OSHA has considered, and asked stakeholders to consider, four alternative scopes for the proposed standard:

(1) Apply it to manufacturing operations only;

(2) Apply it to manufacturing operations and manual handling;

(3) Take the approach reflected by the proposed standard, *i.e.*, provide coverage of all general industry jobs in which a covered MSD occurs; and

(4) Exempt low hazard firms.

The first two approaches listed above—applying the standard only to manufacturing operations, or only to these operations and manual handling—would have the effect of exempting most industries with somewhat lower, but still significantly high, rates of MSDs from coverage by the proposed standard. OSHA welcomes suggestions about other approaches to the scope of the standard that would reduce the burden on industries with somewhat lower rates of

MSDs while still protecting employees from the significant risk of incurring an MSD. Each of these alternative scope provisions is discussed below.

Alternative 17: Cover Manufacturing Operations Only. A proposed standard covering manufacturing operations only would apply to 377,000 establishments and capture 30 percent of all lost workday MSDs. Such an approach would address one of the most concentrated areas of MSD risk. Manufacturing operations involve less than 10% of all establishments in general industry and fewer than 15% of all employees, but they account for almost one-third of all reported MSDs. This approach was strongly opposed by many stakeholders, who pointed out that many very high risk jobs and industries would not be covered by the proposed standard if this alternative were adopted.

Alternative 18: Cover Manufacturing and Manual Handling Operations Only. A standard covering manufacturing operations and manual handling only would cover 1.59 million establishments and capture 60 percent of all MSDs. This approach would expand coverage beyond manufacturing, particularly to the high risk transportation and health care sectors, while still maintaining a sharp focus on a limited number of establishments and employees within general industry. However, this approach would leave a large number of employees at significant risk of incurring debilitating injuries. For example, this approach would not cover carpal tunnel syndrome and tendinitis in airline ticket agents, telephone sales personnel or video display terminal personnel. Many stakeholders objected to this approach, and some stakeholders pointed out that it would not be appropriate to require a program when certain employees in an establishment incurred an MSD while other employees in the same facility would not receive the benefits of a program no matter how many MSDs they incurred.

Alternative 19: Exempt Small Businesses in General Industry. This option is not one that the OSH Act permits OSHA to consider; the Act requires the Agency to protect employees exposed to significant risk to the extent feasible. OSHA's data indicate that there is a significant risk of job-related MSDs even in very small general industry firms. As a result, although OSHA can and is seeking ways to mitigate the standard's impact on small firms, exempting small firms from the standard would leave their employees at significant risk when there are feasible ways of mitigating that risk. OSHA may, however, consider delaying the compliance date or otherwise modifying certain provisions for very small firms. OSHA requests comment on this alternative and on other ways of reducing the costs and impacts of the standard that would protect employees at these firms from the significant risk they face of incurring work-related MSDs.

Alternative 20: Exempt Low Hazard Firms. OSHA believes that the approach taken in the proposed standard of requiring a full program only when MSDs occur or persistent symptoms and supporting information are present will have the effect in practice of exempting most low hazard small firms from the coverage of the standard. However, it is possible under the proposed standard for a large firm with very low rates of MSDs still to be required to have a program. OSHA believes that coverage of such firms is appropriate, because even low hazard firms may have a few high hazard jobs that merit attention. OSHA welcomes comments on approaches that would exempt some operations from the standard's coverage based on a well-supported demonstration that employees in those firms are not at significant risk of incurring a MSD.

Alternative 21: Phased Implementation. The SBREFA Panel recommended that OSHA consider the possibility of phasing in implementation of the proposed standard. OSHA has adopted a phased implementation approach in the proposed rule that allows periods of from one to three years after the effective date of the rule for the implementation of various program elements. For example, establishments are permitted three years to implement permanent engineering controls. In addition, reliance on the one MSD trigger ensures that problem jobs are addressed gradually over time; a more proactive approach would be likely to require all problem jobs to be addressed immediately. These features of the proposed rule combine to ensure that small establishments will only be required to address problem jobs gradually. OSHA therefore believes that the proposed rule is fully responsive to this Panel recommendation.

Alternative 22: Adopt a Safety and Health Program Rule to Cover Ergonomics. OSHA is currently considering proposing a safety and health program rule that would require all establishments in general industry to set up safety and health programs to address hazards covered by existing OSHA standards and the General Duty Clause of the Act. Because there is currently no OSHA ergonomics standard or any other standard addressing work-related MSDs, the safety and health program rule would only address those MSDs that are presently covered by the General Duty Clause. In addition, because the safety and health program rule covers safety and health hazards of all kinds, the provisions it contains are necessarily general. Given that MSDs constitute one-third of all lost workday injuries and illnesses, OSHA feels that employers need more specific direction on how to address MSDs than would be provided through the general safety and health program rule.

In addition, OSHA's experience with the Maine 200 program, which encouraged firms with high numbers of injuries and illnesses to establish safety and health programs, has shown that the establishment of such programs does not necessarily ensure that MSDs will be adequately addressed. Although some firms incorporated ergonomics into their safety and health programs, many firms in the Maine 200 program established programs designed to address traditional safety concerns, but failed to address ergonomics problems at all. OSHA believes that an ergonomics program standard is essential if all general industry firms are to begin to address their ergonomics problems.

6. Responses to the SBREFA Panel Report

Because OSHA anticipated that this proposed standard would cause significant impacts on a substantial number of small entities, the Agency convened a SBREFA Panel as required by that Act. Table VIII–8 lists the recommendations of the SBREFA Panel and indicates how OSHA has responded to these recommendations.

Table VIII–8.—Summary of SBREFA Panel Recommendations and OSHA Responses

SBREFA PANEL RECOMMENDS THAT:	OSHA's RESPONSE
OSHA review its cost estimates in light of these comments, with specific attention to those comments that offered alternative cost and hour estimates or explanations of why the commenters believed the costs to be underestimated and to those areas of the program highlighted by the SERs and the Panel as major cost issues (training, consulting costs, medical removal protection, job hazard analysis, job control). This review, with a presentation of the estimates provided by the SERs, should be included as part of a revised IRFA.	OSHA has commented on the SERs' cost estimates in detail in the Cost Chapter (Chapter V) of this economic analysis. OSHA has since reviewed its costs and has obtained expert review of the Agency's estimated costs. In several cases, the costs now shown in the analysis, such as those for job control and consultants, have been revised upward.
A similar presentation [to that for costs] of the assumptions underlying benefits estimates be included.	OSHA has added a discussion to the IRFA providing a schematic outline of the assumptions underlying the benefits analysis.
OSHA discuss the sources and bases of these assumptions, significant alternative assumptions, and the reasons OSHA selected the proposed assumptions.	OSHA has added this discussion to the IRFA.
OSHA reexamine its estimates of the average number of persons in similar jobs (see below for specific recommendation to modify the term ''similar job''), and how this estimate may impact overall costs.	OSHA has revised both the proposed standard and its approach to measuring the number of jobs affected when an MSD occurs. OSHA has also changed the term to ''same jobs'' for clarity.
OSHA examine its cost estimates to be sure that it has adequately accounted for the burden on firms who do not have an MSD and are not required to have a basic program. This examination should include an examination of the costs of determining whether an MSD is work-related.	OSHA has added costs to its estimated costs of compliance to reflect that even establishments that do not fall within the scope of the standard will incur costs to familiarize themselves with the standard and determine that they are not covered.
OSHA consider whether the Agency's analysis may have underestimated the need for help from outside consultants and that OSHA examine the necessity for, and cost and availability of, the services of ergonomic consultants.	OSHA has reviewed its estimates of the need for consultants and special expertise, and has revised upward both its estimate of the time required for employers to select necessary job controls, the percentage of time consultants will be needed, and the costs associated with consultant services.
OSHA consider the extent to which small firms can pass along any price increases to consumers or might experience feasibility problems if such costs could not be passed along.	This issue is addressed in the economic impact section of the Preliminary Economic Analysis (Chapter VII).
OSHA assess the SERs' statements [concerning selective hiring] as part of its analysis, consider how to mitigate any potential that may exist for expanding such selective hiring incentives or creating new ones, and solicit comment on these issues.	This issue is addressed in the Preamble to the proposed standard (in Section XI) and has been raised as an issue for comment.

Table VIII–8.—Summary of SBREFA Panel Recommendations and OSHA Responses—Continued

SBREFA PANEL RECOMMENDS THAT:	OSHA's RESPONSE
OSHA assess these data [on increases in the number of injuries and illnesses as a result of programs] as part of its analysis. In addition, OSHA provide additional data to support its arguments about the costs and cost-savings implications of these programs and specifically address any potential effects of medical removal protection in encouraging workers to remain off work.	OSHA has reviewed the responses employers made to the Agency's ergonomics survey, and found that even in the first year of a program, firms typically have fewer rather than more MSDs. As discussed in the benefits section of the economic analysis (Chapter IV), OSHA estimates that the work restriction protection provision (formerly the medical removal protection provision) will help to counter the disincentives to employees to report MSDs early.
OSHA conduct the analysis at a level of detail that does not mask the relevant economic differences among industries through aggregation.	OSHA has revised its analysis to conduct the analysis at the three rather than the two digit SIC Code level of detail.
OSHA review whether small businesses would need consultants for other elements of the program, whether they may be necessary in a greater percentage of cases, and to what degree these factors would alter cost estimates.	As discussed in the cost analysis, OSHA has reviewed whether consultants would be needed for other elements of the program and found that consultants will not be needed, given the materials available on how to set up a program.
OSHA evaluate the usefulness of checklists for these purposes. In the event OSHA develops checklists for its own enforcement personnel, it should make these checklists available to the public.	This issue is discussed in the Preamble and is raised as an issue for comment.
OSHA should either consider alternative approaches to this issue [the trigger criteria for a full program] or clarify these criteria.	Both the Preamble to the proposed standard and the IRFA provide discussions of alternative trigger provisions.
OSHA clarify that employers may, if they wish, rely on a physician's opinion in making a work-relatedness determination, and that OSHA would bear the burden of proof if it disagreed with such an opinion.	This issue is discussed in the Preamble.
OSHA clarify and consider alternatives to this trigger [known hazards] (these are discussed in the Alternatives Section at the end of this report), and that OSHA assure that any provision it adopts would not create disincentives to the proactive identification of ergonomic hazards.	OSHA has deleted the "known hazards" provision and is instead relying on a persistent-symptoms-plus-supporting information trigger in manufacturing and manual handling jobs.
OSHA seek ways to clarify, explain, and provide examples of these terms [key terms used in the reg text].	The Preamble to the proposed standard provides additional definitions and examples of the key terms used in the regulatory text.
OSHA clarify the idea of similar jobs and use a more precise term, such as "similar work activities," in light of SER comments that all or a portion of employees sometimes engage in all or a portion of the work activities in the establishment. In addition, OSHA provide in the regulatory document examples of which similar work activities would or would not be covered by the standard.	The concept of "similar" jobs has been deleted from the proposed rule and been replaced with "same" jobs, which are defined in terms of the same work activities.
OSHA clarify that the draft proposed rule only requires the employer to control hazards to the extent feasible for that firm, using the normal OSH Act definition of feasibility (*i.e.*, "Is it capable of being done"), discuss in the preamble the factors that go into that determination, and seek ways to include such explanatory information in the preamble, outreach, and compliance assistance materials.	The technological feasibility chapter of the economic analysis discusses this issue, as does the Job Hazard Analysis and Control section of the preamble.

Table VIII–8.—Summary of SBREFA Panel Recommendations and OSHA Responses—Continued

SBREFA PANEL RECOMMENDS THAT:	OSHA's RESPONSE
Definitions of personal protective equipment and engineering controls be added to the proposed standard, with ergonomic examples that help to explain how they differ.	Definitions of these terms, with examples, have been added to the regulatory text.
OSHA discuss the issue of adequate control and provide examples. In addition, OSHA clarify the meaning of the proposed rule so that employers will have a better idea of when they have done enough to comply with the standard. Examples should be added to the preamble to further clarify this point.	Examples of adequate control have been provided in the technological feasibility section of the economic analysis and are discussed in the Preamble as well. In addition, the regulatory text now includes a step-by-step incremental abatement process.
The proposed standard be modified to clarify the requirement for program evaluations. Such modifications should reflect the flexibility of employers to use non-quantitative measures, quantitative measures, or a combination of these to evaluate their ergonomics programs.	This issue has been clarified in the regulatory text and the Preamble.
If MRP is included in the proposed rule, OSHA explain in the preamble how the proposed provision interacts with state workers' compensation laws and why OSHA believes the rule's MRP provision is not in conflict with Section 4(b)(4) of the OSH Act, and solicit comment on this issue.	OSHA has an extensive discussion of Work Restriction Protection in the Preamble, including a discussion of the relationship between WRP and workers' compensation.
OSHA draft the proposed rule to achieve these objectives [of EEO laws, the ADA and ADEA].	These issues are discussed in the Preamble to the proposed standard.
OSHA address how the ergonomics program accommodates the requirements of the ADA. Also, OSHA seek to minimize any unintended consequences of the rule that might undermine the protections afforded under the ADA, as well as the ADEA.	This issue is addressed in the Preamble to the proposed standard.
OSHA draft the proposed rule to achieve these objectives [of the NLRA] and discuss and give examples of employee participation mechanisms that would allow employers to be in full compliance with both the NLRA and the proposed rule.	OSHA has added this material to the Preamble.
OSHA ensure that the two rules [the ergonomics proposal and the safety and health program proposal] are developed in a way that allows an employer's ergonomics program to be an integral part of that employer's general safety and health program and to avoid duplicative requirements or recordkeeping (for example, by making clear that an ergonomics program can be part of an effective safety and health program). In addition, the economic analyses supporting the two rules be compatible and not double count either costs or benefits. In addition, that OSHA ensure consistency between relevant definitions in their upcoming revision of the recordkeeping rule and the proposed ergonomics standard.	OSHA is developing the two rules so they will be compatible. Because this rule precedes the safety and health program rule, the benefits and costs for this rule have not considered possible overlaps with the safety and health program rule. OSHA has ensured consistency between the definitions of "MSD" and "recordable" in this proposed ergonomics rule and the recordkeeping rule.
OSHA further explain its non-regulatory guidance efforts to date, the basis for its belief that a significant risk remains, and why it believes a proposed rule is now appropriate to reduce that risk. The Panel recommends that OSHA solicit comments on the need for a rule and on the effectiveness of non-regulatory approaches.	Discussions of these topics are included in the Preamble and in the IRFA.
OSHA discuss whether a safety and health program rule would adequately address MSDs, thereby eliminating the need for a separate ergonomics rule.	A discussion of this topic has been included in the IRFA.
OSHA explain why it does not wish to delay this proposed regulatory action until that time [when the second NAS study is completed], and consider any available results of the NAS study that are in the record of the final rule.	This topic is discussed in the Preamble to the proposed standard.
OSHA consider phased implementation, allowing additional time for small employers and/or employers in particular industries where feasibility may be a concern.	A discussion of phased implementation has been included in the Preamble to the proposed rule and in the discussion of alternatives in the IRFA.

Table VIII–8.—Summary of SBREFA Panel Recommendations and OSHA Responses—Continued

SBREFA PANEL RECOMMENDS THAT:	OSHA's RESPONSE
In addition to OSHA's proposed trigger of one work-related MSD, where regular work activities expose the employee to hazards likely to cause or contribute to that MSD, OSHA analyze and consider a variety of alternative triggers, paying special attention to:	A discussion of trigger alternatives has been added to the IRFA.
• A trigger using multiple work-related MSDs over a time frame that might exceed one year; and • Staged implementation of program elements based on multiple work-related MSDs. In addition, the Panel recommends that OSHA look at other types of triggers, including lost workday MSDs, MSD rates, numbers of MSDs or MSD rates for different sizes of firms and different periods of time, as well as the use of a checklist to determine the presence of a hazard. OSHA consider this issue [the known hazard provision] and ensure that any provision it adopts would avoid disincentives to identify hazards. In addition, OSHA consider not including this provision in the proposed rule.	OSHA had deleted the provision about known hazards.
The proposed rule clearly indicate which manual handling and other operations are included in the proposed rule and which are excluded from it.	The regulatory text and definitions section clearly delineate which operations are included and which are excluded, and the Preamble also clarifies this issue.
OSHA continue to analyze and solicit comments on the alternatives of limiting the proposed standard to manufacturing only, and to manufacturing and manual handling only.	The preamble and the IRFA continue to solicit comment on these issues, and the IRFA considers these alternatives.
OSHA pay particular attention to the following issues related to MRP (now called WRP): • Determine whether the evidence indicates that MRP or other provisions are necessary to achieve the goal of prompt and complete reporting of MSDs. The Panel realizes that, as with any other decision, OSHA's final determination of whether MRP is necessary must be based on substantial evidence in the standard's record considered as a whole. In addition, recommend that OSHA solicit comment on the alternative of excluding MRP from the rule; • If MRP or another provision is necessary, examine whether the purposes of MRP could be met with a more limited form of MRP, such as a shorter time limit for MRP coverage, a smaller percentage of income replacement, or recognition of a feasibility limitation on MRP at the firm level, such as that used in OSHA's Methylene Chloride standard; • Assess whether alternatives other than MRP would be as effective in achieving the goals of prompt and complete reporting, such as alternatives that may not involve payments to employees; and • Examine whether MRP should be phased in over a period of time. Some SERs also expressed concern that, as currently drafted, OSHA's regulatory language could be interpreted as providing injured employees on MRP with more take-home pay than they would have had before the injury. The Panel recommends that, if a form of MRP is included in the proposed rule, OSHA make it clear that MRP will not result in higher take-home income for removed employees than they would otherwise have received.	OSHA has modified the provision to require a lower percentage of take-home pay for workers absent from work. These issues are discussed in detail both in the Preamble and in the IRFA.

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IX. Unfunded Mandates

OSHA reviewed the proposed ergonomics program standard in accordance with the Unfunded Mandates Reform Act of 1995 (UMRA) (2 U.S.C. 1501 *et seq.*) and Executive Order 12875. As discussed above in the Summary of the Preliminary Economic Analysis (Section VIII of the preamble), OSHA estimates that compliance with the proposed ergonomics program standard will require the expenditure of approximately $4.2 billion dollars each year by employers in the private sector. Therefore, the proposed ergonomics program standard establishes a federal private sector mandate and is a significant regulatory action, within the meaning of Section 202 of UMRA (2 U.S.C. 1532). OSHA has included this statement to address the anticipated effects of the proposed ergonomics program standard pursuant to Section 202.

OSHA standards do not apply to state and local governments, except in states that have voluntarily elected to adopt an OSHA State Plan. Consequently, the proposed ergonomics program standard does not meet the definition of a ''Federal intergovernmental mandate'' (Section 421(5) of UMRA (2 U.S.C. 658(5)). In addition, the Agency has preliminarily concluded, based on review of the rulemaking record to date, that few, if any, of the affected employers are state, local and tribal governments. In sum, the proposed ergonomics program standard does not impose unfunded mandates on state, local and tribal governments.

The anticipated benefits and costs of this proposed standard are addressed in the Summary of the Preliminary Economic Analysis (Section VIII of this preamble), above, and in the Preliminary Economic Analysis (Ex. 28–1). In addition, pursuant to Section 205 of the UMRA (2 U.S.C. 1535), having considered a reasonable number of alternatives as outlined in this Preamble and in the economic analysis (Ex. 28–1), the Agency has preliminarily concluded that the proposed standard is the most cost-effective alternative for implementation of OSHA's statutory objective of reducing significant risk to the extent feasible. This is discussed at length in the economic analysis (Ex. 28–1) and in the Summary and Explanation (Section IV of this preamble) for the various provisions of the proposed ergonomics program standard.

X. Environmental Impact

OSHA has reviewed its proposed ergonomics standard in accordance with the National Environmental Policy Act (NEPA) (42 USC 4321 *et seq.*), the regulations of the Council on Environmental Quality (40 CFR Part 1500), and DOL's procedures (29 Part 11).

The proposed ergonomics standard will require businesses to correct those jobs that contribute to musculoskeletal disorders (MSDs) by modifying the conditions in which the work is performed. In investigating the regulatory impacts of the proposal, OSHA has identified a large number of possible forms of job modifications. The types of job modifications include work station modification, redesign of tools, job rotation, full or partial automation of tasks, and other changes.

Ergonomics is the science of fitting jobs to people. Job modifications typically result in greater productive efficiencies without the ongoing need for additional resources or increased discharge of pollutants. Frequently, process redesign results in improved quality control, resulting in fewer wasted materials. More broadly, reducing MSDs will reduce the need for medical care resources. For these reasons, OSHA has determined that these job modifications will not generate a significant impact on the external environment.

The proposed ergonomics standard would also require employers to develop ergonomic programs that train workers to recognize and avoid unhealthy work positions, provide for the management of MSDs, and perform analyses of the ergonomic characteristics of jobs. None of these programmatic activities would generate a significant environmental impact.

As a result of this review, OSHA has preliminarily concluded that no significant environmental impacts would result from this proposed rulemaking.

XI. Additional Statutory Issues

This chapter addresses additional issues OSHA has considered in developing this proposed rule. OSHA sets forth preliminary conclusions on each issue. The agency invites public comment on these issues.

A. Occupational hazard—Does OSHA have the authority to regulate MSD hazards, as occupational hazards that cause or contribute to occupational injuries?

OSHA's authority to set standards is limited to ameliorating ''conditions that exist in the workplace.''

Industrial Union Dep't, AFL–CIO v. *American Petroleum Inst. et al. (Benzene),* 448 U.S. 607, 642 (1980). Before OSHA can promulgate a standard, the Agency must make a ''threshold finding that a place of employment is unsafe.'' *Id.* (emphasis added). *See also Atlas Roofing Co.* v. *OSHRC,* 430 U.S. 442, 445 (1977) (''The [OSH] Act created a new statutory duty to avoid maintaining unsafe or unhealthy working conditions.'' (emphasis added)).

Some stakeholders have suggested that because MSDs can result from outside activities as well as from work conditions, OSHA lacks authority to protect workers from occupational exposures that can contribute to MSDs. This suggestion is contrary to precedent and common sense and is antithetical to the purpose of the Act to provide safe and healthy working conditions for every man and woman in the nation.

Many, if not most, of the adverse health conditions OSHA seeks to prevent can be caused by non-work as well as work activities. For example, many health standards, such as the asbestos standard, are designed to protect employees from lung and other cancers.

The courts have made clear that OSHA has authority to regulate workplace conditions that create a significant risk of an impairment, even if such impairments can also be caused by non-work activities. This authority was upheld by the en banc Court of Appeals for the Fourth Circuit in *Forging Industry Assn.* v. *Secretary of Labor,* 773 F.2d 1436,1442 (4th Cir. 1985) (Noise).

That case dealt with a challenge to the Hearing Conservation Amendment to OSHA's Occupational Noise standard. That amendment establishes certain requirements that must be met to reduce the incidence of and/or prevent hearing impairment due to occupational noise exposure. Before issuing the amendment, OSHA found that 10–15% of workers exposed to noise levels below the previous permissible exposure limit (PEL) would suffer material hearing impairment. *Id.* at 1443. OSHA based this finding on a ''panoply of scientific reports and studies,'' including studies done by the National Institute for Occupational Safety and Health (NIOSH) and the Environmental Protection Agency (EPA). *Id.* OSHA also found that those employees who had suffered a hearing decrement of 10 decibels in either ear faced a greater risk from continued exposure to high levels of workplace noise than workers whose hearing was unimpaired. *Id.* OSHA's Hearing Conservation Amendment provided hearing-endangered workers with protection in the workplace in order to decrease the risk of hearing impairment. *Id.*

The Forging Industry Association (FIA) argued that ''because hearing loss may be sustained as a result of activities which take place outside the workplace—such as listening to loud music, age, or engaging in certain recreational activities—OSHA acted beyond its statutory authority by regulating non-occupational conditions or causes.'' Noise, 773 F.2d at 1442. The court found ''no merit'' in FIA's argument. *Id.* The court ruled that OSHA properly relied on ''the extensive and thorough research of several scientific institutions in defining the problems related to industrially-caused hearing loss and designing its proposal.'' *Id.* at 1443. The court also stressed that OSHA excluded non-occupational hearing loss from the proposed rule. *Id.* at 1444 (''To be sure, some hearing loss occurs as a part of the aging process and can vary according to non-occupational noise to which employees are exposed. The amendment, however, is concerned with occupational noise—a hazard of the workplace.''). The court ruled that the fact that non-occupational hazards may contribute to hearing loss does not mean that OSHA should reform from regulating workplace conditions that are shown to cause such loss:

> The amendment provides that non-occupationally caused hearing loss be excluded from its regulation. See 29 CFR §§ 1910.95(g)(8)(ii), 1910.95(g)(10)(ii) (1984). Assuming, however, that some loss caused by aging of smaller amounts of noise sustained for shorter periods also aggravates the hearing loss incurred by an individual employed in a high noise-producing industry, that is scant reason to characterize the primary risk factor as non-occupational. Breathing automobile exhaust and general air pollution, for example, is damaging to lungs, whether healthy or not. The presence of unhealthy lungs in the workplace, however, hardly justifies failure to regulate noxious workplace fumes. Nor would there be logic to characterizing regulation of the fumes as non-occupational because the condition inflicted is aggravated by outside irritants. Noise, 773 F.2d at 1444.

As with the Hearing Conservation Amendment to the Noise standard, the proposed ergonomics rule is limited to regulating work-related MSDs and occupational MSD hazards. The proposed standard requires employers to set up an ergonomics program to eliminate or control workplace MSD hazards. In addition, the proposed rule contains language that ensures that the OSHA recordable MSDs that trigger action under the proposed rule are work-related (*e.g.*, the MSD occurred in a job where the employee is exposed to MSD hazards and the workplace conditions and physical work activities are reasonably likely to cause or contribute to the type of MSD reported).

The Occupational Safety and Health Review Commission has reached the same conclusion in an ergonomics case brought under the Act's general duty clause. In *Secretary of Labor* v. *Pepperidge Farm, Inc.*, 17 O.S.H. Cas. (BNA) 1993 (April 26, 1997) (*Pepperidge Farm*), the Commission held that where work was shown to be a substantial contributing factor to MSDs, the fact that non-work factors may also play a role did not preclude OSHA from requiring the employer to abate the workplace hazards. In that case, Pepperidge Farm contested a number of citations for recordkeeping and repetitive motion violations that OSHA had issued under section 5(a)(1) of the OSH Act. In order to prove a section 5(a)(1) violation, OSHA had the burden of showing that ''a *condition* or activity in the employer's *workplace* presents a hazard to employees.'' *Id.* at 2009 (emphasis added). Pepperidge Farm argued that section 5(a)(1) should not apply to MSD workplace hazards because, among other things, ''non-workplace factors may cause or contribute to the illnesses at issue and that individuals differ in their susceptibility to potential causal factors.'' *Id.* at 2013. The Commission held that such factors should not ''*ipso facto*'' preclude the possibility of enforcement under section 5(a)(1). *Id.* at 2013. The Commission also analyzed a significant amount of evidence that showed a causal relationship between MSDs and workplace hazards, including testimony from medical personnel who examined injured workers, epidemiological data, and injury incidence at a Pepperidge Farm plant. *Id.* at 2020–26. The Commission ultimately found that there was a causal connection:

> We therefore conclude that the Secretary has established on this record a causal connection between [MSDs] affecting the employees at Downingtown [a Pepperidge Farm plant] and their work on the biscuit lines. In doing so, we are mindful that many of these injuries may have had more than one causal factor and of the experts who contend that the specific cause of such injuries is, essentially, unknowable or presently unknown. As is the case with many occupational ills with multiple possible causes, employees are more or less susceptible to injury on the job because of the individual attributes and backgrounds they bring to the workplace. As with

these other ills, the Secretary is not thus foreclosed from attempting to eliminate or significantly reduce the hazard by regulating what is shown to be a substantial contributing factor to the worker injuries. *Id.* at 2029.

The fact that certain physical characteristics of employees may make them more susceptible to developing MSDs also does not divest OSHA of authority to issue the proposed rule. In setting standards under section 6(b)(5) of the OSH Act, OSHA must set the standard ''which most adequately assures * * * that *no employee* will suffer material impairment of health or functional capacity even if such employee has regular exposure to the hazard dealt with by such standard for the period of his working life.'' 29 U.S.C. 655(b)(5) (emphasis added). OSHA may not decline to regulate a hazard because certain people are more susceptible or less susceptible than others to disease or injury if exposed to that hazard.

This principle was upheld by the Court of Appeals for the D.C. Circuit in a challenge to OSHA's Asbestos standard. In the Asbestos rulemaking, OSHA based its significant risk determination, in part, on epidemiologic studies that included workers who smoked. Asbestos, 838 F.2d at 1264–65. The Asbestos Information Association (AIA) claimed that because smoking and asbestos worked synergistically (*i.e.*, the cancer risks of smoking workers exposed to asbestos were greater than the sum of the risks of smoking and asbestos), OSHA overestimated the risks posed by asbestos. *Id.* at 1265. AIA did not claim that OSHA failed to control for smoking. Rather, AIA claimed that OSHA improperly considered smokers' incremental risks from asbestos. *Id.* In rejecting AIA's claim, the court stated:

[Section] 6(b)(5) calls on OSHA to set standards such that ''no employee'' will experience the forbidden level of risk. We understand the employers' aggravation that they are being forced to bear part of the burden imposed by employees' decision to smoke, but we do not think that at this stage of American history smokers can be regarded as so far beyond the pale as to require OSHA to disregard them in computing the risks of asbestos. *Id.*

See also *Reich* v. *Arcadian Corp.*110 F3rd 1192 (5th Cir. 1987) (Act's general duty clause protects especially susceptible employees). OSHA is properly regulating workplace MSD hazards and work-related MSDs.

B. Health standards—Is this proposed rule a section 6(b)(5) standard?

To determine whether the proposed rule is a section 6(b)(5) ''health'' standard first requires determining whether MSD hazards are the type of ''health hazards'' section 6(b)(5) is intended to cover.

1. Section 6(b)(5) ''health'' standards

''The [OSH] Act delegates broad authority to the Secretary to promulgate different kinds of standards.'' *Industrial Union Dept., AFL–CIO* v. *American Petroleum Institute,* 448 U.S. 607, 611 (1980) (Benzene). Where toxic substances or harmful physical agents are concerned, not only must a standard meet the requirements of section 3(8), it must also comply with section 6(b)(5) of the OSH Act. Section 6(b)(5) provides that in promulgating standards dealing with ''toxic materials or harmful physical agents,'' OSHA shall:

- Set the standard which most adequately assures,
- To the extent feasible,
- On the basis of the best available evidence,
- That no employee will suffer material impairment of health or functional capacity,
- Even if such employee has regular exposure to the hazard dealt with by such standard for the period of his working life. 29 U.S.C. 655(b)(5).

While all standards must be highly protective, the ''feasibility mandate'' of section 6(b)(5) also requires OSHA to select ''the most protective standard consistent with feasibility'' that is needed to reduce significant risk of harm due to exposure to a health hazard. *American Textile Mfrs. Institute* v. *Donovan (Cotton Dust),* 452 U.S. 490, 509 (1981). To help ensure that health standards provide such protection, Congress authorized OSHA to include the following among a health standard's requirements:

- Appropriate information or forms of warning about exposure to hazards, relevant symptoms, proper conditions and precautions, and appropriate emergency treatment;
- Monitoring or measuring of employee exposure;
- Medical examinations or tests;
- Suitable protective equipment and control or technological procedures;
- Other information gathering and transmittal provisions. 29 U.S.C. 655(b)(7).

2. Harmful physical agents

Section 6(b)(5) applies only to ''toxic substances or harmful physical agents.'' 29 U.S.C. 655(b)(5). While the OSH Act does not define these terms, the courts have looked to the Act's legislative history and have concluded that Congress intended section 6(b)(5) to address ''latent'' risks of harm; that is, hazard exposures that take their toll over time or whose deleterious effect is not readily apparent. *International Union, UAW* v. *OSHA (LOTO I),* 938 F2d. 1310, 1314–15 (D.C. Cir. 1991); S. Rep. 91–1282, 91st Cong., 2d Sess. 2–39 (1970); H.R. Rep. 91–1291, 91st Cong., 2d Sess. 15 (1970), reprinted in Senate Committee on Labor and Public Welfare, Legislative History of the Occupational Safety and Health Act of 1970 (Legislative History).

In Senate debates, Senator Williams, sponsor of the OSH Act, and Senator Dominick referred to toxic materials and harmful physical agents as ''hidden hazards'' because of the latency period that exists between exposure to these hazards and the occurrence of harm:

A particularly urgent concern repeatedly brought out during our hearings is the frequent exposure of many workers to a great variety of toxic materials or harmful physical agents. [Workers] are often unaware of the nature of such exposure or of its extent. In some cases, the consequences of overexposure may be severe and immediate; in other cases, effects may be delayed or latent. Senator Williams, Legislative History at 415 (emphasis added).[8]

[A]nyone working in toxic agents and physical agents which might be harmful may be subjected to such conditions for the rest of his working life, *so that we can get at something which might not be toxic now, if he works in it a short time, but if he works in it the rest of his life might be very dangerous* * * *.'' Senator Dominick, Legislative History at 503 (emphasis added).

The courts have looked to the legislative history for determining whether a particular rule is a ''health'' or ''safety'' standard. In the Benzene decision, the Supreme Court also said:

[8] Congress codified in the OSH Act this distinction between ''health'' and ''safety'' standards. See 29 U.S.C. 651(6) (''[E]xplor[e] way to discover latent diseases * * * relating to health problems, in recognition of the fact that occupational health standards present problems often different from those involved in occupational safety''); 29 U.S.C. 655(c)(1) (OSHA's authority to issue emergency temporary standard limited to new hazards or to ''health'' hazards whose hazardous character is newly-discovered).

The reason that Congress drafted a special section for [toxic substances and harmful physical agents] was not * * * because it thought that there was a need for special protection in these areas. Rather, it was because Congress recognized that there were special problems in regulating health risks as opposed to safety risks. *In the latter case, the risks are generally immediate and obvious, while in the former, the risks may not be evident until a worker has been exposed for long periods of time to particular substances.* It was to assure that the secretary took account of these long-term risks that Congress enacted § 6(b)(5). Benzene, 448 U.S. at 649 n. 54 (emphasis added).

In the challenge to the Lockout/Tagout standard, 29 CFR 1910.147, the court applied this test in upholding OSHA's determination that unexpected energization of equipment was not a harmful physical agent because it was not the type of ''gradually accumulating hazard'' and ''latent-hazard[]'' contemplated by section 6(b)(5). *International Union, UAW* v. *OSHA (LOTO I),* 938 F.2d 1310, 1314–15 (D.C. Cir. 1991). The court accepted OSHA's position of viewing health standards as coextensive with standards governing latent hazards, ''which are frequently undetectable to the casual observer because they are subtle or develop slowly or after latency periods;'' contrasting them from ''safety'' standards, which address hazards that cause immediately visible physical harm. LOTO I, 938 F.2d at 1313. See also *National Grain and Feed Assn.* v. *OSHA (Grain-Handling),* 866 F.2d 717 (5th Cir. 1989) (holding that ''the immediate and obvious danger posed by grain dust in grain-handling facilities [*i.e.,* explosion] does not constitute a ''harmful physical agent'' within the contemplation of section 6(b)(5)'').

The legislative history, case law, past OSHA practice and evidence in the record all indicate that MSD hazards are the type of latent and insidious hazards which Congress intended section 6(b)(5) to address. The legislative history indicates that Congress, in discussing the hazards covered by section 6(b)(5), repeatedly referred to vibration (one of the MSD hazards this proposed standard covers) as an example of a harmful physical agent. Legislative History at 142–43 (discussing 1967 Surgeon General study finding that 65% of employees in industrial plants were ''potentially exposed to harmful physical agents, such as severe noise or vibration, or to toxic materials''), 412, 415, 446, 516, 845 (Committee Print 1971).

Past OSHA practice also shows that OSHA has consistently regarded MSD hazards as latent hazards. In the OSHA rule on Access to Employee Exposure and Medical Records, for example, MSD hazards are included in the definition of harmful physical agents, which are among the hazards section 6(b)(5) covers:

Toxic substances or harmful physical agent means * * * physical stress (noise, heat, *cold, vibration, repetitive motion,* ionizing and non-ionizing radiation, hypo- or hyperbaric pressure, etc.) which * * * [h]as yielded positive evidence of an acute or chronic health hazard in human, animal, or other biological testing conducted by, or known to, the employer * * * 29 CFR 1910.1020 (emphasis added).

OSHA's Ergonomics Program Management Guidelines for Meatpacking Plants also treat MSD hazards as latent hazards. This document, which provides guidance on preventing and reducing MSDs and which OSHA has drawn upon heavily in developing the proposed standard, includes elements that typically (if not exclusively) are found in OSHA standards dealing with latent hazards, such as:

- Medical surveillance and evaluation,
- Employee exposure monitoring and measuring,
- Information gathering (system for reporting signs and/or symptoms of MSDs), and
- Analysis of trends in injury/illness rates (records review).

See 29 U.S.C. 657(c)(3) (OSHA may issue regulations requiring employers to monitor or measure and record employee exposure to toxic materials and harmful physical agents).

Evidence in the record, which is discussed in greater detail in the Health Effects section above, also shows that MSD hazards are latent hazards. Exposure to these hazards at low levels, infrequently or for short periods of time are not generally associated with the occurrence of MSDs. Rather, it is the cumulative effects of exposure over time to workplace risk factors that result in injury. It ordinarily takes a period of weeks, months or years, depending on the level of the employee's exposure to the hazards, for employees to feel the cumulative effects. Therefore, at the early stages of the latency period employees can easily overlook or ignore MSD hazards because they are not yet experiencing the effects of the exposure to the various risk factors. Employees usually only recognize the effects of exposure as they begin to experience mild symptoms, and they may not recognize the cumulative effect until after symptoms become severe. At this later stage the effects may be permanent damage or disability.

In addition, MSD hazards are also considered latent hazards because they are not obvious or readily observable. This is in part because MSD hazards are multifactoral (Bernard, 1997). They result from exposure to a combination of workplace risk factors and conditions. Moreover, the level of risk also depends on intensity, frequency and duration of exposure to these workplace factors. For example, stakeholders have repeatedly told OSHA that employees often are unaware of either their exposure to or the potential harmful effect of these physical stresses until signs and/or symptoms of MSDs appear.

C. Is the proposed rule cost-effective?

All OSHA standards must be cost-effective. Cotton Dust, 452 U.S. 514 n.32. A standard is cost effective if the protective measures it requires are the least costly of the available alternatives that achieve the same level of protection. *Id.;* see also *LOTO II,* 37 F.2d at 668.

OSHA has worked to ensure that the proposed rule is cost-effective. Below are key provisions OSHA has included in the proposed to contribute to cost-effectiveness. OSHA requests comment on whether these provisions are consistent with the cost-effectiveness criterion—maintaining the same level of protection at reduced cost—and whether there are additional provisions OSHA could include in the rule that would contribute to its cost-effectiveness. First, OSHA is proposing a ''performance-based'' program rule. OSHA is not proposing to require employers to comply with a specific set of work requirements, work limits or equipment requirements. The proposed rule allows employers to select the most cost-effective controls they reasonably anticipate would control the MSD hazard.

Second, OSHA is proposing to allow employers to select from a broad range of types of control to correct problems. OSHA is proposing to allow employers to use any combination of engineering, work practice and administrative measures to control MSD hazards. This would allow employers to implement inexpensive administrative controls (*e.g.,* rest breaks) where they are effective rather than redesigning workplaces or investing in new equipment. The only exception to the flexibility in the controls permitted is that the proposed rule does not permit employers to use personal protective equipment (PPE) alone to protect employees from MSD hazards if feasible engineering, work practice, or administrative controls are available. PPE may be used to supplement other controls, however.

Third, OSHA is proposing to delay up-front costs to employers by the inclusion of the incident trigger. Employers who have no manufacturing or manual handling jobs do not have to take any action under the proposed rule until an MSD is reported. The initial responsibilities of employers with manufacturing and manual handling jobs have been limited to the minimum necessary to assure that employees in these high risks jobs are able to recognize and report MSDs. Employers with these jobs must establish a hazard reporting system and provide information about MSDs to employees. It is only when a covered MSD is reported that employers who have manufacturing and manual handling jobs must implement other elements of the ergonomics program standard such as job hazard analysis.

Fourth, OSHA is proposing a Quick Fix mechanism to allow employers to fix problem jobs without incurring the additional costs of setting up the entire ergonomics program. The Quick Fix provides a process for fixing a problem job quickly and completely. Employers may use a Quick Fix the first time a job is identified as a problem job, provided that the employer (1) puts in Quick Fix controls within 90 days after the job is identified as a problem job; (2) checks the Quick Fix controls within 30 days of implementation to ensure that they have eliminated the hazards, and keeps records of the Quick Fix process; and (3) provides the hazard information the proposed rule requires to employees in the job within 90 days after the job is identified as a problem job. It is only if the Quick Fix controls do not eliminate MSD hazards within the Quick Fix deadline or an MSD is reported in the job within 36 months, that an employer must set up a full ergonomics program. The rule contains an exception that allows employers to use a Quick Fix the second time a covered MSD occurs in a job if the second MSD is related to work activities or job conditions other than those that gave rise to the first MSD.

Fifth, OSHA is proposing to permit employers to discontinue certain aspects of their programs if no MSDs are reported for 3 years. If no MSDs are reported for 3 years, employers who have manufacturing and manual handling jobs must only maintain the following three elements of their ergonomics program: (1) Management leadership and employee participation; (2) hazard information and reporting; and (3) maintenance of implemented controls and training related to those controls. For other jobs where MSDs had been previously reported, if no MSDs are reported for three years, an employer need only maintain existing controls and training for those jobs.

Sixth, OSHA is proposing to allow employers to use an incremental abatement process to control hazards. Rather than requiring all controls to be implemented at once, employers would be free to first try a control, presumably a less costly control, that is reasonably anticipated to eliminate or substantially reduce the hazard. If that control proves ineffective, the employer would be required to proceed to other feasible controls until the hazard was controlled.

Seventh, OSHA is proposing to allow employers to have up to three years to implement permanent controls. This would give employers additional time to find the cheapest controls and/or allow them to purchase off-the-shelf technology rather than hiring outside experts to develop specific interventions.

Finally, OSHA is permitting employers to continue with their existing ergonomics programs, rather than incurring costs to set up an entire new program, if they can show that: (1) Their program satisfies the basic obligation paragraph of each program element and they are in compliance with the recordkeeping requirements of this standard; (2) they implemented and evaluated the program before the effective date of the standard; (3) their evaluation of the program indicates that it is functioning properly; and (4) if MSDs are still occurring, they are complying with section 1910.922 of the proposed rule.

D. Is the proposed rule consistent with the Americans with Disabilities Act?

During the SBREFA process, some small employer representatives (SERs) expressed concerns about the interaction between the proposed rule and the Americans with Disabilities Act (ADA), 42 U.S.C. 12101 *et seq.* (1990). Specifically, they were concerned that the proposed rule might conflict with the ADA and/or create selective hiring incentives that could potentially result in discrimination against qualified individuals with disabilities.

1. Does the proposed ergonomics rule conflict with the ADA?

The ADA prohibits employers with 15 or more employees from discriminating against qualified individuals with disabilities with regard to terms, conditions, and privileges of employment. 42 U.S.C. 12112(a) and (b); 29 CFR 1630.4; EEOC Technical Assistance on the Employment Provisions (Title I) of the ADA (January 1992) (''ADATAM''). The prohibition against discrimination applies to all aspects of employment, including:

- Job application
- Testing
- Evaluations
- Promotion
- Layoff/recall
- Compensation
- Benefits
- Hiring
- Placement/assignment
- Training
- Medical examinations
- Termination
- Leave

When requested, employers must provide reasonable accommodation to qualified individuals with disabilities for any of those aspects. 42 U.S.C. 12112 (b)(5)(A); 29 CFR 1630.9. Employers are not required, however, to provide accommodation that would pose undue hardship. 42 U.S.C. 12102(10); 29 CFR 1630.9.

The proposed ergonomics rule does not conflict with the ADA. The ADA prohibits discrimination against qualified persons with disabilities, and nothing in the proposed ergonomics rule authorizes or requires such discrimination. The goals of the ADA and the proposed ergonomics rule are fully compatible, and in many ways similar. The goal of the ADA is to protect qualified persons with substantially limiting impairments from discrimination on the basis of the impairment so they may fully participate in work:

[I]ndividuals with disabilities * * * have been faced with restrictions and limitations, subjected to a history of purposeful unequal treatment, and relegated to a position of political powerlessness in our society, based on characteristics that are beyond the control of such individuals and resulting from stereotypic assumptions not truly indicative of the individual ability of such individuals to participate in, and contribute to, society. * * * 42 U.S.C. 12101(a)(7).

The ADA achieves this goal by prohibiting an employer from denying employment opportunities or taking actions that adversely affect a person with a disability who is currently able to perform the essential functions of the job without posing a direct threat to the safety or health of the disabled person or others. 42 U.S.C. 12112(b)(5)(A); 29 CFR 1630.9; ADATAM I–3. The ADA also achieves this goal by requiring employers to provide reasonable accommodation (*e.g.*, modifications or adjustments to the job or removal of barriers) where necessary to enable the disabled person to perform the job (ADATAM I–3.5).

The proposed ergonomics rule seeks to prevent material impairment, which includes less severe impairments than disabilities covered under the ADA, from occurring in the first place. In general terms, the proposed rule proposes to achieve this by requiring employers to fit the job to the worker, not the worker to the job:

Ergonomics is the science of fitting workplace conditions and job demands to the capabilities of the working populations. Effective and successful ''fits'' assure high productivity, avoidance of illness and injury risks, and increased satisfaction among the workforce. NIOSH, Elements of Ergonomics Programs, p. 2 (1998).

More specifically, the ergonomics rule would achieve this by requiring employers to implement measures in problem jobs that eliminate or control the physical work activities and job conditions that are reasonably likely to cause, contribute to or aggravate an MSD. Not only will these control measures prevent the likelihood of OSHA recordable MSDs from occurring, but also they should make it easier for persons with more severe impairments to work in those jobs. This is because the proposed rule would require employers to eliminate or control hazards that aggravate pre-existing MSDs.

In many instances the ergonomic solutions to control problem jobs will be similar or related to the type of action an employer might take to provide reasonable accommodation. The following table shows some of the similarities between types of ergonomic controls and reasonable accommodation:

Examples of Reasonable Accommodations Under the ADA and Ergonomic Controls

TYPES OF REASONABLE ACCOMMODATION	TYPES OF ERGONOMIC CONTROLS
• Restructuring jobs by re-distributing certain non-essential job functions	• Rotating employees • Enlarging job (more task variation) • Adding more employees to job (assembly line)
• Altering how and when essential job functions are performed	• Redesigning job • Providing rest breaks
• Using modified, flexible or part-time work schedules	• Limiting total workday exposure
• Acquiring or modifying tools, equipment, workstations	• Designing and/or purchasing new tools and equipment • Rearranging workstation layout
• Reassigning to vacant position	• Using alternative duty jobs during the recovery period for employees with MSDs • Transferring employee to job with a better fit

ASource: ADATAM I–3.10.

2. Would the proposed ergonomics rule increase existing selective hiring incentives?

The SERs' other concern is about whether there would be increased incentives for employers to use selective hiring practices against qualified persons with disabilities because of the proposed ergonomics rule. For the reasons discussed below, OSHA believes the rule would not create such incentives. Hiring practices that discriminate against qualified persons with disabilities are illegal under the ADA, and the ADA has strong remedies to deter such discrimination. In addition, to the extent that selective hiring incentives exist, their existence is not because of the proposed ergonomics standard. In fact, an effective ergonomics program and implementation of measures that control MSD hazards in problem jobs should help to remove job barriers that may have made it difficult for employers to hire qualified persons with disabilities, thus reducing selective hiring incentives.

Under the ADA, it is unlawful for an employer to limit, segregate or classify a job applicant ''in a way that adversely impacts his or her employment opportunities or status on the basis of disability.'' 29 CFR 630.5. During the pre-offer stage of the hiring process, employers are not allowed to ask applicants questions that are likely to elicit information about a disability or conduct medical examinations. 42 U.S.C. 12112(d)(2)(A); 29 CFR 1630.13; ADATAM I–5.1. For example, during the pre-offer stage employers may not ask applicants about existing disabilities, prior job-related injuries, hospitalizations, prescription medications, absenteeism record or workers' compensation history. ADATAM I–5.5; Pre-employment Disability-Related Questions and Medical Examinations, EEOC Notice 915.002 (Oct. 10, 1995). Thus, employers are unlikely even to know that an applicant has a disability (unless the condition is apparent). The purpose of this prohibition is to ensure that persons with disabilities, like other job applicants, are evaluated on their ability to perform the essential functions of the job:

This prohibition is necessary to assure that qualified candidates are not screened out because of their disability before their actual ability to do a job is evaluated. ADATAM I–5.5

At the pre-offer stage, employers may ask applicants about their ability to perform specific functions of the job. 42

U.S.C. 12112(d)(2)(B). They may also may establish job qualifications or hiring criteria (*e.g.*, education, skills, work experience, physical abilities necessary for job performance and health or safety), provided they are uniformly applied to all applicants. ADATAM I–4.1. The ADA does not require employers to hire persons with disabilities who are not capable of performing the essential functions of the job (even with reasonable accommodation). In addition, the ADA does not require employers to lower existing production standards applicable to quality or quantity of work for a given job, provided that these standards are uniformly applied to all applicants and employees in the job. ADATAM I–4.2.

Where hiring criteria tend to screen out individuals based on their disability, the ADA requires that the criteria be both job-related and consistent with business necessity. 42 U.S.C. 12112(b)(6), 42 U.S.C. 12113(a); 29 CFR 1630.10. A job qualification or hiring test meets these criteria only where it is a legitimate measurement of the qualifications or requirements of a specific job, not range or general class of jobs (ADATAM I–4.1–4.1), and only where it relates to the essential functions of the job. 29 CFR 1630.2; ADATAM I–4.3. For example, a hiring test that requires applicants for any manual handling job to safely lift objects weighing 50 pounds would be prohibited if the specific manual handling job only involved lifting objects weighing half that amount or if manual handling was only an incidental or minor part of the job.

Employers who violate these requirements are subject to hefty remedies under the ADA, including compensatory and punitive damages. Damages may include compensation for actual monetary loss, future monetary loss, mental aguish, and inconvenience. Compensatory and punitive damages may be awarded for future monetary loss and emotional injury; with total damages ranging as high as $50,000 to $300,000 based on size of the establishment. These remedies, among others, appear to provide adequate and appropriate deterrence regarding discriminatory selective hiring practices. See also, *Goodman* v. *Boeing* (Under a State law prohibiting discrimination against disabled workers, employee was awarded $1.6 million for the employer's failure to provide reasonable accommodation).

The ADA recognizes employers' obligations to comply with other Federal laws or regulations, such as safety and health laws, as a defense to a claim of discrimination. However, this defense is available only where the discriminatory action is specifically required by the other Federal law. OSHA stresses that there is nothing in the proposed ergonomics standard that would ''require'' employers to act in violation of any of the hiring process requirements of the ADA, or would authorize employers to establish discriminatory selective hiring practices. The proposed ergonomics standard does not contain hiring requirements. It does not require employers to establish job selection standards (*e.g.,* safety and health qualifications). Conversely, it does not prohibit employers from continuing to comply with the hiring process requirements of the ADA.

If selective hiring incentives exist, they are not because of an ergonomics standard. Such incentives are largely the result of other concerns, such as perceptions that disabled persons may not be able to perform the job, may be more likely to suffer workplace injuries, or may request or require expensive accommodations. Under the ADA, discriminatory action on the basis of such perceptions is illegal. The proposed ergonomics rule should not increase these concerns and may help reduce them. The purpose and focus of the proposed standard is to require employers to fix jobs that are posing a significant risk of material harm to workers. OSHA is proposing that employers may use any combination of engineering, work practice or administrative controls to fix the job. Adopting selective hiring practices that exclude disabled workers, however, is not a permissible control measure since it does nothing to reduce the MSD hazards in the job. Therefore, employers could not demonstrate they are in compliance with the ergonomics standard because they have implemented selective hiring practices to control the problem.

Nevertheless, several SERs were convinced that the standard would increase incentives for employers to hire employees selectively. According to these commenters, the standard would do this because it would put employers who hire workers with less than optimal physical capabilities at a disadvantage because such workers are more likely than stronger workers to experience a covered MSD. Employers who believe that they will be able to identify especially ''strong'' persons do not understand that MSDs are cumulative hazards that cause tissue damage over time, and that this tissue damage is generally not apparent until the damage has progressed to the point of clinical injury. These employers are thus unaware that selective hiring practices are generally illegal and are also unlikely to be effective. OSHA believes that the increased awareness of these facts engendered by the standard will over time change these perceptions.

The proposed rule should reduce selective hiring incentives because once MSD hazards are controlled the job should not pose a risk of harm to any qualified person, including those with disabilities. The successful control of problem jobs, therefore, should make it easier for employers to hire disabled workers. Moreover, it should reduce the risk that employers will screen out disabled persons based safety and health concerns. Under the ADA, the employer may require, in a job qualification standard that is uniformly applied to all applicants, that an applicant not pose a direct threat to the health or safety to himself or others. 42 U.S.C. 12113(b). Employer action based on this justification is a recognized defense to a claim of discrimination. 29 CFR 1630.15. However, the employer's action is only justified if this type of qualification standard meets very specific and stringent requirements under the ADA. (29 CFR 1630.2(r); ADATAM I–4.5). The employer must show, based on objective medical or other objective factual evidence, that employment of the particular applicant poses a current and specific significant risk of substantial harm to the health or safety of himself or others which cannot be eliminated or reduced through reasonable accommodation. (29 CFR 1630.2(r). ADATAM I–4.5).

Requiring employers to control problem jobs so that it is no longer reasonably likely that an MSD will occur should reduce employers' concerns about disabled persons presenting a direct threat to safety or health. As such, it should reduce the possibility that employers will rely on the direct threat justification and make it less likely for employers to be able to meet the stringent requirements of that provision.

XII. Federalism

OSHA has reviewed the proposed program rule in accordance with the Executive Order on Federalism (Executive Order 12612, 52 FR 41685, October 30, 1987). This Order requires that agencies, to the extent possible, refrain from limiting state policy options, consult with States prior to taking any actions that would restrict state policy options, and take such actions only when there is clear constitutional authority and the presence of a problem of national scope. The Order provides for preemption of State law only if there is a clear Congressional intent for the agency to do so. Any such preemption is to be limited to the extent possible.

Section 18 of the Occupational Safety and Health Act (OSH Act) expresses Congress' clear intent to preempt State laws with respect to which Federal OSHA has promulgated occupational safety or health standards. Under the OSH Act a State can avoid preemption only if it submits, and obtains Federal approval of, a plan for the development of such standards and their enforcement. Occupational safety and health standards developed by such State Plan States must, among other things, be at least as effective as the Federal standards in providing safe and healthful employment and places of employment.

Since many work-related MSDs are reported every year in every State and since MSD hazards are present in workplaces in every state of the Union, the risk of work-related MSD disorders is a national problem.

The Federally proposed ergonomics program standard is drafted so that employees in every State would be protected by the standard. To the extent that there are any State or regional peculiarities, States with occupational safety and health plans approved under section 18 of the OSH Act would be able to develop their own comparable State standards to deal with any special problems.

In short, there is a clear national problem related to occupational safety and health for employees exposed to MSD hazards in the workplace. Any rule pertaining to ergonomics developed by States that have elected to participate under Section 18 of the OSH Act would not be preempted by this proposed regulation if the State rule is determined by Federal OSHA to be ''at least as effective'' as the Federal rule.

State comments are invited on this proposal and will be fully considered prior to promulgation of a final rule. OSHA has involved representatives of State and local governments in the development of this proposed rule. Several representatives of State and local governments participated in the extensive stakeholders meetings that were held to assist OSHA in developing this proposal.

XIII. State Plans States

The 23 states and 2 territories which operate their own Federally-approved occupational safety and health plans must adopt a comparable standard within six months of the publication date of a final standard. These States include: Alaska, Arizona, California, Connecticut (for State and local government employees only), Hawaii, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Nevada, New Mexico, New York (for State and local government employees only), North Carolina, Oregon, Puerto Rico, South Carolina, Tennessee, Utah, Vermont, Virginia, Virgin Islands, Washington, Wyoming. Until such time as a state or territorial standard is promulgated, Federal OSHA will provide interim enforcement assistance, as appropriate.

XIV. Issues on Which OSHA Seeks Comment

OSHA seeks comment and information from interested parties on all issues raised by the proposed ergonomics program rule. Comments that provide data and information to support the position taken by the commenter are particularly valuable to the Agency, because they permit OSHA to evaluate the point of view of the commenter. Comments in response to these issues, and any other that commenters care to raise, should be submitted to the Agency in accordance with the informations in the **DATES** and **ADDRESSES** sections of this preamble. The issues below are grouped according to the major topics identified in the headings.

A. Scope

1. OSHA requests information and comment on the jobs (manual handling and manufacturing jobs) that the Agency has decided to cover in the first phase of its ergonomics rulemaking. Are these jobs the right ones on which to focus coverage of the standard ? Are there other equally or more hazardous jobs that OSHA should include in the Scope? If so, what are these jobs and why should they be included? Conversely, are there jobs that OSHA should exclude from the Scope? If so, why? Please provide as much data and information as you have to support your answer.

2. OSHA requests information and comment on the definitions of manufacturing and manual handling jobs used in the proposed standard. Are these definitions clear? Could they be improved upon? If so, how? Are the examples OSHA provides of jobs that typically would be classified as manual handling or manufacturing jobs appropriate? Should others be added? Are there jobs that OSHA has identified as not typically constituting manual handling or manufacturing jobs that should be classified as manual handling or manufacturing jobs? If so, why? Should OSHA's definitions include more specification? For example, should the manual handling definition specify the total amount of weight an employee can lift in a day without having the job identified as a manual handling job? Should OSHA attempt to specify how many hours an employee must work at a manufacturing job in a day before the job is identified as a manufacturing job? Should the definition of manual handling be based on quantitative methods such as the NIOSH Lifting Equation?

3. OSHA requests information and comment on defining the term ''covered MSD'' as an ''OSHA recordable MSD'' that additionally meets the standard's screening criteria. Are there alternative definitions of the term covered MSD that would be as protective as the proposed definition? Do the screening criteria in the standard serve the purpose for which they were intended, *i.e.*, do they permit employers to rule out some MSDs that are OSHA-recordable MSDs but that are not a type of MSD that could reasonably be related to the physical work activities and conditions of the employee's job? What other screening criteria might be useful? Please provide examples of MSDs, based on your experience, that are OSHA-recordable MSDs that you believe would be screened out by the standard's screening criteria. In your experience, what proportion of all recordable MSDs might be screened out by these criteria? Please provide any data you have to support the benefits of including the screening criteria in the rule.

4. OSHA requests information and comment on whether the terms, ''core element'' and ''significant amount,'' which are used in the definitions of manual handling and manufacturing jobs, are clear? If not, are there other terms OSHA could use that would capture OSHA's meaning? If so, what are they, and how should they be defined?

5. OSHA requests comments and information about whether agriculture, construction and maritime operations should be included in this first phase of ergonomics rulemaking. Should all of these operations be covered in a second phase, or should OSHA propose the next phase of an ergonomics standard only for one of these industries? If so, which one or ones should be included, and what evidence is there they should be either included or excluded? In addition, should the first phase of this rulemaking cover some operations, such as manual

handling, wherever they occur, including in construction and marine operations?

B. Use of Covered MSD as a Trigger to Implement the Full Program

1. All of OSHA's health standards require employers to conduct exposure assessments to identify the most highly exposed employees and to determine where engineering and work practice controls must be implemented to control exposures. In contrast, the proposed ergonomics program standard uses an MSD incident trigger to initiate job hazard analysis and implementation of exposure controls. OSHA is aware that many employers who have ergonomics programs take a more proactive approach to identify and fix hazardous jobs before injuries occur. What approaches are used to identify hazardous jobs under a proactive program? What criteria are used to identify hazardous jobs? What tools or guidelines are available to employers who wish to identify hazardous jobs before any injuries take place, and what level of expertise is required to use these tools? Are there methods and guidelines available that would enable employers (particularly those in small businesses) to identify hazardous jobs without the need for specialized equipment or expertise? If so, how has it been proven that such methods are reliable and cost-effective?

2. OSHA solicits comment on the use of one MSD as a trigger for fixing jobs and/or implementing a full program. Many commenters expressed interest in alternative triggers such as two MSDs in the same job over various time periods, one lost workday MSD, or persistent signs of MSDs. Others expressed interest in a proactive approach that did not wait until an MSD occurred. OSHA welcomes comment on these and other alternatives. The Initial Regulatory Flexibility Analysis, in section VIII. H., provides a discussion of the pros and cons and the costs and projected benefits of several possible trigger alternatives.

C. Grandfather Clause

1. The Agency seeks comment on whether allowing employers with effective programs that have the core elements of the proposed program to ''grandfather'' their programs in is protective of workers and useful to employers. Is this provision necessary, or is the proposed standard so performance based and flexible that employers would not have to revamp their existing programs to accommodate the ergonomics program standard? Please provide data and examples to support your responses. If the grandfather clause is useful, are there changes that should be made to it to make it more useful? Does it need to be strengthened in any way to ensure employee protection? Are there ways of measuring the effectiveness of ergonomics programs that are reliable and easily implemented for the purpose of determining whether an employer's existing program is effective? If so, could such a measure be the principal means of determining whether a program is eligible for being grandfathered?

D. Quick Fix Option

1. OSHA would like comments on the usefulness of the Quick Fix option. Is it adequately protective of employee health? If so, why? If not, why not? Is it useful for employers? Will it permit them to eliminate MSD hazards and save time and money while still protecting their employees? How often do you think employers should be permitted to avail themselves of this option in a particular job? Are there particular types of jobs to which Quick Fixes are readily applicable and others to which they would not be applicable? If so, what are they? In addition, OSHA would like comments on the time frames provided in the proposed rule's Quick Fix provision.

E. Hazard Information and Reporting

1. OSHA welcomes comments on the adequacy and appropriateness of the proposed standard's requirements for reporting systems. Will the approach used in the standard encourage the early reporting of MSDs? Are there ways that these provisions should be strengthened? For example, should the standard require employers to survey their employees to identify the early signs and symptoms of MSDs? Please provide any data you have on the effectiveness of various employee reporting systems.

F. Job Hazard Analysis and Control

1. OSHA is requesting information on the usefulness of checklists to help small businesses conduct job hazard analyses. Specifically, should OSHA require that employers, or small employers, use these checklists? Should OSHA merely provide checklists as compliance assistance materials at the time of the final rule?

2. OSHA is seeking comments and information on the appropriateness of the risk factors, physical work activities, and job conditions it has identified in this section of the standard. Are there other risk factors that should be included? What assistance could OSHA provide employers to assist them in identifying the risk factors in problem jobs that need to be controlled to prevent recurrences of MSDs? Is the table found in § 1910.918 useful in assisting employers conducting a job hazard analysis?

3. How can OSHA best assist employers to select the appropriate controls to address various kinds or combinations of risk factors? Would including a list of the most commonly used controls to address various ergonomic problems (unassisted manual handling, use of excessive force, repetitive keying) be useful? If so, what are good sources of such lists? Please be as specific as possible in your answers.

4. Are the definitions used in the proposed standard for ''engineering controls,'' ''administrative controls,'' and ''personal protective equipment'' sufficient? Is it clear from these definitions what kinds of equipment and procedures fall into each category of control? Are there any data on the effectiveness of back braces or back belts that would support defining these devices as personal protective equipment? Is the hierarchy of controls clear? Are there any controls that would be defined as personal protective equipment that would be as effective as engineering, administrative, or work practice controls? If so, please submit data supporting the effectiveness of this personal protective equipment.

5. Are the compliance endpoints described in the proposed standard clear and understandable? Are there other ways to define when an employer should be considered to have eliminated or substantially reduced MSD hazards? OSHA believes that many employers use an incremental approach to implementing ergonomic fixes, such as that laid out in the proposed standard. Is the approach taken in the standard reasonable and effective? Are there other approaches that could be taken by employers?

6. Computer vision syndrome (CVS), defined as a complex of eye and vision problems that are experienced during and related to computer use, is a repetitive strain disorder that appears to be growing rapidly, with some studies estimating that 90 percent of the 70 million U.S. workers using computers for more than 3 hours per day experience it in some form. What work practices or controls can employers

use to prevent or reduce the occurrence of CVS? Are studies of the effectiveness of these approaches available?

7. What OSHA compliance assistance materials would be helpful to employers? To employees?

G. MSD Management

1. OSHA would like comments and information on the essential components of an effective MSD management process that OSHA should include as part of the standard. Specifically, should OSHA specify when and under what conditions employers should be required to send employees with MSDs to a health care professional?

2. What studies are available on the percentage of work-related MSDs that recur among employees whose jobs have been controlled? Do the percentages of recurrence differ for different kinds of MSDs?

3. OSHA solicits data on the frequency with which persistent symptoms (*i.e.,* those lasting for 7 days or longer) progress to recordable MSD if (1) the symptoms are treated early; or (2) they are not treated early.

4. OSHA solicits comment on employers' experiences in encouraging the early reporting of signs and symptoms. Which approaches have worked and which have not proven useful?

5. The medical management section of the proposed standard requires an employer to make available medical care whenever an employee has a covered MSD. The employer is required to provide prompt access to a health care professional for effective evaluation, management, and follow up. The standard defines a health care professional as a physician or other licensed health care provider whose legally permitted scope of practice (*e.g.,* license, registration, or certification) allows them to provide some or all of the activities described in the MSD management requirements of the standard. This language permits states to determine the appropriate scope of practice for health care professionals providing the medical management services. Similar language has been incorporaated in all of OSHA's health standards promulgated since 1990 and reflects a growing societal trend to reduce medical costs and improve access to health care. Is it appropriate for OSHA to recognize or promote the role of the non-physician provider with respect to the ergonomics standard? What are the advantages and disadvantages to both employers and employees in using any health care professional with respect to MSDs? Are state scope of practice laws sufficient to ensure that medical management is of sufficient quality to protect the health of employees, and to what extent do these laws create a potential for disparity in treatment between states? Should OSHA more clearly define the competencies necessary for a health care professional with respect to the medical management of MSDs?

6. OSHA welcomes comments on the standard's work restriction provision (WRP). For example, should WRP be provided for a longer period than the 6 months proposed? Is the 6 month period too long? Should WRP cover a much shorter time period such as 3 days or 7 days? What percentage of earnings should WRP cover? Should WRP be expressed as a percentage of earnings or of take-home pay? Are there other methods that might achieve the goals of WRP, *i.e.,* the complete and early reporting of MSDs by employees?

H. When must my program be in place? (Compliance deadlines)

1. MSD management is to be provided as soon as possible or within 5 days, whichever comes first. OSHA would like comments and information on the adequacy and appropriateness of this time period. For example, is it short enough to ensure that employee MSDs are addressed so that they will not progress further?

2. OSHA requests comment on the appropriateness of the proposed start up times contained in § 1910.942 for implementing the various elements of the ergonomics standard.

I. Program Approach

1. OSHA has used a program approach to develop the proposed ergonomics standard. Should this standard be program-based? Should the program elements be spelled out in more detail? Are other elements necessary to ensure that the ergonomics program protects workers? How should the program address management leadership and employee participation?

2. OSHA requests data and additional case studies describing the effect of ergonomics programs on MSD rates, lost-work time, productivity, and medical and worker's compensation costs.

J. Economic Impact Analysis

OSHA solicits comment on the following aspects of the economic analysis and requests any additional relevant information, suggestions, or data:

1. The methodologies for estimating costs and benefits. These methodologies are described in detail in the Preliminary Economic Analysis. The basic unit cost estimates are provided in a summary table in the Initial Regulatory Flexibility Analysis (Section VIII. H.)

2. Data or information on the indirect costs and benefits of the proposed standard. OSHA estimated costs and benefits assuming that industry remains as it is today. OSHA welcomes comment on ways the proposed standard may alter the economy that could lead either to changes in the costs or benefits or to the standard's indirect benefits and costs.

3. Data on the economic impacts of the proposed standard. OSHA summarizes the economic impacts of the Standard in Section VIII of this preamble, and describes them in greater detail in Chapter VIII of the Preliminary Economic Impact Analysis. OSHA welcomes comment on all aspects of its estimates of the economic impacts of the standard.

4. Data on the control costs associated with the job hazard analysis and control provisions of the standard. The control costs associated with these activities and the methodologies for deriving them are documented in detail in the Preliminary Economic Analysis. These cost estimates rely primarily on the judgments of ergonomists with experience in implementing ergonomics programs in a variety of settings. For the purposes of establishing technological feasibility and capturing the productivity effects of ergonomic job interventions, OSHA developed or took from the literature a set of 170 scenarios representing actual workplace jobs and appropriate controls under the proposed standard. Although the scenarios were not used to develop the costs of the job controls for the cost analysis, the scenario costs are consistent with the cost estimates for higher-tech interventions reflected in the cost analysis. If these costs are demonstrated to be under- or overestimated, OSHA will review the basis of its estimates of the costs of job controls. OSHA welcomes comment on these scenarios, and seeks additional scenarios representing specific examples of problem jobs, with or without actual job controls or cost and effectiveness information.

5. Data on the use and effectiveness of specific ergonomic controls. OSHA estimates, based on epidemiological data and examples of program interventions, that ergonomic controls can reduce MSD rates by 50%. OSHA welcomes comment on this estimate (described in greater detail in the Preliminary Risk Assessment of the Preamble and Chapter IV of the Preliminary Economic Analysis) . OSHA also welcomes examples of the effectiveness of particular programs and particular types of controls.

6. Data on the productivity impacts of specific ergonomic controls. OSHA's economic analysis attempts to capture these productivity gains by applying reported improvements occurring in a particular job to other jobs involving the same work activities. OSHA estimated that productivity impacts reduce the gross costs of ergonomic job controls by approximately one third. OSHA welcomes comment on this estimate, the job intervention scenarios on which it is based (presented in the Appendix to Chapter III of the Preliminary Economic Analysis), and data on the experience concerning productivity effects of ergonomic job interventions. Are there better ways of reflecting ergonomically generated productivity gains? For example, would applying a generic productivity factor across the board be a reasonable approach? If so, what should that factor be and what data are available to support it?

7. Data on the effectiveness of ergonomics programs. Please describe the program and the types and percentages of MSDs it has prevented. Are there any particular types of MSDs that ergonomics programs have been more or less effective at preventing, such as particularly severe MSDs or MSDs of certain types, such as low back pain?

8. Data on changes in the reporting of MSDs resulting from implementing ergonomics programs. (There are anecdotal data suggesting that MSD reporting may increase as a result of implementing the employee participation and hazard information aspects of ergonomics programs.) OSHA is particularly interested in quantitative data on the actual experience of employers concerning any increases in MSD reporting, the severity of the MSDs reported, and the length of time any change in the rate of reporting lasted.

9. Data on the annual incidence of lost workday MSDs and non-lost workday MSDs. OSHA particularly welcomes data on the ratio of the total number of MSDs to the total number of MSDs involving days away from work. (These data are not collected by BLS.) OSHA has preliminarily estimated the total number of MSDs using BLS data for all injuries and illnesses (not for MSDs specifically) on the total number of injuries and illnesses involving days away from work and the total number of injuries and illnesses.

10. Data on what percentage of all MSDs would pass the screening criteria of the standard and be considered by the standard to be covered MSDs, thus requiring the jobs in which the covered MSD occurred to be fixed and/or the implementation of a full program. OSHA has preliminarily assumed that all MSDs occurring in jobs that have not yet been fixed will be covered MSDs. Is this a reasonable assumption? If so, why? If not, why not?

11. Data on the nature and costs associated with MSDs that are recorded in the OSHA log but are not workers' compensation claims. OSHA has preliminarily estimated that 30% of all lost workday injuries and illnesses recorded on OSHA logs (OSHA recordables) do not result in accepted workers' compensation claims and that the recordables that do not become accepted workers' compensation claims have the same severity and durations as those injuries and illnesses that are accepted as workers' compensation claims. Is this a reasonable assumption? If so, why? If not, why not?

12. Data or studies on the overreporting or underreporting of MSDs. Many employers fear that the proposed standard could increase the reporting of MSDs, and even perhaps increase the fraudulent reporting of MSDs. Many studies (see the Preliminary Risk Assessment of the Preamble) have shown that many work-related MSDs are not reported either on the OSHA 200 log or filed as workers' compensation claims. OSHA welcomes comment on all aspects of both the current rate of reporting of work-related MSDs to employers and the possible impacts of the proposed standard in increasing or reducing the reporting of work-related MSDs.

13. Comments or data on the time it will take employers to implement the various provisions of the standard. OSHA's estimates are in the Initial Regulatory Flexibility Analysis, Section VIII. H).

14. Comments on the proportion of all covered MSDs that will lead to job analyses requiring an outside consultant. OSHA has estimated that 15 percent of all covered MSDs will lead to job analyses requiring an outside consultant.

15. Comments on the estimates of manufacturing and manual handling jobs and on the estimates of the number of workers in each job. Industry by industry estimates are present in Chapter II of the Preliminary Economic Impact Analysis.

16. Comments on OSHA's methodology for estimating the effect of using multiple MSD triggers to determine coverage by the full ergonomics program. OSHA's methodology assumed that all establishments in an industry without ergonomics programs would have the same risks.

17. In Chapter I of the Preliminary Economic Impact Analysis, OSHA lists ergonomics regulations issued by many countries around the world, as well as several guidelines on ergonomics practices issued by national and international organizations. Are there other standards or guidelines that should be added to this list?

18. Comments on the cost-effectiveness of the proposed standard. Is the standard cost effective or are there changes that could be made that would accomplish the goals of the standard at a lower cost?

XV. Public Participation—Notice of Hearing

A. Written Comments

Interested persons are invited to submit written data, views and arguments concerning the proposed standard. Responses to the questions and issues raised by OSHA at various places in the proposal are particularly encouraged. These comments, including materials such as studies or journal articles, must be postmarked by February 1, 2000. Written submissions must clearly identify:

- The provisions of the proposal that are being addressed,
- The position taken with respect to each issue, and
- The basis for that position.

Mail: Comments must be submitted in duplicate to: OSHA Docket Office, Docket No. S–777, U.S. Department of Labor, 200 Constitution Avenue, N.W., Room N–2625, Washington, DC 20210, (202) 693–2350.

Facsimile: Comments limited to 10 pages or less may be transmitted by facsimile to (202)–693–1648 by February 1, 2000.

Electronic: Written comments may also be submitted electronically through the OSHA Homepage at www.osha.gov. Electronic comments must be transmitted by February 1, 2000. Please note that you may not attach materials such as studies or journal articles. If you wish to include such materials, you must submit them separately in duplicate to the OSHA Docket Office at the address above. When submitting such materials to the OSHA Docket Office, you must clearly identify your electronic comments by name, date, and subject, so that we can attach them to your electronic comments.

All written comments, along with supporting data and references, received within the specified comment period will be made a part of the record and will be available for public inspection and copying at the above Docket Office address. All timely written submissions will be made a part of the record of the proceeding.

B. Notice of Hearings

Pursuant to section 6(b)(3) of the Act, an opportunity to submit oral testimony concerning the issues raised by the proposed standard, including economic and environmental impacts, will be provided at informal public hearings scheduled to begin at 9:30 a.m., February 22, 2000, in the auditorium of the Frances Perkins Building, U.S. Department of Labor, 200 Constitution Avenue, N.W., Washington, DC 20210.

Regional hearings will also be held in March 21–31, 2000, in Portland, OR, and April 11–21, 2000, in Chicago, IL. Actual times and addresses for the location of the regional hearings will be announced in a later **Federal Register** notice.

C. Notice of Intention To Appear at the Hearings

Persons desiring to participate at the informal public hearing must file a notice of intention to appear by January 18, 2000. The notices of intention to appear must contain the following information:

1. The name, address, and telephone number of each person to appear;

2. The capacity in which each person will appear;

3. The approximate amount of time required for the presentation;

4. The specific issues that will be addressed;

5. A brief statement of the position that will be taken with respect to each issue;

6. Whether the party intends to submit documentary evidence and, if so, a brief summary of that evidence; and

7. The hearing at which the party wishes to testify.

Mail: The notice of intention to appear may be sent to: Ms. Veneta Chatmon, OSHA Office of Public Affairs, Docket No. S–777, U.S. Department of Labor, 200 Constitution Avenue, N.W., Room N–3649, Washington, DC 20210, (202) 693–2119.

Facsimile: A notice of intention to appear also may be transmitted by facsimile to (202) 693–1634, by January 24, 2000.

Electronic: A notice of intention to appear may be submitted electronically through the OSHA Homepage at www.osha.gov by January 24, 2000. Notices of intention to appear will be available for inspection and copying at the OSHA Docket Office at the address above.

D. Filing of Hearing Testimony and Documentary Evidence Before the Hearing

Any party requesting more than 10 minutes for presentation at the informal public hearing, or who intends to submit documentary evidence at the hearing, must provide the complete text of the testimony, and documentary evidence to Ms. Veneta Chatmon, at the address above. These materials must be postmarked by February 1, 2000. Testimony and documentary evidence must be submitted either in quadruplicate, or 1 original (hardcopy) and 1 disk (3½) in WP 5.1, 6.1, 8.0 or ASCII. Any information not contained on disk, *e.g.,* studies, articles, etc., must be submitted in quadruplicate to Ms. Veneta Chatmon. One copy of the testimony and supporting documentary evidence must be suitable for copying and must not be stapled. Notices of intention to appear, hearing testimony and documentary evidence will be available for inspection and copying at the OSHA Docket Office.

Each submission will be reviewed in light of the amount of time requested in the notice of intention to appear. In instances where the information contained in the submission does not justify the amount of time requested, a more appropriate amount of time will be allocated and the participant will be notified of that fact prior to the informal hearing.

Any party who has not substantially complied with this requirement may be limited to a 10-minute presentation, and be requested to return for questioning at a later time. Any party who has not filed a Notice of Intention to Appear may be allowed to testify, as time permits, at the discretion of the Administrative Law Judge.

OSHA emphasizes that the hearing is open to the public, and that interested persons are welcome to attend. However, only persons who have filed proper Notices of Intention to Appear at the hearing will be entitled to ask questions and otherwise participate fully in the proceedings.

E. Conduct and Nature of the Informal Public Hearing

The hearings will commence at 9:30 a.m. on the first day. At that time, any procedural matters relating to the proceeding will be resolved. The hearings will reconvene on subsequent days at 8:30 a.m.

The nature of an informal rulemaking hearing is established in the legislative history of section 6 of the OSH Act and is reflected by OSHA's rules of procedure for hearings (29 CFR 1911.15(a)). Although the presiding officer is an Administrative Law Judge and questioning by interested persons is allowed on crucial issues, the proceeding is informal and legislative in type. The Agency's intent, in essence, is to provide interested persons with an opportunity to make effective oral presentations that can be carried out expeditiously in the absence of procedural restraints or rigid procedures that might unduly impede or protract the rulemaking process.

Additionally, since the hearing is primarily for information gathering and clarification, it is an informal administrative proceeding rather than adjudicative one; the technical rules of evidence, for example, do not apply. The regulations that govern hearings and the pre-hearing guidelines to be issued for this hearing will ensure fairness and due process and also facilitate the development of a clear, accurate and complete record. Those rules and guidelines will be interpreted in a manner that furthers that development. Thus, questions of relevance, procedure and participation generally will be decided so as to favor development of the record.

The hearing will be conducted in accordance with 29 CFR part 1911. It should be noted that § 1911.4 specifies that the Assistant Secretary may upon reasonable notice issue alternative procedures to expedite proceedings or for other good cause. The hearing will be presided over by an Administrative Law Judge who makes no decision or recommendation on the merits of OSHA's proposal. The responsibility of the Administrative Law Judge is to ensure that the hearing proceeds at a reasonable pace and in an orderly manner. The Administrative Law Judge, therefore, will have all the powers necessary and appropriate to conduct a full and fair informal hearing as provided in 29 CFR part 1911, including the powers:

1. To regulate the course of the proceedings;

2. To dispose of procedural requests, objections and comparable matters;

3. To confine the presentations to the matters pertinent to the issues raised;

4. To regulate the conduct of those present at the hearing by appropriate means;

5. In the Judge's discretion, to question and permit the questioning of any witnesses and to limit the time for questioning; and

6. In the Judge's discretion, to keep the record open for a reasonable, stated time (known as the post-hearing comment period) to receive written information and additional data, views and arguments from any person who has participated in the oral proceedings.

OSHA recognizes that there may be interested persons or organizations who, through their knowledge of the subject matter or their experience in the field, would wish to endorse or support the whole proposal or certain provisions of the proposal. OSHA welcomes such supportive comments, including any pertinent data and cost information which may be available, in order that the record of this rulemaking will present a balanced picture of public response on the issues involved.

At the close of the hearing, the Administrative Law Judge will set a post-hearing comment period for those persons participating in the hearing. The first part of that period will be for the submission of additional data and information to OSHA. The second part will be for the submission of briefs, arguments and summations. Only those persons who have submitted a proper Notice of Intention to Appear at the hearing will be entitled to participate in the posthearing comment period.

F. Certification of Record and Final Determination After the Informal Public Hearing

Following the close of the hearing and post-hearing comment period, the presiding Administrative Law Judge will certify the record to the Assistant Secretary of Labor for Occupational Safety and Health. The Administrative Law Judge does not make or recommend any decisions as to the content of the final standard.

The proposed standard will be reviewed in light of all oral and written submissions received as part of the record, and a permanent Ergonomics Program Standard will be issued, based upon the entire record in the proceeding, including the written comments and data received from the public.

XVI. OMB Review under the Paperwork Reduction Act of 1995

This proposed ergonomics program standard contains collections of information that are subject to review by the Office of Management and Budget (OMB) under the Paperwork Reduction Act of 1995 (PRA'95), 44 U.S.C. 3501 *et seq.* and its regulation at 5 CFR part 1320. PRA'95 defines collection of information to mean, ''the obtaining, causing to be obtained, soliciting, or requiring the disclosure to third parties or the public of facts or opinions by or for an agency regardless of form or format.'' [44 U.S.C. 3502(3) (A)].

The title, description of the need for and proposed use of the information, summary of the collections of information, description of the respondents, and frequency of response of the information collection are described below with an estimate of the annual cost and reporting burden as required by § 1320.5(a)(1)(iv) and § 1320.8(d)(2). Reporting burden includes the time for reviewing instructions, gathering and maintaining the data needed, and completing and reviewing the collection of information.

OSHA invites comments on whether the proposed collection of information:

(1) Ensures that the collection of information is necessary for the proper performance of the functions of the agency, including whether the information will have practical utility;

(2) Estimates the projected burden accurately, including the validity of methodology and assumptions used;

(3) Enhances the quality, utility, and clarity of the information to be collected; and

(4) Minimizes the burden of the collection of information on those who are to respond, including through the use of appropriate automated, electronic, mechanical, or other technological collection techniques or other forms of information technology, *e.g.*, permitting electronic submissions of responses.

Title: The ergonomics program standard Subpart Y, 29 CFR 1910.900 through 1910.945.

Description: The proposed ergonomics program standard is an occupational safety and health standard that will address the significant risk of work-related musculoskeletal disorders (MSDs) confronting employees in various jobs in general industry workplaces. The standard's information collection requirements are essential components that will assist both employers and their employees in identifying MSDs as well as identifying means to take to reduce or eliminate MSDs. OSHA compliance officers will use some of the information in their enforcement of the standard.

Summary of the Collections of Information: The collections of information contained in the standard are for establishing and evaluating an ergonomics program, and for developing and maintaining records associated with the ergonomic program standard. The following ergonomics program elements contain collections of information:

1. Management Leadership and Employee Participation (sections 1910.911 through 1910.913);

2. Hazard Information and Reporting (sections 1910.914 through 1910.916);

3. Job Hazard Analysis and Control (sections 1910.917 through 1910.922);

4. MSD Management (sections 1910.929 through 1910.935); and

5. Program Evaluation (sections 1910.936 through 1910.938).

Records, as identified in sections 1910.939 through 1910.940, include employee reports of MSDs and the employer's response, job hazard analysis results, hazard control, quick fix process, ergonomics program evaluation and MSD management records.

Respondents: Employers in general industry whose employees work in manufacturing jobs or manual handling jobs, or general industry employers whose employees report an MSD as defined in the proposal.

Frequency of Response: Frequency of response will be determined by whether the employer has manufacturing and/or manual handling jobs, the number of MSDs reported, and actions the employer will take in response to the MSD; that is, whether the employer chooses to use a quick fix option, or must establish an ergonomics program.

Average Time per Response: Time per response varies, from minimal recordkeeping for a quick fix MSD situation, to establishing and implementing a complete ergonomics program.

Total Burden Hours: Approximately 21,402,291 hours.

Estimated Costs (Operating and Maintenance): $513,332,000 (purchasing services).

The Agency has submitted a copy of the information collection request to OMB for its review and approval. Interested parties are requested to send comments regarding this information collection to the Office of Information and Regulatory Affairs, Attn. OSHA Desk Officer, OMB, New Executive Office Building, 725 17th Street NW, Room 10235, Washington, DC 20503.

Comments submitted in response to this notice will be summarized and/or included in the request for Office of Management and Budget approval of the final information collection request: they will also become a matter of public record.

Copies of the referenced information collection request are available for inspection and copying in the OSHA Docket Office and will be mailed immediately to persons who request copies by telephoning Todd Owen or Barbara Bielaski at (202) 693–2444. For electronic copies of the ergonomics information collection request, contact the OSHA webpage on the Internet at http://www.osha.gov/. Copies of the information collection request are also available at the OMB docket office.

XVII. Authority and Signature

This document was prepared under the direction of Charles N. Jeffress, Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, 200 Constitution Avenue, NW, Washington, DC 20210.

Pursuant to sections 4, 6 and 8, Occupational Safety and Health Act, 29 U.S.C. 653, 655, 657, Secretary of Labor's Orders Nos. 12–71 (36 FR 8754, 8–76 (41 FR 25059), 9–83 (48 FR 35736), 1–90 (55 FR 9033), or 6–96 (62 FR 111), as applicable, and 29 CFR Part 1911; 29 CFR part 1910 is amended as set forth below.

List of Subjects in 29 CFR Part 1910

Ergonomics program, Health, Musculoskeletal disorders, Health, Occupational safety and health, Reporting and recordkeeping requirements.

Signed, at Washington, DC, this 1st day of November, 1999.

Charles N. Jeffress,

Assistant Secretary of Labor for Occupational Safety and Health.

XVIII. The Proposed Standard

General Industry

The Occupational Safety and Health Administration proposes to amend Part 1910 of title 29 of the Code of Federal Regulations as follows:

PART 1910—[AMENDED]

1. New Subpart Y of 29 CFR Part 1910 is added to read as follows:

Subpart Y—Ergonomics Program Standard

Sec.

What Records Must I Keep?

When Must My Program be in Place?

Definitions

Subpart Y—Ergonomics Program Standard

Authority: Secs. 4, 6 and 8, Occupational Safety and Health Act, 29 U.S.C. 653, 655, 657, Secretary of Labor's Orders Nos. 12-71 (36 FR 8754), 8-76 (41 FR 25059), 9-83 (48 FR 35736), 1-90 (55 FR 9033), or 6-96 (62 FR 111), as applicable; and 29 CFR Part 1911.

§ 1910.900 Table of contents.

This section is the table of contents for the sections in Subpart Y:

Does This Standard Apply to Me?

Sec.

How Does This Standard Apply to Me?

Management Leadership and Employee Participation

Hazard Information and Reporting

Job Hazard Analysis and Control

Training

MSD Management

Program Evaluation

What Records Must I Keep?

When Must My Program be in Place?

Definitions

Note to § 1910.900: In this standard, the terms that are defined in § 1910.945 are put in ''quotations'' the first time they appear.

Does This Standard Apply to Me?

§ 1910.901 Does this standard apply to me?

This standard applies to employers in general industry whose employees work in ''manufacturing jobs'' or ''manual handling jobs,'' or report ''musculoskeletal disorders (MSDs)'' that meet the criteria of this standard. This standard applies to the following ''jobs'':

(a) *Manufacturing jobs.* Manufacturing jobs are production jobs in which employees perform the ''physical work activities'' of producing a product and in which these activities make up a significant amount of their worktime;

(b) *Manual handling jobs.* Manual handling jobs are jobs in which employees perform forceful lifting/lowering, pushing/pulling, or carrying. Manual handling jobs include only those jobs in which forceful manual handling is a core element of the employee's job; and

Note to paragraphs (a) and (b): Although each manufacturing and manual handling job must be considered on the basis of its actual physical work activities and conditions, the definitions section of this standard (§ 1910.945) includes a list of jobs that are typically included in and excluded from these definitions.

(c) *Jobs with a musculoskeletal disorder.* Jobs with an MSD are those jobs in which an employee reports an MSD that meets all of these criteria:

(1) The MSD is reported after [the effective date of the final rule];

(2) The MSD is an ''OSHA recordable MSD,'' or one that would be recordable if ''you'' were required to keep OSHA injury and illness records; and

(3) The MSD also meets the screening criteria in § 1910.902.

Note to paragraph (c): In this standard, the term ''covered MSD'' refers to a musculoskeletal disorder that meets the requirements of this section.

§ 1910.902 Does this standard allow me to rule out some MSDs?

Yes. The standard only covers those OSHA recordable MSDs that also meet these screening criteria:

(a) The physical work activities and conditions in the job are reasonably likely to cause or contribute to the type of MSD reported; and

(b) These activities and conditions are a core element of the job and/or make up a significant amount of the employee's worktime.

§ 1910.903 Does this standard apply to the entire workplace or to other workplaces in the company?

No. This standard is job-based. It only applies to the jobs specified in § 1910.901, not to your entire workplace or to other workplaces in your company.

§ 1910.904 Are there areas this standard does not cover?

Yes. This standard does not apply to agriculture, construction or maritime operations.

How Does This Standard Apply to Me?

§ 1910.905 What are the elements of a complete ergonomics program?

In this standard, a full ''ergonomics'' program consists of these six program elements:

(a) Management Leadership and Employee Participation;

(b) Hazard Information and Reporting;

(c) Job Hazard Analysis and Control;

(d) Training;

(e) ''MSD Management,'' and

(f) Program Evaluation.

§ 1910.906 How does this standard apply to manufacturing and manual handling jobs?

You must:

(a) Implement the first two elements of the ergonomics program (Management Leadership and Employee Participation, and Hazard Information and Reporting) even if no MSD has occurred in those jobs.

(b) Implement the other program elements when either of the following occurs in those jobs (unless you ''eliminate MSD hazards'' using the Quick Fix option in § 1910.909):

(1) A covered MSD is reported; or

(2) ''Persistent MSD symptoms'' are reported plus:

(i) You ''have knowledge'' that an MSD hazard exists in the job;

(ii) Physical work activities and conditions in the job are reasonably likely to cause or contribute to the type of ''MSD symptoms'' reported; and

(iii) These activities and conditions are a core element of the job and/or make up a significant amount of the employee's worktime.

Note to § 1910.906: ''Covered MSD'' refers to MSDs that meet the criteria in § 1910.901(c). As it applies to manufacturing and manual handling jobs, ''covered MSD'' also refers to persistent MSD symptoms that meet the criteria of this section.

§ 1910.907 How does this standard apply to other jobs in general industry?

In other jobs in general industry, you must comply with all of the program elements in the standard when a covered MSD is reported (unless you eliminate the MSD hazards using the Quick Fix option).

§ 1910.908 How does this standard apply if I already have an ergonomics program?

If you already have an ergonomics program for the jobs this standard covers, you may continue that program, even if it differs from the one this standard requires, provided you show that:

(a) Your program satisfies the basic obligation section of each program element in this standard, and you are in compliance with the recordkeeping requirements of this standard (§§ 1910.939 and 1910.940);

(b) You have implemented and evaluated your program and controls before [the effective date of the final rule]; and

(c) The evaluation indicates that the program elements are functioning properly and that you are in compliance with the control requirements in § 1910.921.

§ 1910.909 May I use a Quick Fix instead of setting up a full ergonomics program?

Yes. A Quick Fix is a way to fix a ''problem job'' quickly and completely. If you ''eliminate MSD hazards'' using a Quick Fix, you do not have to set up the full ergonomics program this standard requires. You must do the following when you Quick Fix a problem job:

(a) Promptly make available the MSD management this standard requires;

(b) Consult with employee(s) in the problem job about the physical work activities or conditions of the job they associate with the difficulties, observe the employee(s) performing the job to identify whether any risk factors are present, and ask employee(s) for recommendations for eliminating the MSD hazard;

(c) Put in Quick Fix controls within 90 days after the covered MSD is identified, and check the job within the next 30 days to determine whether the controls have eliminated the hazard;

(d) Keep a record of the Quick Fix controls; and

(e) Provide the hazard information this standard requires to employee(s) in the problem job within the 90-day period.

Note to § 1910.909: If you show that the MSD hazards only pose a risk to the employee with the covered MSD, you may limit the Quick Fix to that individual employee's job.

§ 1910.910 What must I do if the Quick Fix does not work?

You must set up the complete ergonomics program if either of these occurs:

(a) The Quick Fix controls do not eliminate the MSD hazards within the Quick Fix deadline (within 120 days after the covered MSD is identified); or

(b) Another covered MSD is reported in that job within 36 months.

Note to § 1910.910: Exception: If a second covered MSD occurs in that job resulting from different physical work activities and conditions, you may use the Quick Fix a second time.

Management Leadership and Employee Participation

§ 1910.911 What is my basic obligation?

You must demonstrate management leadership of your ergonomics program. Employees (and their designated representatives) must have ways to report ‘‘MSD signs’’ and ‘‘MSD symptoms;’’ get responses to reports; and be involved in developing, implementing and evaluating each element of your program. You must not have policies or practices that discourage employees from participating in the program or from reporting MSDs signs or symptoms.

§ 1910.912 What must I do to provide management leadership?

You must:

(a) Assign and communicate responsibilities for setting up and managing the ergonomics program so managers, supervisors and employees know what you expect of them and how you will hold them accountable for meeting those responsibilities;

(b) Provide those persons with the authority, ‘‘resources,’’ information and training necessary to meet their responsibilities;

(c) Examine your existing policies and practices to ensure that they encourage and do not discourage reporting and participation in the ergonomics program; and

(d) Communicate ‘‘periodically’’ with employees about the program and their concerns about MSDs.

§ 1910.913 What ways must employees have to participate in the ergonomics program?

Employees (and their designated representatives) must have:

(a) A way to report MSD signs and symptoms;

(b) Prompt responses to their reports;

(c) Access to this standard and to information about the ergonomics program; and

(d) Ways to be involved in developing, implementing and evaluating each element of the ergonomics program.

Hazard Information and Reporting

§ 1910.914 What is my basic obligation?

You must set up a way for employees to report MSD signs and symptoms and to get prompt responses. You must evaluate employee reports of MSD signs and symptoms to determine whether a covered MSD has occurred. You must periodically provide information to employees that explains how to identify and report MSD signs and symptoms.

§ 1910.915 What information must I provide to employees?

You must provide this information to current and new employees:

(a) Common MSD hazards;

(b) The signs and symptoms of MSDs, and the importance of reporting them early;

(c) How to report MSD signs and symptoms; and

(d) A summary of the requirements of this standard.

§ 1910.916 What must I do to set up a reporting system?

You must:

(a) Identify at least one person to receive and respond to employee reports, and to take the action this standard requires.

(b) Promptly respond to employee reports of MSD signs or symptoms in accordance with this standard.

Job Hazard Analysis and Control

§ 1910.917 What is my basic obligation?

You must analyze the problem job to identify the ‘‘ergonomic risk factors’’ that result in MSD hazards. You must eliminate the MSD hazards, reduce them to the extent feasible, or materially reduce them using the incremental abatement process in this standard. If you show that the MSD hazards only pose a risk to the employee with the covered MSD, you may limit the job hazard analysis and control to that individual employee’s job.

§ 1910.918 What must I do to analyze a problem job?

You must:

(a) Include in the job hazard analysis all of the employees in the problem job or those who represent the range of physical capabilities of employees in the job;

(b) Ask the employees whether performing the job poses physical difficulties and, if so, which physical work activities or conditions of the job they associate with the difficulties;

(c) Observe the employees performing the job to identify which of the following physical work activities, workplace conditions and ergonomic risk factors are present:

PHYSICAL WORK ACTIVITIES AND CONDITIONS	ERGONOMIC RISK FACTORS THAT MAY BE PRESENT
(1) Exerting considerable physical effort to complete a motion	(i) Force (ii) Awkward postures (iii) Contact stress
(2) Doing same motion over and over again	(i) Repetition (ii) Force (iii) Awkward postures (iv) Cold temperatures
(3) Performing motions constantly without short pauses or breaks in between	(i) Repetition (ii) Force (iii) Awkward postures (iv) Static postures (v) Contact stress (vi) Vibration
(4) Performing taks that involve long reaches	(i) Awkward postures (ii) Static postures (iii) Force
(5) Working surfaces are too high or too low	(i) Awkward postures (ii) Static postures (iii) Force (iv) Contact stress
(6) Maintaining same position or posture while performing tasks	(i) Awkward posture (ii) Static postures (iii) Force (iv) Cold temperatures
(7) Sitting for a long time	(i) Awkward posture (ii) Static postures (iii) Contact stress

PHYSICAL WORK ACTIVITIES AND CONDITIONS	ERGONOMIC RISK FACTORS THAT MAY BE PRESENT
(8) Using hand and power tools	(i) Force (ii) Awkward postures (iii) Static postures (iv) Contact stress (v) Vibration (vi) Cold temperatures
(9) Vibrating working surfaces, machinery or vehicles	(i) Vibration (ii) Force (iii) Cold temperatures
(10) Workstation edges or objects press hard into muscles or tendons	(i) Contact stress
(11) Using hand as a hammer	(i) Contact stress (ii) Force
(12) Using hands or body as clamp to hold object while performing tasks	(i) Force (ii) Static postures (iii) Akward postures (iv) Contact stress
(13) Gloves are bulky, too large or too small	(i) Force (ii) Contact stress
MANUAL HANDLING (lifting/lowering, pushing/pulling and carrying)	
(14) Objects or people moved are heavy	(i) Force (ii) Repetition (iii) Awkward postures (iv) Static postures (v) Contact stress
(15) Horizontal reach is long (Distance of hands from body to grasp object to be handled)	(i) Force (ii) Repetition (iii) Awkward postures (iv) Static postures (v) Contact stress
(16) Vertical reach is below knees or above the shoulders (Distance of hands above the ground when the object is grasped or released)	(i) Force (ii) Repetition (iii) Awkward postures (iv) Static postures (v) Contact stress
(17) Objects or people are moved significant distance	(i) Force (ii) Repetition (iii) Awkward postures (iv) Static postures (v) Contact stress
(18) Bending or twisting during manual handling	(i) Force (ii) Repetition (iii) Awkward postures (iv) Static postures
(19) Object is slippery or has no handles	(i) Force (ii) Repetition (iii) Awkward postures (iv) Static postures
(20) Floor surfaces are uneven, slippery or sloped	(i) Force (ii) Repetition (iii) Awkward postures (iv) Static postures

(d) Evaluate the ergonomic risk factors in the job to determine the MSD hazards associated with the covered MSD. As necessary, evaluate the duration, frequency and magnitude of employee exposure to the risk factors.

§ 1910.919 What hazard control steps must I follow? You must:

(a) Ask employees in the problem job for recommendations about eliminating or materially reducing the MSD hazards;

(b) Identify, assess and implement feasible controls (interim and/or permanent) to eliminate or materially reduce the MSD hazards. This includes prioritizing the control of hazards, where necessary;

(c) Track your progress in eliminating or materially reducing the MSD hazards. This includes consulting with employees in problem jobs about whether the implemented controls have eliminated or materially reduced the hazards; and

(d) Identify and evaluate MSD hazards when you change, design or purchase equipment or processes in problem jobs.

§ 1910.920 What kinds of controls must I use?

(a) In this standard, you must use any combination of ‘‘engineering,’’ ‘‘administrative’’ and/or ‘‘work practice controls’’ to eliminate or materially reduce MSD hazards. Engineering controls, where feasible, are the preferred method for eliminating or materially reducing MSD hazards. However, administrative and work practice controls also may be important in addressing MSD hazards.

(b) ‘‘Personal protective equipment’’ (PPE) may be used to supplement engineering, work practice and administrative controls, but may only be used alone where other controls are not feasible. Where PPE is used, you must provide it at ‘‘no cost to employees.’’

Note to § 1910.920: Back belts/braces and wrist braces/splints are not considered PPE for the purposes of this standard.

§ 1910.921 How far must I go in eliminating or materially reducing MSD hazards when a covered MSD occurs?

The occurrence of a covered MSD in a problem job is not itself a violation of this standard. You must comply with one of the following:

(a) You implement controls that materially reduce the MSD hazards using the incremental abatement process in § 1910.922; or

Note to paragraph (a): ‘‘Materially reduce MSD hazards’’ means to reduce the duration, frequency and/or magnitude of exposure to one or more ergonomic risk factors in a way that is reasonably anticipated to significantly reduce the likelihood that covered MSDs will occur.

(b) You implement controls that reduce the MSD hazards to the extent feasible. Then, you periodically look to see whether additional controls are now feasible and, if so, you implement them promptly; or

(c) You implement controls that eliminate the MSD hazards in the problem job.

Note to paragraph (c): ''Eliminate MSD hazards'' means that you eliminate employee exposure to ergonomic risk factors associated with the covered MSD, or you reduce employee exposure to the risk factors to such a degree that a covered MSD is no longer reasonably likely to occur.

§ 1910.922 What is the ''incremental abatement process'' for materially reducing MSD hazards?

You may materially reduce MSD hazards using the following incremental abatement process:

(a) When a covered MSD occurs, you implement one or more controls that materially reduce the MSD hazards; and

(b) If continued exposure to MSD hazards in the job prevents the injured employee's condition from improving or another covered MSD occurs in that job, you implement additional feasible controls to materially reduce the hazard further; and

(c) You do not have to put in further controls if the injured employee's condition improves and no additional covered MSD occurs in the job. However, if the employee's condition does not improve or another covered MSD occurs, you must continue this incremental abatement process if other feasible controls are available.

Training

§ 1910.923 What is my basic obligation?

You must provide training to employees so they know about MSD hazards and your ergonomics program and measures for eliminating or materially reducing the hazards. You must provide training initially, periodically, and at least every 3 years at no cost to employees.

§ 1910.924 Who must I train?

You must train:

(a) Employees in problem jobs;

(b) Supervisors of employees in problem jobs; and

(c) Persons involved in setting up and managing the ergonomics program, except for any outside consultant you may use.

§ 1910.925 What subjects must training cover?

This table specifies the subjects training must cover:

YOU MUST PROVIDE TRAINING FOR...	SO THAT THEY KNOW...
(a) Employees in problem jobs and their supervisiors	(1) How to recognize MSD signs and symptoms; (2) How to report MSD signs and symptoms, and the importance of early reporting; (3) MSD hazards in their jobs and the measures they must follow to protect themselves from exposure to MSD hazards; (4) Job-specific controls implemented in their jobs; (5) The ergonomics program and their role in it; and (6) The requirements of this standard.
(b) Persons involved in setting up and managing the ergonomics program	(1) The subjects above; (2) How to set up and manage an ergonomics program; (3) How to identify and analyze MSD hazards and measures to eliminate or materially reduce the hazards; and (4) How to evaluate the effectiveness of ergonomics programs and controls.

§ 1910.926 What must I do to ensure that employees understand the training?

You must provide training and information in language that employees understand. You also must give employees an opportunity to ask questions and receive answers.

§ 1910.927 When must I train employees?

This table specifies when you must train employees:

IF YOU HAVE...	THEN YOU MUST PROVIDE TRAINING AT THESE TIMES...
(a) Employees in problem jobs and their supervisors	(1) When a problem job is identifed; (2) When initially assigned to a problem job; (3) Periodically as needed (*e.g.,* when new hazards are identified in a problem job or changes are made to a problem job that may increase exposure to MSD hazards); and (4) At least every 3 years.
(b) Persons involved in setting up and managing the ergonomics program	(1) When they are initially assigned to setting up and managing the ergonomics program; (2) Periodically as needed (*e.g.,* when evaluation reveals significant deficiencies in the program, when significant changes are made in the ergonomics program); and (3) At least every 3 years.

§ 1910.928 Must I retrain employees who have received training already?

No. You do not have to provide initial training to current employees, new employees and persons involved in setting up and managing the ergonomics programs if they have received training in the subjects this standard requires within the last 3 years. However, you must provide initial training in the subjects in which they have not been trained.

MSD Management

§ 1910.929 What is my basic obligation?

You must make MSD management available promptly whenever a covered MSD occurs. You must provide MSD management at no cost to employees. You must provide employees with the temporary ‘‘work restrictions’’ and ‘‘work restriction protection (WRP)’’ this standard requires.

§ 1910.930 How must I make MSD management available?

You must:

(a) Respond promptly to employees with covered MSDs to prevent their condition from getting worse;

(b) Promptly determine whether temorary work restrictions or other measures are necessary;

(c) When necessary, provide employees with prompt access to a ‘‘health care professional’’ (HCP) for evaluation, management and ‘‘follow-up,’’

(d) Provide the HCP with the information necessary for conducting MSD management; and

(e) Obtain a written opinion from the HCP and ensure that the employee is also promptly provided with it.

§ 1910.931 What information must I provide to the health care professional (HCP)?

You must provide:

(a) A description of the employee’s job and information about the MSD hazards in it;

(b) A description of available work restrictions that are reasonably likely to fit the employee’s capabilities during the recovery period;

(c) A copy of this MSD management section and a summary of the requirements of this standard;

(d) Opportunities to conduct workplace walkthroughs.

§ 1910.932 What must the HCP’s written opinion contain?

The written opinion must contain:

(a) The HCP’s opinion about the employee’s medical conditions related to the MSD hazard in the employee’s job.

(1) You must instruct the HCP that any findings, diagnoses or information not related to workplace exposure to MSD hazards must remain confidential and must not be put in the written opinion or communicated to you.

(2) To the extent permitted and required by law, you must ensure employee privacy and confidentiality regarding medical conditions related to workplace exposure to MSD hazards that are identified during the MSD management process;

(b) Any recommended temporary work restrictions and follow-up;

(c) A statement that the HCP informed the employee about the results of the evaluation and any medical conditions resulting from exposure to MSD hazards that require further evaluation or treatment;

(d) A statement that the HCP informed the employee about other physical activities that could aggravate the covered MSD during the recovery period.

§ 1910.933 What must I do if temporary work restrictions are needed?

You must:

(a) *Work restrictions.* Provide temporary work restrictions, where necessary, to employees with covered MSDs. Where you have referred the employee to a HCP, you must follow the temporary work restriction recommendations in the HCP’s written opinion;

(b) *Follow-up.* Ensure that appropriate follow-up is provided during the recovery period; and

(c) *Work restriction protection (WRP).* Maintain the employee’s WRP while temporary work restrictions are provided. You may condition the provision of WRP on the employee’s participation in the MSD management this standard requires.

§ 1910.934 How long must I maintain the employee’s work restriction protection when an employee is on temporary work restriction?

You must maintain the employee’s WRP until the FIRST of these occurs:

(a) The employee is determined to be able to return to the job;

(b) You implement measures that eliminate the MSD hazards or materially reduce them to the extent that the job does not pose a risk of harm to the injured employee during the recovery period; or

(c) 6 months have passed.

§ 1910.935 May I offset an employee’s WRP if the employee receives workers’ compensation or other income?

Yes. You may reduce the employee’s WRP by the amount the employee receives during the work restriction period from:

(a) Workers’ compensation payments for lost earnings;

(b) Payments for lost earnings from a compensation or insurance program that is publicly funded or funded by you; and

(c) Income from a job taken with another employer that was made possible because of the work restrictions.

Program evauation

§ 1910.936 What is my basic obligation?

You must evaluate your ergonomics program periodically, and at least every 3 years, to ensure that it is in compliance with this standard.

§ 1910.937 What must I do to evaluate my ergonomics program?

You must:

(a) Consult with employees in problem jobs to assess their views on the effectiveness of the program and to identify any significant deficiencies in the program;

(b) Evaluate the elements of your program to ensure they are functioning properly; and

(c) Evaluate the program to ensure it is eliminating or materially reducing MSD hazards.

§ 1910.938 What must I do if the evaluation indicates my program has deficiencies?

If your evaluation indicates that your program has deficiencies, you must promptly take action to correct those deficiencies so that your program is in compliance with this standard.

What Records Must I Keep?

§ 1910.939 Do I have to keep records of the ergonomics program?

You only have to keep records if you had 10 or more employees (including part-time employees and employees provided through personnel services) on any one day during the preceding calendar year.

§ 1910.940 What records must I keep and for how long?

This table specifies the records you must keep and how long you must keep them:

YOU MUST KEEP THESE RECORDS...	FOR AT LEAST...
(a) Employee reports and your responses	3 years
(b) Job hazard analysis	3 years or until replaced by updated records, whichever comes first
(c) Hazard control records	3 years or until replaced by updated records, whichever comes first
(d) Quick Fix control records	3 years or until replaced by updated records, whichever comes first
(e) Ergonomics program evaluation	3 years or until replaced by updated records, whichever comes first
(f) MSD management records	The duration of the injured employee's employment plus 3 years

Note to § 1910.940: The record retention period in this standard is shorter than that required by OSHA's rule on Access to Employee Exposure and Medical Records (29 CFR 1910.1020). However, you must comply with the other requirements of that rule.

When Must My Program Be In Place?

§ 1910.941 When does this standard become effective?

This standard becomes effective 60 days after [publication date of final rule].

§ 1910.942 When do I have to be in compliance with this standard?

This standard provides start-up time for setting up the ergonomics program and putting in controls in problem jobs. You must comply with the requirements of this standard, including recordkeeping, by the deadlines in this table:

YOU MUST COMPLY WITH THESE REQUIREMENTS AND RELATED RECORD-KEEPING...	NO LATER THAN...
(a) MSD management	Promptly when an MSD is reported
(b) Management leadership and employee participation	[1 year after the effective date of the final rule]
(c) Hazard information and reporting	[1 year after the effective date of the final rule]
(d) Job hazard analysis	[2 years after the effective date of the final rule]
(e) Interim controls	[2 years after the effective date of the final rule]
(f) Training	[2 years after the effective date of the final rule]
(g) Permanent controls	[3 years after the effective date of the final rule]
(h) Program evaluation	[3 years after the effective date of the final rule]

Note to § 1910.942: The compliance deadlines in this section do not apply if you are using a Quick Fix.

§ 1910.943 What must I do if some or all of the compliance deadlines have passed before a covered MSD is reported?

If the compliance start-up deadline has passed before you must comply with a particular element of this standard, you may take the following additional time to comply with that element and the related recordkeeping:

YOU MUST COMPLY WITH THESE REQUIREMENTS AND RELATED RECORD-KEEPING...	WITHIN...
(a) MSD management	5 days
(b) Management leadership and employee participation	30 days (In manufacturing and manual handling jobs, these requirements must be implemented by [1 year after the effective date of the final rule])
(c) Hazard information and reporting	30 days (In manufacturing and manual handling jobs, these requirements must be implemented by [1 year after the effective date of the final rule])
(d) Job hazard analysis	60 days
(e) Interim controls	90 days
(f) Training	90 days
(g) Permanent controls	1 year
(h) Program evaluation	1 year

Note to § 1910.943: The compliance deadlines in this section do not apply if you are using a Quick Fix.

§ 1910.944 May I discontinue certain aspects of my program if covered MSDs no longer are occurring?

Yes. However, as long as covered MSDs are reported in a job, you must maintain all the elements of the ergonomics program for that job. If you eliminate or materially reduce the MSD hazards and no covered MSD is reported for 3 years, you only have to continue the elements in this table:

IF YOU ELIMINATE OR MATERIALLY REDUCE THE HAZARDS AND NO COVERED MSD IS REPORTED FOR 3 YEARS IN...	THEN YOU MAY STOP ALL EXCEPT THE FOLLOWING PARTS OF YOUR PROGRAM IN THAT JOB...
(a) A manufacturing or manual handling job	(1) Management leadership and employee participation (2) Hazard information and reporting (3) Maintenance of implemented controls and training related to the controls.
(b) Other jobs in general industry where a covered MSD had been reported	Maintenance of controls and training related to the controls.

Definitions

§ 910.945 What are the key terms in this standard?

Administrative controls are changes in the way that work in a job is assigned or scheduled that reduce the magnitude, frequency or duration of exposure to ergonomic risk factors. Examples of administrative controls for MSD hazards include:

(1) Employee rotation;

(2) Job task enlargement;

(3) Alternative tasks;

(4) Employer-authorized changes in work pace.

Covered MSD is:

(1) An MSD, reported in any job in general industry, that meets these criteria:

(i) It is reported after [the effective date of the final rule];

(ii) It is an OSHA recordable MSD;

(iii) It occurred in a job in which the physical work activities and conditions are reasonably likely to cause or contribute to the type of MSD reported;

(iv) These activities and conditions are a core element and/or make up a significant amount of the employee's worktime.

(2) In a manufacturing or manual handling job, persistent MSD symptoms are also considered a covered MSD if they meet these criteria:

(i) They last for at least 7 consecutive days after they are reported;

(ii) The employer has knowledge that an MSD hazard exists in the job;

(iii) They occurred in a job in which the physical work activities and conditions are reasonably likely to cause or contribute to the type of MSD signs or symptoms reported; and

(iv) These activities and conditions are a core element and/or make up a significant amount of the employee's worktime.

Eliminate MSD hazards means to eliminate employee exposure to the ergonomic risk factors associated with the covered MSD, or to reduce employee exposure to the risk factors to such a degree that a covered MSD is no longer reasonably likely to occur.

Engineering controls are physical changes to a job that eliminate or materially reduce the presence of MSD hazards. Examples of engineering controls for MSD hazards include changing, modifying or redesigning the following:

(1) Workstations;

(2) Tools;

(3) Facilities;

(4) Equipment;

(5) Materials;

(6) Processes.

Ergonomics is the science of fitting jobs to people. Ergonomics encompasses the body of knowledge about physical abilities and limitations as well as other human characteristics that are relevant to job design.

Ergonomic design is the application of this body of knowledge to the design of the workplace (*i.e.*, work tasks, equipment, environment) for safe and efficient use by workers.

Ergonomic risk factors. (1) Ergonomic risk factors are the following aspects of a job that pose a biomechanical stress to the worker:

(i) Force (*i.e.*, forceful exertions, including dynamic motions);

(ii) Repetition;

(iii) Awkward postures;

(iv) Static postures;

(v) Contact stress;

(vi) Vibration; and

(vii) Cold temperatures.

(2) Ergonomic risk factors are elements of MSD hazards that must be considered in light of their combined effect in causing or contributing to an MSD. Jobs that have multiple risk factors have a greater likelihood of causing or contributing to MSDs, depending on the duration, frequency and magnitude of employee exposure to each risk factor or to a combination of them. Ergonomic risk factors are also call ergonomic stressors and ergonomic factors.

Follow-up is the process or protocol an employer and/or HCP uses to check up on the condition of employees with covered MSDs when they are given temporary work restrictions during the recovery period. Prompt follow-up helps to ensure that the MSD is resolving and, if it is not, that other measures are promptly taken.

Have knowledge means that you have been provided information that MSD hazards exist in a manufacturing or manual handling job by any of the following:

(1) An insurance company;

(2) A consultant;

(3) A health care professional;

(4) A person or persons working for you who have the requisite training to identify and analyze MSD hazards.

Health care professional (HCPs) are physicians or other licensed health care professionals whose legally permitted scope of practice (*e.g.*, license, registration or certification) allows them to independently provide or be delegated the responsibility to provide some or all of the MSD management requirements of this standard.

Job means the physical work activities or tasks that employees perform. In this standard, the term ''job'' also includes those jobs involving the same physical work activities and conditions even if the jobs have different titles or classification.

Manual handling jobs are jobs in which employees perform forceful lifting/lowering, pushing/pulling, or carrying. Manual handling jobs include only those jobs in which forceful manual handling is a core element of an employee's job. Although each job must be considered on the basis of its actual physical work conditions and work activities, this table lists jobs that typically are included in and excluded from this definition:

(1) EXAMPLES OF JOBS THAT TYPICALLY ARE MANUAL HANDLING JOBS	(2) EXAMPLES OF JOB/ TASKS THAT TYPICALLY ARE NOT MANUAL HANDLING JOBS
(i) Patient handling jobs (*e.g.,* nurses aides, orderlies, nurse assistants) (ii) Package sorting, handling and delivering (iii) Hand packing and packaging (iv) Baggage handling (*e.g.,* porters, airline baggage handlers, airline check-in) (v) Warehouse manual picking and placing (vi) Beverage delivering and handling (vii) Stock handling and bagging (viii) Grocery store bagging (ix) Grocery store stocking (x) Garbage collecting'	(i) Administrative jobs (ii) Clerical jobs (iii) Supervisory/managerial jobs that do not involve manual handling work (iv) Technical and professional jobs (v) Jobs involving unexpected manual handling (vi) Lifting object or person in emergency situation (*e.g.,* lifting or carrying injured co-worker) (vii) Jobs involving manual handling that is so infrequent it does not occur on any predictable basis (*e.g.,* filling in on a job due to unexpected circumstances, replacing empty water bottle, lifting of box of copier paper) (viii) Jobs involving manual handling that is done only on an infrequent ''as needed'' basis (*e.g.,* assisting with delivery of large or heavy package, filling in once for an absent employee) (ix) Jobs involving minor manual handling that is incidental to the job (*e.g.,* carrying briefcase to meeting, carrying baggage on work travel)

Manufacturing jobs are production jobs in which employees perform the physical work activities of producing a product and in which these activities make up a significant amount of their worktime. Although each job must be considered on the basis of its actual physical work conditions and work activities, this table lists jobs that typically are included in and excluded from this definition:

(1) EXAMPLES OF JOBS THAT TYPICALLY ARE MANUFACTURING JOBS	(2) EXAMPLES OF JOBS THAT TYPICALLY ARE NOT MANUFACTURING JOBS
(i) Assembly line jobs producing (A) Products (durable and non- durable) (B) Subassemblies (C) Components and parts (ii) Paced assembly jobs (assembling and disassembling) (iii) Piecework assembly jobs (assembling and disassembling) and other time-critical assembly jobs (iv) Product inspection jobs (*e.g.,* testers, weighers) (v) Meat, poultry, and fish cutting and packing (vi) Machine operation (vii) Machine loading/unloading (viii) Apparel manufacturing jobs (ix) Food preparation assembly line jobs (x) Commercial baking jobs (xi) Cabinetmaking (xii) Tire building	(i) Administrative jobs (ii) Clerical jobs (iii) Supervisory/managerial jobs that do not involve production work (iv) Warehouse jobs in manufacturing facilities (v) Technical and professional jobs (vi) Analysts and programmers (vii) Sales and marketing (viii) Procurement/purchasing jobs (ix) Customer service jobs (x) Mail room jobs (xi) Security guards (xii) Cafeteria jobs (xiii) Grounds keeping jobs (*e.g.,* gardeners) (xiv) Jobs in power plant in manufacturing facility (xv) Janitorial (xvi) Maintenance (xvii) Logging jobs (xviii) Production of food products (*e.g.,* bakery, candy and other confectionary products) primarily for direct sale on the premises to household customers.

Materially reduce MSD hazards means to reduce the duration, frequency and/or magnitude of exposure to one or more ergonomic risk factors in a way that is reasonably anticipated to significantly reduce the likelihood that covered MSDs will occur.

Musculoskeletal disorders (MSDs) are injuries and disorders of the muscles, nerves, tendons, ligaments, joints, cartilage and spinal discs. Exposure to physical work activities and conditions that involve risk factors may cause or contribute to MSDs. MSDs do not include injuries caused by slips, trips, falls, or other similar accidents. Examples of MSDs include:

(1) Carpal tunnel syndrome;

(2) Rotator cuff syndrome;

(3) De Quervain's disease;

(4) Trigger finger;

(5) Tarsal tunnel syndrome;

(6) Sciatica;

(7) Epicondylitis;

(8) Tendinitis;

(9) Raynaud's phenomenon;

(10) Carpet layers knee;

(11) Herniated spinal disc;

(12) Low back pain.

MSD hazards are physical work activities and/or physical work conditions, in which ergonomic risk factors are present, that are reasonably likely to cause or contribute to a covered MSD.

MSD management is your process for ensuring that employees with covered MSDs receive prompt and effective evaluation, management and follow-up, at no cost to them, in order to prevent permanent damage or disability from occurring.

(1) In this standard, the MSD management process includes:

(i) Evaluation, management and follow-up of injured employees by persons in the workplace and/or by HCPs; and

(ii) A method for identifying available work restrictions and promptly providing them when needed.

(2) MSD management does not include establishing specific medical treatment for MSDs. Medical treatment protocols and procedures are established by the health care professions.

MSD signs are objective physical findings that an employee may be developing an MSD. Examples of MSD signs include:

(1) Decreased range of motion;

(2) Deformity;

(3) Decreased grip strength;

(4) Loss of function.

MSD symptoms are physical indications that an employee may be developing an MSD. Symptoms can vary in severity, depending on the amount of exposure to MSD hazards. Symptoms often appear gradually as muscle fatigue or pain at work that disappears during rest. Symptoms usually become more severe as exposure continues (*e.g.,* tingling continues after work ends, numbness makes it difficult to perform the job, and finally pain is so severe the employee cannot perform the job). Examples of MSD symptoms include:

(1) Numbness;

(2) Burning;

(3) Pain;

(4) Tingling;

(5) Cramping;

(6) Stiffness.

No cost to employees means that PPE, training, MSD management and other requirements of this standard are provided to employees free of charge and while they are ''on the clock'' (*e.g.,* paying for time employees spend receiving training outside the work day).

OSHA recordable MSD is an MSD that meets the occupational injury and illness recording requirements of 29 CFR Part 1904. Under Part 1904, an MSD is recordable when:

(1) Exposure at work caused or contributed to the MSD or aggravated a pre- existing MSD.

(2) The MSD results in at least one of the following:

(i) A diagnosis of an MSD by an HCP.

(ii) A positive physical finding (*e.g.,* an MSD sign or a positive Finkelstein's, Phalen's, or Tinel's test result).

(iii) An MSD symptom plus at least one of these:

(A) Medical treatment;

(B) One or more lost work days;

(C) Restricted work activity;

(D) Transfer or rotation to another job.

Periodically means that a process or activity, such as records review or training, is performed on a regular basis that is appropriate for the conditions in the workplace. Periodically also means that the process or activity is conducted as often as needed, such as when significant changes are made in the workplace that may result in increased exposure to MSD hazards.

Persistent MSD symptoms are ''MSD symptoms'' that persist for at least 7 consecutive days after they are reported.

Personal protective equipment (PPE) is equipment employees wear that provides an effective protective barrier between the employee and MSD hazards. Examples of PPE are vibration-reduction gloves and carpet layer's knee pads.

Physical work activities are the physical demands, exertions and functions of the task or job.

Problem job is a job in which a covered MSD is reported. A problem job also includes any job in the workplace that involves the same physical work activities and conditions as the one in which the covered MSD is reported, even if the jobs have different titles or classifications.

Resources are the provisions necessary to develop, implement and maintain an effective ergonomics program. Resources include money (*e.g.,* to purchase items such as job hazard analysis equipment, training materials, and controls), personnel, and work time to conduct program responsibilities (*e.g.,* job hazard analysis, program evaluation).

Work practice controls are changes in the way an employee performs the physical work activities of a job that reduce exposure to MSD hazards. Work practice controls involve procedures and methods for safe work. Examples of work practice controls for MSD hazards include:

(1) Training in proper work postures;

(2) Training in use of the appropriate tool;

(3) Employer-authorized micro breaks.

Work restriction protection (WRP) means the maintenance of the earnings and other employment rights and benefits of employees who are on temporary work restrictions as though they had not been placed on temporary work restriction. For employees who are on restricted work activity, WRP includes maintaining 100% of the after-tax earnings employees with covered MSDs were receiving at the time they were placed on restricted work activity. For employees who have been removed from the workplace, WRP includes maintaining 90% of the after-tax earnings. Benefits mean 100% of the non-wage-and- salary value employees were receiving at the time they were placed on restricted work activity or were removed from the workplace. Benefits include seniority, insurance programs, retirement benefits and savings plans.

Work restrictions are limitations on an injured employee's exposure to MSD hazards during the recovery period. Work restrictions may involve limitations on the work activities of the employee's current job, transfer to temporary alternative duty jobs, or complete removal from the workplace. To be effective, work restrictions must not expose the injured employee to the same MSD hazards as were present in the job giving rise to the covered MSD.

You means the employer as defined by the Occupational Safety and Health Act of 1970 (29 U.S.C. 651 et seq.).

[FR Doc. 99–28981 Filed 11–22–99; 8:45 am]

BILLING CODE 4510–26–P