

**INJURIES, ILLNESSES,  
AND HAZARDOUS EXPOSURES  
IN THE MINING INDUSTRY,  
1986-1995:  
A SURVEILLANCE REPORT**

**U.S. Department of Health and Human Services**  
Public Health Service  
Centers for Disease Control and Prevention  
National Institute for Occupational Safety and Health  
Washington, DC

May 2000

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## FOREWORD

This publication represents the first comprehensive surveillance report on injuries and illnesses in the U.S. mining industry. The tracking of occupational injuries, illnesses, and hazards, documents the Nation's progress in reducing the burden of work-related diseases and injuries and may help identify old and new problems that require additional research and prevention efforts. It is through surveillance data that we have been able to document that during the 20<sup>th</sup> century, deaths in the mining industry dropped approximately 37-fold and injury fatality rates have decreased approximately 13-fold, to 25 per 100,000 during 1996-1997. Much of this success can be attributed to research, which led to workplace interventions (such as safer equipment and improved ventilation), and regulations. Despite the progress that has been made in reducing the death and injury toll in mining, much work remains to be done.

The National Institute for Occupational Safety and Health is now the only federal agency with a mandate to conduct research and prevention activities for all the nation's workers, including the vital mining workforce. There are many challenges facing NIOSH in the field of mine safety and health in the new millennium. Traditional causes of injuries and fatalities and the potential for underground disasters still exist in U.S. mines today. For example, mine roof collapses account for a large portion of underground deaths and injuries. Respirable coal mine dust, which can lead to "black lung" disease, and harmful noise levels remain persistent health concerns. In addition, the introduction of new mining technologies may create new hazards not yet recognized in the field.

NIOSH is well positioned to meet these challenges and will continue to draw on its strong background of research, partnership, and prevention coupled with solutions-oriented engineering expertise. NIOSH will aggressively continue to develop the science and technology necessary to protect the safety and health of U.S. mine workers into the 21st century.

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Director

## ACKNOWLEDGMENTS

This report was prepared primarily by Deborah D. Landen, Barbara Fotta, Richard C. Wang, Barbara D. Makowski, and Robert J. Tuchman of the Office for Mine Safety and Health Research, Pittsburgh Research Laboratory, and by Larry A. Layne of the Division of Safety Research, NIOSH.

Ted Lowe of the Office for Mining Safety and Health Research, Spokane Research Laboratory, and E. William Rossi of the Pittsburgh Research Laboratory created the maps. Janet M. Hale of the Division of Respiratory Disease Studies contributed analyses of occupational respiratory sampling data. Carol A. Burnett of the Division of Surveillance, Hazard Evaluations, and Field Studies contributed analyses of death certificate data. Lynette K. Hartle and Pamela K. Schumacher of the Division of Surveillance, Hazard Evaluations, and Field Studies, and Linda H. Plybon of the Education and Information Division assisted with coding of Mine Safety and Health Administration job titles into U.S. Bureau of the Census groupings. Lynn L. Rethi and Michael J. Brnich, Jr., of the Office for Mine Safety and Health Research, Pittsburgh Research Laboratory, assisted with classification of miners' work activities.

## ABBREVIATIONS

|                   |   |
|-------------------|---|
| ANSI              | American National Standards Institute                 |
| BLS               | U.S. Bureau of Labor Statistics                       |
| BOC               | U.S. Bureau of the Census                             |
| CFOI              | Census of Fatal Occupational Injuries                 |
| CFR               | Code of Federal Regulations                           |
| CI                | confidence interval                                   |
| CPS               | Current Population Survey                             |
| dB                | decibel(s)  |
| dba               | decibel(s), A-weighted                                |
| hr                | hour(s)   |
| ICD               | International Classification of Disease               |
| ISO               | International Organization for Standardization        |
| kHz               | kilohertz   |
| L/min             | liter(s) per minute                                   |
| lb                | pound(s)  |
| mg                | milligram(s)  |
| mg/m <sup>3</sup> | milligram(s) per cubic meter                          |
| MIPS              | Mining Industry Population Survey                     |
| MRE               | Mines Research Establishment                          |
| MSHA              | Mine Safety and Health Administration                 |
| NCHS              | National Center for Health Statistics                 |
| NEC               | not elsewhere classified                              |
| NIOSH             | National Institute for Occupational Safety and Health |
| NOHSM             | National Occupational Health Survey of Mining         |
| NOMS              | National Occupational Mortality Surveillance          |
| OSHA              | Occupational Safety and Health Administration         |
| PEL               | permissible exposure limit                            |
| PMR               | proportionate mortality ratio                         |
| SIC               | Standard Industrial Classification                    |
| U.K.              | United Kingdom  |
| USBM              | U.S. Bureau of Mines                                  |

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Table 6-9. Percent of workers potentially exposed to musculoskeletal overload conditions by condition and commodity, National Occupational Health Survey of Mining (NOHSM), 1984-1989.

## INTRODUCTION

This surveillance report summarizes data on work-related fatal and nonfatal injuries, illnesses, and hazardous exposures in the mining industry for the 10-year period 1986-1995. The term “surveillance,” as used in public health, may be new to many readers of this report. With regard to occupational safety and health, the goal of surveillance is to describe the occurrence of work-related injuries, illnesses, and known hazardous exposures; to identify new hazards that may occur due to the introduction of new technology or other factors; and to assess the effects of preventive measures designed to improve worker safety and health. Surveillance provides an overall picture, which can be used to focus resources on areas most in need of prevention programs or further research.

Surveillance generally requires the use of multiple sources of data, all of which have their own strengths and limitations. Surveillance in the U.S. mining industry is complicated by the fact that U.S. national data systems that provide information on mining are based on *two different definitions of the mining industry*. One is established by the Mine Safety and Health Administration (MSHA), the other by the Standard Industrial Classification (SIC) System [Office of Management and Budget 1987] and the 1980 U.S. Bureau of the Census (BOC) Classification System [U.S. Bureau of the Census 1982].

The mining industry as defined by MSHA is based on the regulatory jurisdiction of that agency. Reporting requirements for injuries, illnesses, and workplace exposures are stipulated under the Federal Coal Mine Health and Safety Act of 1969 and the Federal Mine Safety and Health Amendments Act of 1977. Of note is that the oil and gas extraction industry falls outside of MSHA jurisdiction. The Occupational Safety and Health Administration (OSHA) was charged with enforcement in the oil and gas industry under the Occupational Safety and Health Act of 1970.

Under the SIC, the definition of mining covers the extraction of naturally occurring minerals, including liquids (petroleum), gases (natural gas) and solids (coal, metal, and nonmetallic minerals). Exploration and development of mineral properties are also included in the SIC definition of the mining industry. The SIC was developed by the Office of Management and Budget for use in classifying establishments based on the type of economic activity in which they are engaged and serves as the industry classification standard for all establishment-based Federal economic statistics. This classification is important for occupational safety and health surveillance because it also serves as the industry classification system for all data on work-related injuries and illnesses collected by the U.S. Bureau of Labor Statistics (BLS).

The U.S. Bureau of the Census uses an industry coding scheme similar to that used by the SIC. For the mining

industry, the categorization is identical in both systems. Death certificate data made available by the National Center for Health Statistics (NCHS) are categorized under this system. Death certificate data are particularly important for surveillance of mortality from work-related illnesses.

Key differences between the SIC/BOC categorization system and the MSHA system can be summarized as follows:

- MSHA excludes the oil and gas industry, which is classified as part of the mining industry under SIC/BOC.
- MSHA excludes work that is done off of mine property; work off of mine property is included under SIC/BOC if it is performed by an establishment falling into one of the SIC/BOC mining industry codes.
- MSHA includes mine-associated mills and processing plants; these are classified under the manufacturing industry, rather than mining, according to the SIC/BOC coding structure.

Since the data collected by MSHA and the data collected by BLS and NCHS using the SIC/BOC classification system are both important sources of information on the mining industry and in many cases serve different purposes, data from both systems are presented in this report. In general, data using the SIC/BOC system are comparable across U.S. industries and should be used when comparing mining to other U.S. industries.

Much of the data in this report are presented in the form of frequencies or rates. A frequency provides only a count of the number of cases without providing any information about the risk of occurrence. Rates provide an estimate of the risk of injury or illness. *The reader is cautioned, however, that rates based on small numbers can be unstable; thus, any inferences should be drawn with care.* In this report, no rates are presented for groups in which there were fewer than three cases.

The incidence of most injury and illness conditions differs by age, sex, and race. For this reason, data in many surveillance reports are adjusted for these demographic factors. It was not possible to do this for most of the rates in this report because information on demographics was not available. With the exception of the proportionate mortality ratios (PMRs), all data presented are unadjusted.

A detailed account of the sources of data is in appendix A. The methods used in data selection and analysis are described in appendix B.

## CHAPTER 1. FATAL INJURIES IN THE MINING INDUSTRY: CENSUS OF FATAL OCCUPATIONAL INJURIES

An examination of the Census of Fatal Occupational Injuries (CFOI) data for the period 1992-1995 shows that 659 fatalities occurred in the mining industry as defined by the SIC. Oil and gas accounted for slightly more than one-half of all fatalities (figure 1-1). The coal industry had the highest fatality rate for the 4-year period, with 35.6 deaths per 100,000 full-time workers, followed by metal (23.1 per 100,000), oil and gas (23.1 per 100,000), and nonmetal (20.1 per 100,000). The fatality rate for all U.S. industries during this same period was 5.1 per 100,000 full-time workers. Figure 1-2 compares the fatal injury rates by year for the four major industry sectors of mining to the fatality rate for all industries combined.

Figure 1-3 compares age-specific fatality rates in the mining industry to those seen for U.S. industry as a whole. Fatality rates for all industries combined were lowest for young workers and steadily increased in relation to workers' ages. In the mining industry, fatality rates by age group show a U-shaped curve. Young workers under 20 years of age had the highest injury rate (54.6 per 100,000), followed by workers aged 20-24 (50.8 per 100,000) and workers over age 65 (37.7 per 100,000).

Table 1-1 shows the distribution of injuries by type of injury event. The mining industry, in comparison with all industries, had a considerably larger proportion of fatalities classified as *caught in or crushed by collapsing materials* (9.1% and 1.9%, respectively) and *fires and explosions* (10.0% and 3.1%, respectively). *Transportation events* comprised the largest proportion of fatal injuries in both the mining industry and all industries. Within the mining industry only, *transportation* accounted for the largest proportion of fatalities in all mining sectors except coal. A more detailed examination of the transportation events within the mining industry showed that highway incidents (50.5%) were the most common, followed by nonhighway incidents (22.2%), pedestrian incidents (10.6%), and those incurred during rail, water, and air transport (15.7%). Incidents involving *caught in or crushed by collapsing materials* comprised a higher percentage of injuries in the coal and metal sectors, while fall-from-height incidents were more frequent in the oil and gas sector. The classification system used in CFOI for type of injury event is not compatible with any variables contained in the MSHA data; therefore, direct comparisons are not attempted.

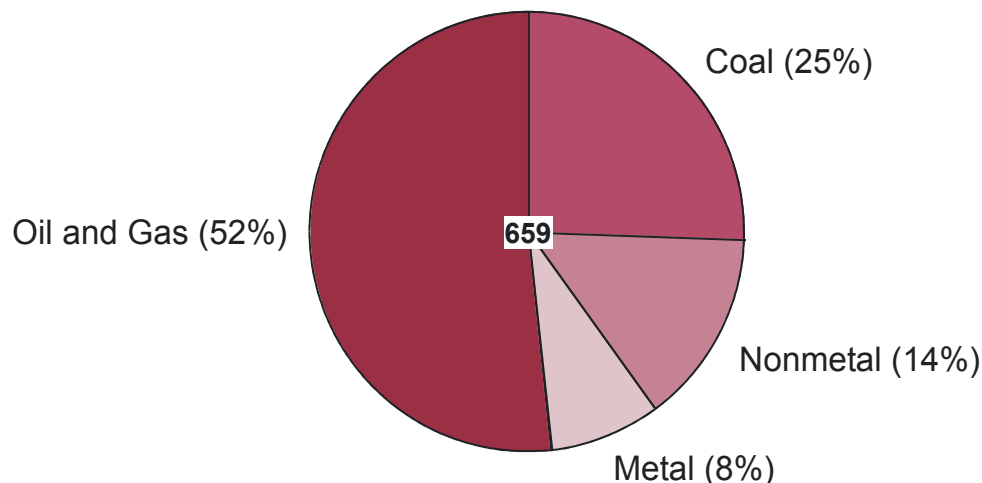


Figure 1-1.—Percentage of fatal injuries in the mining industry by industry sector, 1992-1995. (Note: “Nonmetal” Includes nonmetallic minerals, stone, and sand and gravel.) (Source: CFOI data-BLS)

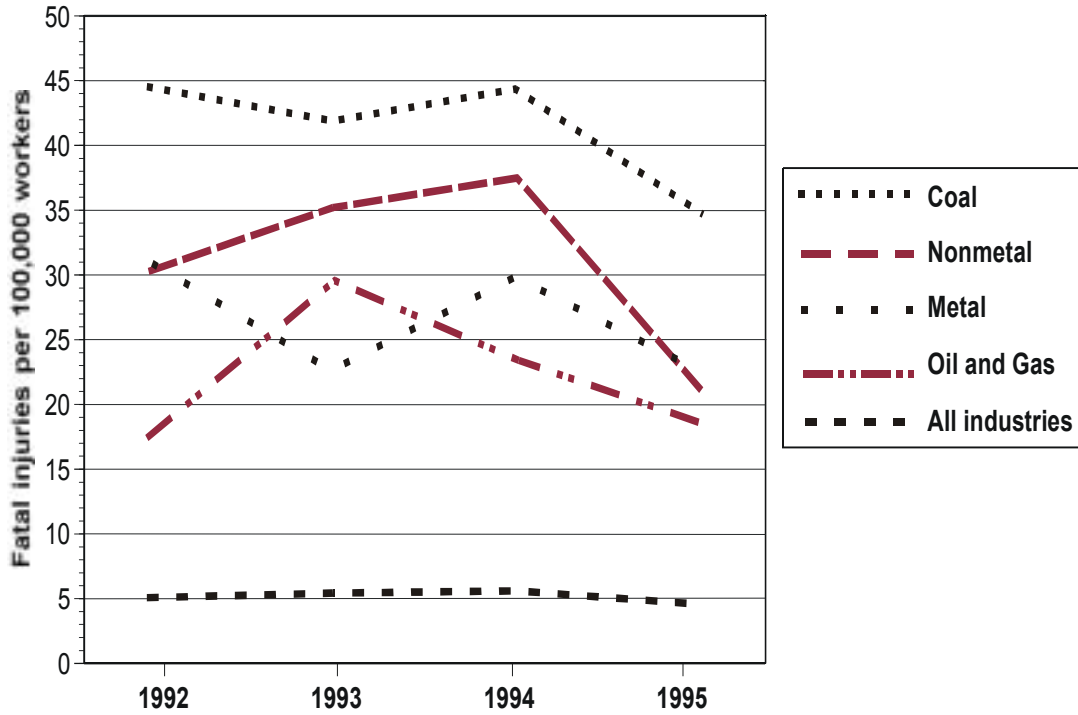


Figure 1-2.—Rate of fatal injuries (per 100,000 workers) in the mining industry by industry sector, and in all industries, 1992-1995. (Note: “Nonmetal” includes nonmetallic minerals, stone, and sand and gravel.) (Source: CFOI data-BLS)

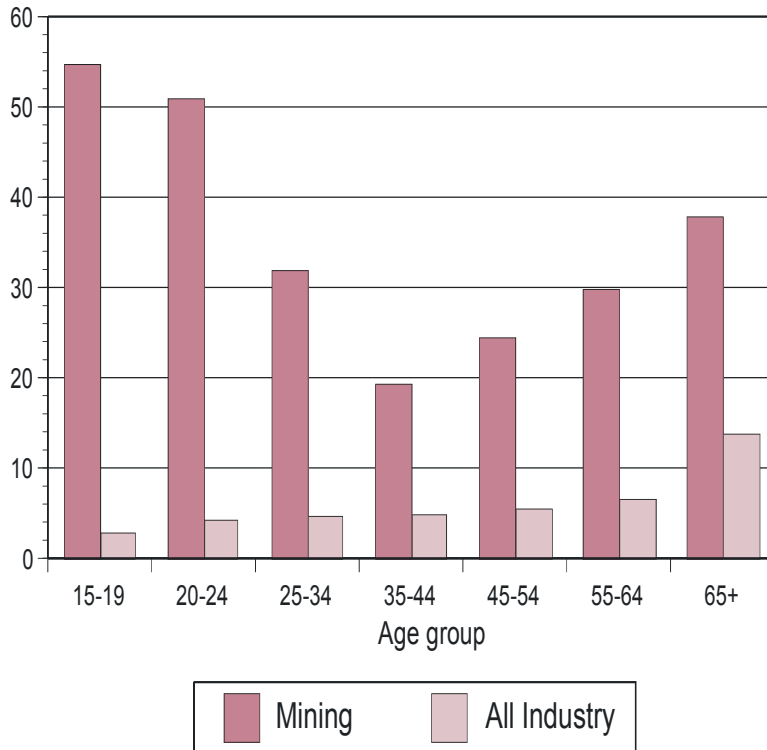


Figure 1-3.—Rates of fatal injuries (per 100,000 workers) by age group in the mining industry and in all industry, 1992-1995. (Source: CFOI data-BLS)



**Table 1-1.—Number and percent of fatal injuries by type of event for all U.S. industries and for the mining industry by sector, 1992-1995.**

| Injury event                                    | Coal          | Nonmetal      | Metal         | Oil and gas    | All mining     | All industries    |
|---|---------------|---------------|---------------|----------------|----------------|-------------------|
| Struck by falling object                        | 18<br>(10.7%) | 2<br>(2.1%)   | 7<br>(12.7%)  | 43<br>(12.6%)  | 70<br>(10.6%)  | 1,400<br>(5.6%)   |
| Caught in or compressed by equipment or Objects | 31<br>(18.5%) | 9<br>(7.4%)   | 2<br>(3.6%)   | 15<br>(4.4%)   | 57<br>(8.6%)   | 1,157<br>(4.6%)   |
| Caught in or crushed by collapsing materials    | 35<br>(20.8%) | 11<br>(11.6%) | 10<br>(18.2%) | 4<br>(1.2%)    | 60<br>(9.1%)   | 478<br>(1.9%)     |
| Fall from height                                | 3<br>(1.8%)   | 6<br>(6.3%)   | 2<br>(3.6%)   | 28<br>(8.2%)   | 39<br>(5.9%)   | 2,113<br>(8.4%)   |
| Electric current                                | 13<br>(7.7%)  | 6<br>(6.3%)   | 1<br>(1.8%)   | 26<br>(7.6%)   | 46<br>(7.0%)   | 1,348<br>(5.4%)   |
| Transportation                                  | 34<br>(20.2%) | 37<br>(38.9%) | 21<br>(38.2%) | 106<br>(31.1%) | 198<br>(30.0%) | 10,251<br>(40.8%) |
| Fires and explosions                            | 19<br>(11.3%) | 7<br>(7.4%)   | 4<br>(7.3%)   | 36<br>(10.6%)  | 66<br>(10.0%)  | 772<br>(3.1%)     |
| All other                                       | 15<br>(8.9%)  | 17<br>(17.9%) | 8<br>(14.5%)  | 83<br>(24.3%)  | 123<br>(18.7%) | 8,991<br>(35.8%)  |
| Total   | 168<br>(100%) | 95<br>(100%)  | 55<br>(100%)  | 341<br>(100%)  | 659<br>(100%)  | 25,110<br>(100%)  |

Source: Census of Fatal Occupational Injuries.

## CHAPTER 2. PROPORTIONATE MORTALITY RATIOS: NATIONAL OCCUPATIONAL MORTALITY SURVEILLANCE DATA

This chapter presents proportionate mortality ratios (PMRs) derived from death certificate data in the National Occupational Mortality Surveillance (NOMS) database for the years 1986 through 1993. At the time this report was prepared, 1993 was the latest year for which data were available. Industry is classified under the 1980 U.S. Bureau of the Census classification system [Bureau of the Census 1982]; cause of death, under the International Classification of Diseases, Ninth Revision (ICD-9) [World Health Organization 1977].

A PMR of 100 indicates a mortality risk for a particular industry group that is similar to that for all industry groups combined. A PMR over 100 suggests a higher risk; a PMR under 100 suggests a lower risk. PMRs are subject to many factors that affect their reliability and validity and may not be comparable across populations with very different causes of death. An elevated PMR for a specified cause of death among an occupational or industry group *may* indicate a relationship between a work exposure and the cause of death specified. However, there are many limitations of PMRs as a measure of risk; they are most useful for generating hypotheses about exposure-disease relationships, which can then be tested in other studies.

Selected PMRs are presented separately for males and females for coal mining, metal mining, nonmetallic mineral mining and quarrying (which includes nonmetal, stone, and sand and gravel), and for oil and gas extraction. All PMRs have been adjusted for age and race. In general, PMRs are presented

only if the lower 95% confidence limit exceeded 100. If a PMR in an ICD-9 subcategory was above 100, however, the PMR for the larger category into which the subcategory falls is always presented and may be less than 100.

PMRs can be expected to be elevated for conditions that have a high prevalence in particular occupational groups. PMRs showed elevated values for conditions known to affect miners, such as coal workers' pneumoconiosis, pneumoconiosis due to silica, tuberculosis, chronic pulmonary heart disease, and injuries. Additional findings of interest were—

- An elevated PMR for myocardial infarction among male coal miners (table 2-1);
- Elevated PMRs for neurologic disease in general and anterior horn cell disease, in particular among male metal miners (table 2-3);
- An elevated PMR for rheumatic heart disease in male metal miners (table 2-3);
- Elevated PMRs for malignant neoplasms of the digestive organs and peritoneum and for malignant neoplasms of the colon and rectum in female nonmetal miners (table 2-6); and
- Elevated PMRs for non-A, non-B hepatitis and arteriosclerotic heart disease among male oil and gas workers (table 2-7).

**Table 2-1.—Male workers age 18 and older with usual industry on death certificate listed as coal mining, selected States: proportionate mortality ratios and 95% confidence intervals for selected ICD classified causes of death, 1986-1993; adjusted for age and race. Total deaths = 46,451**

| Cause of death (ICD-9 code)                           | No.    | PMR   | 95% CI       |
|---|--------|-------|--------------|
| Infectious and parasitic diseases (001-139)           | 575    | 74    | 68, 80       |
| Tuberculosis (010-018, 137)                           | 73     | 204   | 160, 256     |
| Pulmonary tuberculosis (011)                          | 62     | 233   | 179, 299     |
|   |        |       |              |
| Malignant neoplasms (140-208)                         | 10,205 | 90    | 88, 91       |
| Malignant neoplasm, trachea, bronchus, and lung (162) | 4,173  | 108   | 105, 111     |
|   |        |       |              |
| Diseases of the heart (390-398, 402, 404-429)         | 16,848 | 98    | 97, 99       |
| Ischemic heart disease (410-414)                      | 11,856 | 97    | 96, 99       |
| Acute myocardial infarction (410)                     | 6,621  | 103   | 101, 105     |
| Other ischemic heart disease (411-414)                | 5,235  | 91    | 88, 93       |
|   |        |       |              |
| Diseases of the respiratory system (460-519)          | 8,771  | 175   | 172, 177     |
| Chronic obstructive pulmonary disease (490-496)       | 3,335  | 128   | 125, 132     |
| Coal workers' pneumoconiosis (500)                    | 3,145  | 3,743 | 3,722, 3,764 |
| Pneumoconiosis due to silica (502)                    | 49     | 513   | 380, 679     |
| Other and unspecified pneumoconiosis (503-505)        | 151    | 1,686 | 1,428, 1,977 |
|   |        |       |              |
| External causes of injury and poisoning (E800-E999)   | 2,279  | 108   | 104, 112     |

Source: National Occupational Mortality Surveillance (NOMS) database.

**Table 2-2.—Female workers age 18 and older with usual industry on death certificate listed as coal mining, selected States: proportionate mortality ratios and 95% confidence intervals for selected ICD classified causes of death, 1986-1993; adjusted for age and race. Total deaths = 387**

| Cause of death (ICD-9 code)                               | No. | PMR    | 95% CI        |
|---|-----|--------|---------------|
| Malignant neoplasms (140-208)                             | 79  | 91     | 72, 114       |
| Malignant neoplasm connective and other soft tissue (171) | 3   | 521    | 107, 1522     |
|   |     |        |               |
| Diseases of the respiratory system (460-519)              | 40  | 117    | 84, 159       |
| Coal workers' pneumoconiosis (500)                        | 2   | 73,000 | 8,839, >9,999 |
| Other and unspecified pneumoconiosis (503-505)            | 1   | 22,000 | 540, >9,999   |
|   |     |        |               |
| External causes of injury and poisoning (E800-E999)       | 24  | 182    | 117, 271      |

Source: National Occupational Mortality Surveillance (NOMS) database.

**Table 2-3.—Male workers age 18 and older with usual industry on death certificate listed as metal mining, selected States: proportionate mortality ratios and 95% confidence intervals for selected ICD classified causes of death, 1986-1993; adjusted for age and race. Total deaths = 5,542**

| Cause of death (ICD-9 code)   | No.   | PMR   | 95% CI       |
|---|-------|-------|--------------|
| Infectious and parasitic diseases (001-139)   | 67    | 65    | 51, 83       |
| Tuberculosis (010-018, 137)   | 12    | 271   | 140, 173     |
|   |       |       |              |
| Diseases of the nervous system and sense organs (320-389)                           | 116   | 120   | 99, 144      |
| Anterior horn cell disease (335)  | 19    | 180   | 108, 280     |
|   |       |       |              |
| Diseases of the heart (390-398, 402, 404-429)                                       | 1,733 | 86    | 83, 90       |
| Rheumatic fever and rheumatic heart disease (390-398)                               | 19    | 182   | 110, 284     |
| Other forms of heart disease, including diseases of pulmonary circulation (415-429) | 574   | 110   | 101, 119     |
|   |       |       |              |
| Diseases of the respiratory system (460-519)  | 784   | 141   | 131, 151     |
| Pneumonia and influenza (480-487)   | 223   | 122   | 107, 139     |
| Chronic obstructive pulmonary disease (490-496)                                     | 423   | 144   | 131, 158     |
| Pneumoconiosis due to silica (502)  | 37    | 3,575 | 2,517, 4,928 |
| Other and unspecified pneumoconiosis (503-505)                                      | 6     | 598   | 220, 1302    |
|   |       |       |              |
| External causes of injury and poisoning (E800-E999)                                 | 472   | 137   | 125, 150     |

Source: National Occupational Mortality Surveillance (NOMS) database.

**Table 2-4.—Female workers age 18 and older with usual industry on death certificate listed as metal mining, selected States: proportionate mortality ratios and 95% confidence intervals for selected ICD classified causes of death, 1986-1993; adjusted for age and race. Total deaths = 189**

| Cause of death (ICD-9 code)                         | No. | PMR | 95% CI   |
|---|-----|-----|----------|
| Diseases of the respiratory system (460-519)        | 24  | 156 | 100, 232 |
|   |     |     |          |
| External causes of injury and poisoning (E800-E999) | 19  | 147 | 89, 230  |

Source: National Occupational Mortality Surveillance (NOMS) database.

**Table 2-5.—Male workers age 18 and older with usual industry on death certificate listed as nonmetallic mining and quarrying, selected States: proportionate mortality ratios and 95% confidence intervals for selected ICD classified causes of death, 1986-1993; adjusted for age and race. Total deaths = 5,384**

| Cause of death (ICD-9 code)  | No.   | PMR   | 95% CI       |
|--|-------|-------|--------------|
| Infectious and parasitic diseases (001-139)                          | 69    | 66    | 51, 83       |
| Tuberculosis (010-018, 137)  | 9     | 202   | 92, 383      |
| Pulmonary tuberculosis (011)   | 8     | 242   | 105, 478     |
|  |       |       |              |
| Malignant neoplasms (140-208)  | 1,306 | 96    | 92, 101      |
| Malignant neoplasm of respiratory and intrathoracic organs (160-165) | 525   | 110   | 101, 120     |
|  |       |       |              |
| Diseases of the heart (390-398, 402, 404-429)                        | 1,884 | 98    | 95, 102      |
| Chronic pulmonary heart disease (416)                                | 11    | 238   | 119, 426     |
|  |       |       |              |
| Diseases of the respiratory system (460-519)                         | 643   | 122   | 113, 132     |
| Chronic obstructive pulmonary disease (490-496)                      | 372   | 134   | 121, 148     |
| Pneumoconiosis due to silica (502)                                   | 24    | 2,318 | 1,485, 3,450 |
|  |       |       |              |
| External causes of injury and poisoning (E800-E999)                  | 393   | 116   | 105, 128     |

Source: National Occupational Mortality Surveillance (NOMS) database.

**Table 2-6.—Female workers age 18 and older with usual industry on death certificate listed as nonmetallic mining and quarrying, selected States: proportionate mortality ratios and 95% confidence intervals for selected ICD classified causes of death, 1986-1993; adjusted for age and race. Total deaths = 185**

| Cause of death (ICD-9 code)                                    | No. | PMR | 95% CI   |
|--|-----|-----|----------|
| Malignant neoplasms (140-208)                                  | 50  | 111 | 83, 147  |
| Malignant neoplasm, digestive organs, and peritoneum (150-159) | 19  | 182 | 109, 283 |
| Malignant neoplasm, colon (153)                                | 13  | 275 | 146, 470 |
|  |     |     |          |
| External causes of injury and poisoning (E800-E999)            | 15  | 205 | 115, 337 |

Source: National Occupational Mortality Surveillance (NOMS) database.

**Table 2-7.—Male workers age 18 and older with usual industry on death certificate listed as petroleum and natural gas extraction, selected States: proportionate mortality ratios and 95% confidence intervals for ICD classified causes of death; adjusted for age and race. Total deaths = 13,840**

| Cause of death (ICD-9 code)                           | No.   | PMR | 95% CI   |
|---|-------|-----|----------|
| Infectious and parasitic diseases (001-139)           | 186   | 66  | 57, 76   |
| Non-A, non-B viral hepatitis (0704-0709)              | 10    | 277 | 133, 509 |
|   |       |     |          |
| Malignant neoplasms (140-208)                         | 3,331 | 100 | 97, 103  |
| Malignant neoplasm, trachea, bronchus, and lung (162) | 1,242 | 109 | 104, 115 |
|   |       |     |          |
| Diseases of the heart (390-398, 402, 404-429)         | 5,038 | 102 | 100, 104 |
| Ischemic heart disease (410-414)                      | 3,635 | 103 | 101, 106 |
| Acute myocardial infarction (410)                     | 1,954 | 104 | 100, 108 |
| Other ischemic heart disease (411-414)                | 1,681 | 102 | 98, 107  |
|   |       |     |          |
| External causes of injury and poisoning (E8000-E999)  | 1,225 | 119 | 115, 124 |

Source: National Occupational Mortality Surveillance (NOMS) database.

**Table 2-8.—Female workers age 18 and older with usual industry on death certificate listed as petroleum and natural gas extraction, selected States: proportionate mortality ratios and 95% confidence intervals for ICD classified causes of death; adjusted for age and race. Total deaths = 806**

| Cause of death (ICD-9 code)                         | No. | PMR | 95% CI  |
|---|-----|-----|---------|
| Malignant neoplasms (140-208)                       | 238 | 109 | 96, 124 |
|   |     |     |         |
| External causes of injury and poisoning (E800-E999) | 47  | 121 | 89, 161 |

Source: National Occupational Mortality Surveillance (NOMS) database.

### CHAPTER 3. EMPLOYMENT AND ACTIVE MINING OPERATIONS: MSHA DATA

This chapter presents MSHA data on mine employment and active mining operations during 1986-1995. Figures 3-1 through 3-10 show, for each commodity, the location of mine operations in 1995, and employee hours and active mining operations by year during 1986-1995 for mine operators.

For coal and nonmetal operators, the number of active mining operations and the number of employee hours decreased over the 10-year period. For metal operators, the number of active operations decreased, while the number of employee hours increased. For stone and sand and gravel operators, the number of active operations and the number of employee hours remained about the same.

Figures 3-11 and 3-12 show that over the 10-year period, there was an increase in the proportion of hours worked by contractors in coal mining, while the overall employment decreased. For metal, nonmetal, stone, and sand and gravel combined, the proportion of contractor hours increased, with overall employment also increasing.

Table 3-1 shows the distribution of hours worked during 1986-1995 by commodity and type of operation. For coal, the majority of hours worked were in underground mines. For metal, nonmetal, and stone, the largest number of hours worked were in mills and preparation plants. For sand and gravel, all work hours other than office were in surface mines.

**Table 3-1.—Number and percent of employee hours (in millions) by commodity and type of operation for operators, 1986-1995.**

| Type of operation               | Coal              |         | Metal             |         | Nonmetal          |         | Stone             |         | Sand and gravel   |         |
|---------------------------------|-------------------|---------|-------------------|---------|-------------------|---------|-------------------|---------|-------------------|---------|
|                                 | Hours in millions | (%)     | Hours in millions | (%)     | Hours in millions | (%)     | Hours in millions | (%)     | Hours in millions | (%)     |
| <b>Underground mines</b>        |                   |         |                   |         |                   |         |                   |         |                   |         |
| Underground operations          | 1,210.50          | (46.0)  | 127.85            | (13.2)  | 70.44             | (11.2)  | 30.83             | (2.0)   | NA                | NA      |
| Surface operations              | 124.10            | (4.7)   | 33.70             | (3.4)   | 12.82             | (2.0)   | 8.04              | (<1.0)  | NA                | NA      |
| <b>Surface mines</b>            |                   |         |                   |         |                   |         |                   |         |                   |         |
| Strip                           | 846.59            | (32.2)  | 307.01            | (31.8)  | 121.39            | (19.3)  | 572.40            | (37.0)  | 490.11            | (72.2)  |
| Auger                           | 6.54              | (<1.0)  | NA                | NA      | NA                | NA      | NA                | NA      | NA                | NA      |
| Culm bank                       | 6.58              | (<1.0)  | NA                | NA      | NA                | NA      | NA                | NA      | NA                | NA      |
| Dredge                          | 1.05              | (<1.0)  | 8.79              | (<1.0)  | 1.71              | (<1.0)  | 3.05              | (<1.0)  | 93.02             | (13.7)  |
| Other surface                   | NA                | NA      | 2.95              | (<1.0)  | .02               | (<1.0)  | NA                | NA      | NA                | NA      |
| <b>Shops</b>                    | 20.72             | (1.0)   | 8.30              | (<1.0)  | .14               | (<1.0)  | 4.35              | (<1.0)  | NA                | NA      |
| <b>Mills/preparation plants</b> | 283.60            | (10.8)  | 370.48            | (38.4)  | 337.93            | (53.7)  | 720.39            | (46.6)  | NA                | NA      |
| <b>Office</b>                   | 130.18            | (4.9)   | 106.65            | (11.0)  | 84.91             | (13.5)  | 206.38            | (13.4)  | 95.24             | (14.0)  |
| <b>Total</b>                    | 2,629.86          | (100.0) | 965.77            | (100.0) | 629.35            | (100.0) | 1,545.40          | (100.0) | 678.37            | (100.0) |

NA - Not applicable; operation does not exist for this commodity, or breakdown of hours is unavailable.

Source: Mine Safety and Health Administration data.

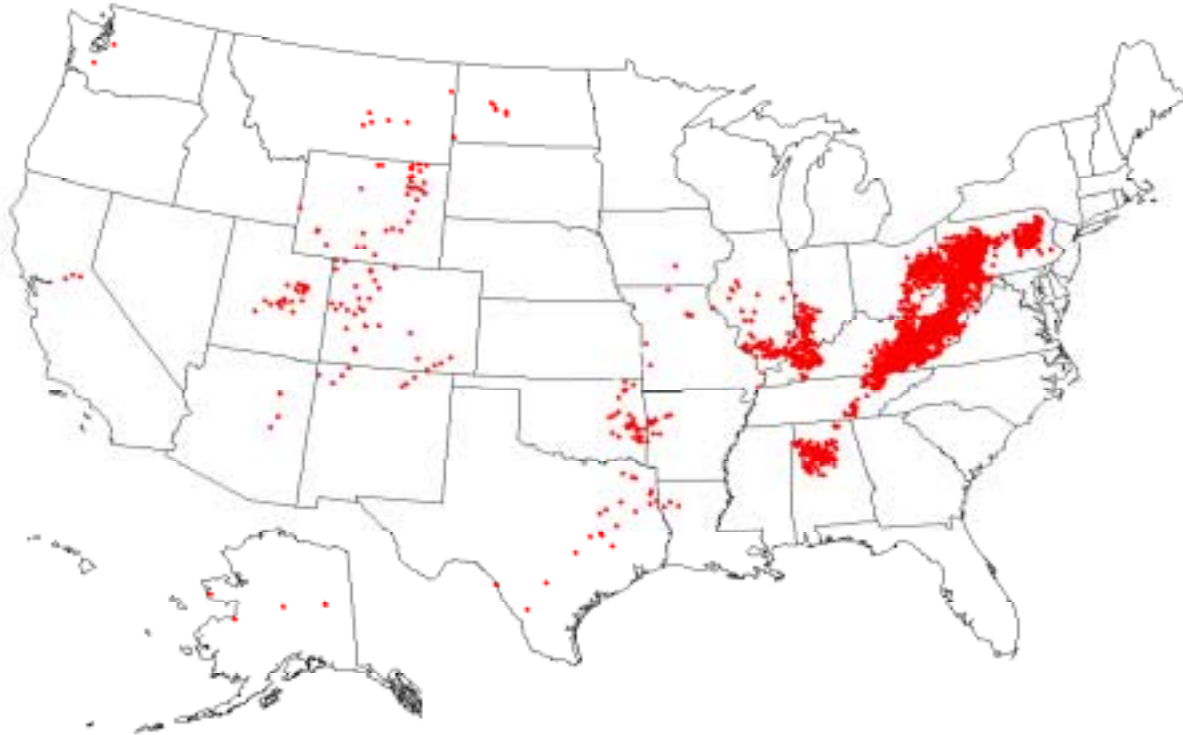


Figure 3-1.—Locations of active mining operations, coal industry, 1995. (Source: MSHA)

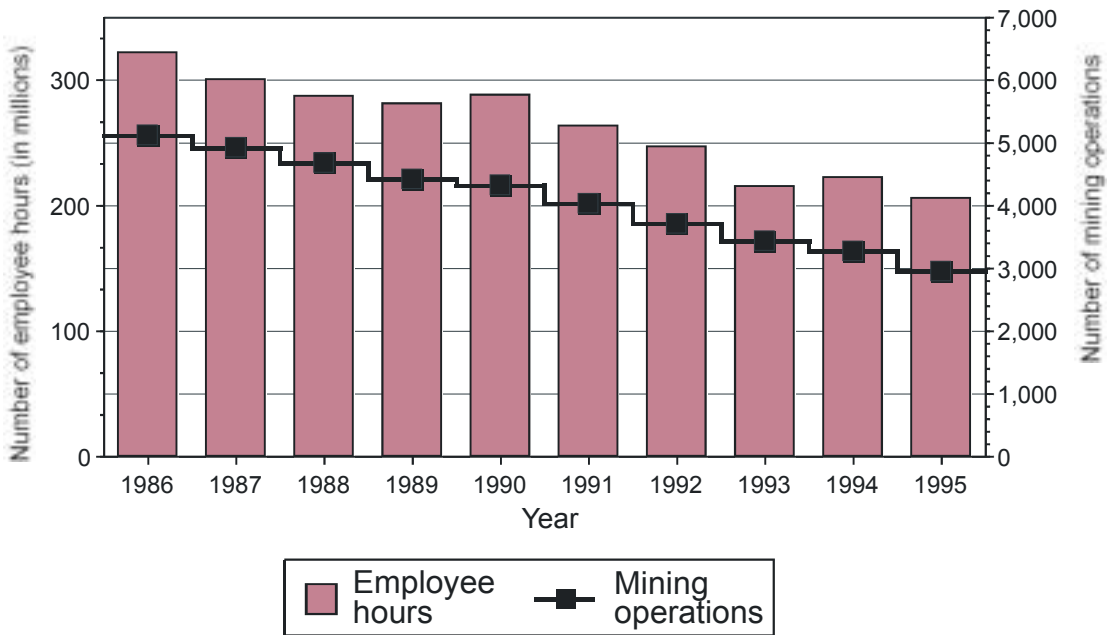


Figure 3-2.—Coal operators: number of employee hours in millions and number of active mining operations by year, 1986-1995. (Source: MSHA)





Figure 3-3.—Locations of active metal mining operations, metal industry, 1995. (Source: MSHA)

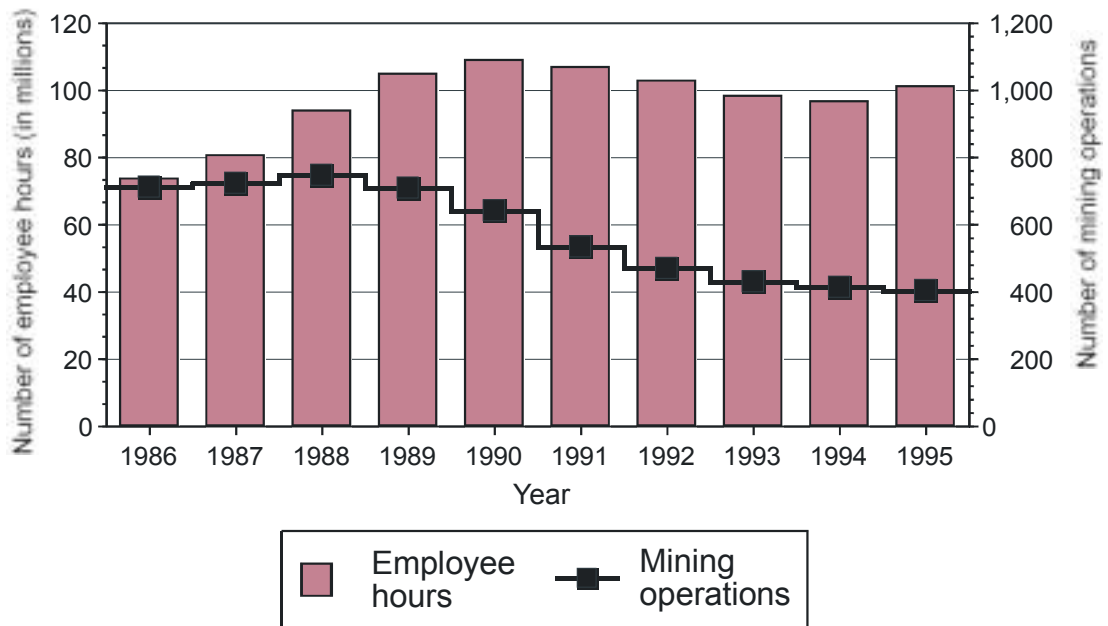


Figure 3-4.—Metal operators: number of employee hours in millions and number of active mining operators by year, 1986-1995. (Source: MSHA)



Figure 3-5.—Locations of active mining operations, nonmetal industry, 1995. (Source: MSHA)

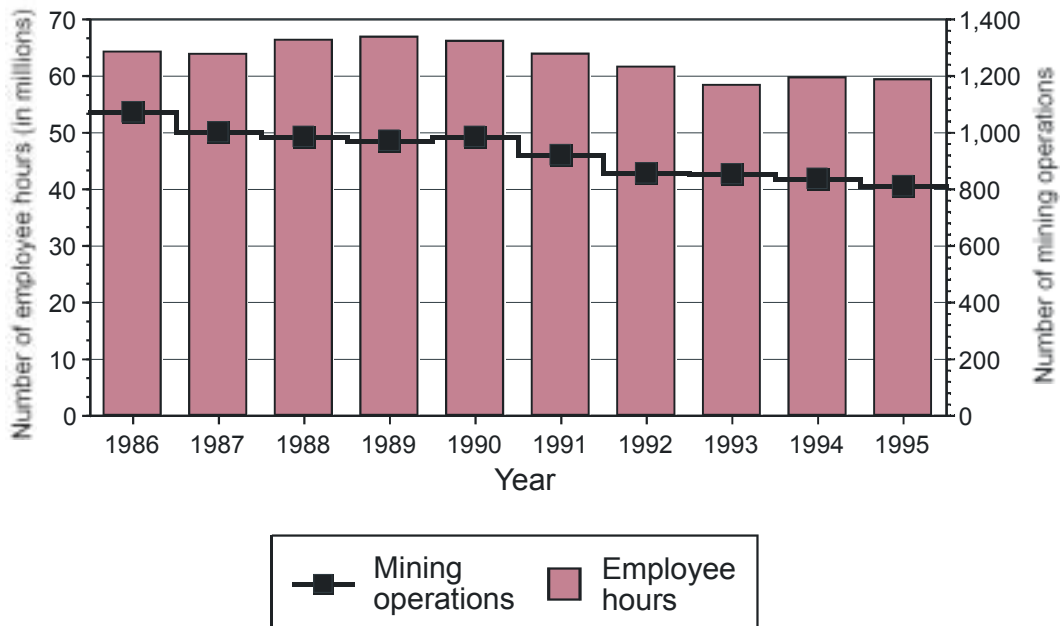


Figure 3-6.—Nonmetal operators: number of employee hours in millions and number of active mining operations by year, 1986-1995. (Source: MSHA)



Figure 3-7.—Locations of active mining operations, stone industry, 1995. (Source: MSHA)

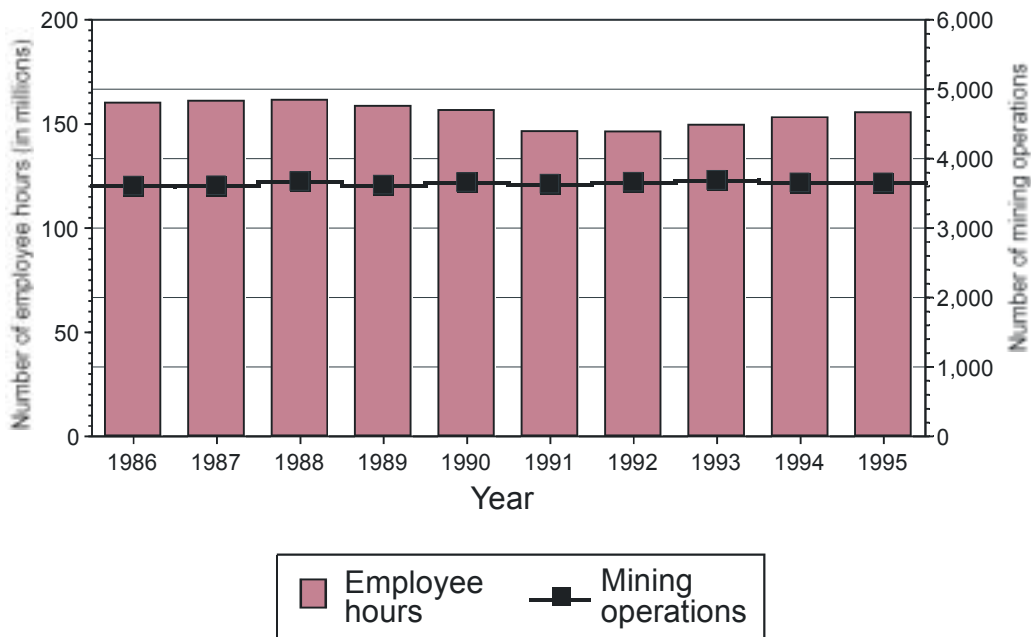


Figure 3-8.—Stone operators: number of employee hours in millions and number of active mining operations by year, 1986-1995. (Source: MSHA)



Figure 3-9.—Locations of active mining operations, sand and gravel industry, 1995. (Source: MSHA)

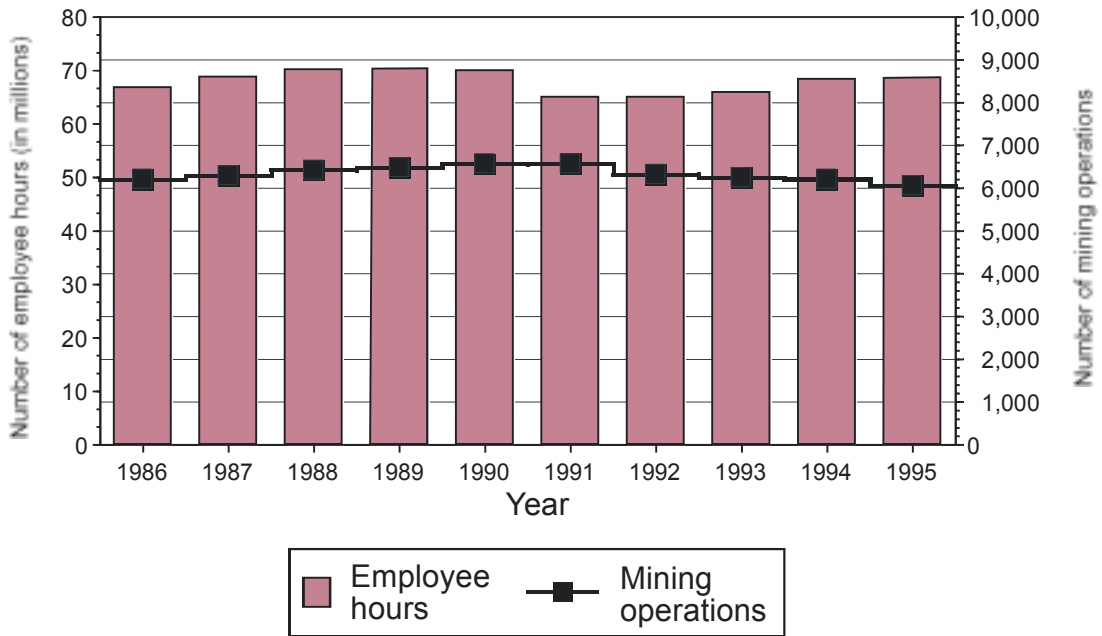


Figure 3-10.—Sand and gravel operators: number of employee hours in millions and number of active mining operations by year, 1986-1995. (Source: MSHA)

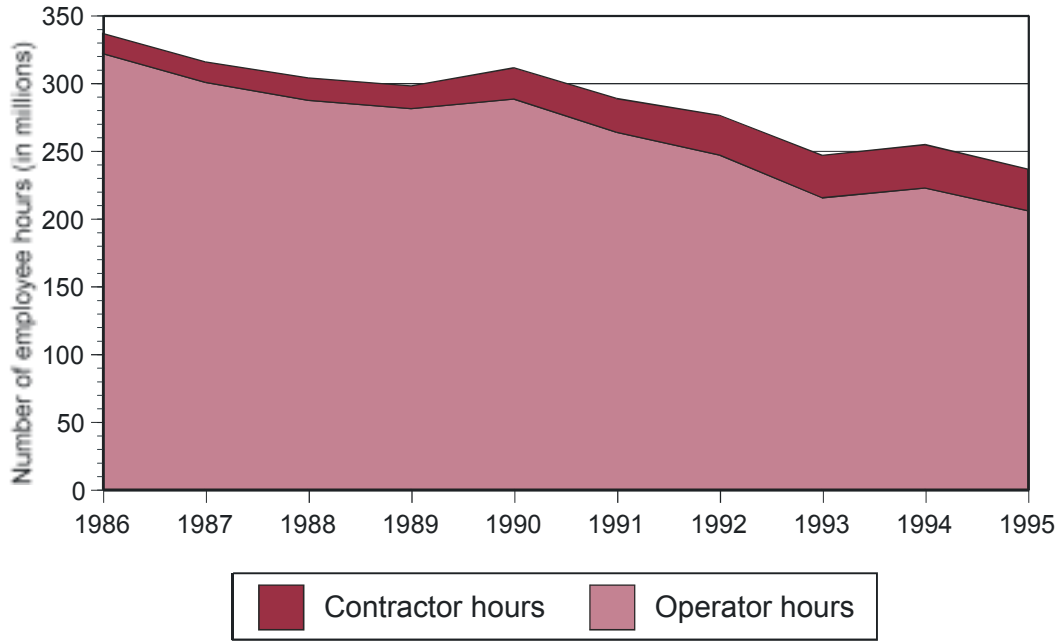


Figure 3-11.—Coal industry: number of employee hours (in millions) for operators and contractors by year. (Source: MSHA)

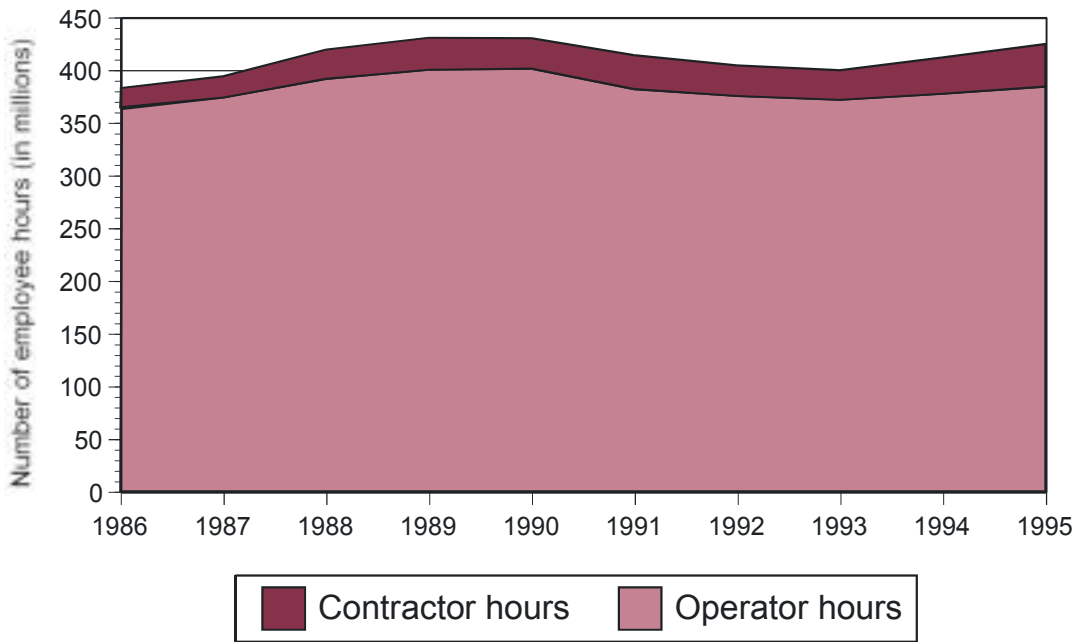


Figure 3-12.—Metal, nonmetal, stone, and sand and gravel industries: number of employee hours (in millions) for operators and contractors by year, 1986-1995. (Source: MSHA)

## CHAPTER 4. FATAL AND NONFATAL INJURIES: MSHA DATA

This chapter presents an overview of fatal and nonfatal injuries reported to MSHA during 1986-1995. Reportable injuries follow the criteria for reporting specified in 30 CFR 50. These criteria are listed in appendix A. The data used for these analyses came from the MSHA accident, injury, and illness data closeout files for the years 1986-1995. The MSHA data are described in appendix A and methods used in data analysis in appendix B. *There may be slight discrepancies between the figures presented here and other presentations of MSHA data for the following reasons: (1) injuries to nonemployees have been excluded from analysis; and (2) injuries identified by MSHA after the files were closed out are not included.*

Within the MSHA data, there are differences in reporting requirements for operators and contractors. Contractors are required to report only those injuries that occur during certain categories of work (described in appendix A). For this reason, *data on injuries among employees of operators and contractors in the MSHA database should not be considered directly comparable.*

As discussed in the “Introduction,” the MSHA data on fatal injuries differ from the CFOI data (chapter 1) because of varying definitions used for the mining industry. As compared to the CFOI data, MSHA data exclude injuries that occurred off of mine property and include injuries occurring at mills and processing plants on mine property.

Tables 4-1 through 4-9 and figure 4-1 provide comparisons of injury frequencies and rates among the commodities. These comparisons are followed by sections 4A through 4E, which provide more detailed tables and figures for each commodity separately. The method used to calculate injury rates is described in appendix B. *Since denominator data for occupations (job titles) were available for 1986 only, estimates of rates by occupation for the entire 10-year period are based on extrapolation from 1986 data. For this reason, estimates of injury by occupation should be interpreted with caution.*

### Fatal Injuries

A total of 1,078 fatal on-the-job injuries were reported to MSHA during the 10-year period 1986-1995. The average annual fatal injury rate for all commodities combined during this period was 30.9 per 100,000 full-time equivalent workers. Mine operators accounted for 908 (84%) of the fatalities and had an average annual fatal injury rate of 28.2 per 100,000. While mine contractors comprised only 16% (n = 170) of the total number of fatalities, their average annual fatal injury rate was 2.3 times higher than that of mine operators (65.0 per 100,000).

Table 4-1 presents the number and rates of fatal injuries by commodity for operators and contractors. Contractors in metal, nonmetal, stone, and sand and gravel are grouped together, since MSHA data on employment were not available for rate calculations for these commodities separately. The highest average annual fatality rate for the period, 66.5 per 100,000, occurred among metal and nonmetallic mineral mining contractors, followed closely by coal contractors (63.1 per 100,000). Among mine operators, the highest average annual fatal injury rate was in coal (38.9 per 100,000); the lowest was in nonmetal (14.3 per 100,000).

Table 4-2 shows the average annual fatal injury rate by type of operation for each commodity for mine operators only. Of commodities with underground mines, all except stone had higher fatality rates at underground than at surface operations of these mines. The highest fatality rate for any operation occurred in surface operations at underground stone mines (124.5 fatal injuries per 100,000 workers). Stone had the second highest fatality rate for underground operations at underground mines (77.9 per 100,000). The highest rate for underground operations at underground mines occurred in metal (87.6 per 100,000).

Table 4-3 shows the number and rate of fatal injuries by U.S. Bureau of the Census occupational groups (described in appendix D) for the 10 occupation-commodity groups with the highest fatal injury rates. These data should be interpreted with caution because the denominator used in calculating the rates was based on an extrapolation from data for the year 1986 only, as described in appendix B. Extractive occupations are represented in this group for three commodities: coal, metal, and sand and gravel. Construction trades are included for coal, sand and gravel, and nonmetal.

The distribution of fatal injuries by commodity and work activity for mine operators is presented in table 4-4. A description of the work activity categories is in appendix C. Overall, the leading work activity at the time of injury was using or operating tools and machinery (26.4%) followed by constructing, repairing, and cleaning (24.0%), vehicular operations (18.8%), and materials handling (12.6%). The distribution varied by commodity. The largest percentage of fatal injuries occurred while operating tools and machinery in both coal and stone; during vehicular operations in metal; and during constructing, repairing, and cleaning activities in nonmetal and sand and gravel.

Table 4-5 shows the distribution of fatal injuries by commodity and MSHA accident classification for mine operators. A description of the MSHA accident classifications appears in appendix E. The largest proportion of injuries overall occurred during powered haulage (28.5%). The

leading MSHA classifications varied by commodity: fall of ground was responsible for the largest proportion of injuries in coal and nonmetal, while powered haulage was the leading MSHA classification for metal, stone, and sand and gravel.

### Nonfatal Injuries

Among the 267,232 nonfatal injuries reported to MSHA during 1986-1995, mine operators accounted for 95% (253,536) of the total. In contrast to the rates for fatal injuries, mine operators had higher nonfatal injury rates than contractors (7.9 per 100 full-time workers for operators compared to 5.2 per 100 for contractors). The largest number of injuries (131,144) and the highest injury rate (49.1 per 100) occurred among coal operators (table 4-6).

Table 4-7 shows the distribution and average annual rate of nonfatal injuries by commodity and subunit for mine operators. In coal, 75% of all nonfatal injuries occurred at underground mines; 69% of all nonfatal injuries occurred at underground locations of underground mines. The injury rates incurred at surface locations of underground mines were higher than those for underground locations in the commodities of nonmetal and stone; however, these results must be interpreted with caution due to the small percentage of total employment represented by surface locations of underground mines in these two commodities. Of surface mines, 83% of all injuries reported in sand and gravel occurred at strip mines; this compares to coal (16%), metal (26%), nonmetal (18%), and stone (40%). The highest injury rates reported at strip mines occurred in stone and sand and gravel (7.7 and 6.6 per 100 workers, respectively). An additional 17% of injuries in sand and gravel were reported in dredging operations. Preparation plants and mills accounted for a significant proportion of the injuries in the commodities of metal (41%), nonmetal (63%), and stone (56%). Preparation plants comprised about 8% of all nonfatal injuries in coal.

Figure 4-1 shows the nonfatal injury rates over the 10-year period by commodity sector for mine operators. All five commodity sectors show similar patterns when injury rates are examined by year, with the nonfatal injury rates increasing sharply from 1986 to 1988 (or 1989), then declining for the remainder of the period. This spike in injury rates seen during 1988 and 1989 was probably due to clarification of reporting requirements by MSHA, which resulted in improved reporting of injuries by mine operators.

Of all nonfatal injuries to mine operators, 61% resulted in time lost from work. By commodity sector, coal had the largest proportion of injuries that resulted in days lost from work (73%). Fifty-seven percent of all injuries in sand and gravel resulted in days lost, followed by stone (48%), nonmetal (42%), and metal (42%). The mean number of days lost in the

commodity of coal was 27 days, followed by metal (15 days), sand and gravel (13 days), nonmetal (12 days), and stone (12 days).

For sprains and strains, 76% of all injuries involved time lost from work compared to 51% of the injuries classified as nonsprains. Sprains and strains and lacerations were the two most common types of injury in all five commodity sectors. Contusions and fractures were the third and fourth most frequent, although the rank order varied among the commodity sectors. Table 4-8 shows the percentage of injuries and mean days lost by type of injury and commodity for the four most common types of injuries.

Table 4-9 shows the percentage of injuries and mean days lost by work activity and commodity for the four most common types of work activity. Overall, handling materials (30%) was the most common activity being performed at the time of injury, followed by using or operating tools or machinery (26%), constructing, repairing, and cleaning tasks (18%), and vehicular and transportation operations (13%).

Figures 4-2 and 4-3 show the body parts most commonly injured for injuries classified as strains and nonstrains among employees of mine operators in all commodities. The back was the body part most frequently affected by strain injuries (49%). For nonstrain injuries, the fingers were the most frequently affected body part, accounting for 23% of all injuries.

During the 10-year period, the distribution of workforce demographics (e.g., age and work experience) of injured workers varied by commodity sector. In coal, the average age and total mining experience of the injured workers steadily increased, while years of experience at current mine decreased. The number of years at current job remained relatively steady over the 10-year period. In the other four commodity sectors, the work experience indicators all remained relatively constant over the 10-year period. The average age of injured workers increased slightly, but less than the increase seen in coal.

Sections 4A through 4E are separate presentations of injury data for each commodity. Additional information not discussed here is provided in these sections, including a breakdown, within each MSHA classification, of the event and source resulting in injury. However, event and source are not provided for injuries due to fall of ground, since both event and source were falling rock for over 90% of these injuries.

**Table 4-1.—Mine operators and contractors: number and average annual rate of fatal injuries (per 100,000 full-time workers) by commodity, 1986-1995.**

| Employer type and commodity                 | Number       | (%)            | Rate        |
|---|--------------|----------------|-------------|
| <b>Operators</b>                            |              |                |             |
| Coal  | 511          | (47.4)         | 38.9        |
| Metal                                       | 106          | (9.8)          | 22.0        |
| Nonmetal                                    | 45           | (4.2)          | 14.3        |
| Stone                                       | 157          | (14.6)         | 20.3        |
| Sand and gravel                             | 89           | (8.3)          | 26.2        |
| <b>Contractors</b>                          |              |                |             |
| Coal  | 74           | (6.9)          | 63.1        |
| Metal, nonmetal, stone, and sand and gravel | 96           | (8.9)          | 66.5        |
| <b>Total</b>                                | <b>1,078</b> | <b>(100.0)</b> | <b>30.9</b> |

Source: Mine Safety and Health Administration data.

**Table 4-2.—Mine operators: number and average annual rate of fatal injuries (per 1000,000 full-time workers) by commodity and subunit, 1986-1995.**

| Subunit                        | Coal       |             | Metal      |             | Nonmetal  |             | Stone      |             | Sand and gravel |             |
|--------------------------------|------------|-------------|------------|-------------|-----------|-------------|------------|-------------|-----------------|-------------|
|                                | No.        | Rate        | No.        | Rate        | No.       | Rate        | No.        | Rate        | No.             | Rate        |
| <b>Underground mines</b>       |            |             |            |             |           |             |            |             |                 |             |
| Underground                    | 337        | 55.7        | 56         | 87.6        | 16        | 45.4        | 12         | 77.9        | NA              | NA          |
| Surface                        | 31         | 50.0        | 5          | 29.7        | 0         | *           | 5          | 124.5       | NA              | NA          |
| <b>Surface mines</b>           |            |             |            |             |           |             |            |             |                 |             |
| Strip                          | 99         | 23.4        | 31         | 20.2        | 17        | 28.0        | 99         | 34.6        | 67              | 27.3        |
| Other surface                  | 3          | 42.4        | 0          | *           | 0         | *           | 0          | *           | 22              | 47.3        |
| <b>Independent shops/yards</b> | 2          | *           | 1          | *           | 0         | *           | 0          | *           | NA              | NA          |
| <b>Mill/preparation plant</b>  | 39         | 27.5        | 13         | 7.0         | 12        | 7.1         | 41         | 11.4        | NA              | NA          |
| <b>Office</b>                  | 0          | *           | 0          | *           | 0         | *           | 0          | *           | 0               | *           |
| <b>Total</b>                   | <b>511</b> | <b>38.9</b> | <b>106</b> | <b>22.0</b> | <b>45</b> | <b>14.3</b> | <b>157</b> | <b>20.3</b> | <b>89</b>       | <b>26.2</b> |

\*Rate not calculated because there were fewer than 3 fatalities.

NA - Not applicable; subunit does not exist for this commodity; or injuries and employment hours were not reported separately for the subunit.

Source: Mine Safety and Health Administration data.



**Table 4-3.—Mine operators: number and average annual rate of fatal injuries (per 100,000 full-time workers) for the 10 occupation-commodity groups with the highest fatal injury rates.**

| Occupational group and commodity        | Number of fatalities | Average annual rate per 100,000 |
|---|----------------------|---------------------------------|
| Construction trades, sand and gravel    | 3                    | 307.7                           |
| Extractive occupations, coal            | 196                  | 85.1                            |
| Extractive occupations, metal           | 44                   | 75.5                            |
| Protective service, coal                | 4                    | 69.8                            |
| Precision production, stone             | 7                    | 59.9                            |
| Construction trades, coal               | 94                   | 55.9                            |
| Extractive occupations, sand and gravel | 5                    | 51.3                            |
| Construction trades, nonmetal           | 3                    | 50.5                            |
| Professional specialty, coal            | 9                    | 47.8                            |
| Helpers and laborers, sand and gravel   | 12                   | 45.1                            |

Source: Mine Safety and Health Administration data.

**Table 4-4.—Mine operators: number and percent of fatal injuries by commodity and work activity, 1986-1995.**

| Work activity                         | Coal |         | Metal |         | Nonmetal |         | Stone |         | Sand and gravel |         | All operators |         |
|---------------------------------------|------|---------|-------|---------|----------|---------|-------|---------|-----------------|---------|---------------|---------|
|                                       | No.  | (%)     | No.   | (%)     | No.      | (%)     | No.   | (%)     | No.             | (%)     | No.           | (%)     |
| Using or operating tools or machinery | 141  | (27.6)  | 20    | (18.9)  | 6        | (13.3)  | 47    | (29.9)  | 26              | (29.2)  | 282           | (26.4)  |
| Constructing, repairing, cleaning     | 121  | (23.7)  | 21    | (19.8)  | 14       | (31.1)  | 33    | (21.0)  | 29              | (32.6)  | 256           | (24.0)  |
| Vehicle/transportation operations     | 97   | (19.0)  | 26    | (24.5)  | 5        | (11.1)  | 32    | (20.4)  | 11              | (12.4)  | 202           | (18.8)  |
| Materials handling                    | 56   | (11.0)  | 16    | (15.1)  | 10       | (22.2)  | 17    | (10.8)  | 15              | (16.9)  | 139           | (12.6)  |
| All other                             | 96   | (18.8)  | 23    | (21.7)  | 10       | (22.2)  | 28    | (17.8)  | 8               | (9.0)   | 199           | (18.2)  |
| Total                                 | 511  | (100.0) | 106   | (100.0) | 45       | (100.0) | 157   | (100.0) | 89              | (100.0) | 1,078         | (100.0) |

Source: Mine Safety and Health Administration data.

**Table 4-5.—Mine operators: number and percent of fatal injuries by MSHA accident classification and commodity, 1986-1995.**

| MSHA accident classification | Coal |         | Metal |         | Nonmetal |         | Stone |         | Sand and gravel |         | All operators |         |
|------------------------------|------|---------|-------|---------|----------|---------|-------|---------|-----------------|---------|---------------|---------|
|                              | No.  | (%)     | No.   | (%)     | No.      | (%)     | No.   | (%)     | No.             | (%)     | No.           | (%)     |
| Powered haulage              | 118  | (23.1)  | 33    | (31.1)  | 11       | (24.4)  | 61    | (38.9)  | 36              | (40.5)  | 259           | (28.5)  |
| Fall of ground               | 162  | (31.7)  | 18    | (17.0)  | 13       | (28.9)  | 13    | (8.3)   | 1               | (1.0)   | 207           | (22.8)  |
| Machinery                    | 85   | (16.6)  | 10    | (9.4)   | 7        | (15.6)  | 25    | (15.9)  | 17              | (19.1)  | 144           | (15.9)  |
| Electrical                   | 42   | (8.2)   | 9     | (8.4)   | 5        | (11.1)  | 12    | (7.6)   | 17              | (19.1)  | 86            | (9.5)   |
| All other                    | 104  | (20.4)  | 36    | (34.0)  | 9        | (20.0)  | 46    | (29.2)  | 18              | (20.2)  | 212           | (23.3)  |
| Total                        | 511  | (100.0) | 106   | (100.0) | 45       | (100.0) | 157   | (100.0) | 89              | (100.0) | 908           | (100.0) |

Source: Mine Safety and Health Administration data.

**Table 4-6.—Mine operators and contractors: number and average annual rate of nonfatal injuries (per 100 full-time workers) by commodity for mine operators and contractors, 1986-1995.**

| Employer type and commodity                 | Number  | (%)     | Rate |
|---|---------|---------|------|
| <b>Operators</b>                            |         |         |      |
| Coal  | 131,144 | (49.1)  | 10.0 |
| Metal                                       | 31,494  | (11.8)  | 6.5  |
| Nonmetal                                    | 17,133  | (6.4)   | 5.4  |
| Stone                                       | 54,359  | (20.3)  | 7.0  |
| Sand and gravel                             | 19,406  | (7.3)   | 5.7  |
| <b>Contractors</b>                          |         |         |      |
| Coal  | 5,472   | (2.0)   | 4.7  |
| Metal, nonmetal, stone, and sand and gravel | 8,224   | (3.1)   | 5.7  |
| Total                                       | 267,232 | (100.0) | 7.7  |

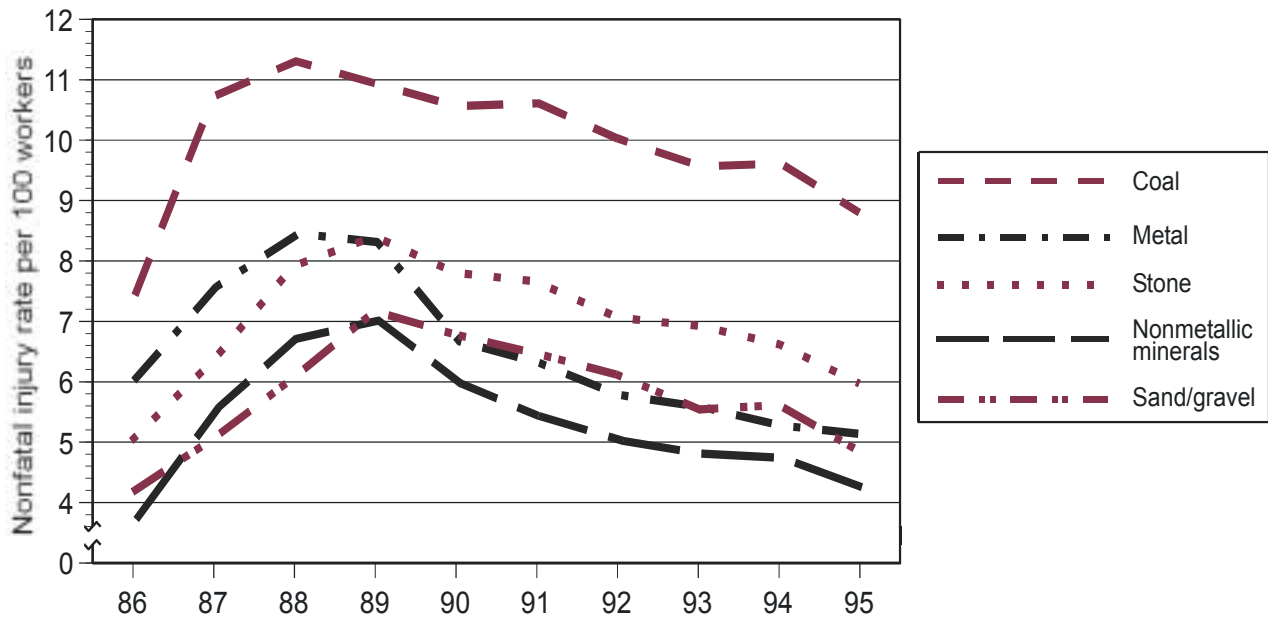
Source: Mine Safety and Health Administration data.

**Table 4-7.—Mine operators: number and average annual rate of nonfatal injuries (per 100 full-time workers) by commodity and subunit, 1986-1995.**

| Subunit                        | Coal    |      | Metal  |      | Nonmetal |      | Stone  |      | Sand and gravel |      |
|--------------------------------|---------|------|--------|------|----------|------|--------|------|-----------------|------|
|                                | No.     | Rate | No.    | Rate | No.      | Rate | No.    | Rate | No.             | Rate |
| <b>Underground mines</b>       |         |      |        |      |          |      |        |      |                 |      |
| Underground                    | 91,011  | 15.0 | 8,177  | 12.8 | 2,575    | 7.3  | 1,173  | 7.6  | NA              | NA   |
| Surface                        | 6,784   | 10.9 | 1,293  | 7.7  | 566      | 8.8  | 450    | 11.2 | NA              | NA   |
| <b>Surface mines</b>           |         |      |        |      |          |      |        |      |                 |      |
| Strip                          | 21,388  | 5.1  | 8,179  | 5.3  | 3,043    | 5.0  | 21,982 | 7.7  | 16,045          | 6.6  |
| Other surface                  | 571     | 8.1  | 488    | 8.3  | 69       | 8.0  | 93     | 6.1  | 3,252           | 7.0  |
| <b>Independent shops/yards</b> | 870     | 8.4  | 276    | 6.6  | 6        | 8.6  | 168    | 7.7  | NA              | NA   |
| <b>Mill/preparation plant</b>  | 10,234  | 7.2  | 12,921 | 7.0  | 10,770   | 6.4  | 30,223 | 8.4  | NA              | NA   |
| <b>Office</b>                  | 286     | 0.4  | 160    | 0.3  | 104      | 0.2  | 270    | 0.3  | 109             | 0.2  |
| <b>Total</b>                   | 131,144 | 10.0 | 31,494 | 6.5  | 17,133   | 5.4  | 54,359 | 7.0  | 19,406          | 5.7  |

NA - Not applicable.

Source: Mine Safety and Health Administration data.



**Figure 4.1—Mine operators: rate of nonfatal injury (per 100 full-time workers) by commodity and year, 1986-1995. (Source: MSHA)**

**Table 4-8.—Mine operators: percent of injuries and mean days lost work for the 4 leading types of injury by commodity.**

| Nature of injury       | Coal<br>(131,144 injuries) |                | Metal<br>(31,494 injuries) |                | Nonmetal<br>(17,133 injuries) |                | Stone<br>(54,359 injuries) |                | Sand and gravel<br>(19,406 injuries) |                |
|------------------------|----------------------------|----------------|----------------------------|----------------|-------------------------------|----------------|----------------------------|----------------|--------------------------------------|----------------|
|                        | % of injuries              | Mean days lost | % of injuries              | Mean days lost | % of injuries                 | Mean days lost | % of injuries              | Mean days lost | % of injuries                        | Mean days lost |
| <b>Sprains/strains</b> | 40.4                       | 35             | 34.2                       | 22             | 36.1                          | 17             | 32.7                       | 16             | 29.7                                 | 16             |
| <b>Lacerations</b>     | 16.4                       | 5              | 23.4                       | 2              | 19.9                          | 2              | 19.4                       | 3              | 21.2                                 | 3              |
| <b>Contusions</b>      | 12.2                       | 19             | 7.3                        | 12             | 8.8                           | 7              | 9.1                        | 8              | 9.1                                  | 9              |
| <b>Fractures</b>       | 10.3                       | 37             | 11.4                       | 23             | 7.9                           | 23             | 9.3                        | 24             | 9.2                                  | 25             |
| <b>All other</b>       | 20.7                       | 26             | 23.7                       | 14             | 27.3                          | 11             | 29.5                       | 12             | 30.8                                 | 13             |
| <b>Total</b>           | 100.0                      | 27             | 100.0                      | 15             | 100.0                         | 12             | 100.0                      | 12             | 100.0                                | 13             |

Source: Mine Safety and Health Administration data.

**Table 4-9.—Mine operators: percent of injuries and mean days lost work for the 4 leading work activities by commodity.**

| Work activity                                | Coal<br>(131,144 injuries) |                | Metal<br>(31,494 injuries) |                | Nonmetal<br>(17,133 injuries) |                | Stone<br>(54,359 injuries) |                | Sand and gravel<br>(19,406 injuries) |                |
|--|----------------------------|----------------|----------------------------|----------------|-------------------------------|----------------|----------------------------|----------------|--------------------------------------|----------------|
|  | % of injuries              | Mean days lost | % of injuries              | Mean days lost | % of injuries                 | Mean days lost | % of injuries              | Mean days lost | % of injuries                        | Mean days lost |
| <b>Handling materials</b>                    | 30.9                       | 29             | 29.0                       | 15             | 34.9                          | 13             | 28.5                       | 12             | 26.4                                 | 13             |
| <b>Using or operating tools or machinery</b> | 25.1                       | 20             | 27.7                       | 10             | 23.3                          | 8              | 27.6                       | 9              | 27.4                                 | 9              |
| <b>Constructing, repairing, cleaning</b>     | 16.0                       | 24             | 18.7                       | 13             | 17.9                          | 10             | 20.9                       | 12             | 23.3                                 | 13             |
| <b>Vehicle / transportation operations</b>   | 14.5                       | 31             | 11.3                       | 22             | 10.2                          | 17             | 10.8                       | 17             | 7.6                                  | 17             |
| <b>All other</b>                             | 13.5                       | 31             | 13.3                       | 20             | 13.7                          | 16             | 12.2                       | 16             | 15.3                                 | 17             |
| <b>Total</b>                                 | 100.0                      | 27             | 100.0                      | 15             | 100.0                         | 12             | 100.0                      | 12             | 100.0                                | 13             |

Source: Mine Safety and Health Administration data.

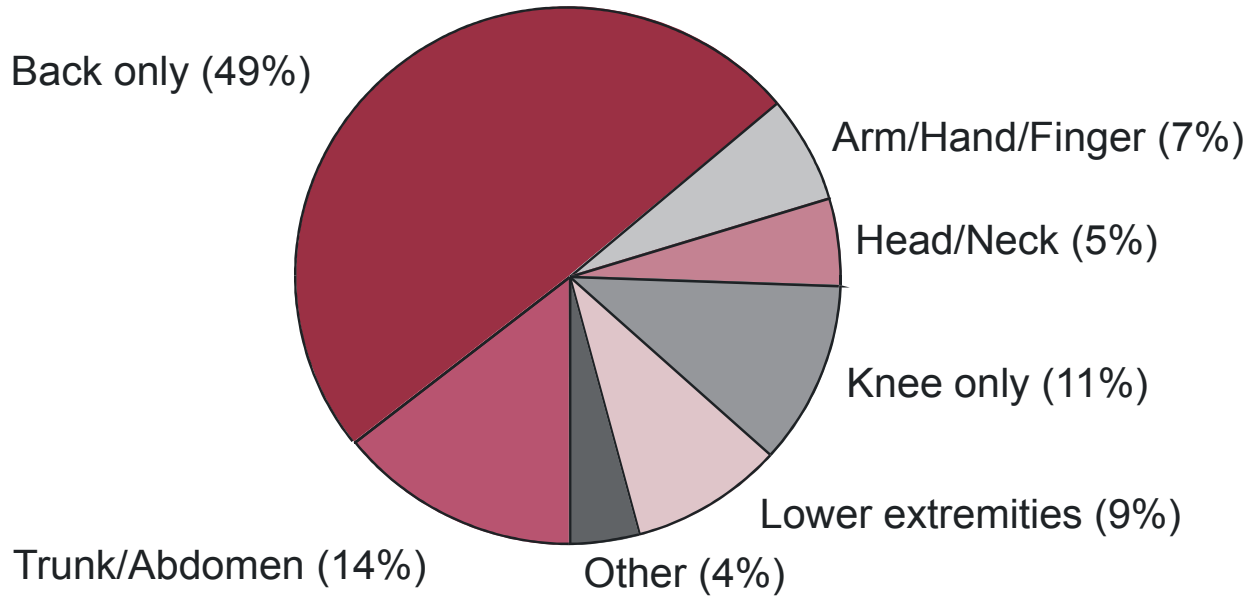


Figure 4-2.—Body part affected for strain injuries, all commodities combined, 1986-1995. (Source: MSHA)

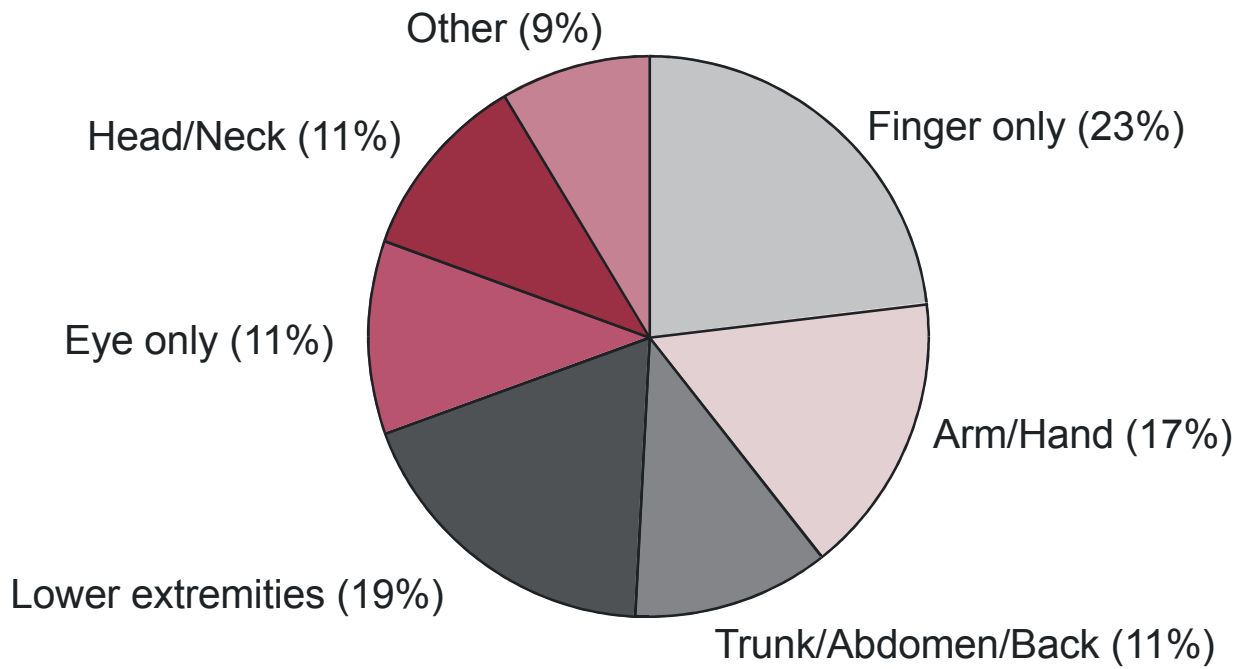


Figure 4-3.—Body part affected for nonstrain injuries, all commodities combined, 1986-1995. (Source: MSHA)

### 4A. INJURIES IN COAL MINING

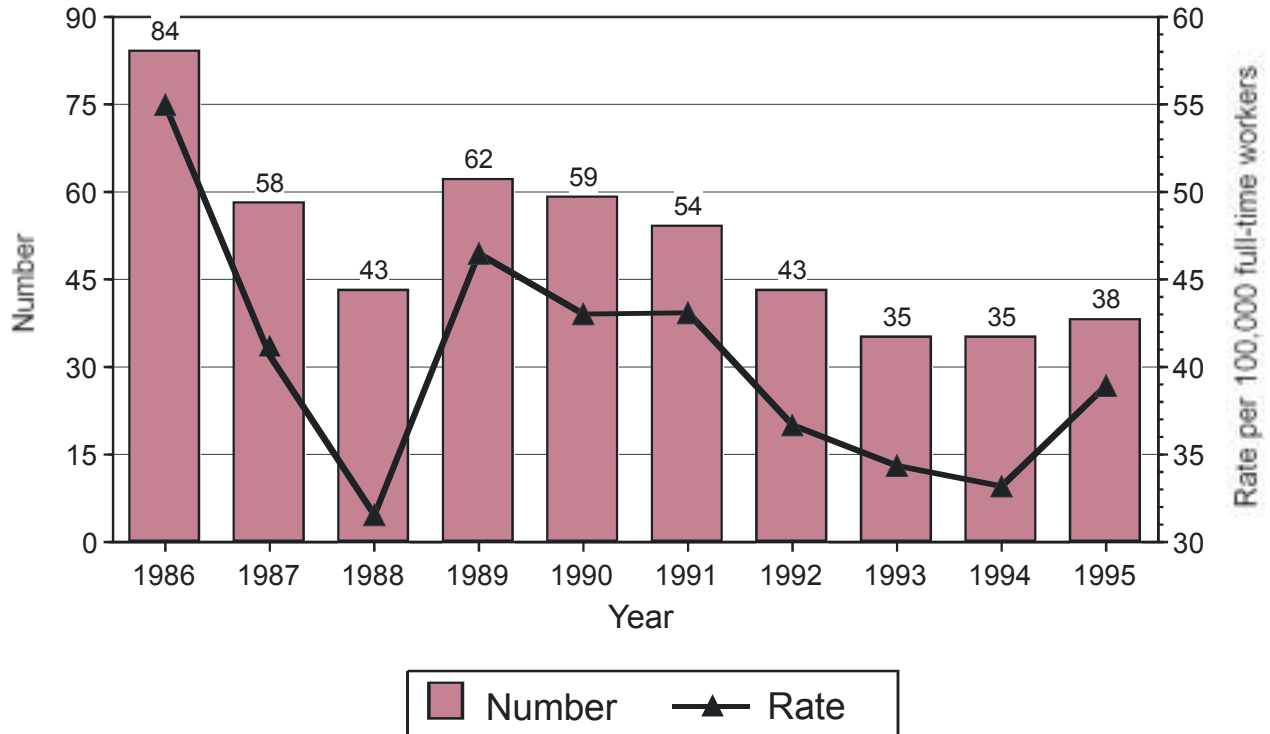


Figure 4A-1.—Coal operators: number and rate (per 100,000 workers) of fatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4A-1.—Coal operators: number and average annual rate (per 100,000) workers of fatal injuries by subunit, 1986-1995.

| <b>Mining operation</b>        | <b>Number, 1986-1995</b> | <b>Average annual rate per 100,000 full-time workers</b> |
|--------------------------------|--------------------------|--|
| <b>Underground mines:</b>      |                          |  |
| Underground operations         | 337                      | 55.68  |
| Surface operations             | 31                       | 49.96  |
| <b>Surface mines:</b>          |                          |  |
| Strip                          | 99                       | 23.39  |
| Auger                          | 1                        | *  |
| Culm Bank                      | 2                        | *  |
| Dredge                         | 0                        | *  |
| <b>Independent shops/yards</b> | 2                        | *  |
| <b>Preparation Plants</b>      | 39                       | 27.5   |
| <b>Office</b>                  | 0                        | *  |
| <b>Total</b>                   | <b>511</b>               | <b>38.86</b>   |

\* Rate not calculated because there were fewer than 3 fatalities

Source: Mine Safety and Health Administration data.

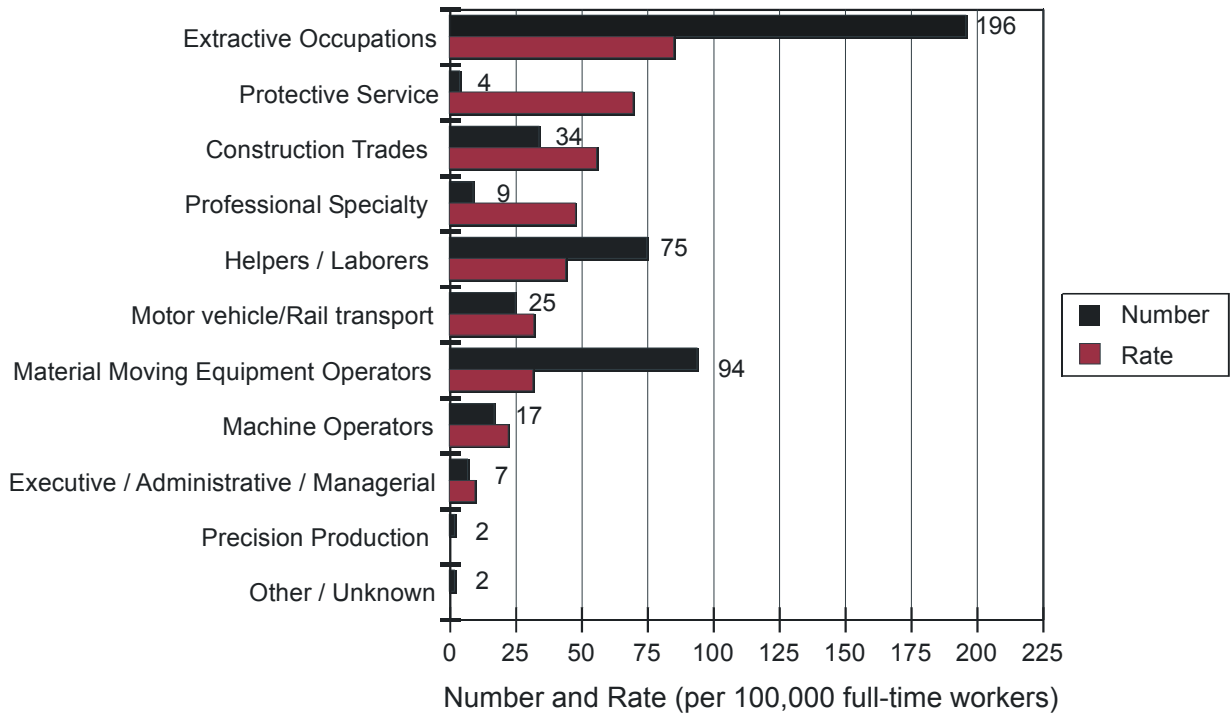


Figure 4A-2.—Coal operators: number and rate (per 100,000 workers) of fatal injuries by U.S. Bureau of the Census Occupation Division, 1986-1995. (Source: MSHA data)

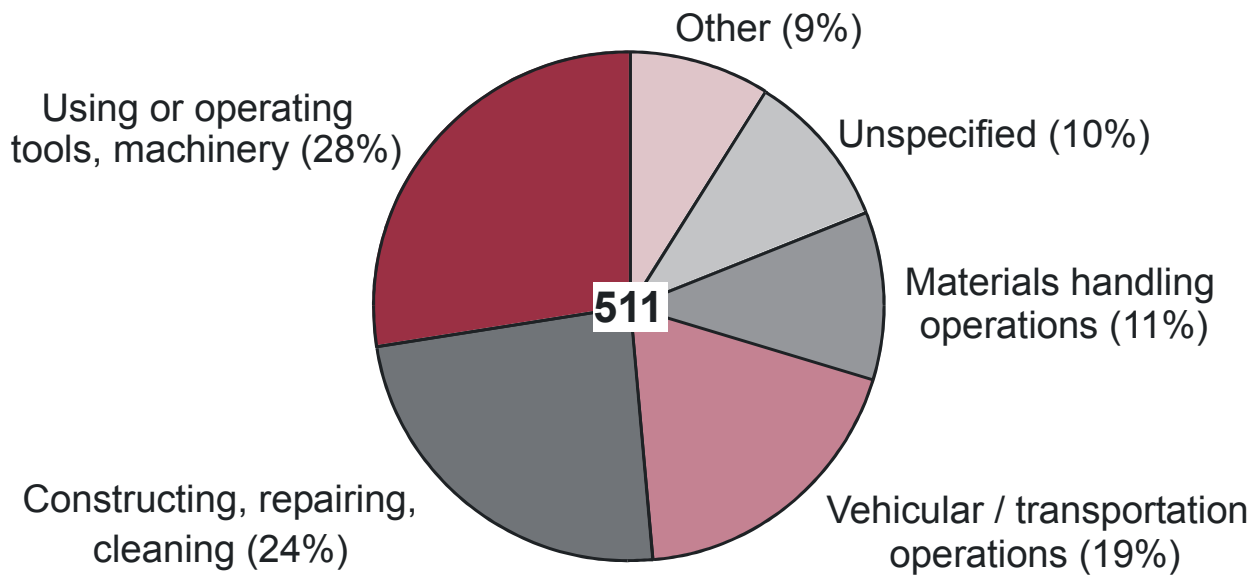


Figure 4A-3.—Coal operators: percent of fatal injuries by work activity, 1986-1995. (Source: MSHA data)

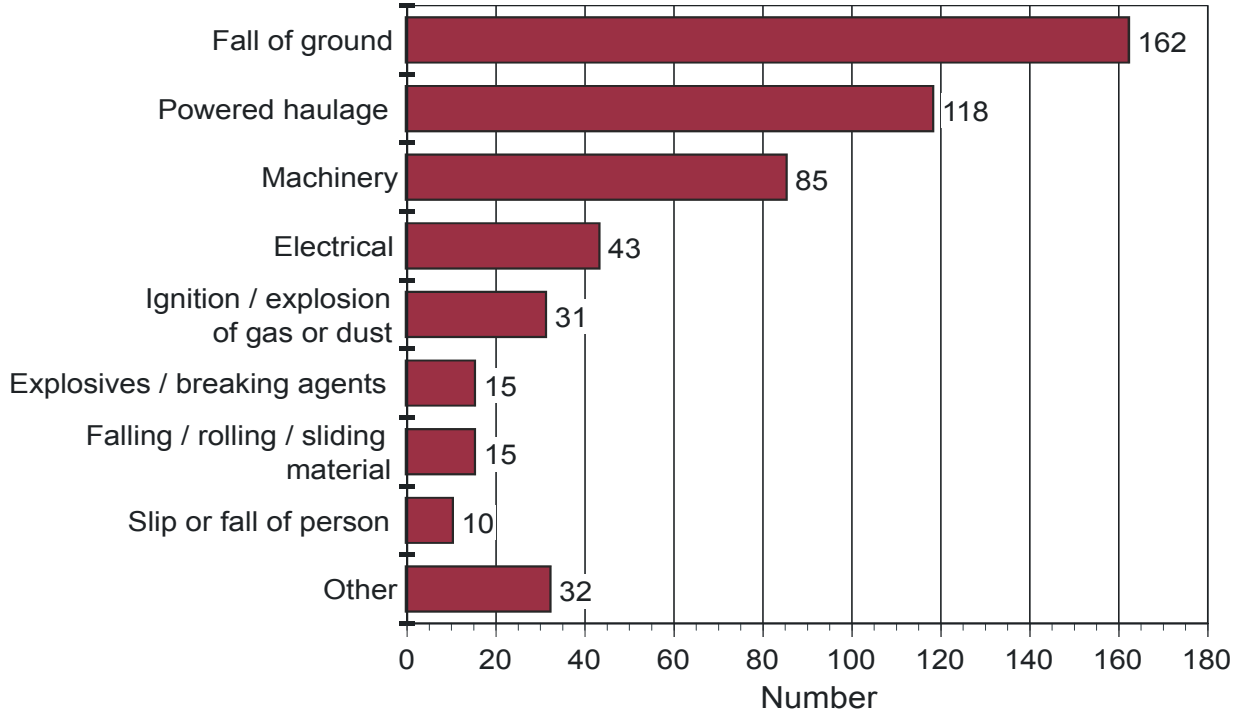


Figure 4A-4.—Coal operators: number of fatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

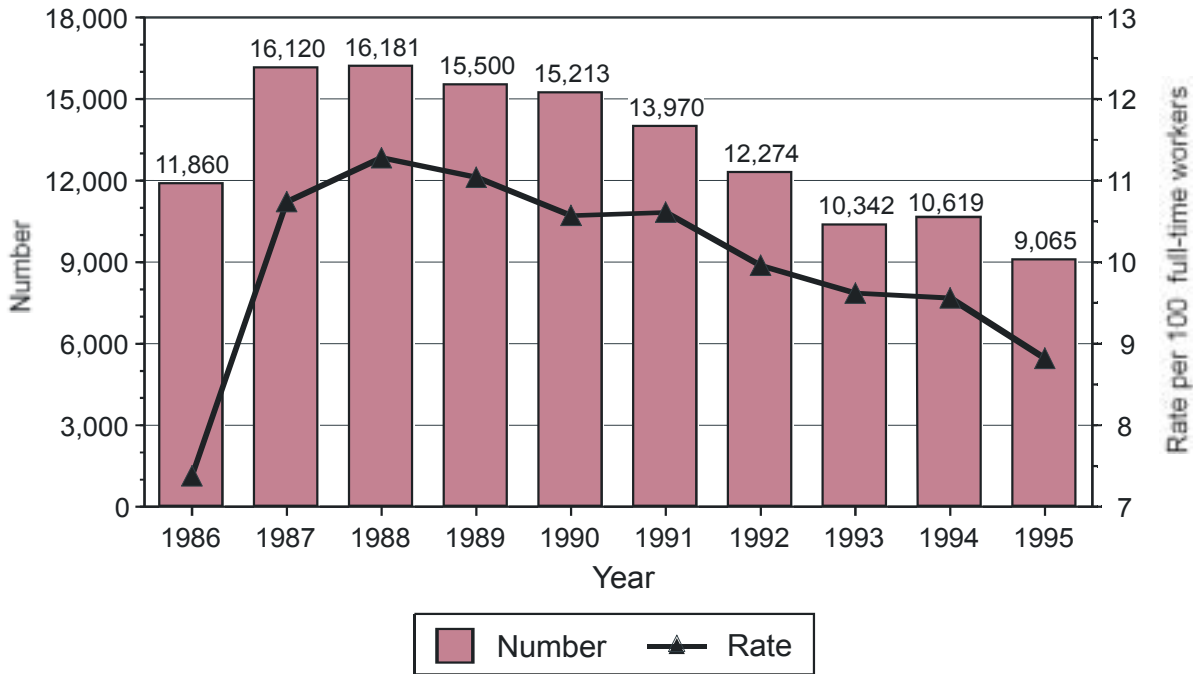


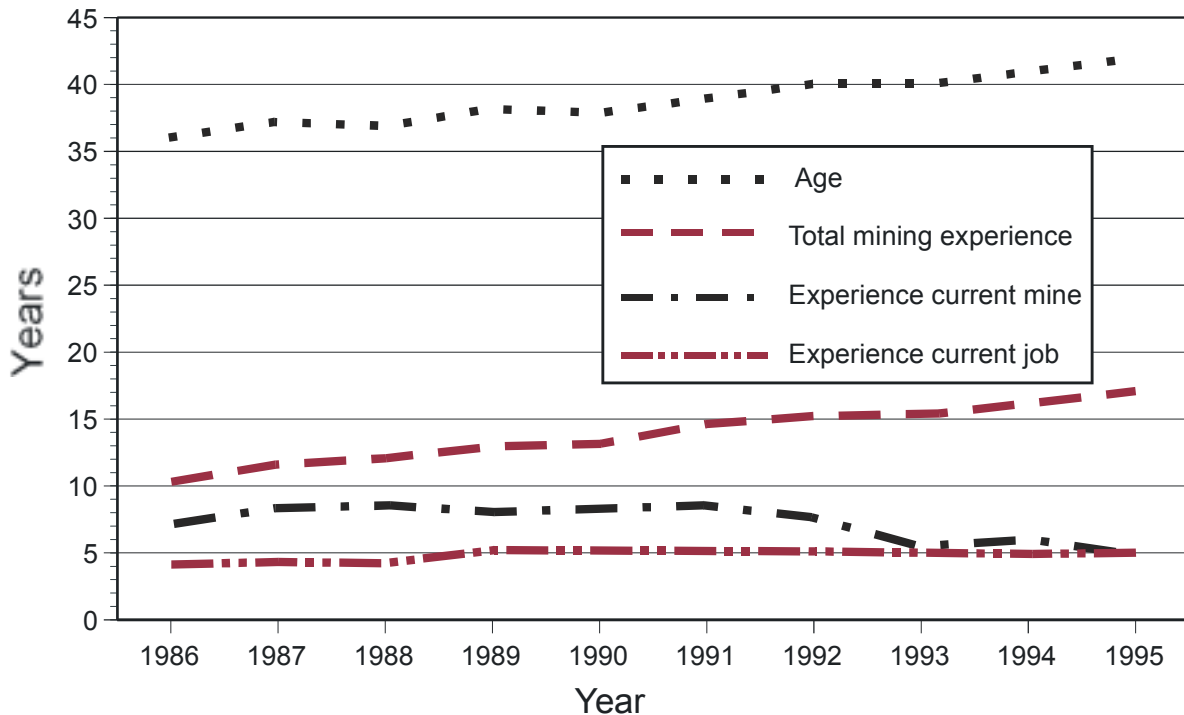
Figure 4A-5.—Coal operators: number and rate (per 100 workers) of nonfatal injuries by year, 1986-1995. (Source: MSHA data)



**Table 4A-2.—Coal operators: number and average annual rate (per 100 workers) of nonfatal injuries by subunit, 1986-1995.**

| <u>Mining operation</u>        | <u>Number, 1986-1995</u> | <u>Average annual rate per 100 full-time workers</u> |
|--------------------------------|--------------------------|--|
| <b>Underground mines:</b>      |                          |  |
| Underground operations         | 91,011                   | 15.04  |
| Surface operations             | 6,784                    | 10.93  |
| <b>Surface mines:</b>          |                          |  |
| Strip                          | 21,388                   | 5.05   |
| Auger                          | 266                      | 8.14   |
| Culm Bank                      | 286                      | 8.7  |
| Dredge                         | 19                       | 3.62   |
| <b>Independent shops/yards</b> | 870                      | 8.4  |
| <b>Preparation Plant</b>       | 10,234                   | 7.22   |
| <b>Office</b>                  | 286                      | 0.44   |
| <b>Total</b>                   | <b>131,144</b>           | <b>9.97</b>  |

Source: Mine Safety and Health Administration data.



**Figure 4A-6.—Coal operators: median values for age, total mining experience in current mine, and experience in current job for workers with nonfatal injuries by year, 1986-1995. (Source: MSHA data)**

**Table 4A-3.—Coal operators: nonfatal injuries, 1986-1995, by nature of injury. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days work lost for all cases, and statutory days charged for all cases.**

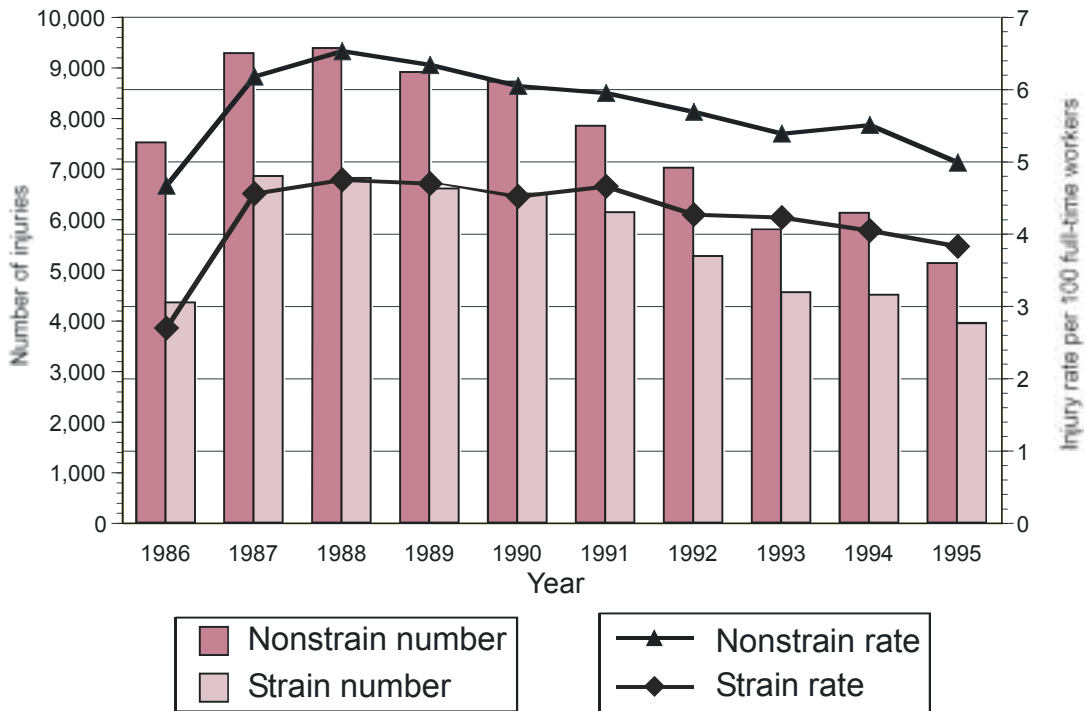
| Nature of injury                                    | Number of cases | Lost workday cases (%) | Mean days lost work | Total days lost  | Total statutory days |
|---|-----------------|------------------------|---------------------|------------------|----------------------|
| Sprains and strains                                 | 52,939          | 87.0                   | 35.31               | 1,869,202        | 59,874               |
| Fracture  | 13,487          | 71.8                   | 36.57               | 493,066          | 43,175               |
| Contusions  | 16,010          | 81.3                   | 18.90               | 302,523          | 10,970               |
| Lacerations   | 21,543          | 33.6                   | 5.36                | 115,546          | 4,245                |
| Hernia  | 1,117           | 84.2                   | 31.90               | 35,635           | 45,450               |
| Crushing  | 1,499           | 71.8                   | 20.32               | 30,421           | 5,550                |
| Amputation or enucleation                           | 665             | 75.3                   | 44.14               | 29,352           | 325,173              |
| Dislocation   | 600             | 80.0                   | 39.80               | 23,879           | 350                  |
| Burn, heat  | 1,351           | 64.8                   | 13.43               | 18,115           | 0                    |
| Electric shock                                      | 247             | 82.2                   | 54.74               | 13,520           | 0                    |
| Joint, tendon, or muscle inflammation or irritation | 485             | 78.6                   | 26.94               | 13,065           | 0                    |
| Noncontact electric arc burn                        | 983             | 73.6                   | 10.02               | 9,854            | 0                    |
| Abrasions   | 1,139           | 61.7                   | 6.74                | 7,675            | 0                    |
| Brain concussion                                    | 185             | 88.1                   | 36.05               | 6,633            | 6,000                |
| Electrical burn                                     | 195             | 76.4                   | 19.50               | 3,802            | 50                   |
| Burn, chemical                                      | 701             | 56.5                   | 4.71                | 3,305            | 0                    |
| Dust in eyes  | 1,559           | 41.2                   | 1.59                | 2,479            | 0                    |
| Poisoning   | 244             | 50.4                   | 2.74                | 669              | 0                    |
| Other specified causes                              | 1,255           | 75.3                   | 27.28               | 34,237           | 5,400                |
| Multiple injuries, unspecified                      | 9,093           | 75.5                   | 29.77               | 270,626          | 69,480               |
| Other unspecified injuries                          | 5,847           | 81.6                   | 36.70               | 214,558          | 9,000                |
| <b>Total</b>  | <b>131,144</b>  | <b>73.2</b>            | <b>26.28</b>        | <b>3,498,162</b> | <b>584,717</b>       |

Source: Mine Safety and Health Administration data.

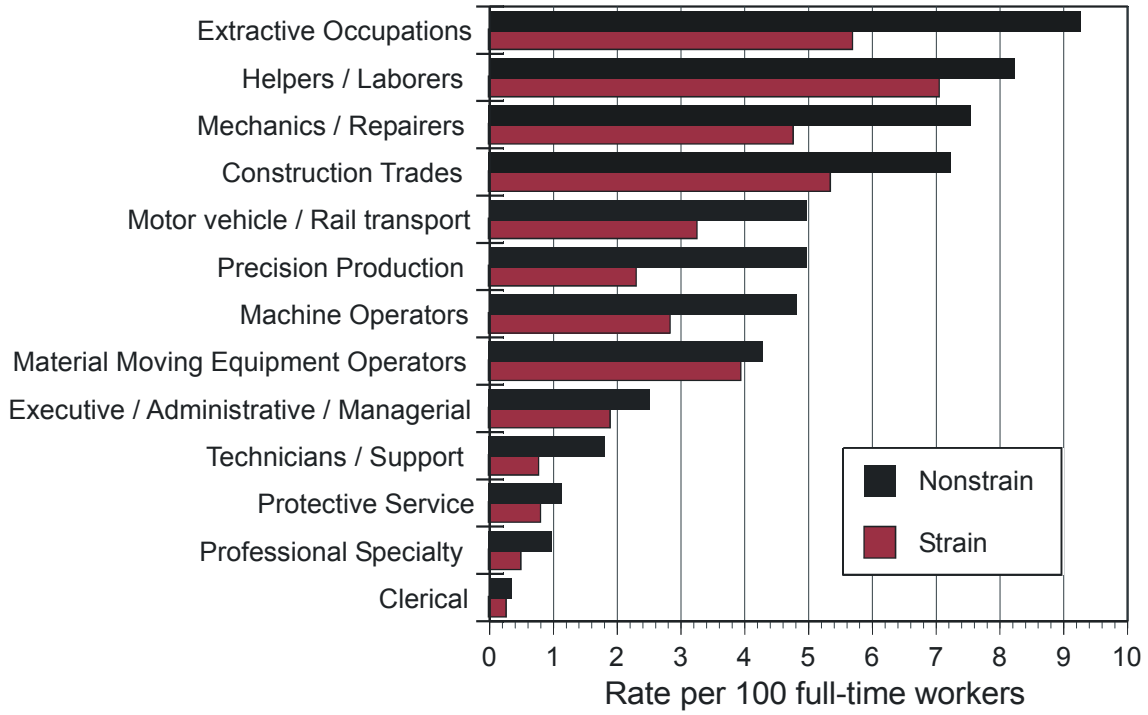
**Table 4A-4.—Coal operators: nonfatal injuries, 1986-1995, by work activity. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days work lost for all cases, and statutory days charged for all cases.**

| Work activity                           | Number of cases | Lost workday cases (%) | Mean days work lost | Total days lost  | Total statutory days |
|---|-----------------|------------------------|---------------------|------------------|----------------------|
| Materials handling                      | 40,469          | 77.3                   | 29.25               | 1,183,702        | 163,034              |
| Using or operating tools or machinery   | 32,899          | 64.0                   | 20.49               | 673,893          | 134,133              |
| Vehicular and transportation operations | 19,000          | 80.4                   | 30.58               | 580,959          | 95,945               |
| Constructing, repairing, or cleaning    | 20,963          | 68.8                   | 24.22               | 507,737          | 131,235              |
| Bodily movement                         | 12,373          | 78.4                   | 30.00               | 371,211          | 22,065               |
| Other                                   | 4,295           | 74.4                   | 29.16               | 125,235          | 27,555               |
| Unspecified                             | 1,145           | 88.5                   | 48.41               | 55,425           | 10,750               |
| <b>Total</b>                            | <b>131,144</b>  | <b>73.2</b>            | <b>26.68</b>        | <b>3,498,162</b> | <b>584,717</b>       |

Source: Mine Safety and Health Administration data.



**Figure 4A-7.—Coal operators: nonfatal injuries, 1986-1995. Number and rate (per 100 workers) of strain and nonstrain injuries by year. (Source: MSHA data)**



**Figure 4A-8.—Coal operators: nonfatal injuries, 1986-1995. Rate (per 100 workers) of strain and nonstrain injuries by U.S. Bureau of the Census Occupation Division. (Data on occupations were missing for 3,726 out of 131,144 cases (1.8%).) (Source: MSHA data)**

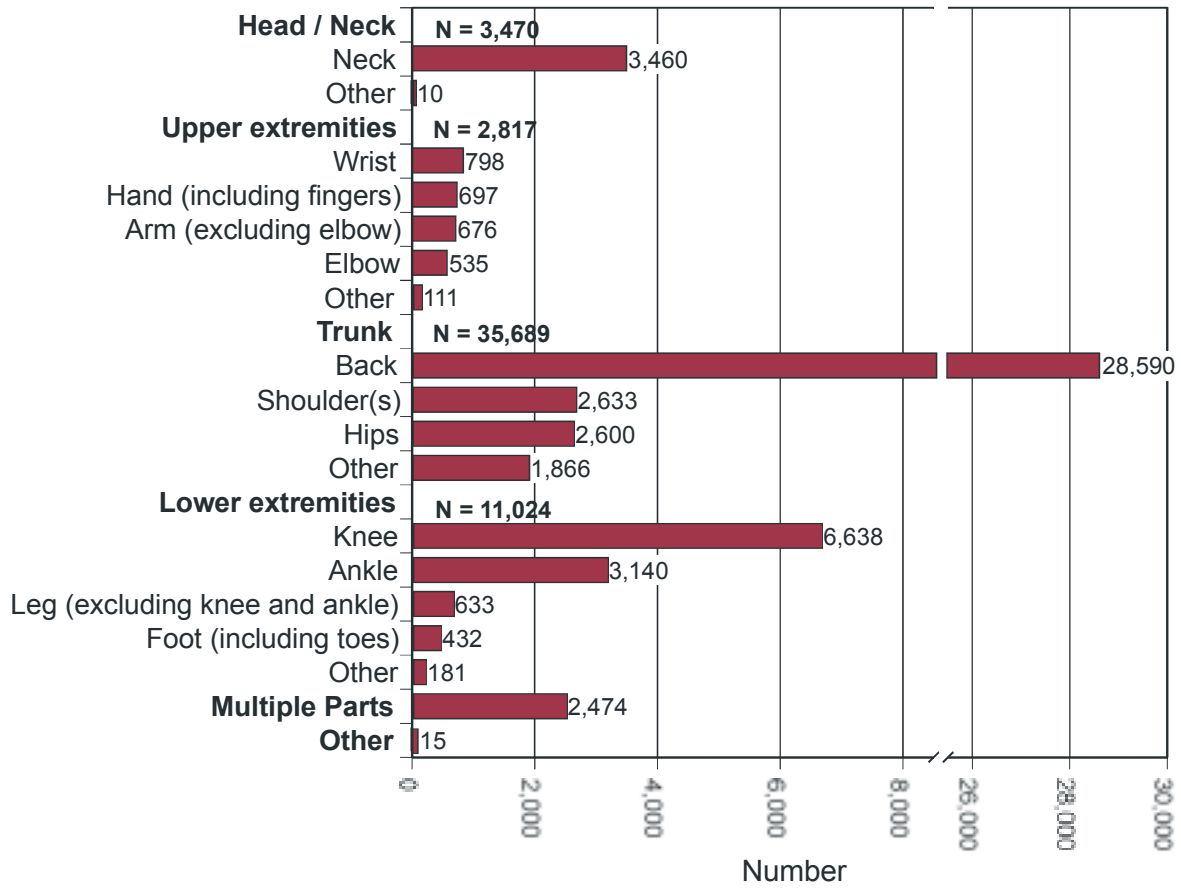


Figure 4A-9.—Coal operators: number of (nonfatal) strain injuries by body part injured, 1986-1995. (Source: MSHA data)

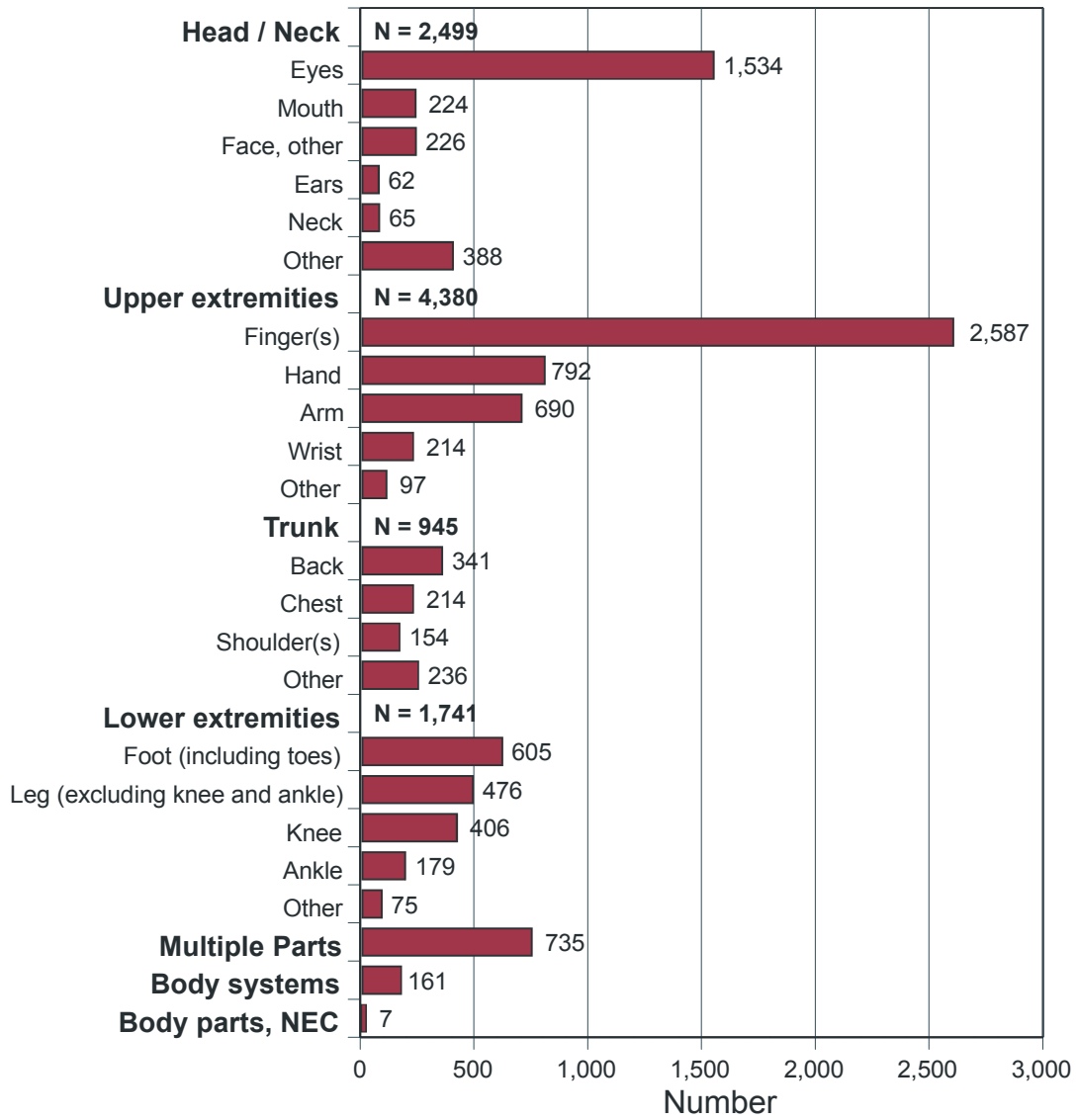
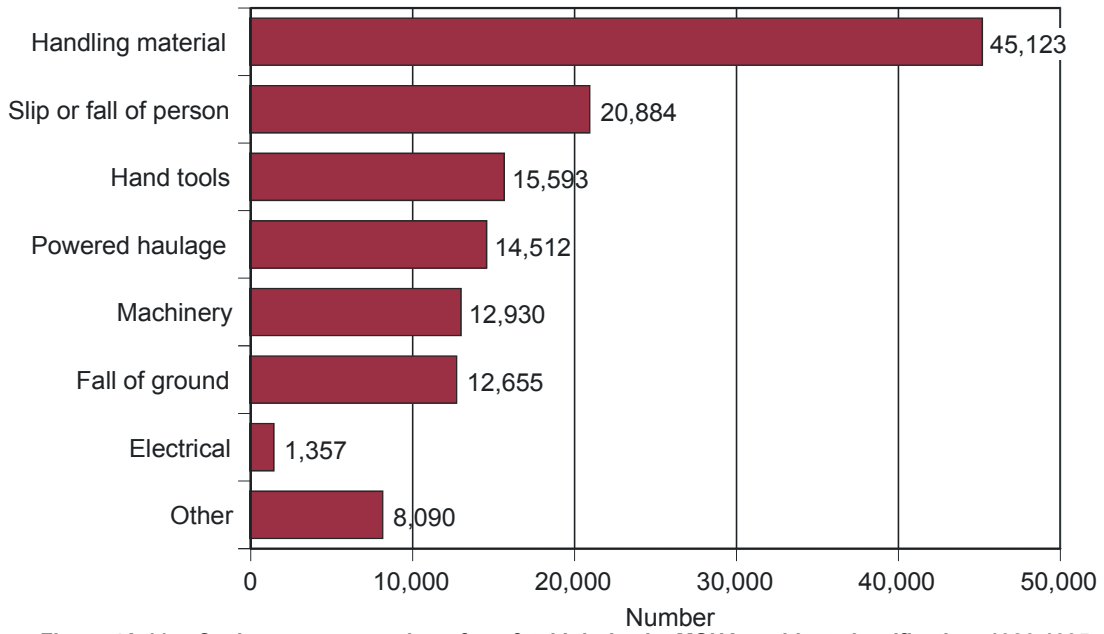


Figure 4A-10.—Coal operators: number of (nonfatal) nonstrain injuries by body part injured, 1986-1995. (Source: MSHA data)



**Figure 4A-11.—Coal operators: number of nonfatal injuries by MSHA accident classification, 1986-1995.**  
(Source: MSHA data)

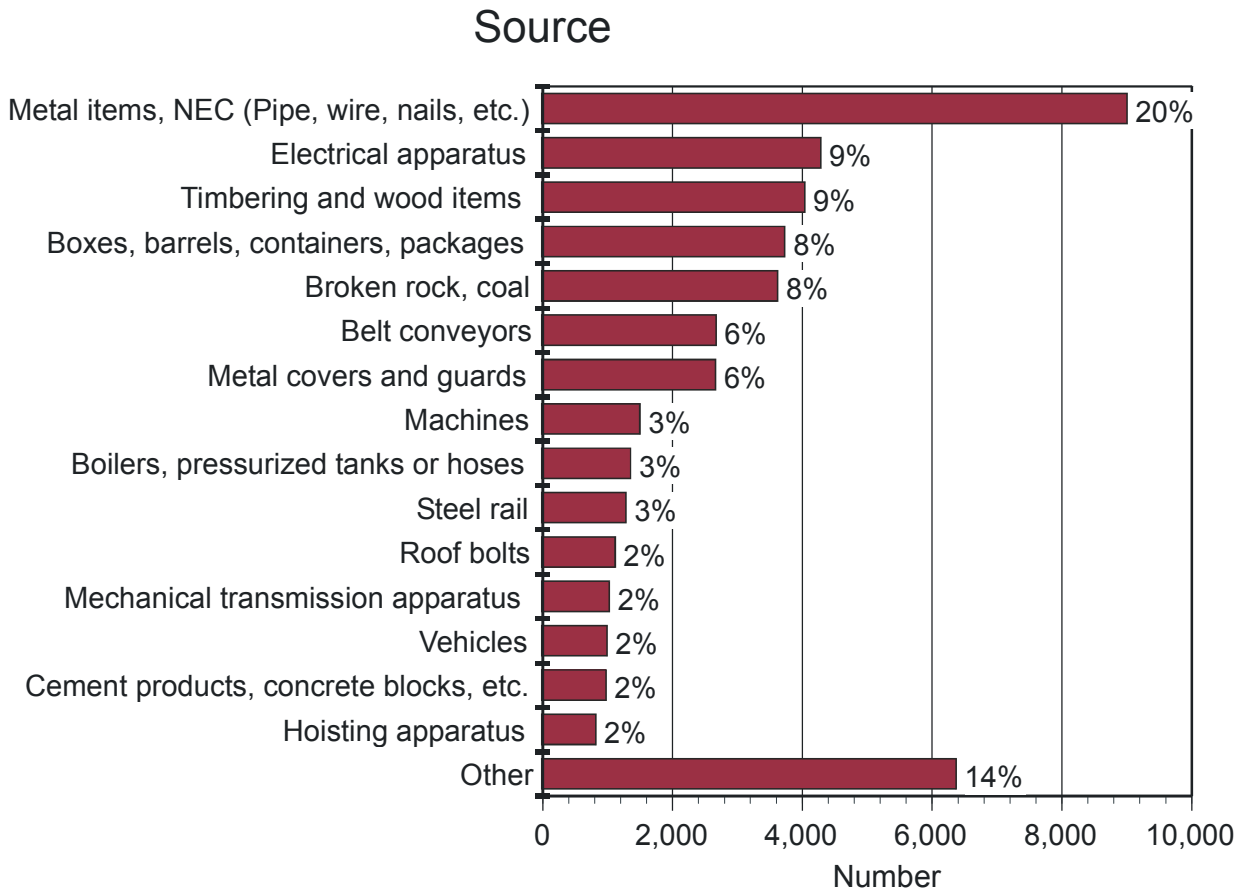
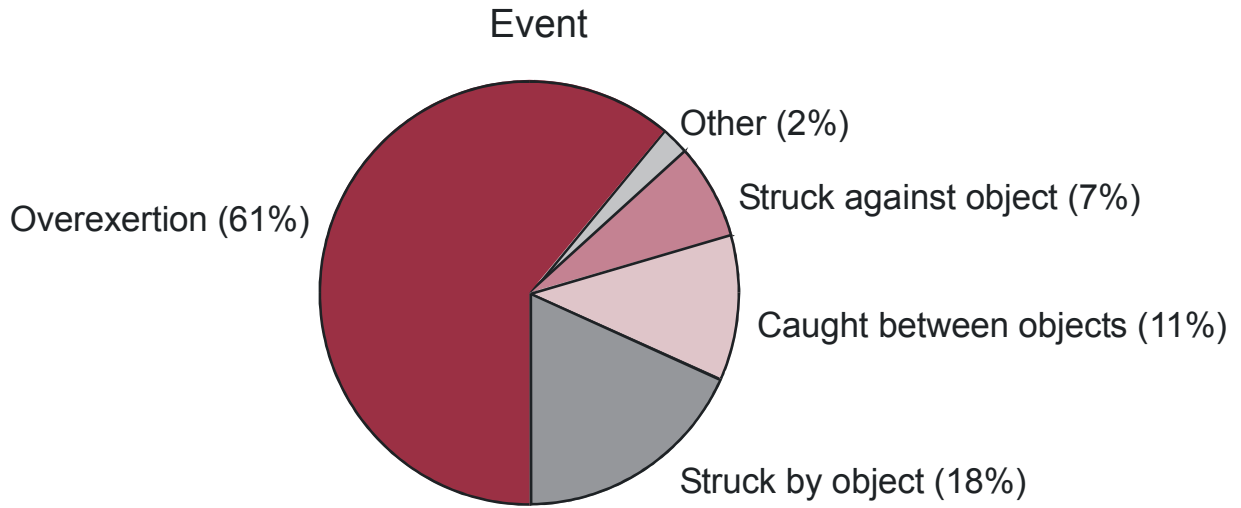


Figure 4A-12.—Coal operators: nonfatal material handling injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 45,123). (Source: MSHA data)



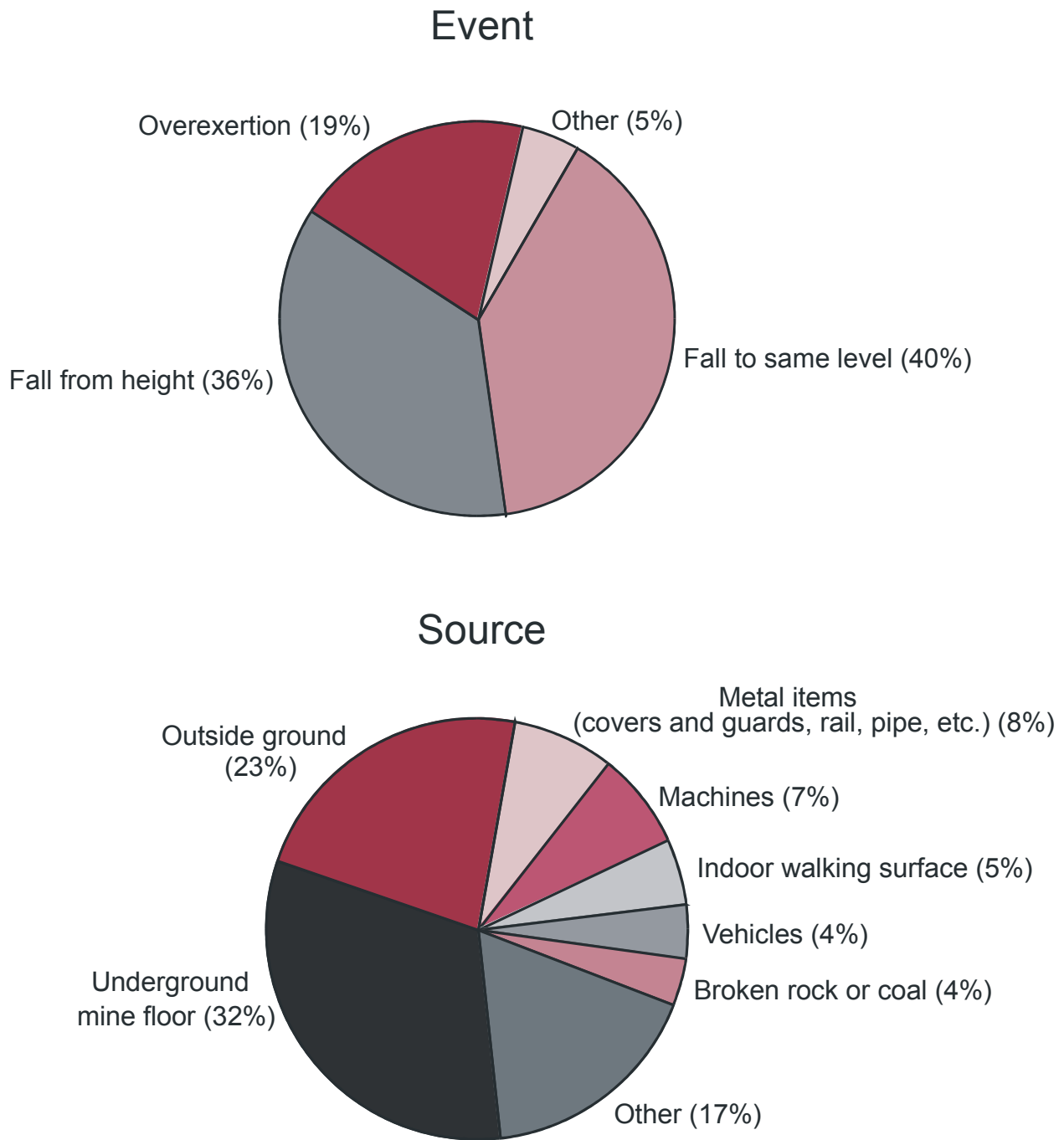


Figure 4A-13.—Coal operators: nonfatal fall injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 20,884). (Source: MSHA data)

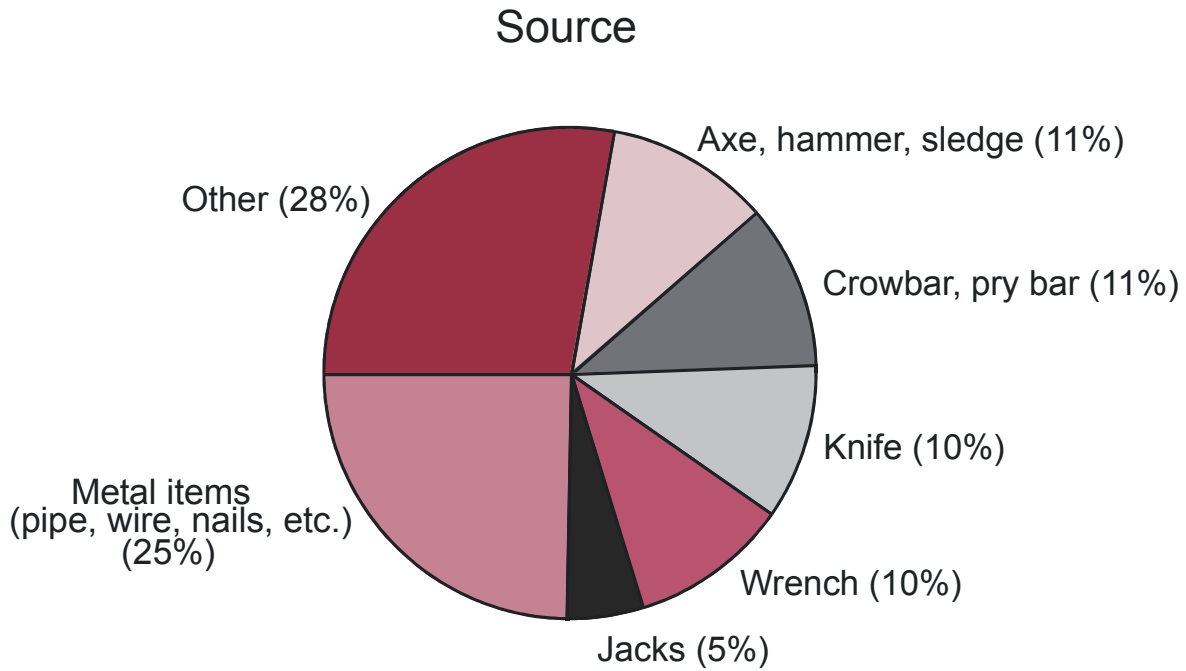
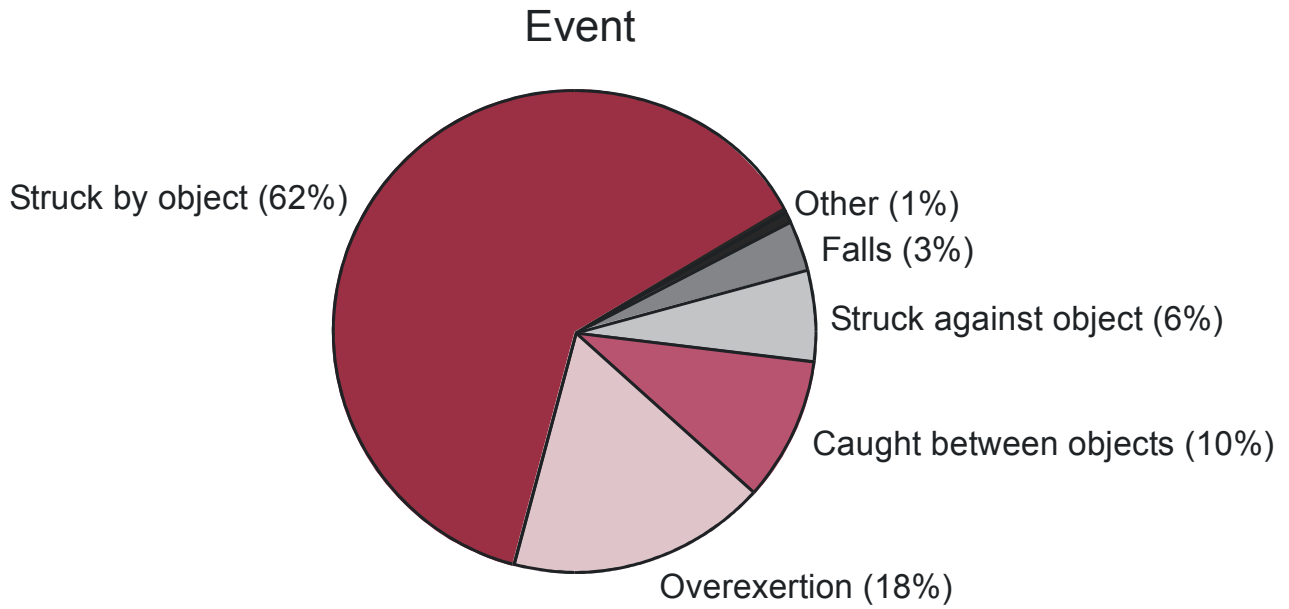
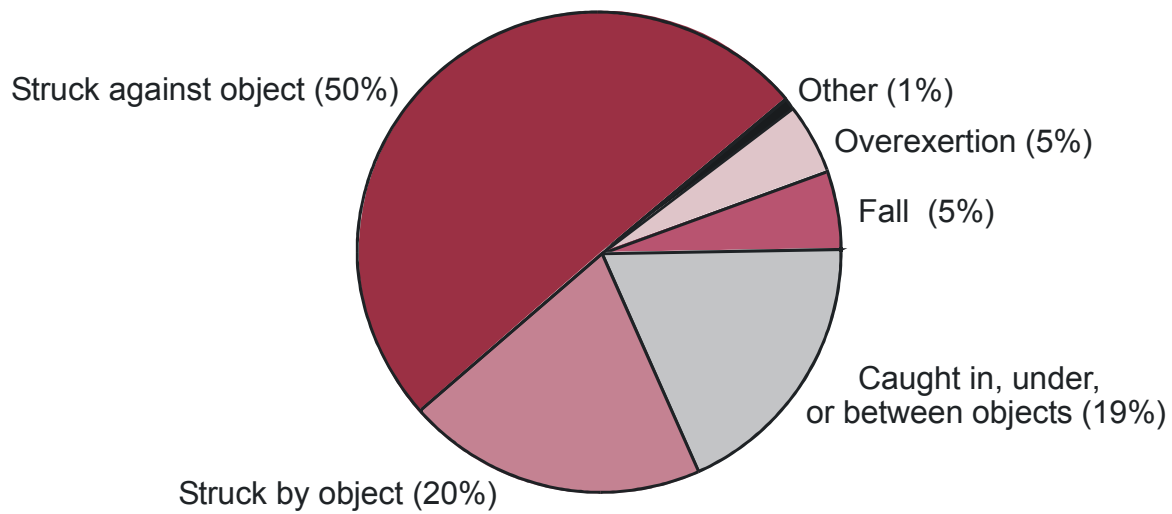


Figure 4A-14.—Coal operators: nonfatal hand tool injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 15,593). (Source: MSHA data)

### Event



### Source

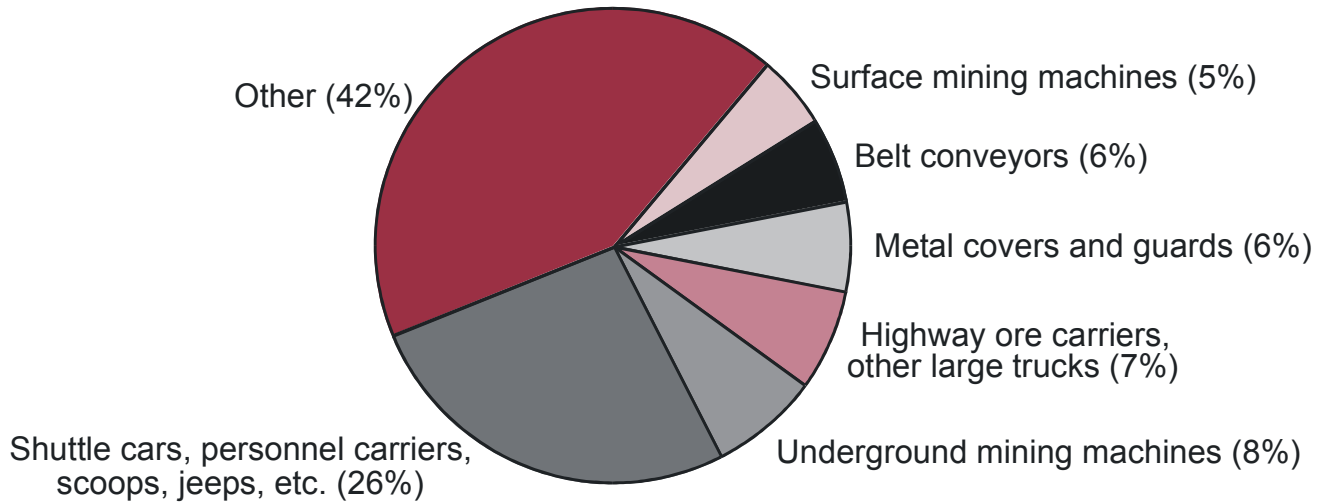


Figure 4A-15.—Coal operators: nonfatal powered haulage injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 14,512), (Source: MSHA data)

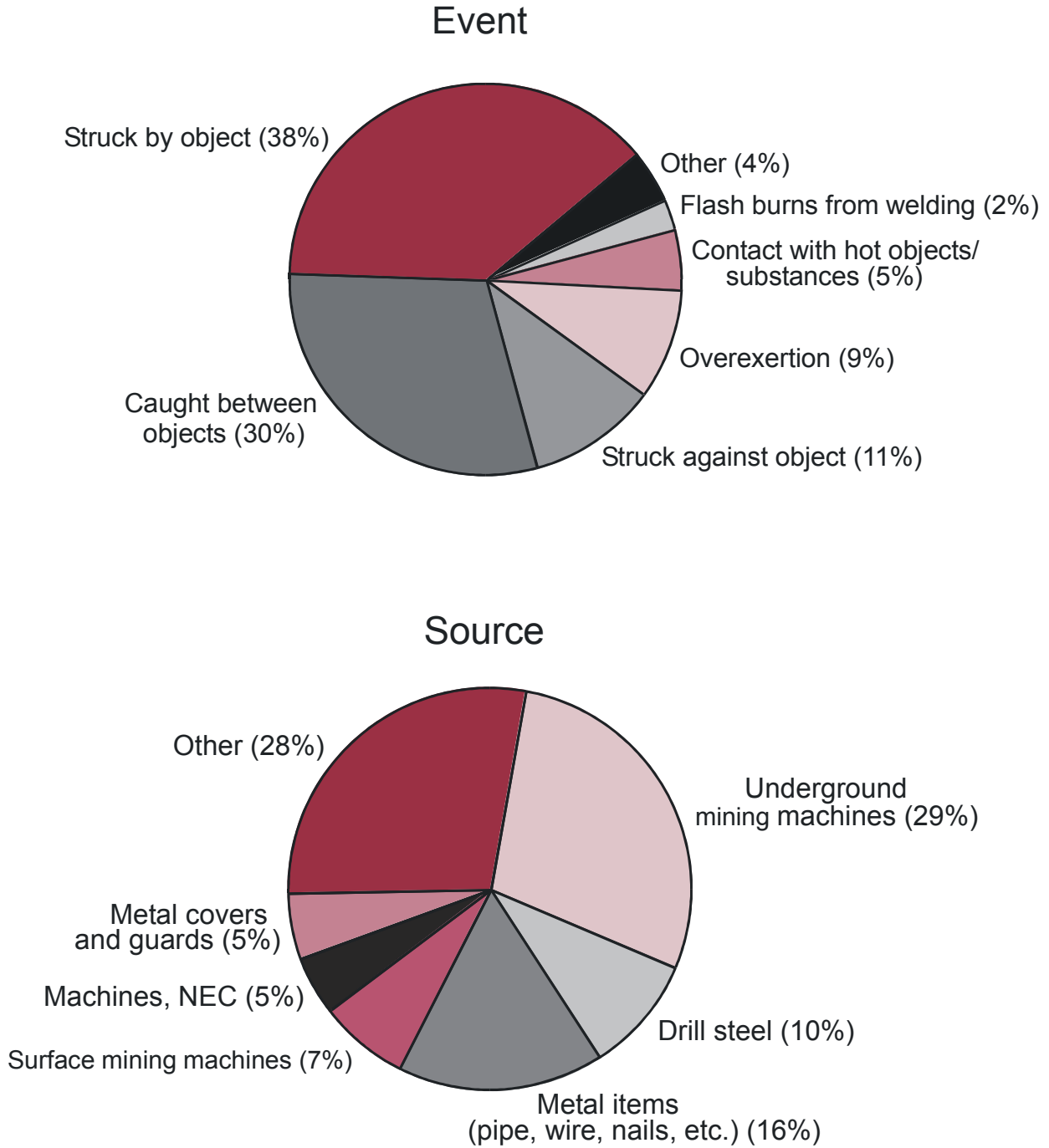


Figure 4A-16.—Coal operators: nonfatal machine injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 12,930). (Source: MSHA data)

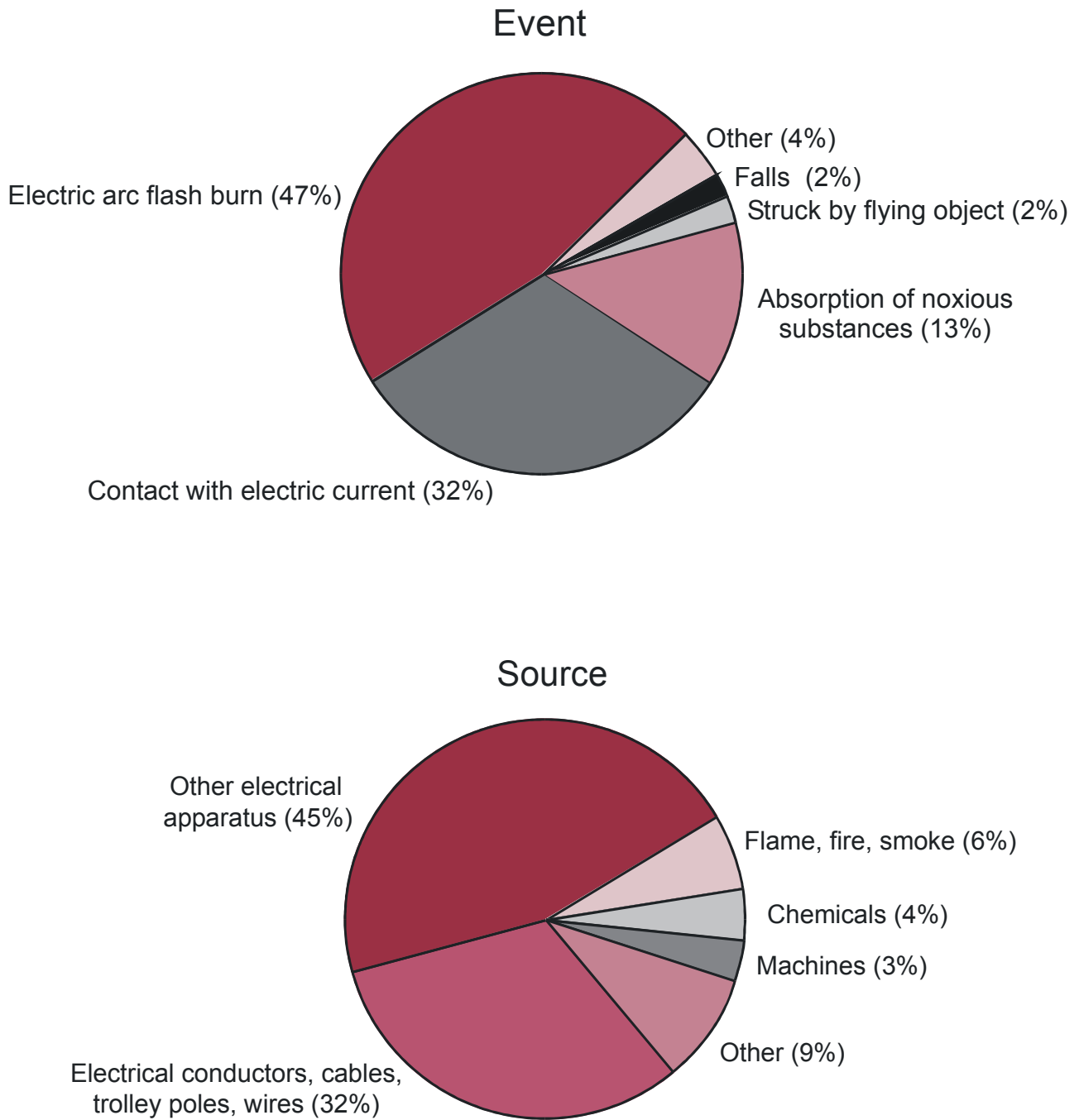


Figure 4A-17.—Coal operators: nonfatal electrical injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 1,357). (Source: MSHA data)

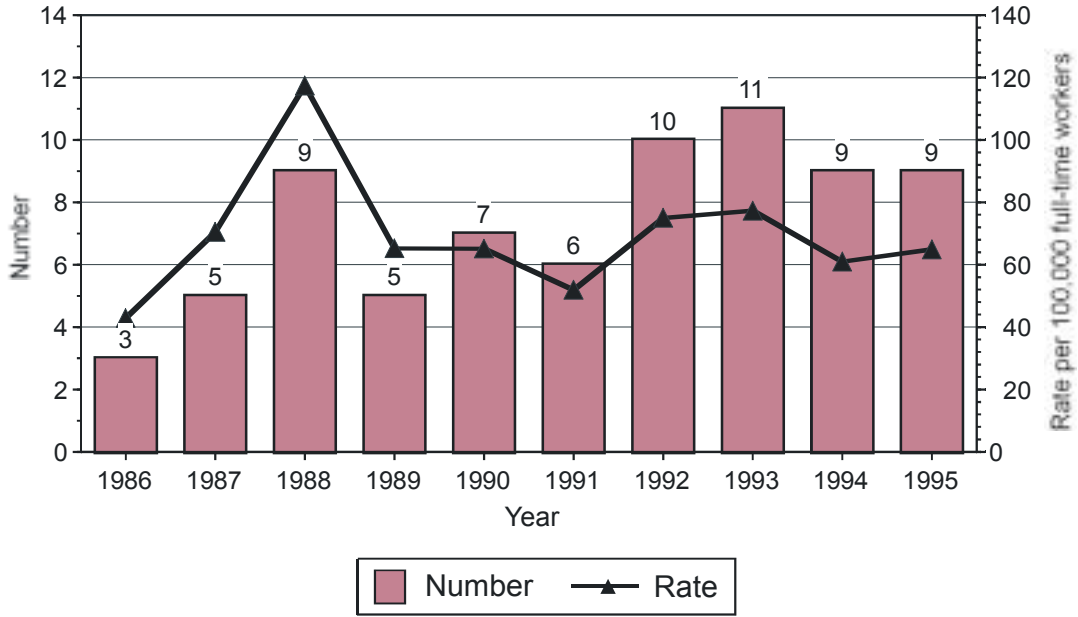


Figure 4A-18.—Coal contractors: number and rate of fatal injuries (per 1000,000 workers) by year. (Source: MSHA data)

Table 4A-5.—Coal contractors: number and average annual rate (per 100,00 workers) of fatal injuries by subunit, 1986-1995.

| <u>Mining operation</u>        | <u>Number, 1986-1995</u> | <u>Average annual rate per 100,000 full-time workers</u> |
|--------------------------------|--------------------------|--|
| <b>Underground mines:</b>      |                          |  |
| Underground operations         | 2                        | *  |
| Surface operations             | 13                       | 68.3   |
| <b>Surface mines:</b>          |                          |  |
| Strip                          | 36                       | 64.4   |
| Auger                          | 4                        | 396.7  |
| Culm Bank                      | 1                        | *  |
| Dredge                         | 0                        | *  |
| <b>Independent shops/yards</b> | 1                        | *  |
| <b>Preparation Plants</b>      | 17                       | 75.87  |
| <b>Office</b>                  | 0                        | *  |
| <b>Total</b>                   | <b>74</b>                | <b>63.1</b>  |

\* Rate not calculated because there were fewer than 3 fatalities

Source: Mine Safety and Health Administration data.

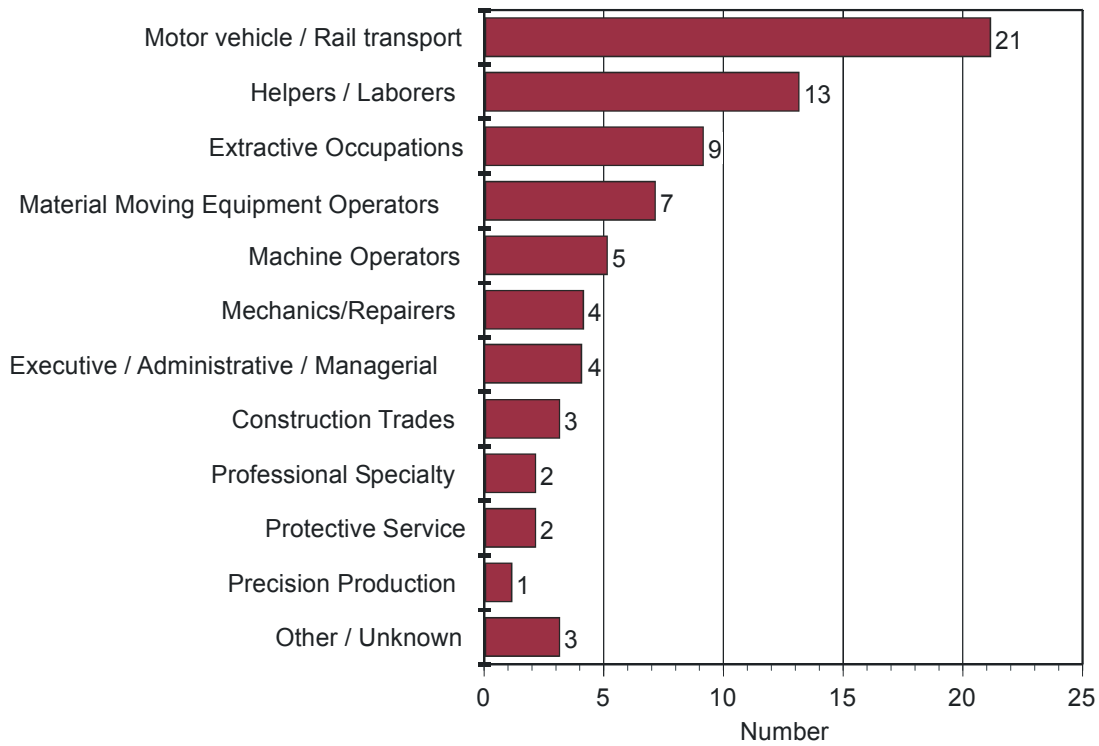


Figure 4A-19.—Coal contractors: number of fatal injuries by U.S. Bureau of the Census Occupation Division, 1986-1995. (Source: MSHA data)

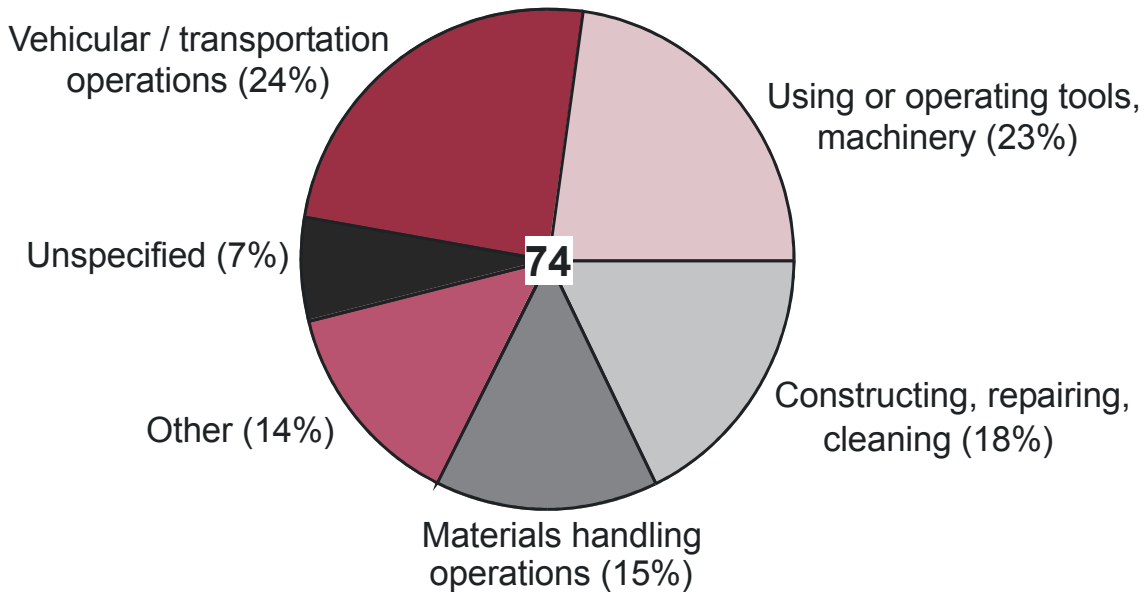


Figure 4A-20.—Coal contractors: percent of fatal injuries by work activity, 1986-1995. (Source: MSHA data)

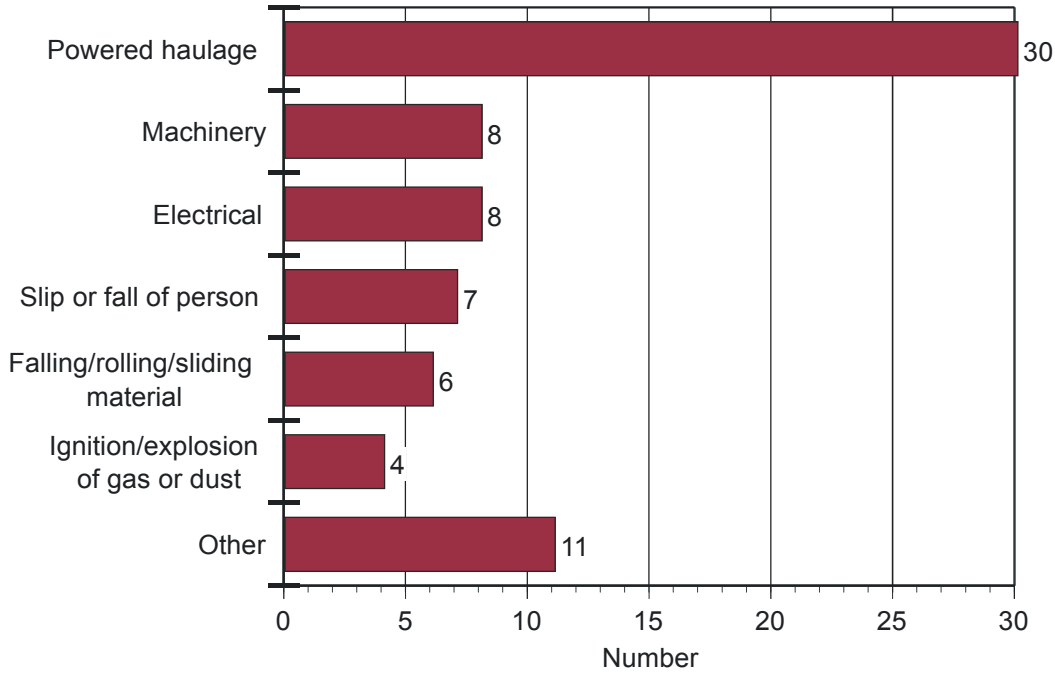


Figure 4A-21.—Coal contractors: number of fatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

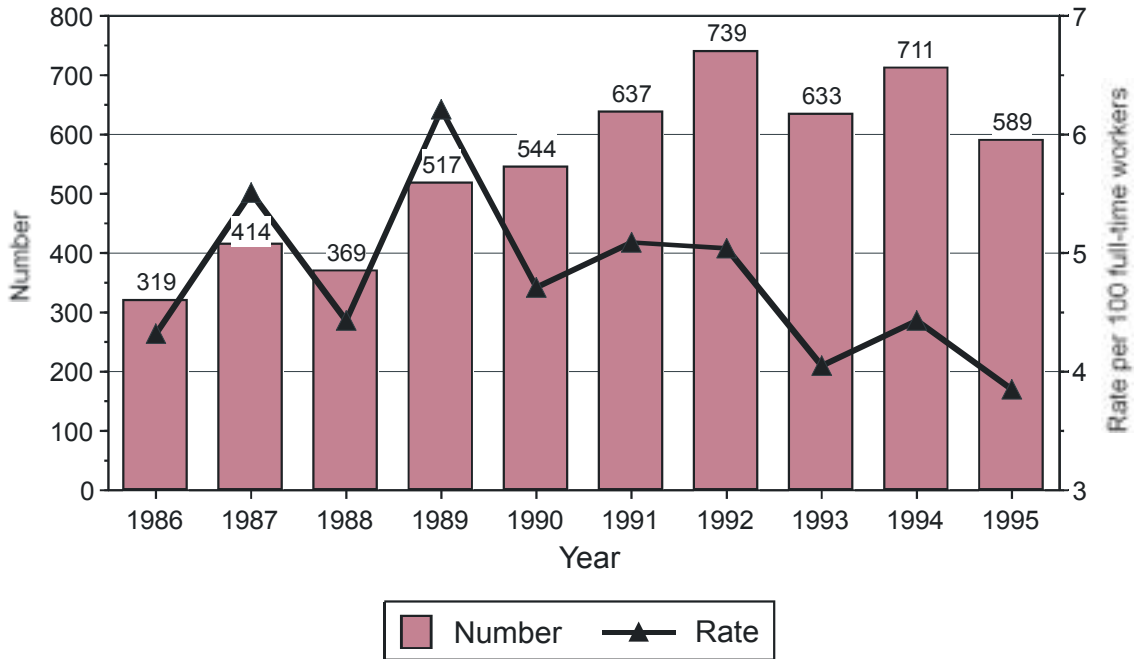


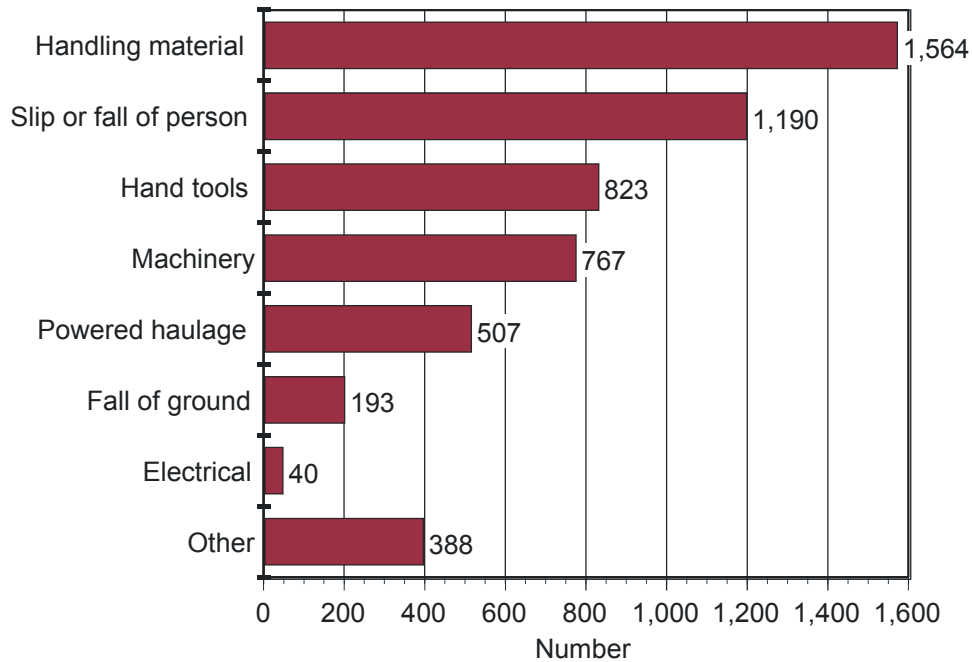
Figure 4A-22.—Coal contractors: number and rate (per 100 workers) of nonfatal injuries by year. (Source: MSHA data)



**Table 4A-6.—Coal contractors: number and average annual rate (per 100 workers) of nonfatal injuries by subunit, 1986-1995.**

| <u>Mining operation</u>        | <u>Number, 1986 -1995</u> | <u>Average annual rate per 100 full-time workers</u> |
|--------------------------------|---------------------------|--|
| <b>Underground mines:</b>      |                           |  |
| Underground operations         | 1,375                     | 15.87  |
| Surface operations             | 623                       | 3.27   |
| <b>Surface mines:</b>          |                           |  |
| Strip                          | 1,911                     | 3.42   |
| Auger                          | 75                        | 7.44   |
| Culm Bank                      | 10                        | 1.69   |
| Dredge                         | 2                         | 1.22   |
| <b>Independent shops/yards</b> | 26                        | 17.55  |
| <b>Preparation Plant</b>       | 1,379                     | 6.15   |
| <b>Office</b>                  | 71                        | 0.76   |
| <b>Total</b>                   | 5,472                     | 4.67   |

Source: Mine Safety and Health Administration data.



**Figure 4A-23.—Coal contractors: number of nonfatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)**

### 4B. INJURIES IN METAL MINING

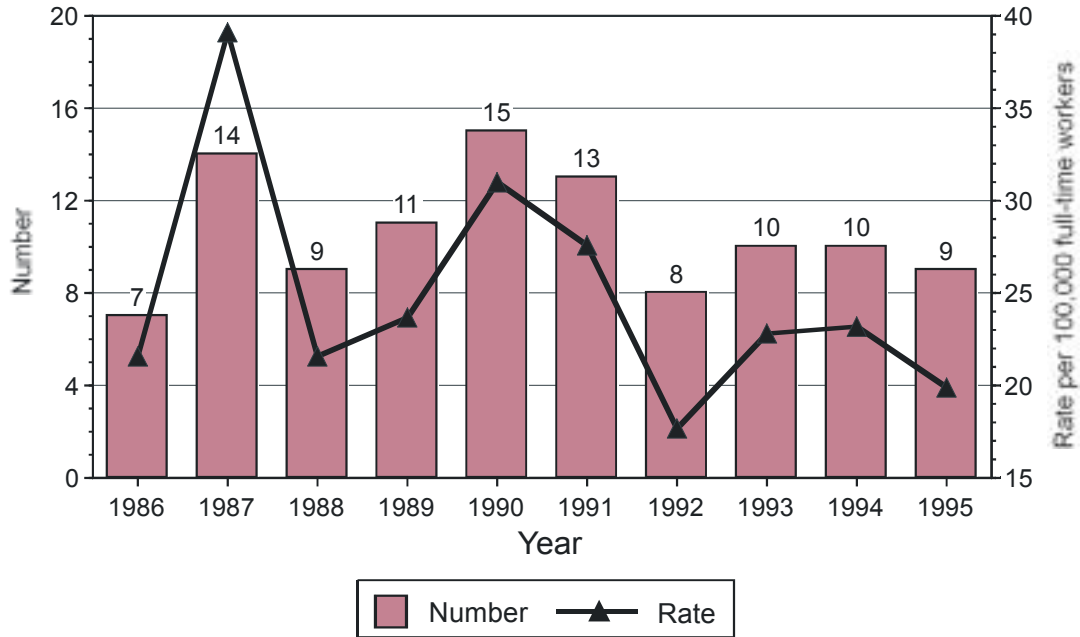


Figure 4B-1.—Metal operators: number and rate (per 100,000 workers) of fatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4B-1.—Metal operators: number and average annual rate (per 100,000 workers) of fatal injuries by subunit, 1986-1995.

| <u>Mining operation</u>        | <u>Number, 1986-1995</u> | <u>Average annual rate per 100,000 full-time workers</u> |
|--------------------------------|--------------------------|--|
| <b>Underground mines:</b>      |                          |  |
| Underground operations         | 56                       | 87.6   |
| Surface operations             | 5                        | 29.7   |
| <b>Surface mines:</b>          |                          |  |
| Strip                          | 31                       | 20.2   |
| Dredge                         | 0                        | *  |
| Other surface mining           | 0                        | *  |
| <b>Independent shops/yards</b> | 1                        | *  |
| <b>Mill</b>                    | 13                       | 7  |
| <b>Office</b>                  | 0                        | *  |
| <b>Total</b>                   | <b>106</b>               | <b>22</b>  |

\* Rate not calculated because there were fewer than 3 fatalities

Source: Mine Safety and Health Administration data.

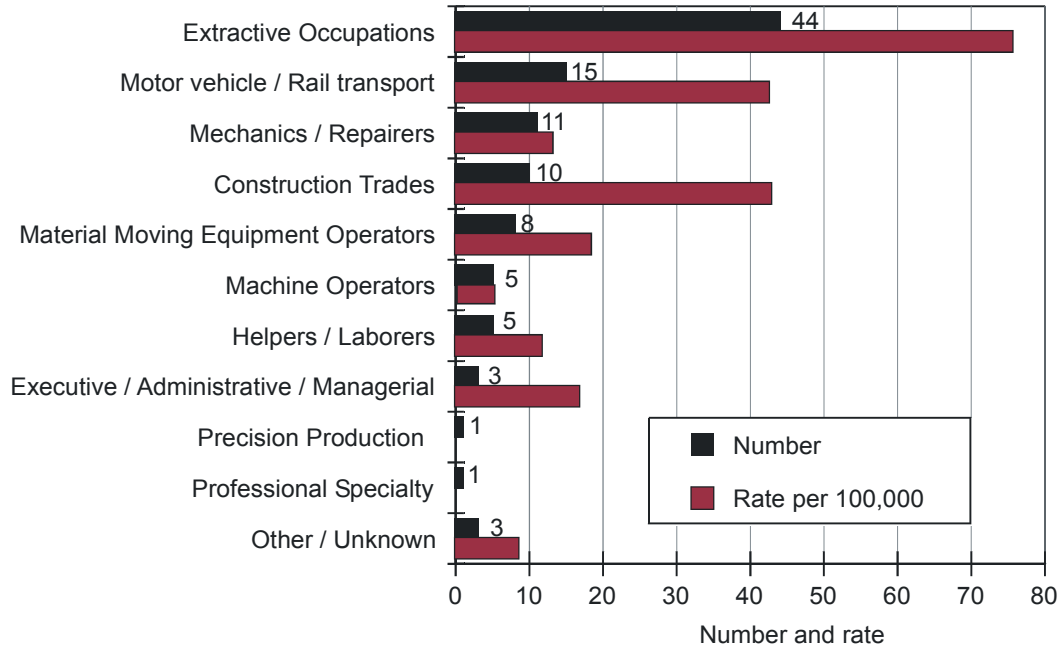


Figure 4B-2.—Metal operators: number and rate (per 100,000 workers) of fatal injuries by U.S. Bureau of the Census Occupation Division, 1996-1995. (Source: MSHA data)

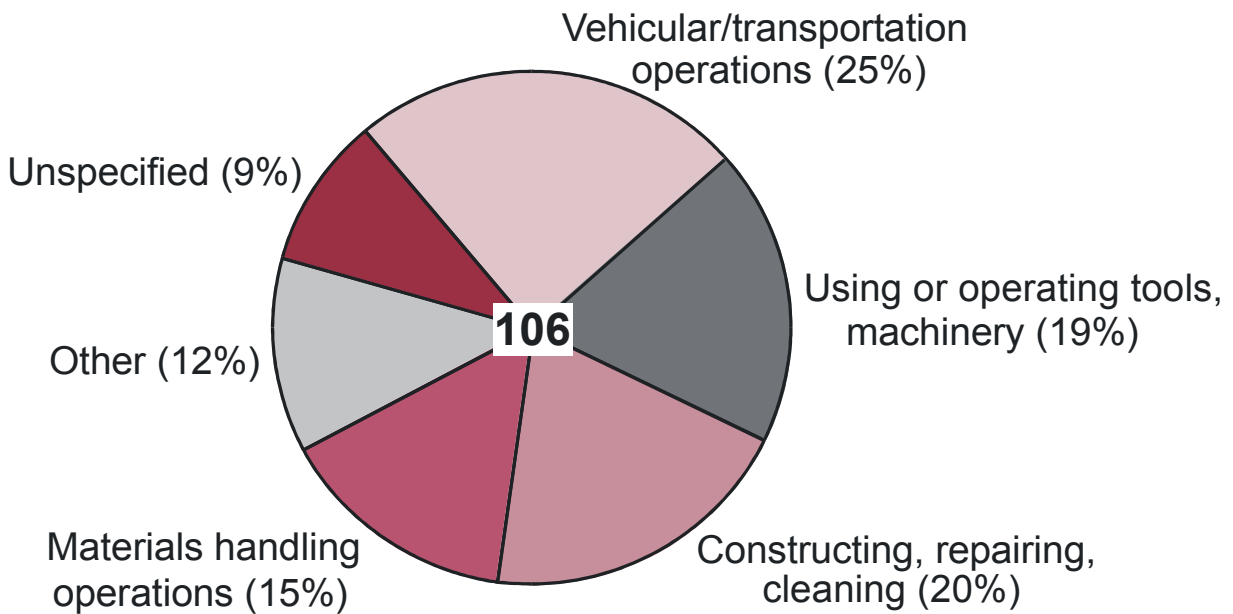


Figure 4B-3.—Metal operators: number of fatal injuries by work activity, 1986-1995. (Source: MSHA data)

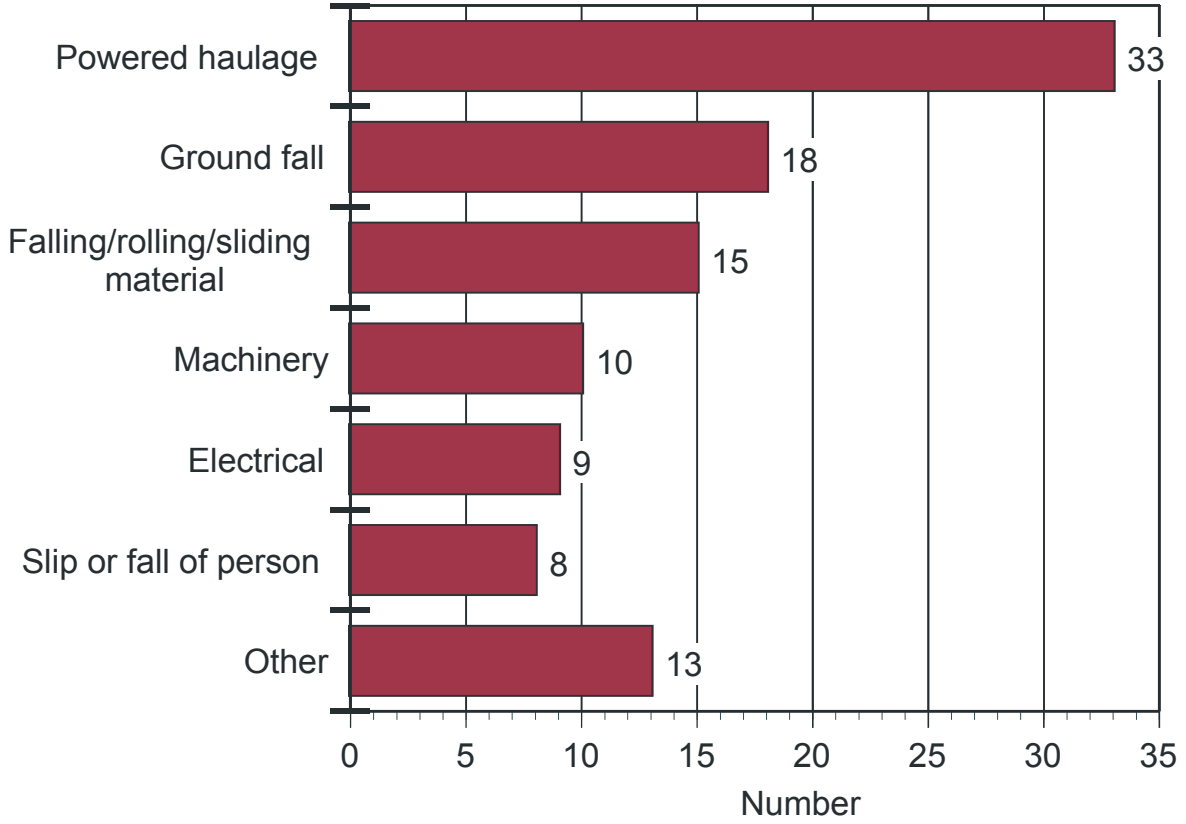


Figure 4B-4.—Metal operators: number of fatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

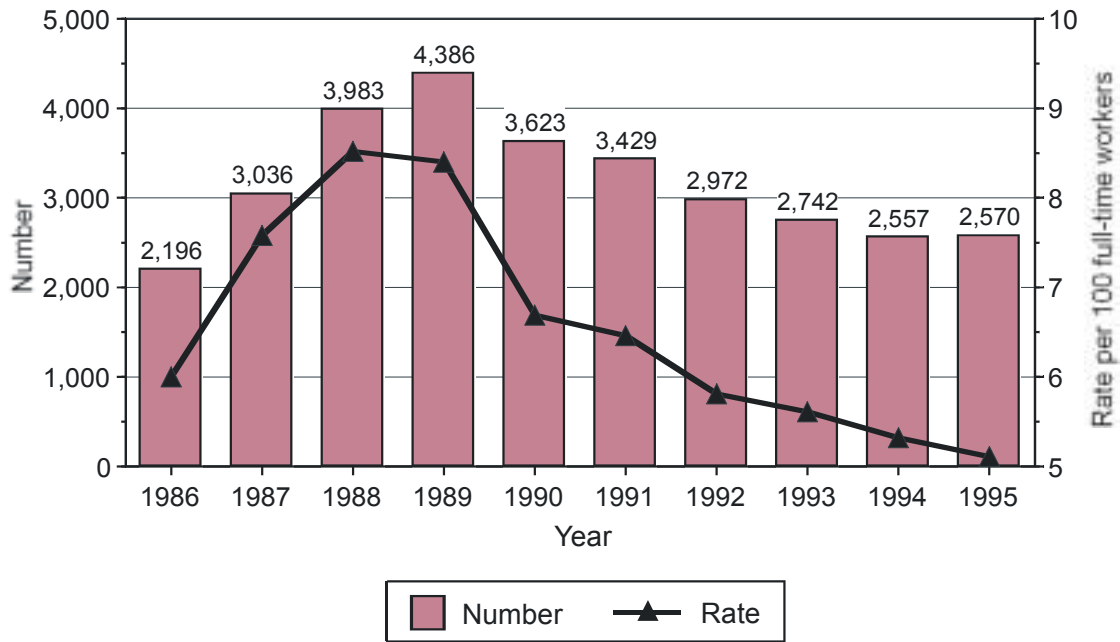


Figure 4B-5.—Metal operators: number and rate (per 100 workers) of nonfatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4B-2.—Metal operators: number and average annual rate (per 100 workers) of nonfatal injuries by subunit, 1986-1995.

| <u>Mining operation</u>        | <u>Number, 1986-1995</u> | <u>Average annual rate per 100 full-time workers</u> |
|--------------------------------|--------------------------|--|
| <b>Underground mines:</b>      |                          |  |
| Underground operations         | 8,177                    | 12.79  |
| Surface operations             | 1,293                    | 7.67   |
| <b>Surface mines:</b>          |                          |  |
| Strip                          | 8,179                    | 5.33   |
| Dredge                         | 417                      | 9.49   |
| Other surface mining           | 71                       | 9.67   |
| <b>Independent shops/yards</b> | 276                      | 6.61   |
| <b>Mill</b>                    | 12,921                   | 6.98   |
| <b>Office</b>                  | 160                      | 0.3  |
| <b>Total</b>                   | <b>31,494</b>            | <b>6.52</b>  |

Source: Mine Safety and Health Administration data.

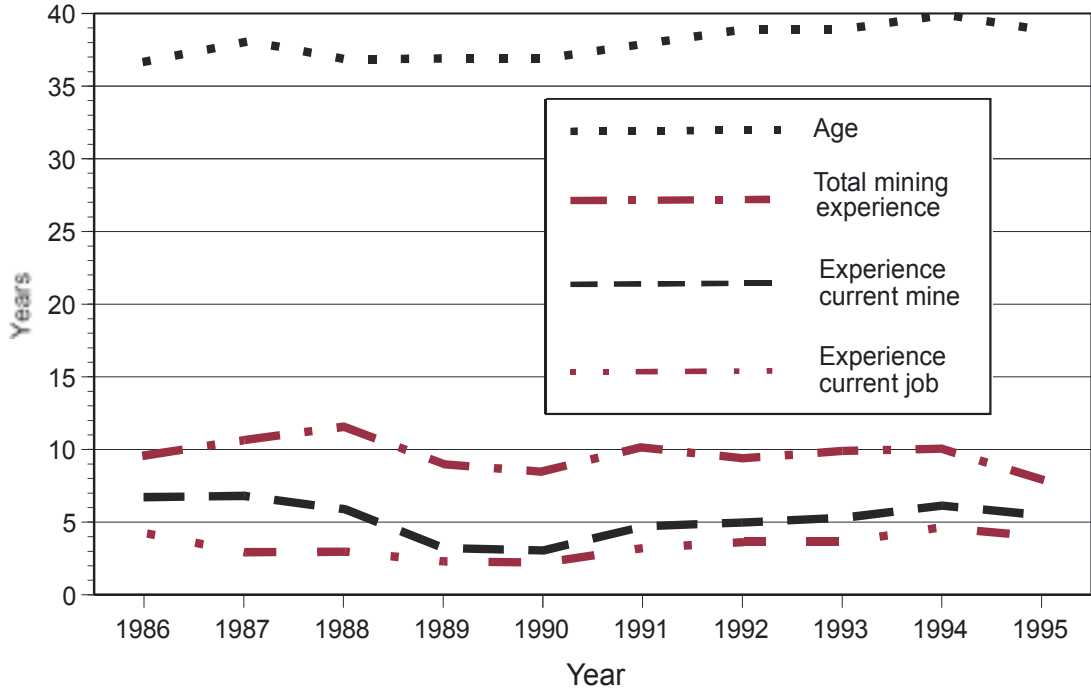


Figure 4B-6.—Metal operators: median values for age, total mining experience, experience in current mine, and experience in current job for workers with nonfatal injuries by year, 1986-1995. (Source: MSHA data)

**Table 4B-3.—Metal operators: nonfatal injuries, 1986-1995, by nature of injury. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days work lost for all cases, and statutory days charged for all cases.**

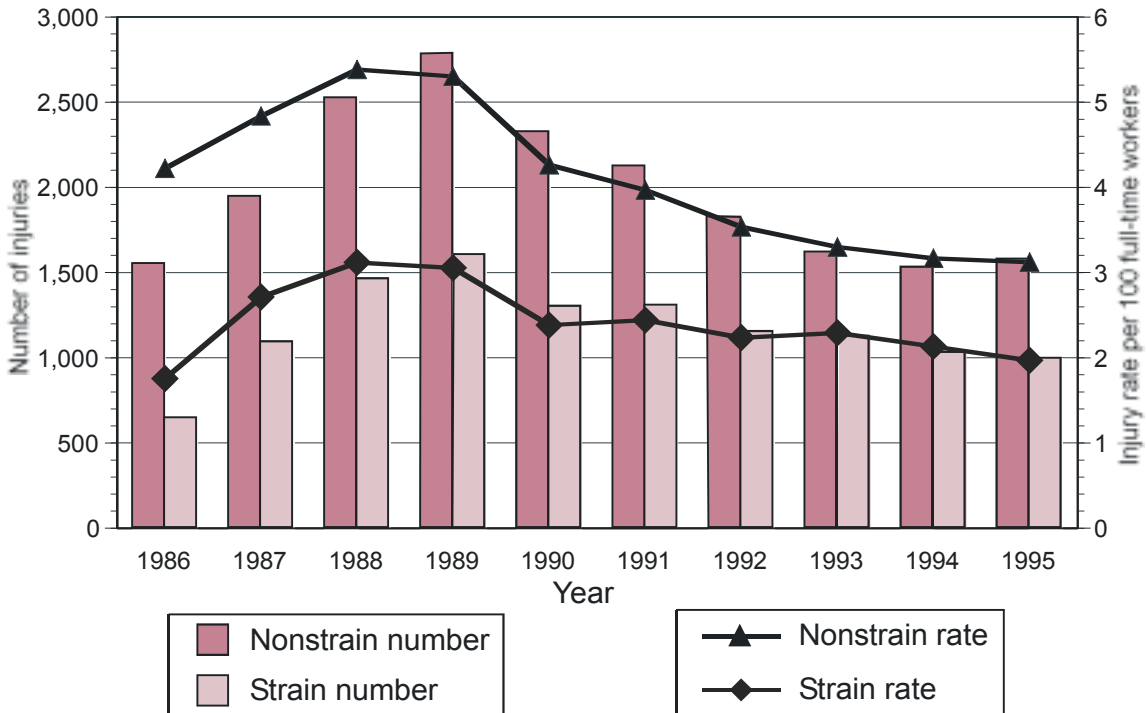
| Nature of Injury                                    | Number of cases | Lost workday cases (%) | Mean days lost work | Total days lost | Total statutory days |
|---|-----------------|------------------------|---------------------|-----------------|----------------------|
| Sprains and strains                                 | 10,761          | 59.0                   | 21.81               | 234,696         | 17,540               |
| Fracture  | 3,605           | 43.5                   | 22.86               | 82,399          | 15,912               |
| Contusions  | 2,306           | 50.4                   | 11.67               | 26,908          | 0                    |
| Lacerations   | 7,371           | 12.8                   | 2.05                | 15,111          | 1,870                |
| Hernia  | 366             | 82.5                   | 26.12               | 9,560           | 13,600               |
| Amputation or enucleation                           | 191             | 66.5                   | 30.75               | 5,874           | 74,025               |
| Dislocation   | 194             | 54.6                   | 27.72               | 5,377           | 950                  |
| Joint, tendon, or muscle inflammation or irritation | 247             | 50.6                   | 21.51               | 5,313           | 0                    |
| Burn, heat  | 671             | 33.2                   | 6.94                | 4,657           | 450                  |
| Crushing  | 260             | 40.0                   | 12.32               | 3,204           | 6,950                |
| Burn, chemical                                      | 733             | 32.7                   | 4.32                | 3,165           | 0                    |
| Noncontact electric arc burn                        | 216             | 42.1                   | 5.46                | 1,179           | 0                    |
| Brain concussion                                    | 63              | 79.4                   | 15.59               | 982             | 0                    |
| Poisoning   | 166             | 41.6                   | 4.75                | 788             | 0                    |
| Abrasions   | 417             | 33.3                   | 1.88                | 784             | 0                    |
| Electrical burn                                     | 21              | 57.1                   | 21.29               | 447             | 0                    |
| Dust in eyes  | 705             | 14.5                   | 0.57                | 401             | 0                    |
| Electric shock                                      | 29              | 58.6                   | 29.00               | 269             | 0                    |
| Other specified causes                              | 405             | 48.9                   | 12.68               | 5,137           | 6,943                |
| Multiple injuries, unspecified                      | 2,239           | 50.0                   | 14.79               | 44,193          | 16,785               |
| Other unspecified injuries                          | 528             | 57.8                   | 22.41               | 11,835          | 75                   |
| <b>Total</b>  | <b>31,494</b>   | <b>42.4</b>            | <b>14.68</b>        | <b>462,279</b>  | <b>155,100</b>       |

Source: Mine Safety and Health Administration data.

**Table 4B-4.—Metal operators: nonfatal injuries, 1986-1995, by work activity. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days work lost for all cases, and statutory days charged for all cases.**

| Work activity                           | Number of cases | Lost workday cases (%) | Mean days lost work | Total days lost | Total statutory days |
|---|-----------------|------------------------|---------------------|-----------------|----------------------|
| Materials handling                      | 9,148           | 44.9                   | 14.68               | 134,332         | 48,010               |
| Using or operating tools or machinery   | 8,724           | 32.8                   | 10.32               | 90,071          | 32,535               |
| Constructing, repairing or cleaning     | 5,894           | 38.7                   | 13.36               | 78,767          | 35,735               |
| Vehicular and transportation operations | 3,565           | 55.6                   | 21.86               | 77,935          | 7,570                |
| Bodily movement                         | 3,020           | 50.6                   | 18.85               | 56,914          | 6,360                |
| Other                                   | 830             | 47.1                   | 16.71               | 13,871          | 20,690               |
| Unspecified                             | 313             | 62.6                   | 33.19               | 10,389          | 4,200                |
| <b>Total</b>                            | <b>31,494</b>   | <b>42.4</b>            | <b>14.68</b>        | <b>462,279</b>  | <b>155,100</b>       |

Source: Mine Safety and Health Administration data.



**Figure 4B-7.—Metal operators: nonfatal injuries 1986-1995. Number and rate (per 100 workers) of strain and nonstrain injuries by year, 1986-1995. (Source: MSHA data)**



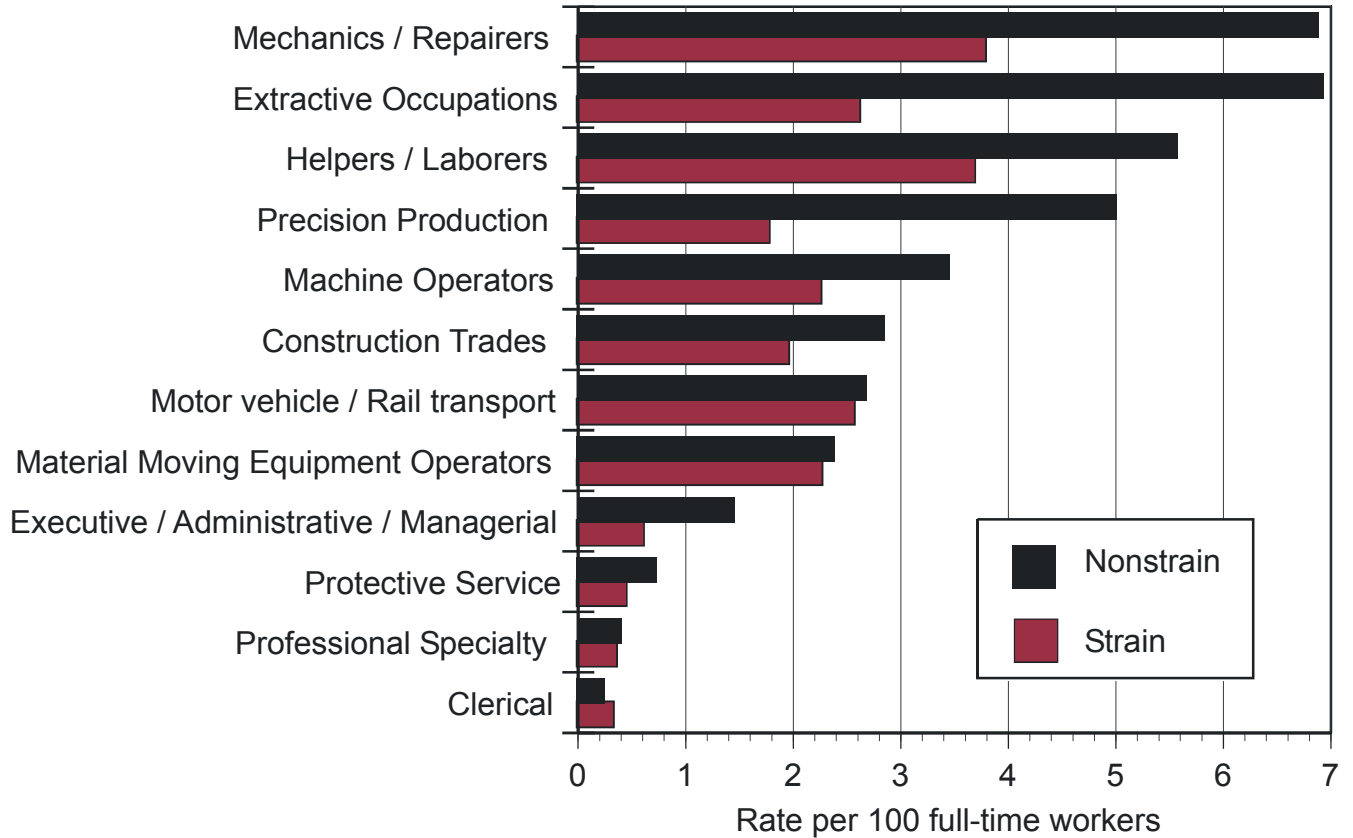


Figure 4B-8.—Metal operators: nonfatal injuries 1986-1995. Number and rate (per 100 workers) of strain and nonstrain injuries by U.S. Bureau of the Census Occupation Division, 1986-1995. (Data on occupations were missing for 915 out of 31,492 cases (2.9%).) (Source: MSHA data)

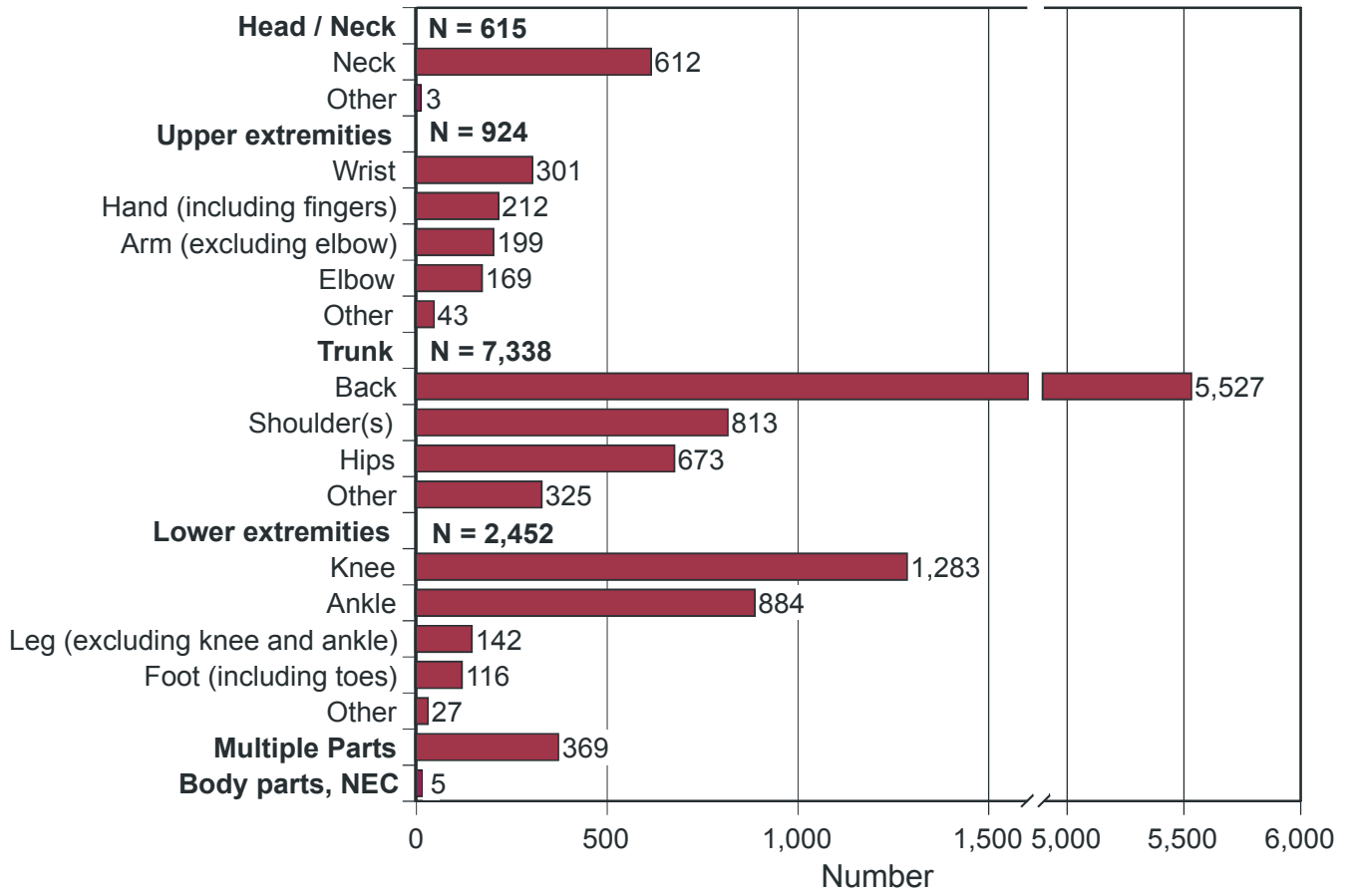


Figure 4B-9.—Metal operators: number of (nonfatal) strain injuries by body part injured, 1986-1995. (Source: MSHA data)

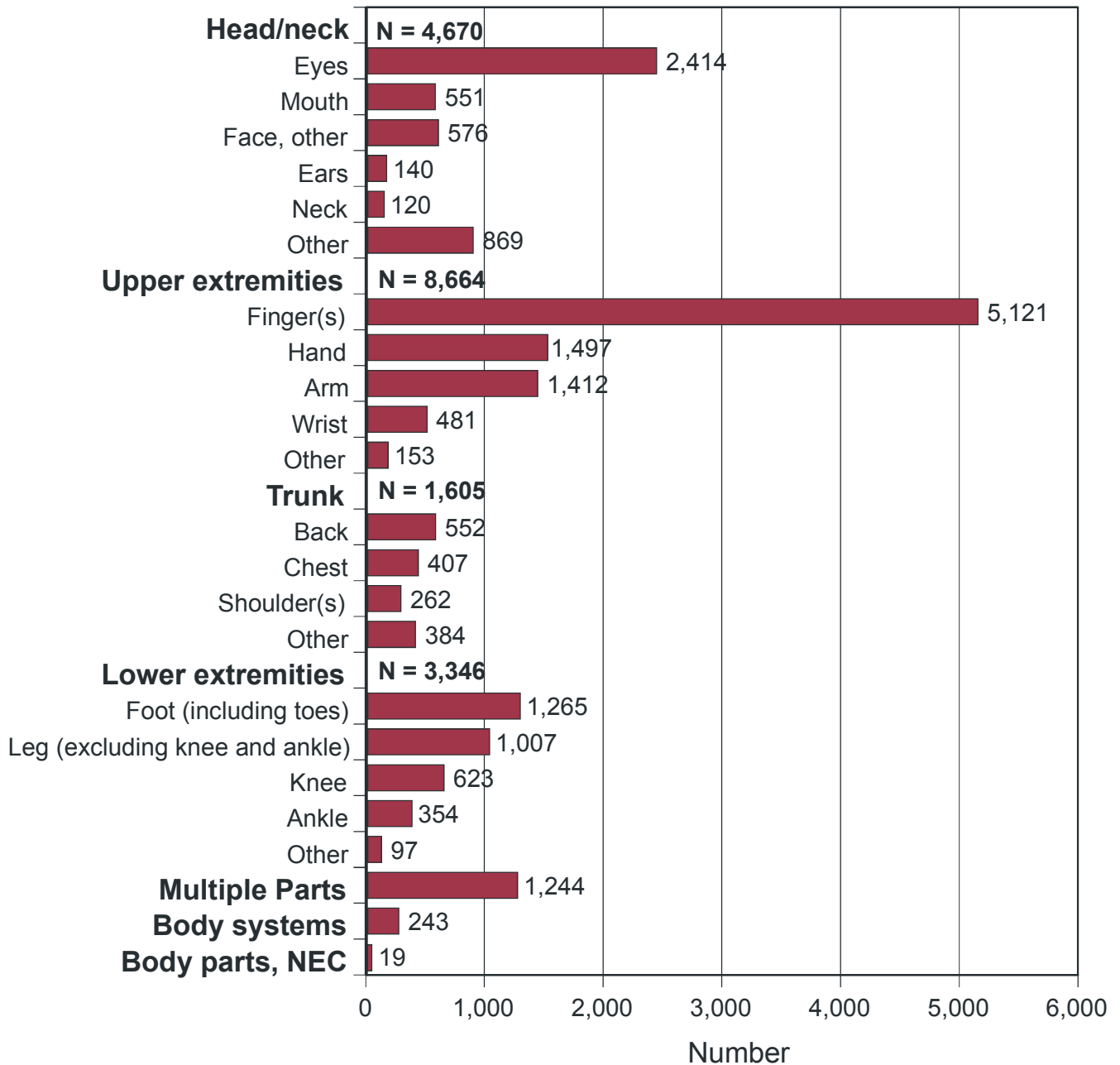


Figure 4B-10.—Metal operators: number of (nonfatal) nonstrain injuries by body part injured, 1986-1995. (Source: MSHA data)

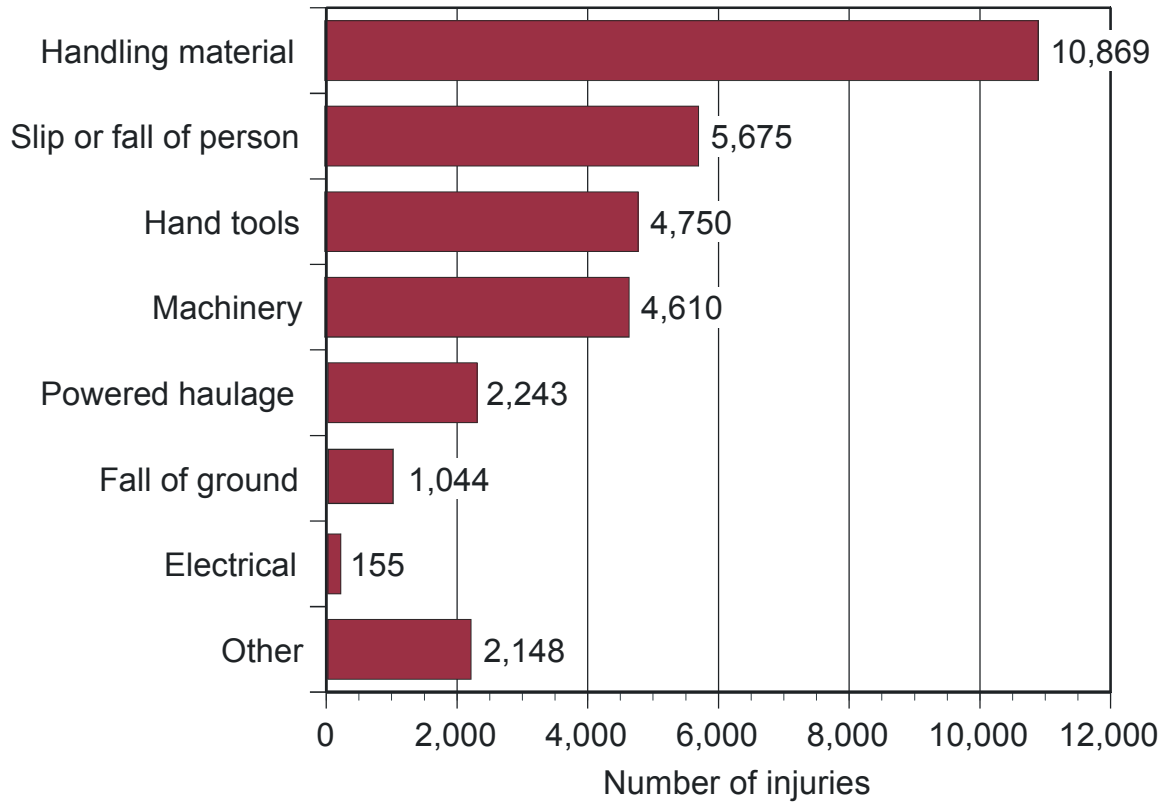
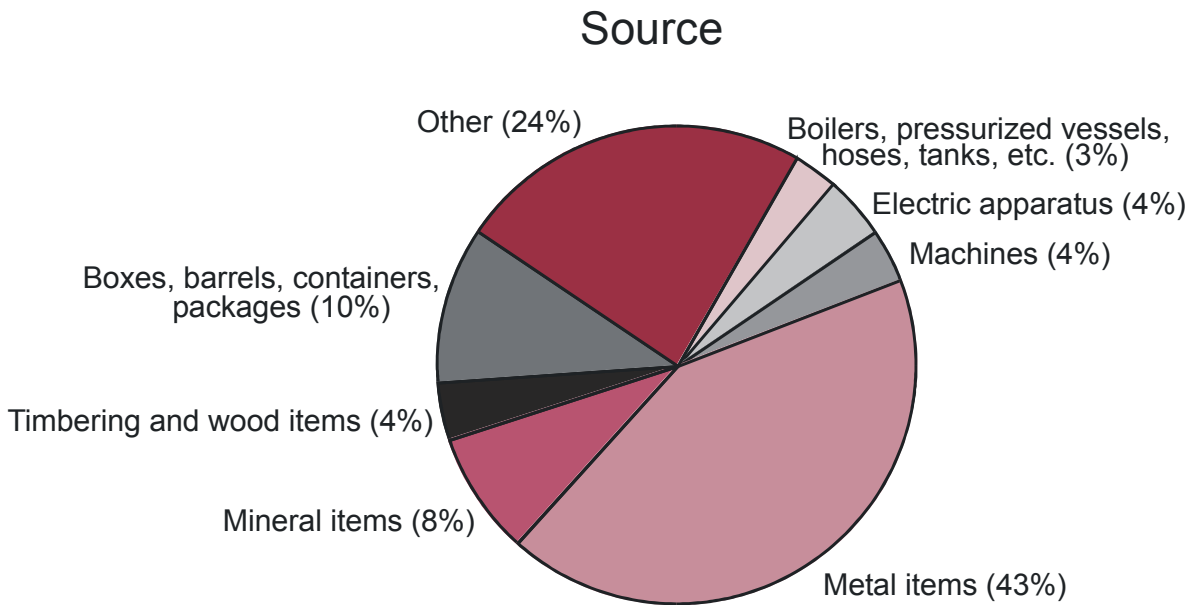
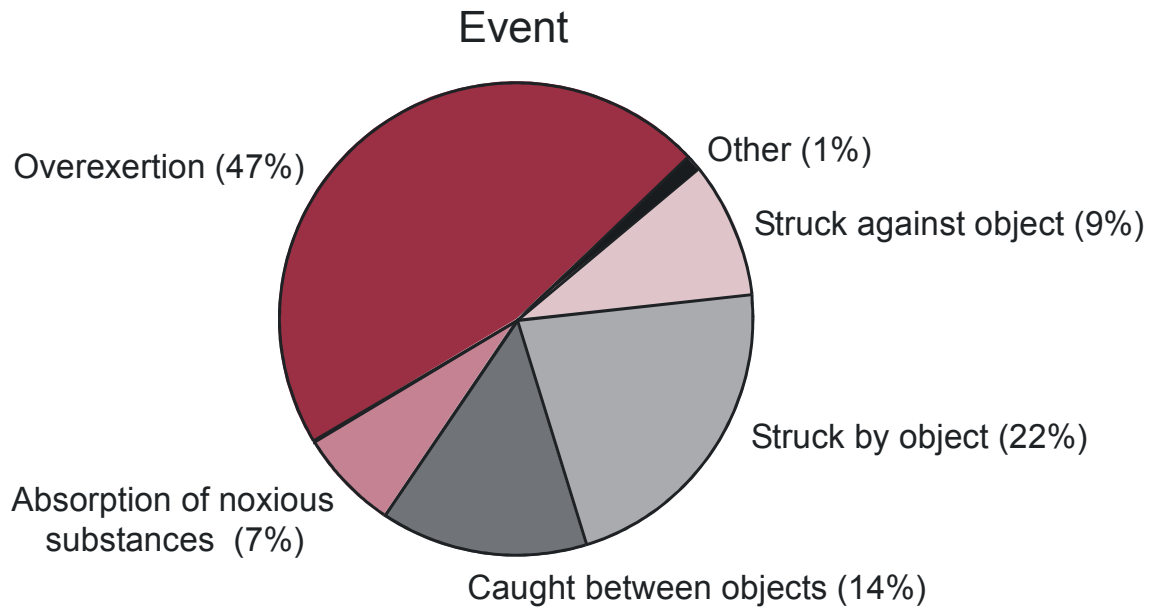


Figure 4B-11.—Metal operators: number of nonfatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)



**Figure 4B-12.—Metal operators: nonfatal material handling injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 10,869). (Source: MSHA data)**

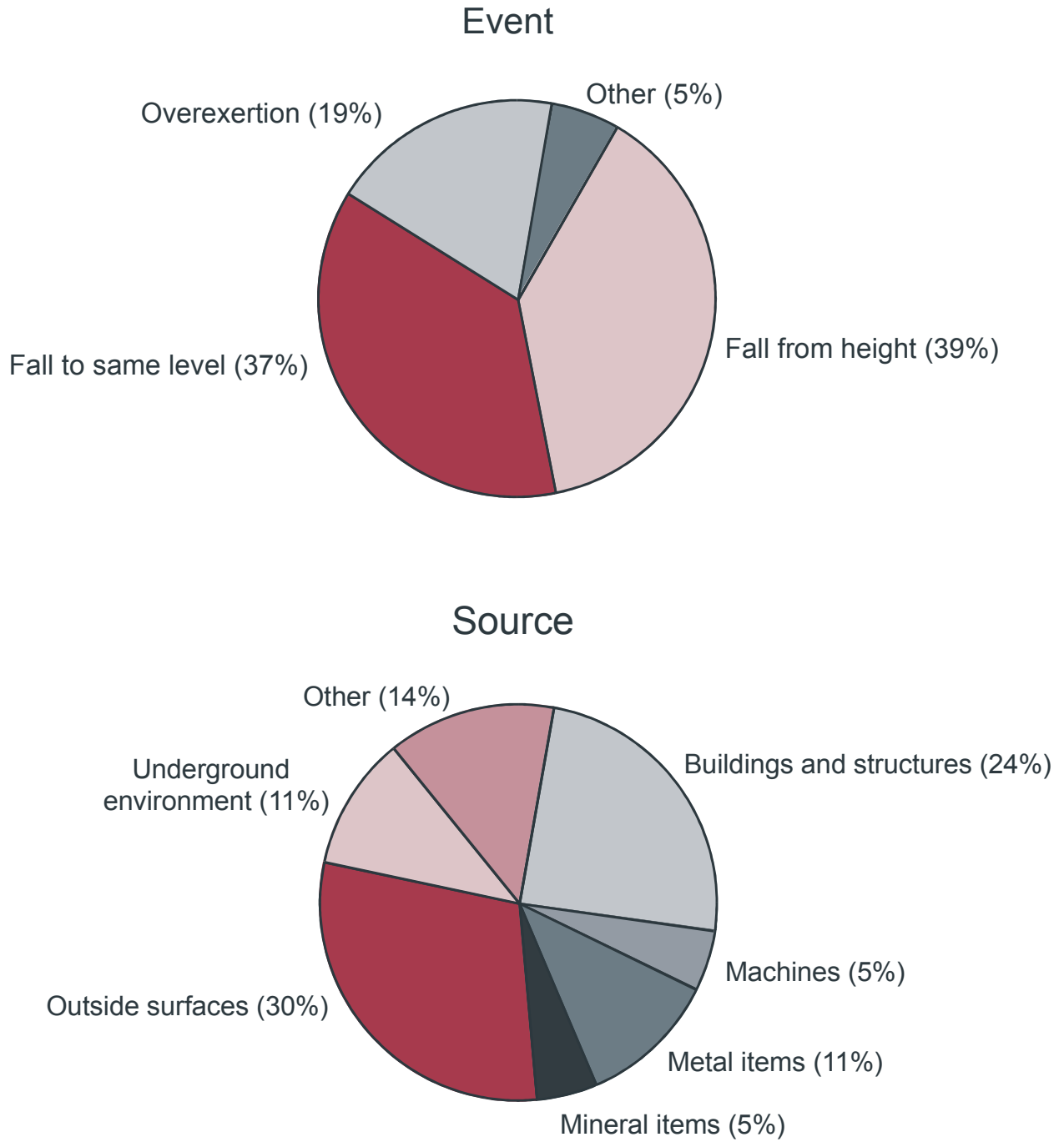


Figure 4B-13.—Metal operators: nonfatal fall injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 5,675). (Source: MSHA data)

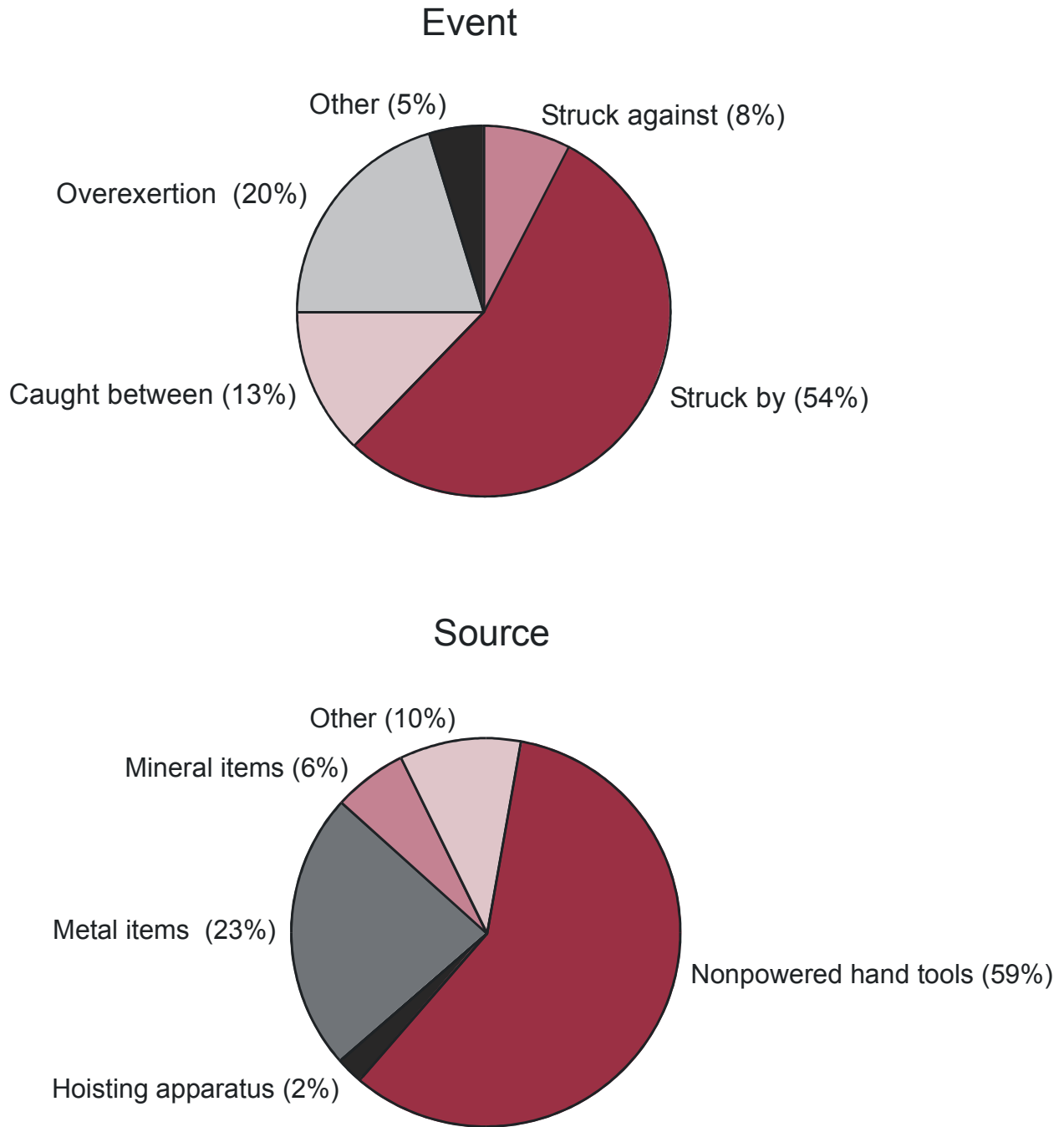


Figure 4B-14.—Metal operators: nonfatal hand tool injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 4,750). (Source: MSHA data)

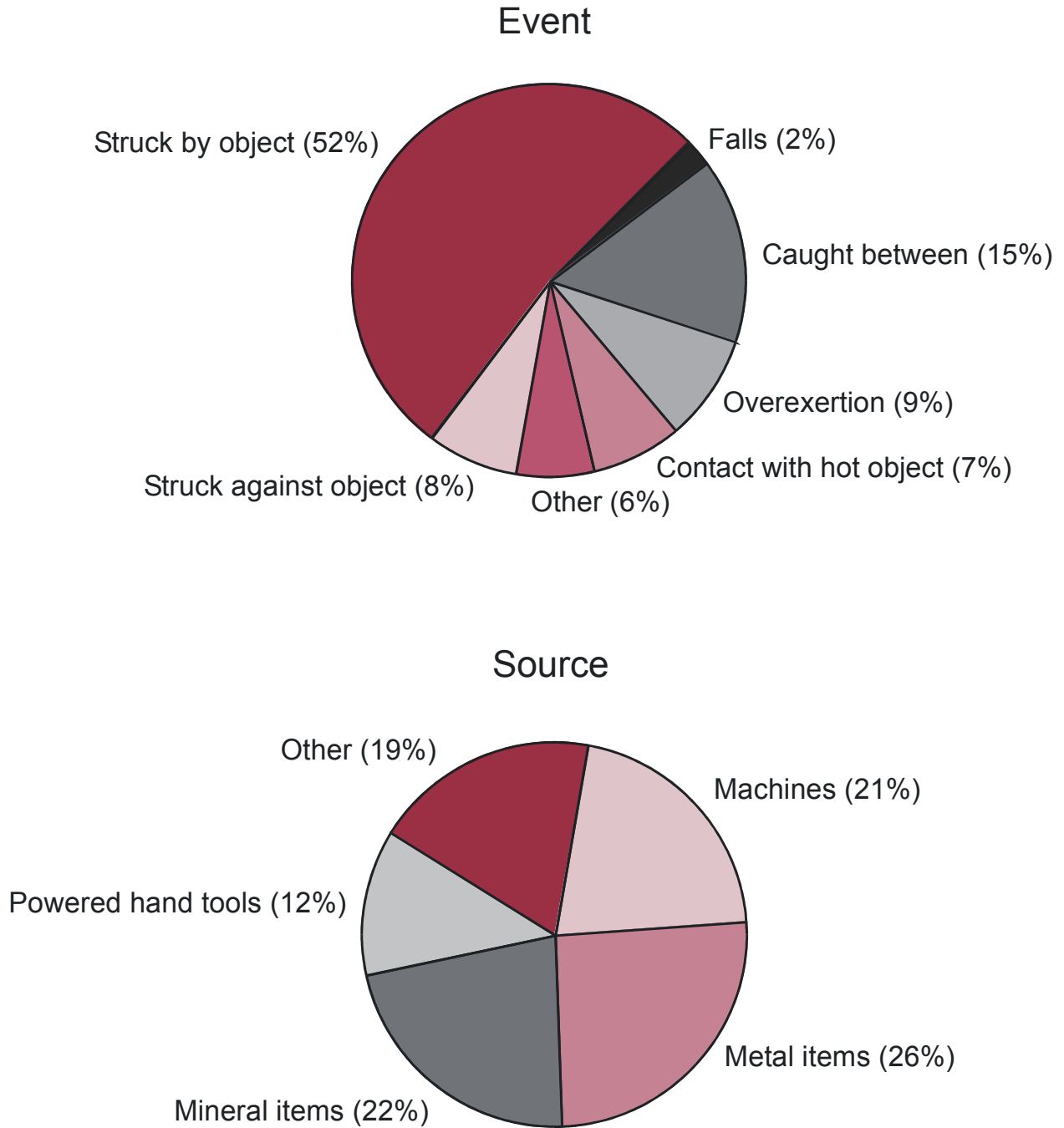


Figure 4B-15.—Metal operators: nonfatal machine injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 4,610). (Source: MSHA data)



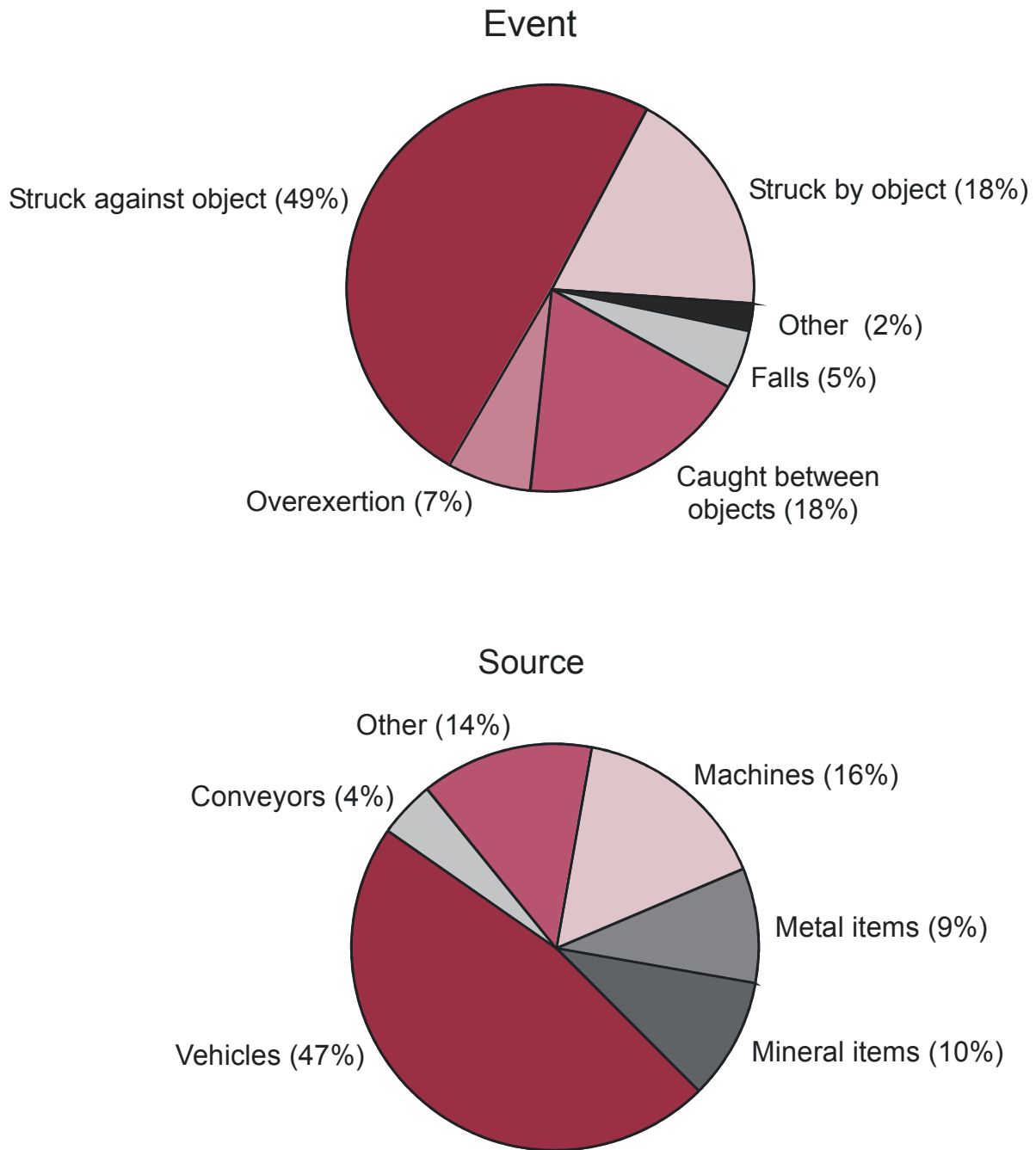


Figure 4B-16.—Metal operators: nonfatal powered haulage injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 2,243). (Source: MSHA data)

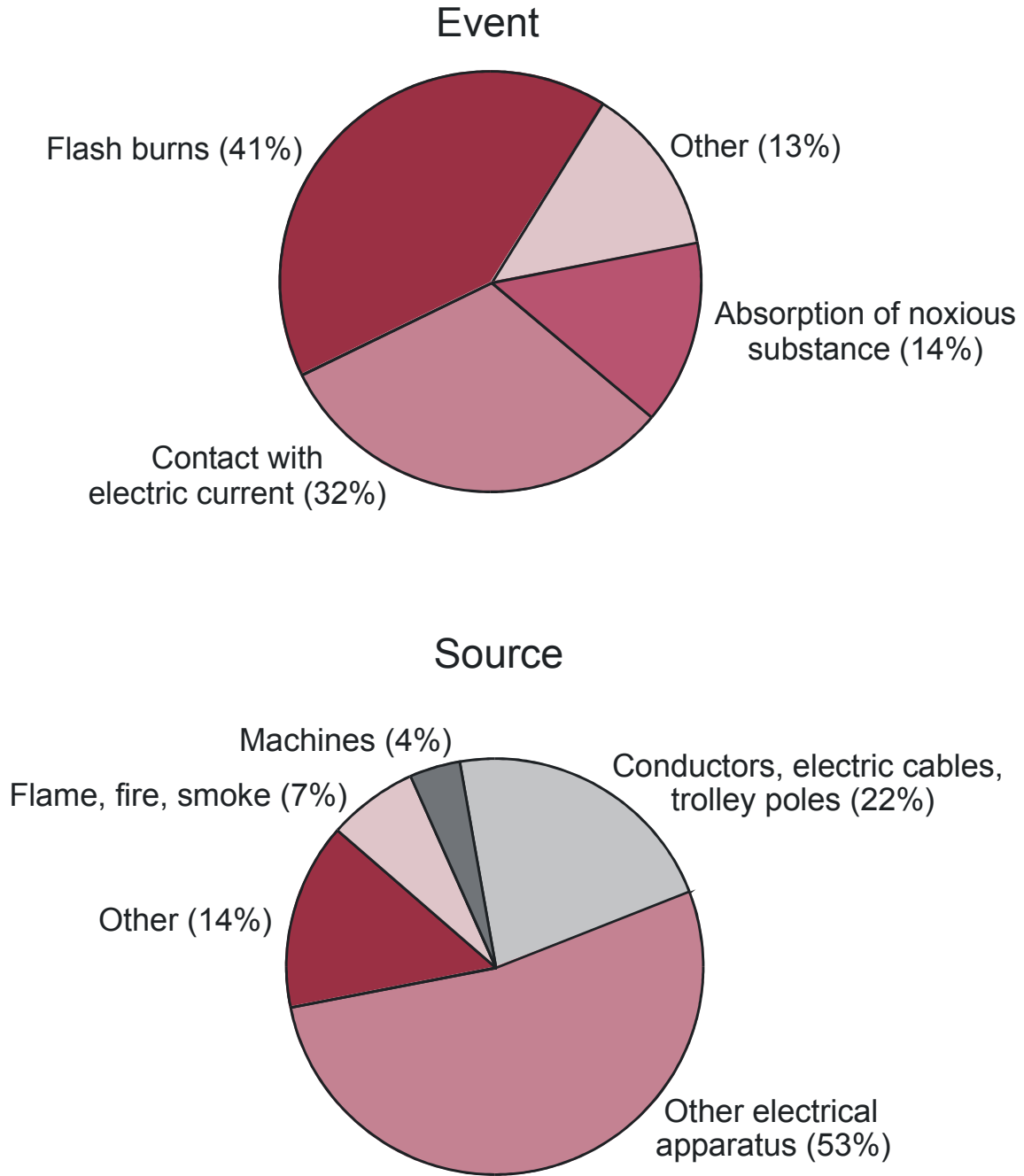


Figure 4B-17.—Metal operators: nonfatal electrical injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 155). (Source: MSHA data)

### 4C. INJURIES IN NONMETAL MINING

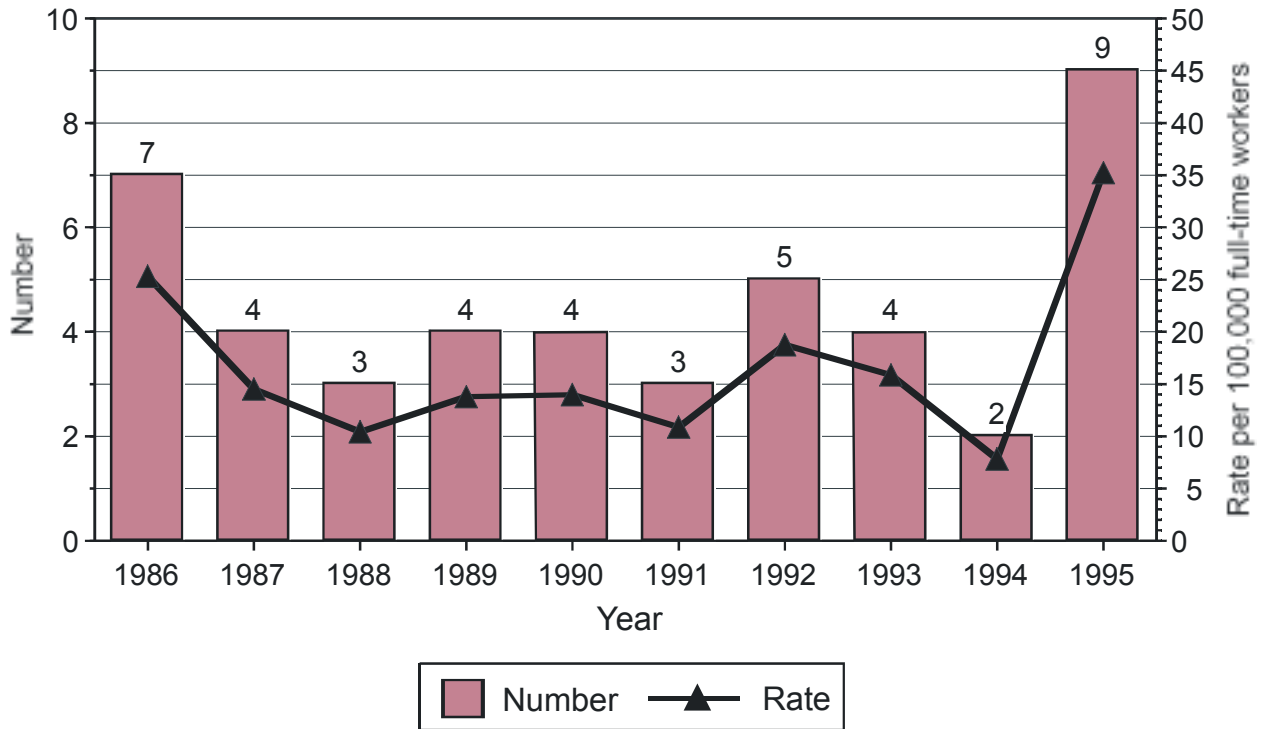


Figure 4C-1.—Nonmetal operators: number and rate (per 100,000 workers) of fatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4C-1.—Nonmetal operators: number and average annual rate (per 100,000 workers) of fatal injuries by subunit, 1986-1995.

| <u>Mining operation</u>        | <u>Number, 1986-1995</u> | <u>Average annual rate per 100,000 full-time workers</u> |
|--------------------------------|--------------------------|--|
| <b>Underground mines:</b>      |                          |  |
| Underground operations         | 16                       | 45.4   |
| Surface operations             | 0                        | *  |
| <b>Surface mines:</b>          |                          |  |
| Strip                          | 17                       | 28   |
| Dredge                         | 0                        | *  |
| Other surface mining           | 0                        | *  |
| <b>Independent shops/yards</b> | 0                        | 0  |
| <b>Mill</b>                    | 12                       | 7.1  |
| <b>Office</b>                  | 0                        | *  |
| <b>Total</b>                   | 45                       | 14.3   |

\* Rate not calculated because there were fewer than 3 fatalities

Source: Mine Safety and Health Administration data.

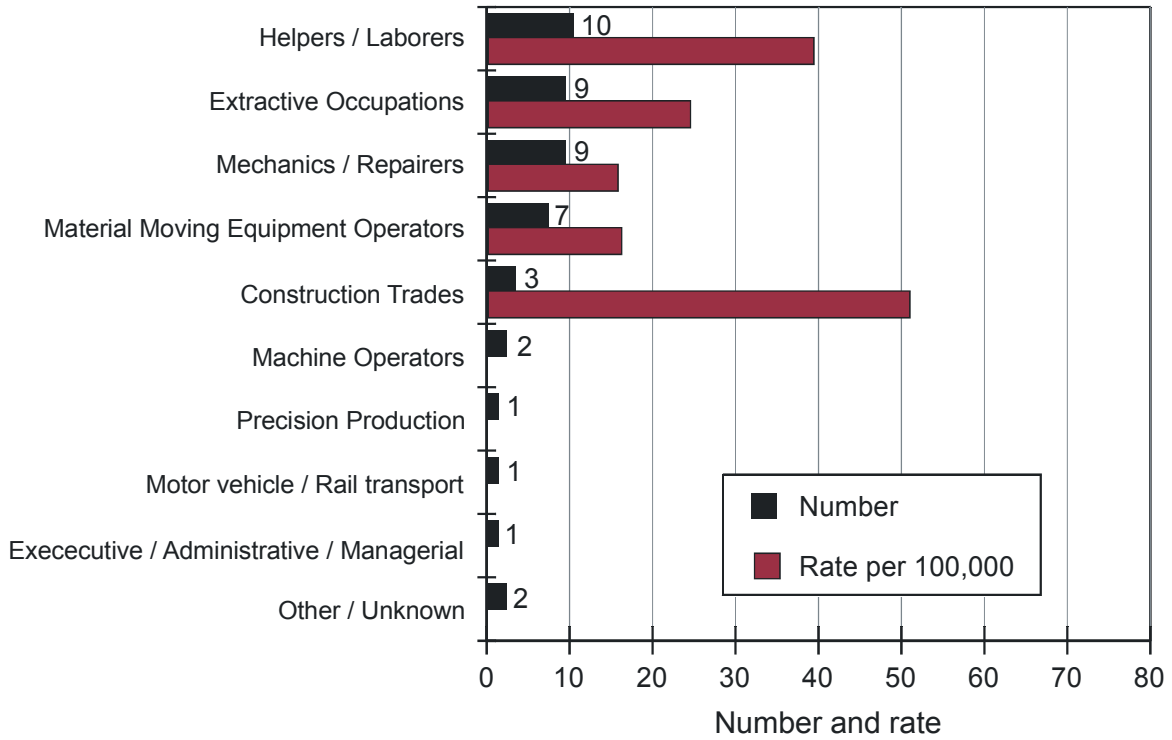


Figure 4C-2.—Nonmetal operators: number and rate (per 100,000 workers) of fatal injuries by U.S. Bureau of the Census Occupation Division, 1986-1995. (Source: MSHA data)

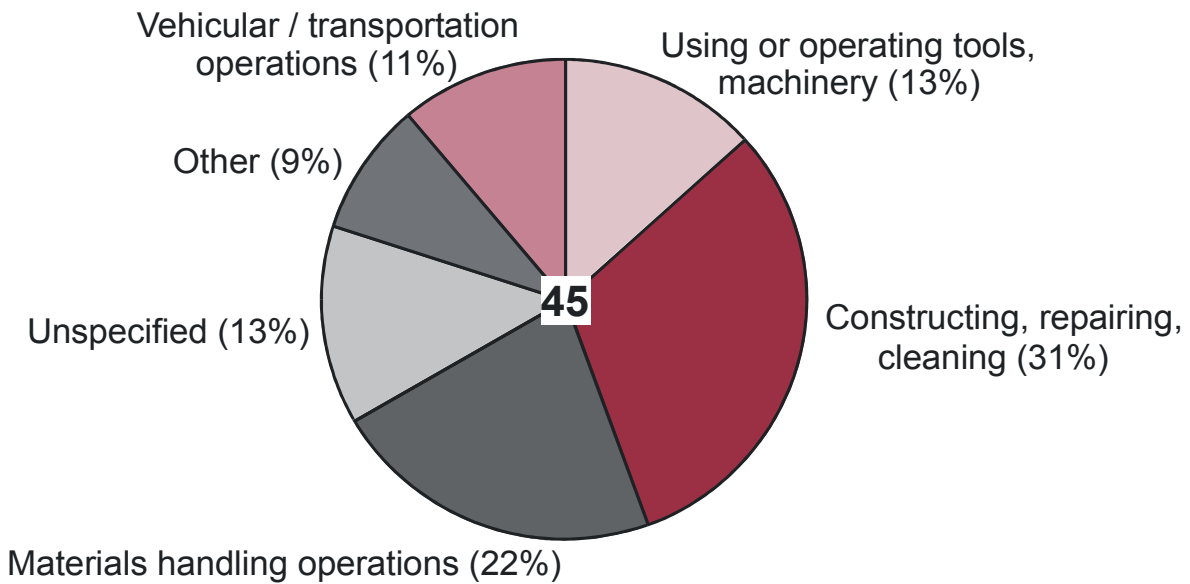


Figure 4C-3.—Nonmetal operators: percent of fatal injuries by work activity, 1986-1995. (Source: MSHA data)

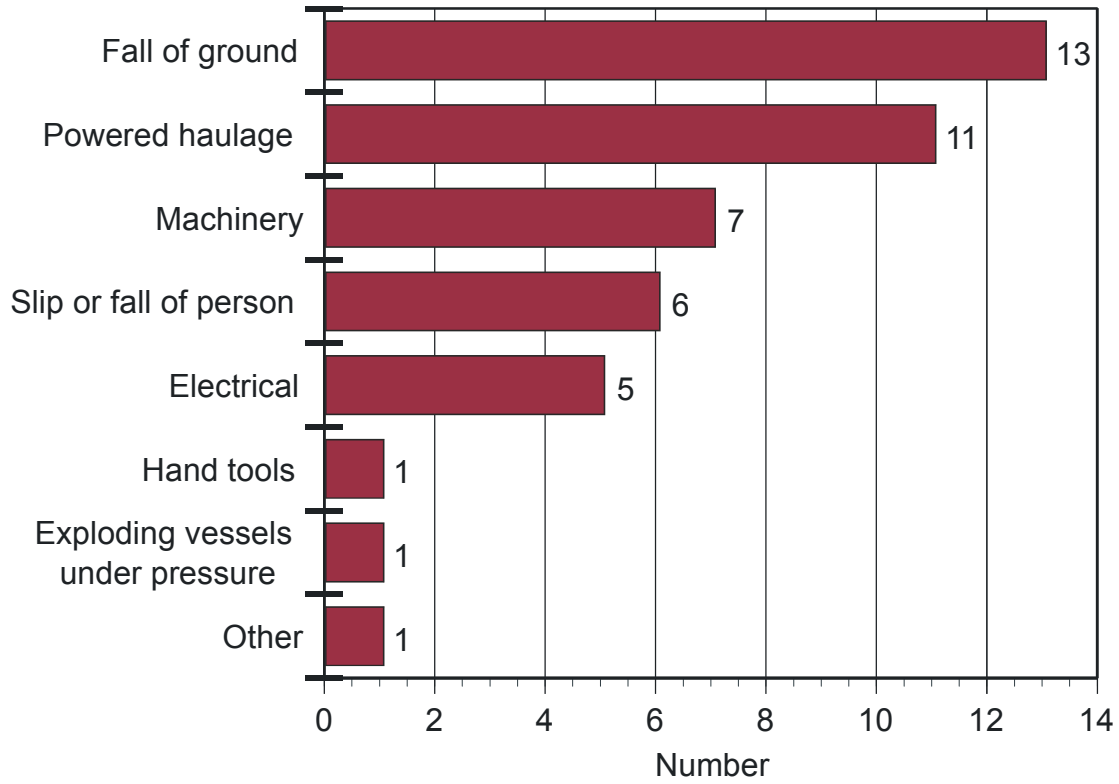


Figure 4C-4.—Nonmetal operators: number of fatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

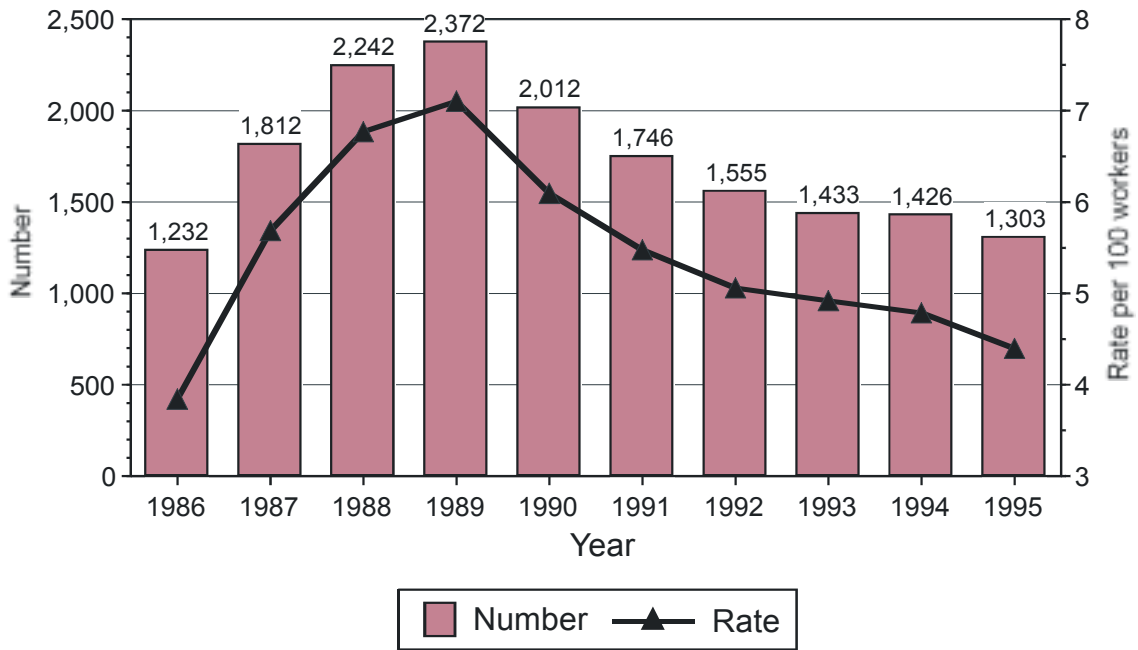


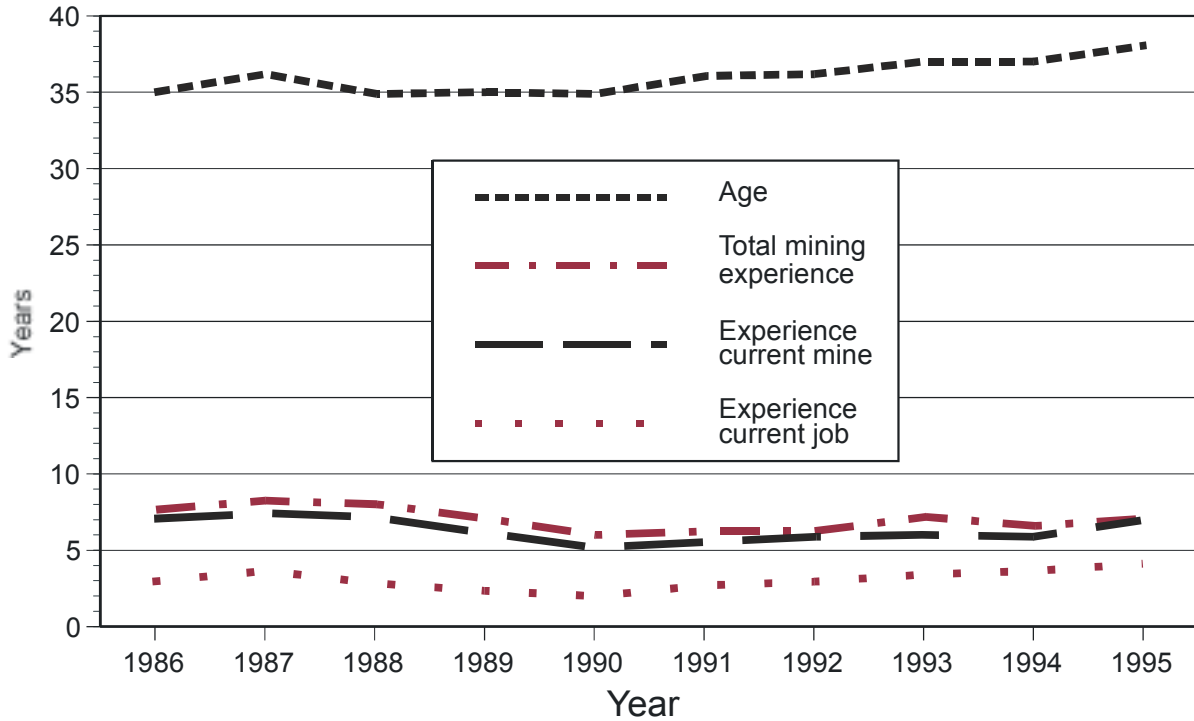
Figure 4C-5.—Nonmetal operators: number and rate (per 100,000 workers) of nonfatal injuries by year, 1986-1995. (Source: MSHA data)

**Table 4C-2.—Nonmetal operators: number and average annual rate (per 100 workers) of nonfatal injuries by subunit, 1986-1995.**

| <u>Mining operation</u>   | <u>Number, 1986-1995</u> | <u>Average annual rate per 100 full-time workers</u> |
|---------------------------|--------------------------|--|
| <b>Underground mines:</b> |                          |  |
| Underground operations    | 2,575                    | 7.31   |
| Surface operations        | 566                      | 8.83   |
| <b>Surface mines:</b>     |                          |  |
| Strip                     | 3,043                    | 5.01   |
| Dredge                    | 68                       | 7.99   |
| Other surface mining      | 1                        | *  |
| Independent shops/yards   | 6                        | 8.57   |
| <b>Mill</b>               | <b>10,770</b>            | <b>6.37</b>  |
| <b>Office</b>             | <b>104</b>               | <b>0.24</b>  |
| <b>Total</b>              | <b>17,133</b>            | <b>5.44</b>  |

\* Rate not calculated because there were fewer than 3 nonfatal injuries

Source: Mine Safety and Health Administration data.



**Figure 4C-6.—Nonmetal operators: median values for age, total mining experience, experience in current mine, and experience in current job for workers with nonfatal injuries by year, 1986-1995. (Source: MSHA data)**

**Table 4C-3.—Nonmetal operators: Nonfatal injuries, 1986-1995, by nature of injury. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days work lost for all cases, and statutory days charged for all cases.**

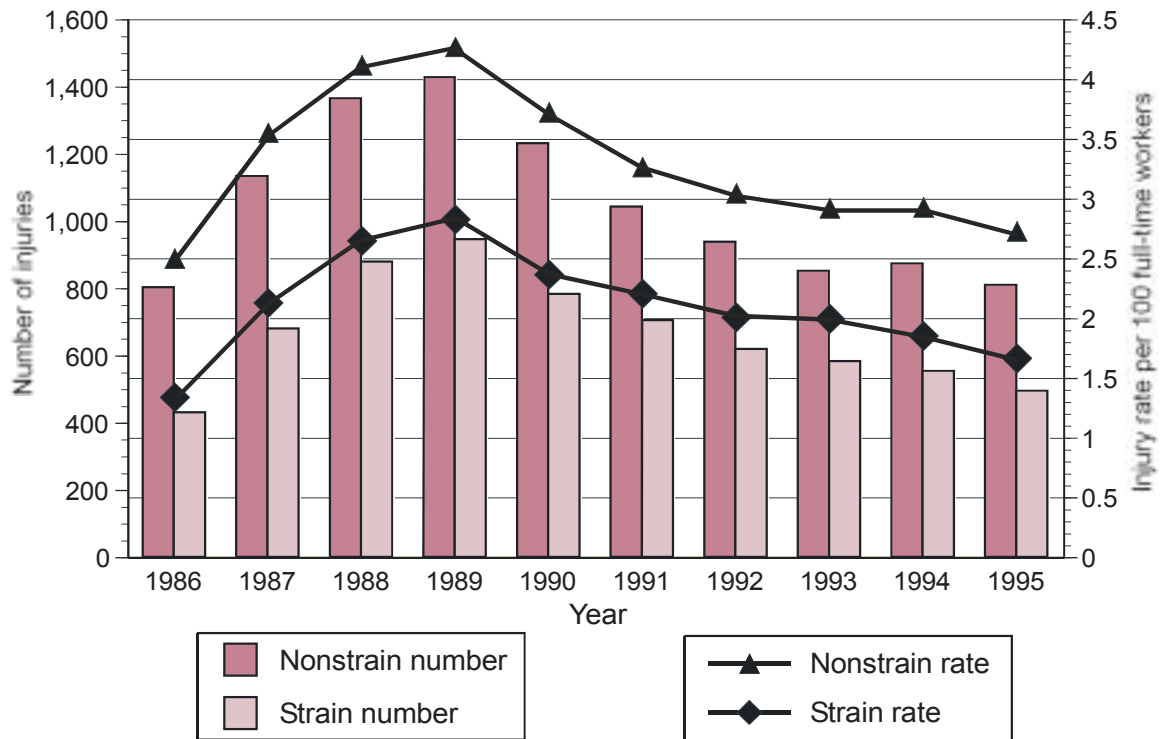
| Nature of injury                                    | Number of cases | Lost workday cases (%) | Mean days lost work | Total days lost | Total statutory days |
|---|-----------------|------------------------|---------------------|-----------------|----------------------|
| Sprains and strains                                 | 6,191           | 56.2                   | 17.02               | 105,359         | 9,520                |
| Fracture  | 1,362           | 44.5                   | 22.55               | 30,713          | 7,090                |
| Contusions  | 1,505           | 42.3                   | 7.38                | 11,110          | 0                    |
| Lacerations   | 3,417           | 14.6                   | 1.90                | 6,494           | 350                  |
| Hernia  | 154             | 78.6                   | 25.71               | 3,959           | 6,250                |
| Burn, heat  | 409             | 35.9                   | 8.52                | 3,485           | 0                    |
| Amputation or enucleation                           | 117             | 53.8                   | 28.58               | 3,344           | 63,242               |
| Crushing  | 211             | 36.0                   | 8.86                | 1,870           | 1,800                |
| Dislocation   | 96              | 46.9                   | 17.65               | 1,694           | 0                    |
| Joint, tendon, or muscle inflammation or irritation | 165             | 40.0                   | 9.76                | 1,611           | 50                   |
| Burn, chemical                                      | 239             | 29.3                   | 2.77                | 663             | 0                    |
| Electric shock                                      | 32              | 56.3                   | 19.41               | 621             | 0                    |
| Noncontact electric arc burn                        | 142             | 45.1                   | 3.95                | 561             | 0                    |
| Abrasions   | 240             | 27.5                   | 1.36                | 327             | 0                    |
| Poisoning   | 103             | 31.1                   | 3.10                | 319             | 0                    |
| Dust in eyes  | 597             | 23.6                   | 0.53                | 318             | 0                    |
| Electrical burn                                     | 16              | 43.8                   | 19.25               | 308             | 0                    |
| Brain concussion                                    | 20              | 70.0                   | 7.65                | 153             | 0                    |
| Other specified causes                              | 274             | 40.5                   | 10.17               | 2,786           | 6,300                |
| Multiple injuries, unspecified                      | 1,237           | 44.1                   | 14.77               | 18,270          | 19,090               |
| Other unspecified injuries                          | 606             | 63.5                   | 19.35               | 11,729          | 0                    |

Source: Mine Safety and Health Administration data.

**Table 4C-4.—Nonmetal operators: nonfatal injuries, 1986-1995, by work activity. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days lost for all cases, and statutory days charged for all cases.**

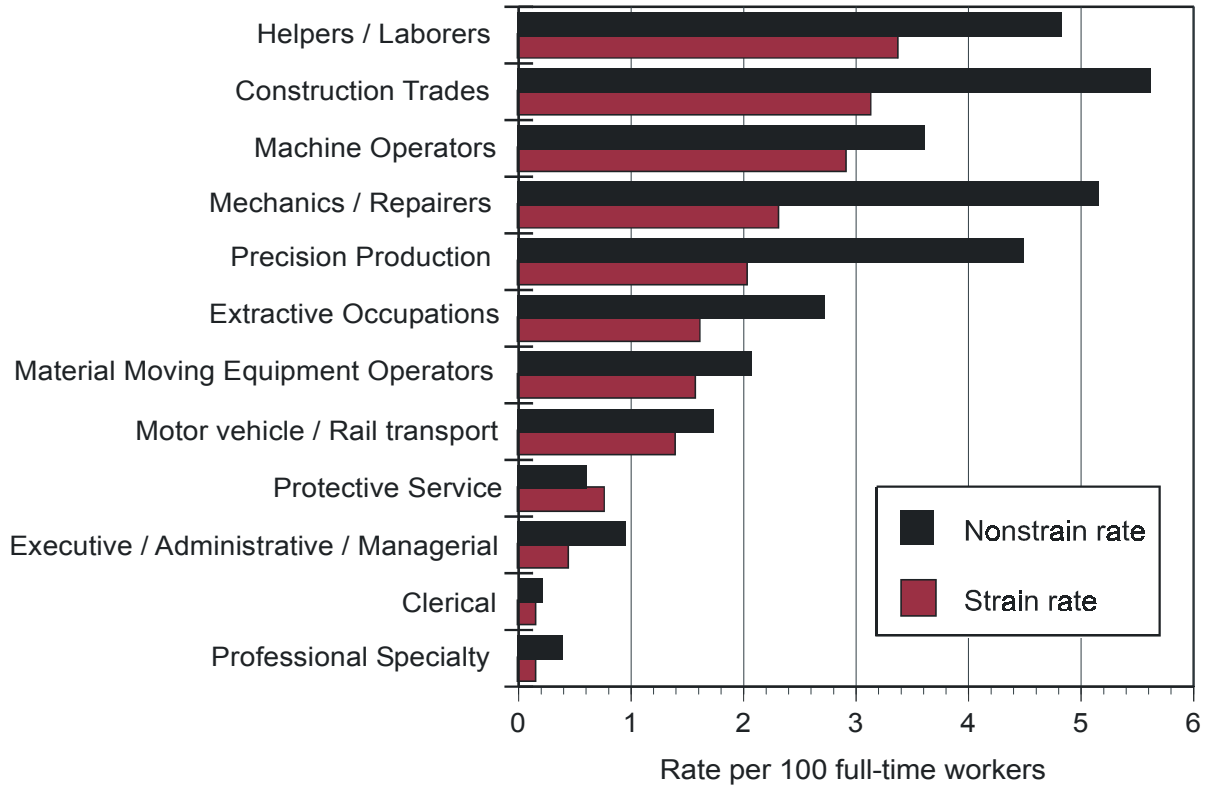
| Work activity                           | Number of cases | Lost workday cases (%) | Mean days lost work | Total days lost | Total statutory days |
|---|-----------------|------------------------|---------------------|-----------------|----------------------|
| Materials handling                      | 5,972           | 46.1                   | 12.58               | 75,098          | 14,726               |
| Using or operating tools or machinery   | 3,984           | 31.5                   | 8.28                | 32,997          | 32,325               |
| Constructing, repairing, or cleaning    | 3,066           | 36.5                   | 10.34               | 31,707          | 44,691               |
| Vehicular and transportation operations | 1,748           | 51.8                   | 16.56               | 28,952          | 15,320               |
| Bodily movement                         | 1,821           | 49.3                   | 14.89               | 27,116          | 1,880                |
| Other                                   | 391             | 44.5                   | 15.24               | 5,958           | 4,700                |
| Unspecified                             | 151             | 61.6                   | 25.60               | 3,866           | 50                   |
| <b>Total</b>                            | <b>17,133</b>   | <b>42.0</b>            | <b>12.01</b>        | <b>205,694</b>  | <b>113,692</b>       |

Source: Mine Safety and Health Administration data.



**Figure 4C-7.—Nonmetal operators: nonfatal injuries 1986-1995. Number and rate (per 100 workers) of strain and nonstrain injuries by year, 1986-1995. (Source: MSHA data)**





**Figure 4C-8.—Nonmetal operators: nonfatal injuries, 1986-1995.** Rate (per 100 workers) of strain and nonstrain injuries by U.S. Bureau of the Census Occupation Division, 1986-1995. (Data on occupations were missing for 500 out of 17,133 cases (2.9%).) (Source: MSHA data)

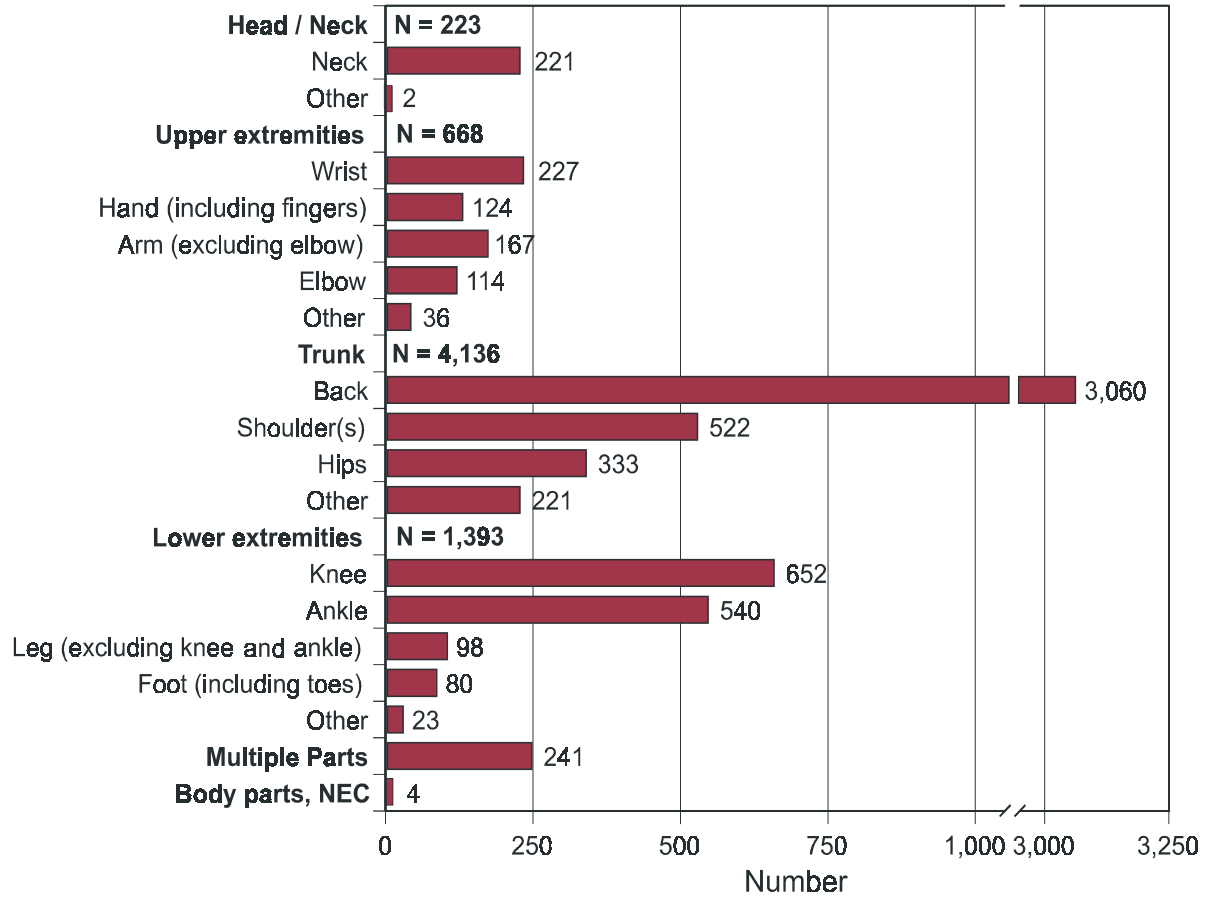


Figure 4C-9.—Nonmetal operators: number of (nonfatal) strain injuries by body part injured, 1986-1995. (Source: MSHA data)

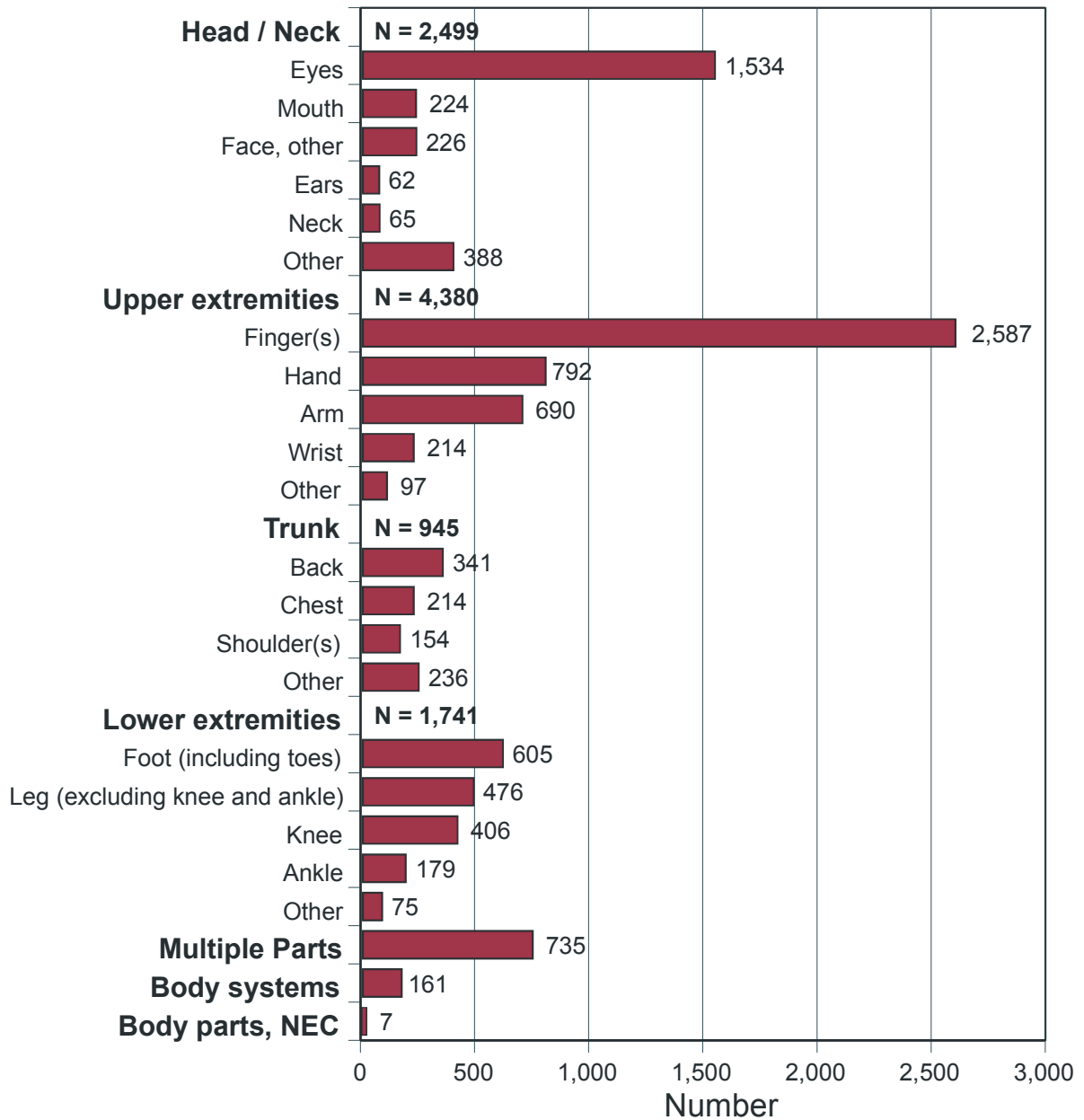


Figure 4C-10.—Nonmetal operators: number of (nonfatal) nonstrain injuries by body part injured, 1986-1995. (Source: MSHA data)

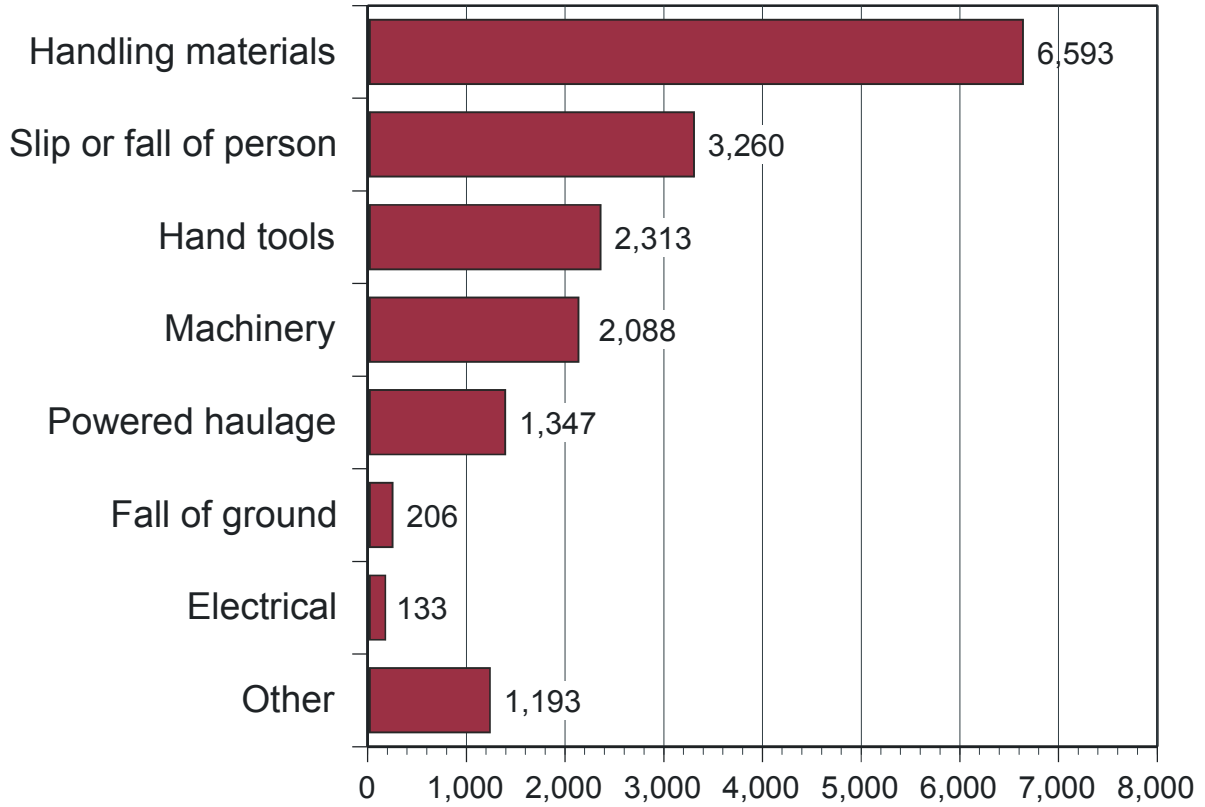


Figure 4C-11.—Nonmetal operators: number of nonfatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

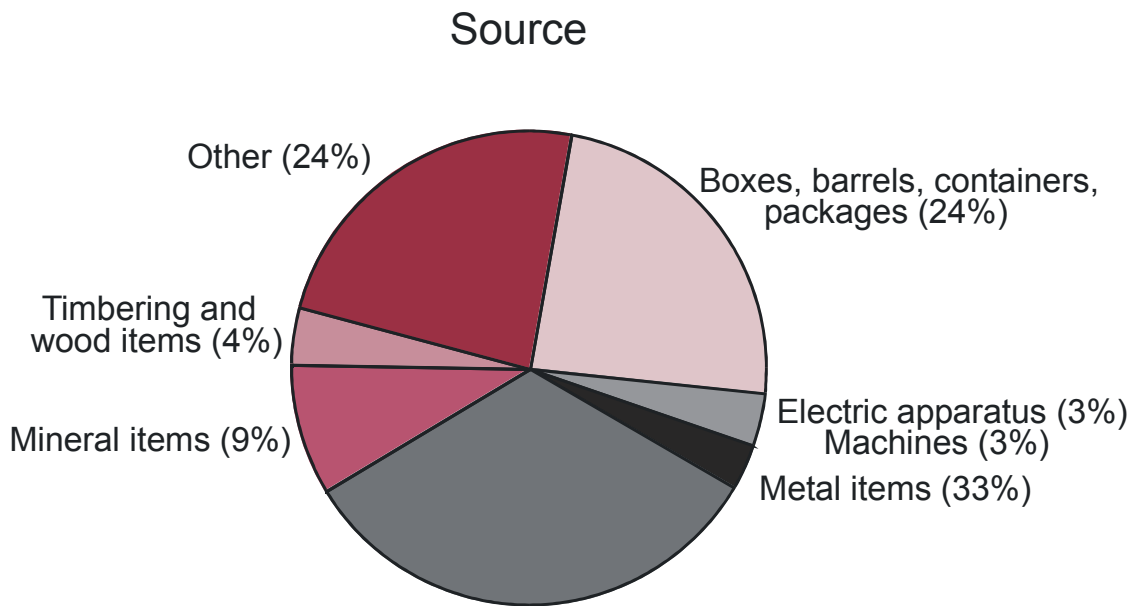
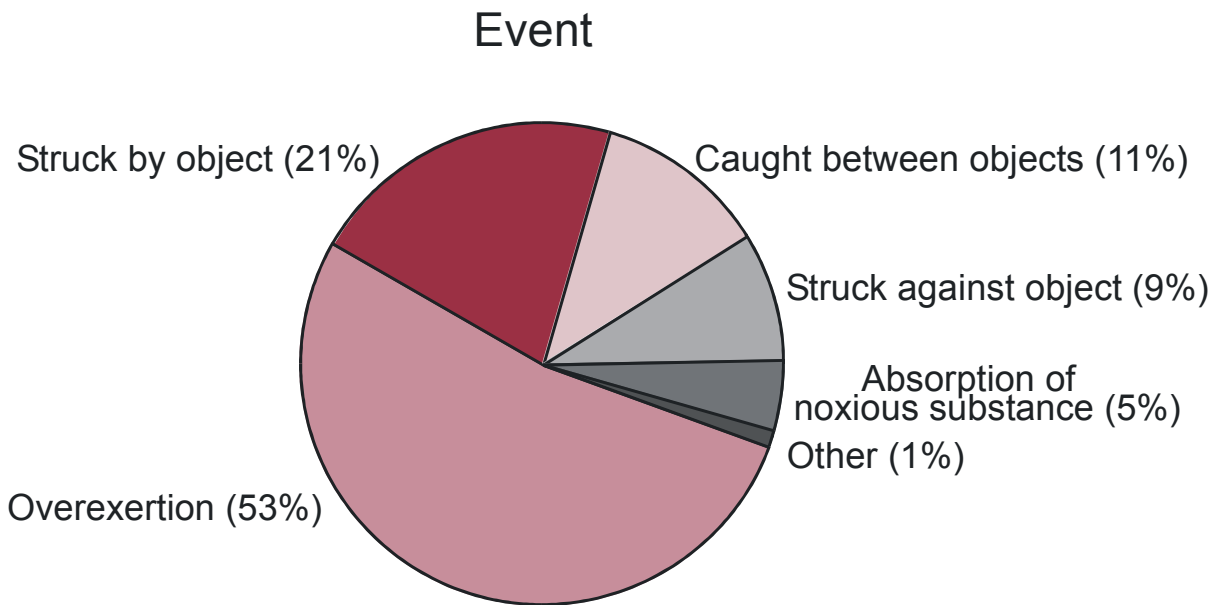
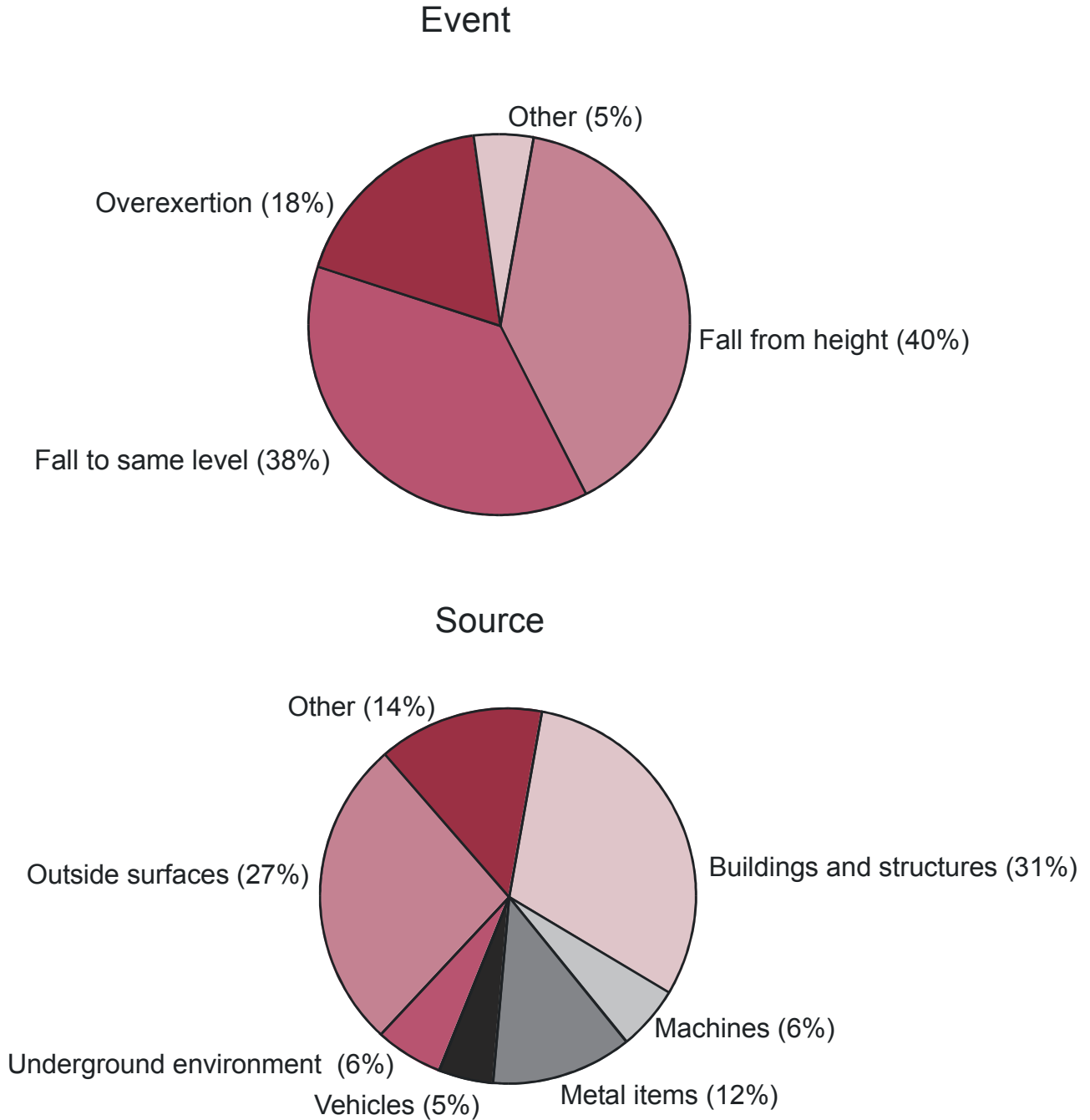


Figure 4C-12.—Nonmetal operators: nonfatal material handling injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 6,593). (Source: MSHA data)



**Figure 4C-13.—Nonmetal operators: nonfatal fall injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 3,260). (Source: MSHA data)**

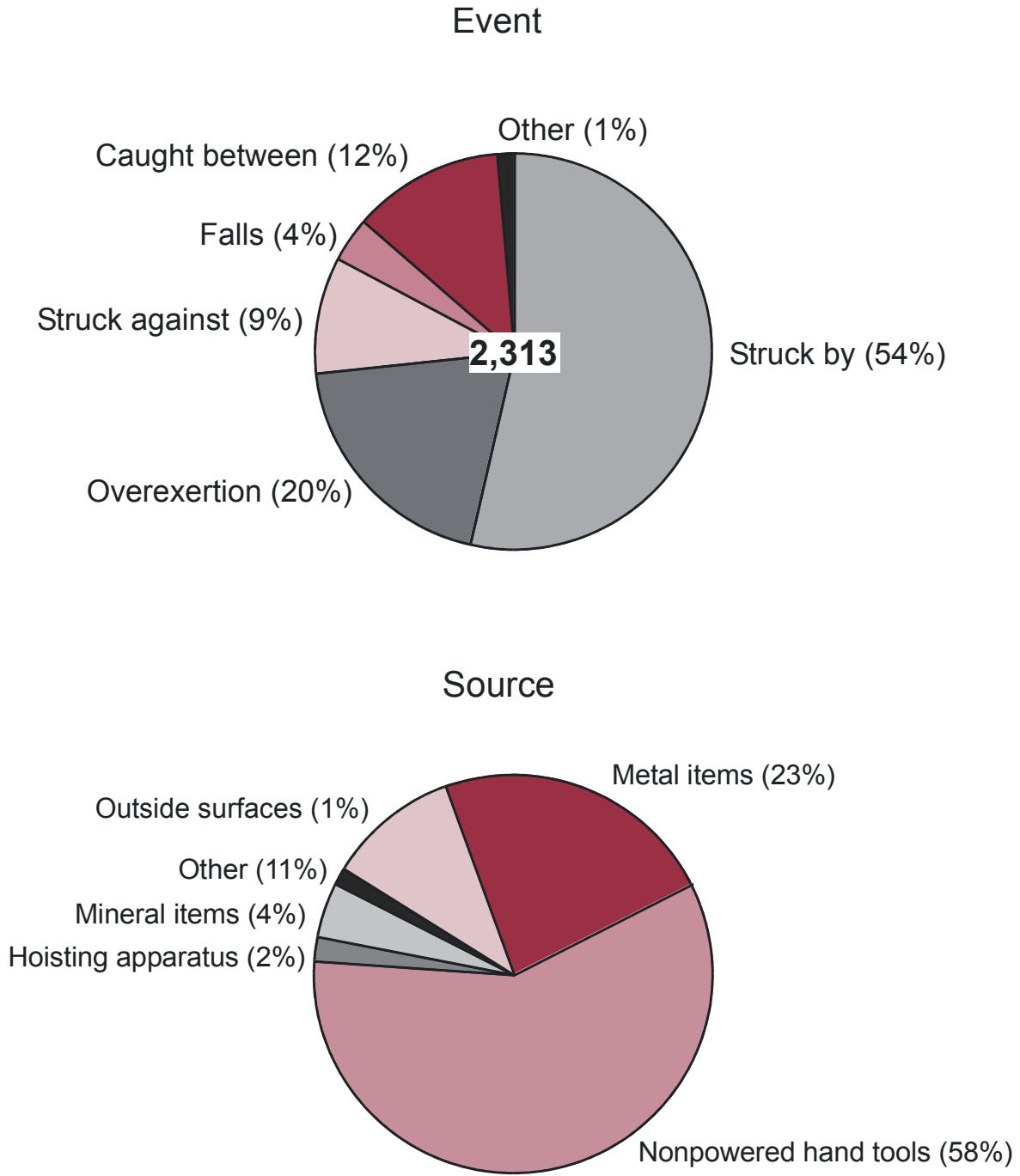


Figure 4C-14.—Nonmetal operators: nonfatal hand tool injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 2,313). (Source: MSHA data)

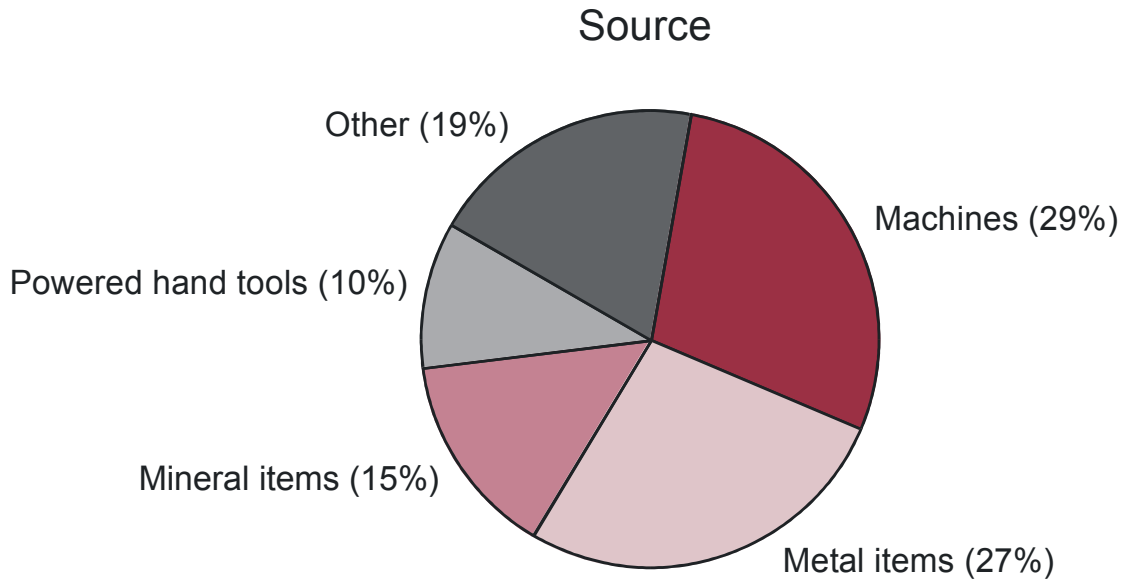
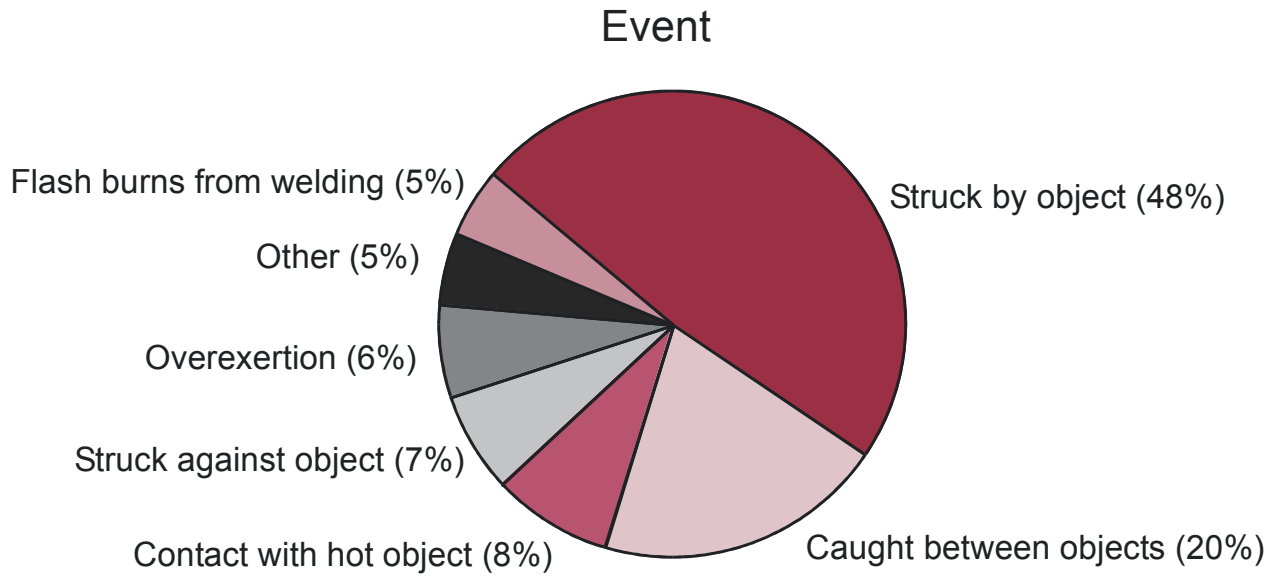


Figure 4C-15.—Nonmetal operators: nonfatal machine injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 2,088). (Source: MSHA data)



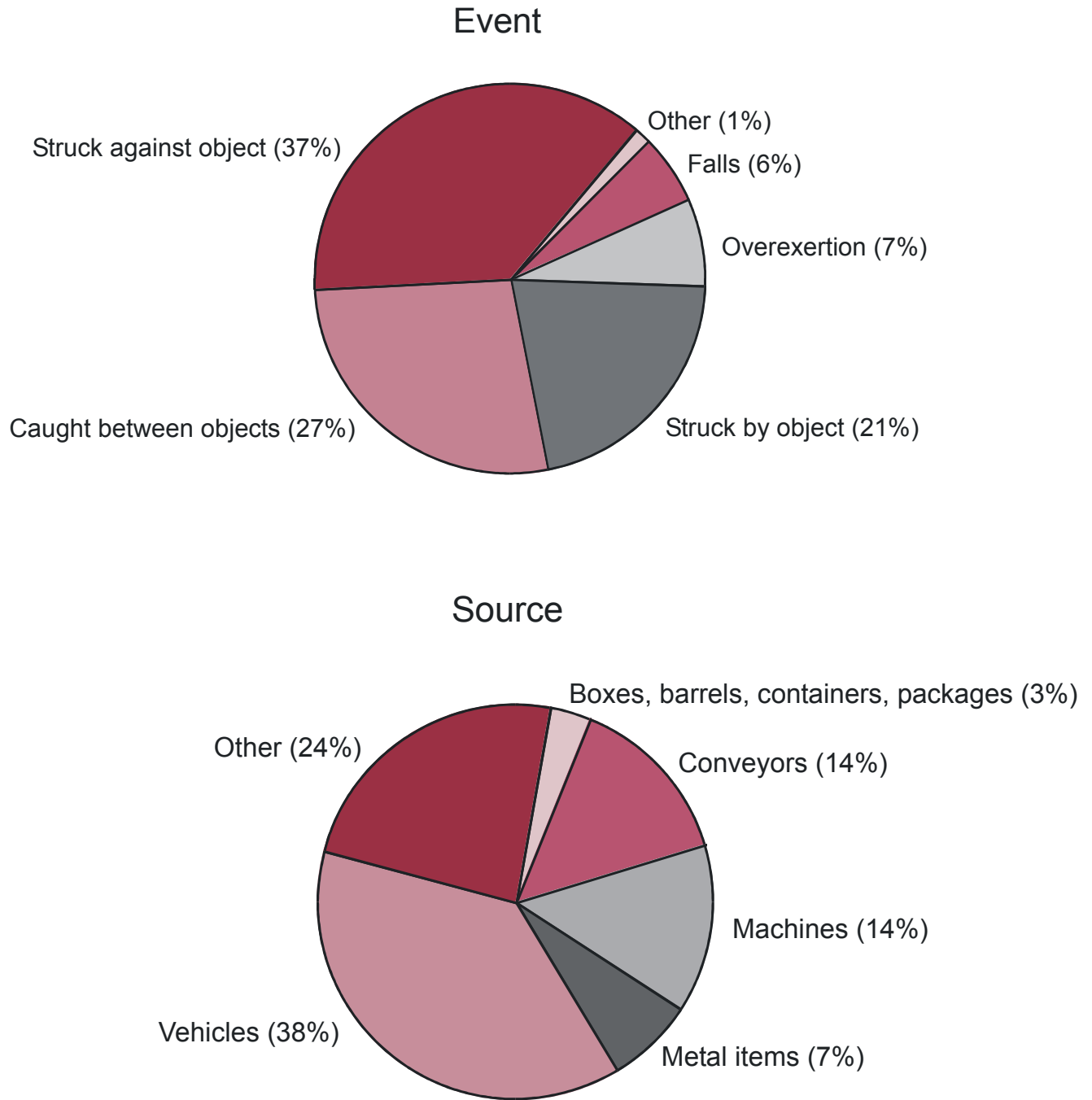
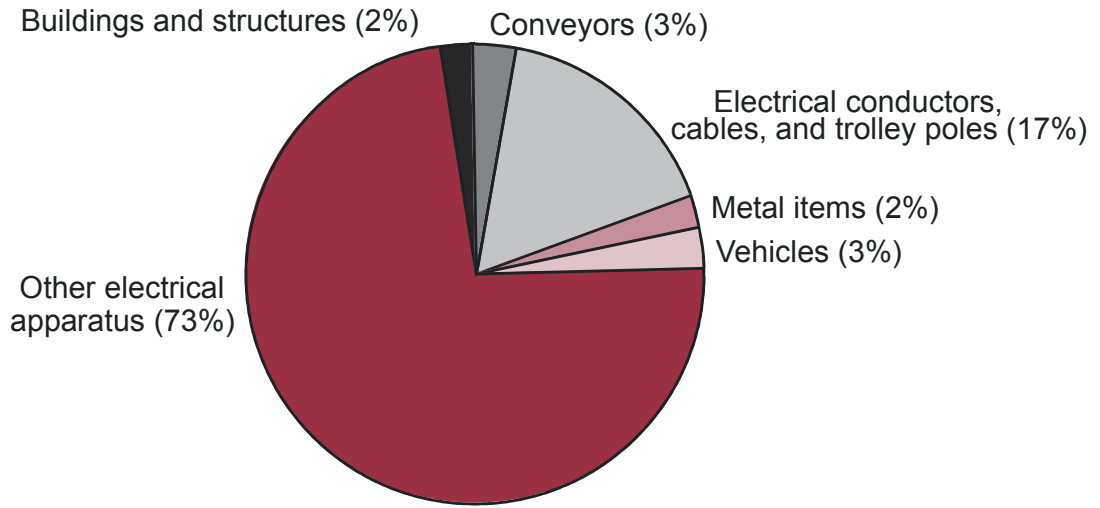


Figure 4C-16.—Nonmetal operators: nonfatal powered haulage injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 1,347). (Source: MSHA data)

### Source



### Event

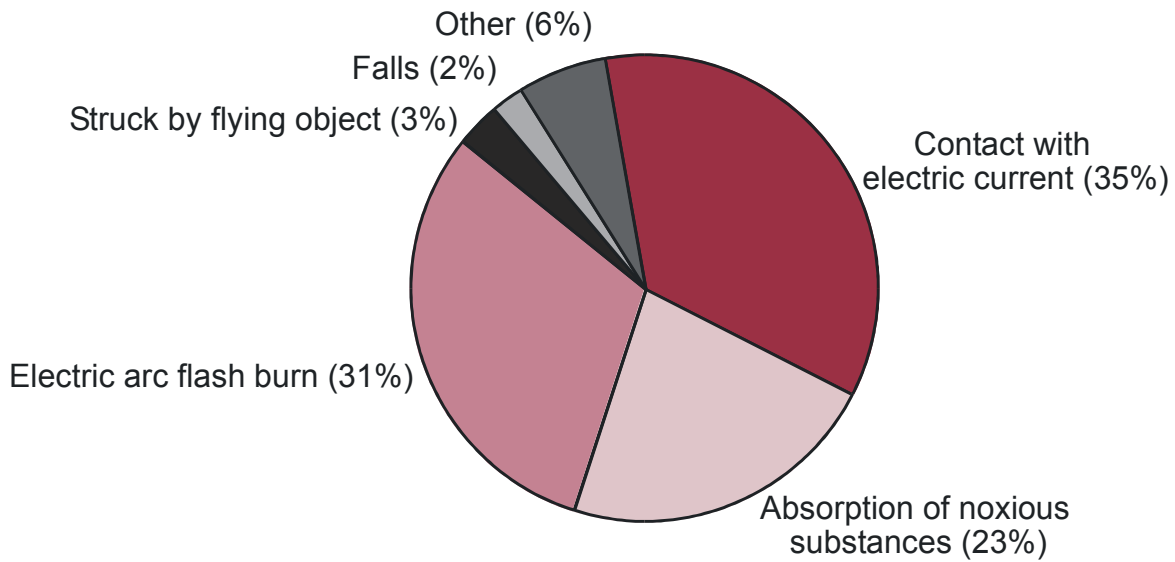


Figure 4C-17.—Nonmetal operators: nonfatal electrical injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 133). (Source: MSHA data)

#### 4D. INJURIES IN STONE MINING

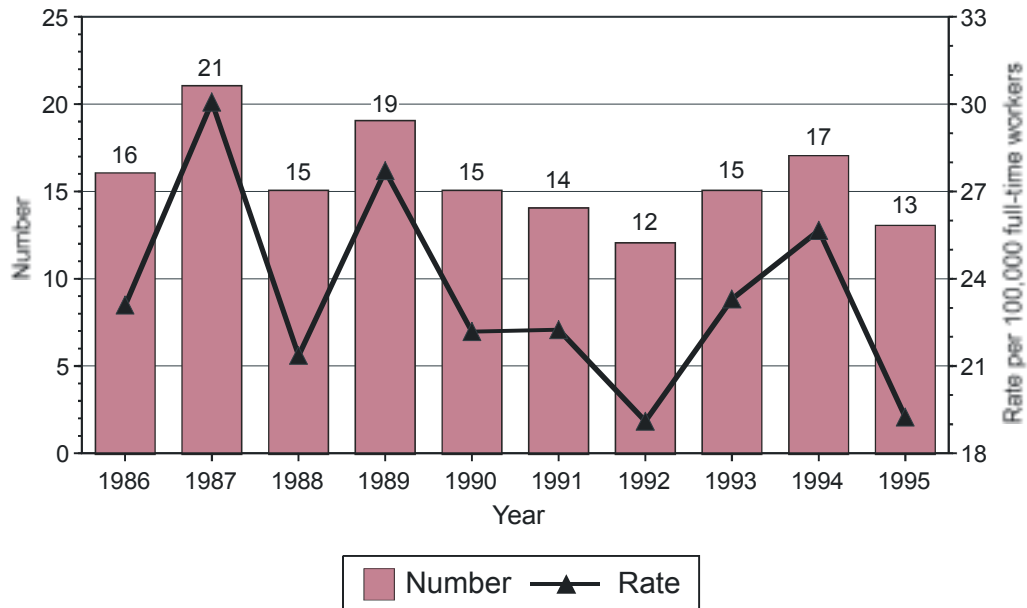


Figure 4D-1.—Stone operators: number and rate (per 100,000 workers) of fatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4D-1.—Stone operators: number and average annual rate (per 100,000 workers) of fatal injuries by subunit, 1986-1995.

| <u>Mining operation</u>        | <u>Number, 1986-1995</u> | <u>Average annual rate per 100,000 full-time workers</u> |
|--------------------------------|--------------------------|--|
| <b>Underground mines:</b>      |                          |  |
| Underground operations         | 12                       | 77.9   |
| Surface operations             | 5                        | 124.5  |
| <b>Surface mines:</b>          |                          |  |
| Strip                          | 99                       | 34.6   |
| Dredge                         | 0                        | *  |
| <b>Independent shops/yards</b> | 0                        | *  |
| <b>Mill</b>                    | 41                       | 11.4   |
| <b>Office</b>                  | 0                        | *  |
| <b>Total</b>                   | <b>157</b>               | <b>20.3</b>  |

\* Rate not calculated because there were fewer than 3 fatalities

Source: Mine Safety and Health Administration data.

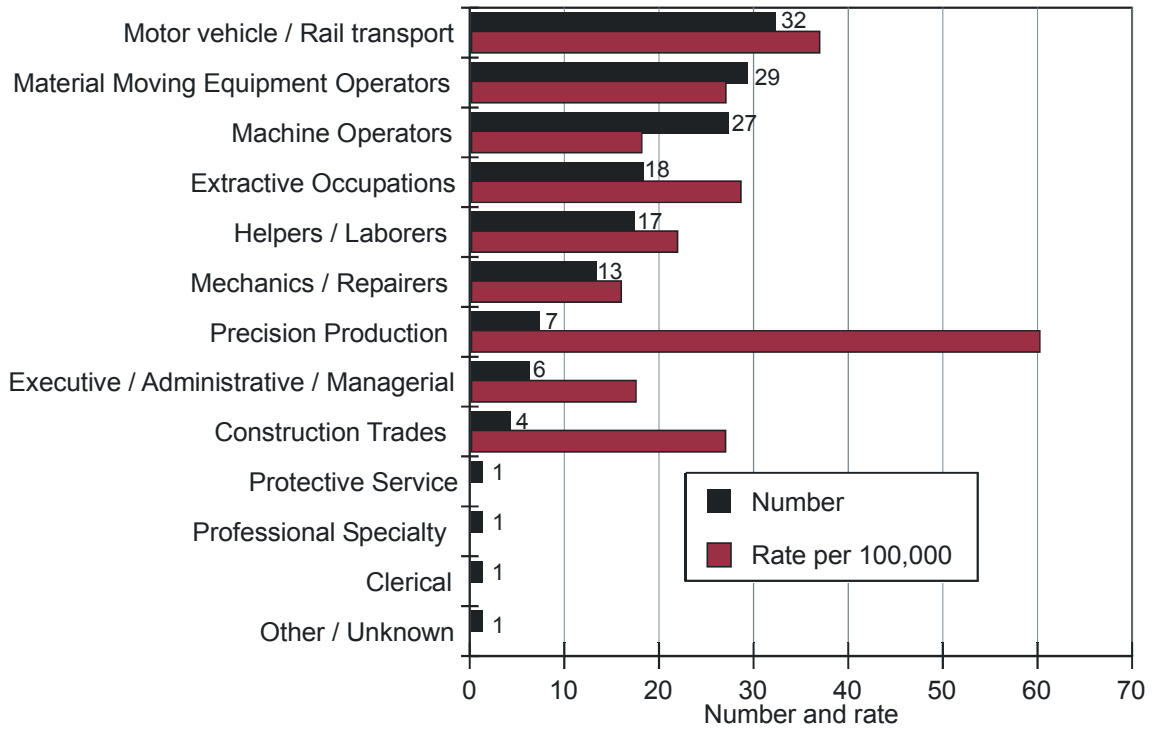


Figure 4D-2.—Stone operators: number and rate (per 100,000 workers) of fatal injuries by U.S. Bureau of the Census Occupation Division, 1986-1995. (Source: MSHA data)

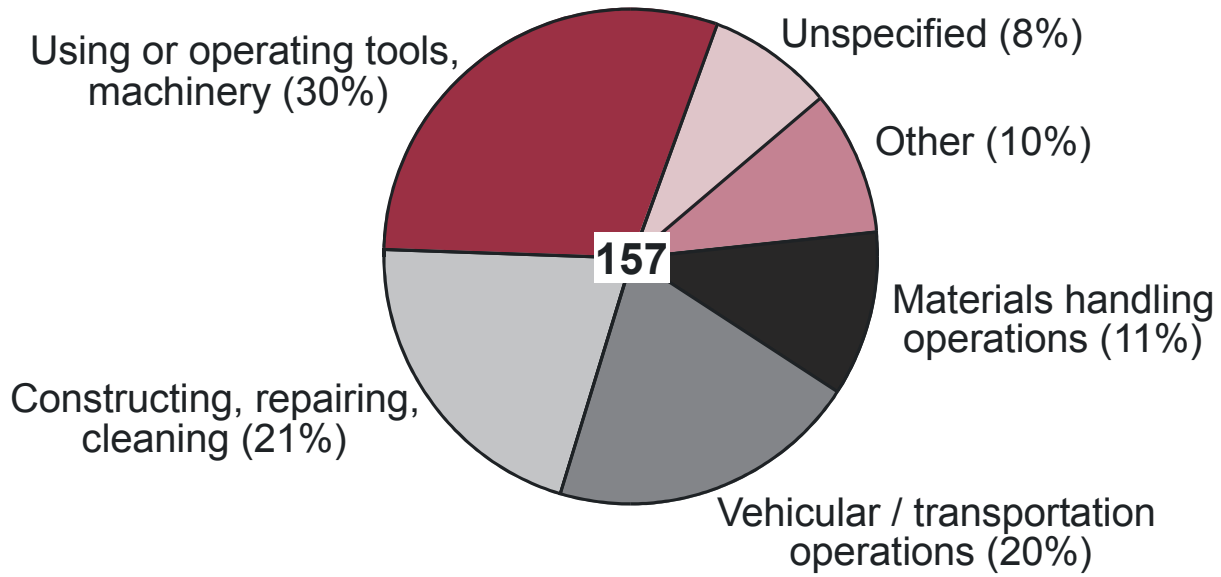


Figure 4D-3.—Stone operators: number of fatal injuries by work activity, 1986-1995. (Source: MSHA data)

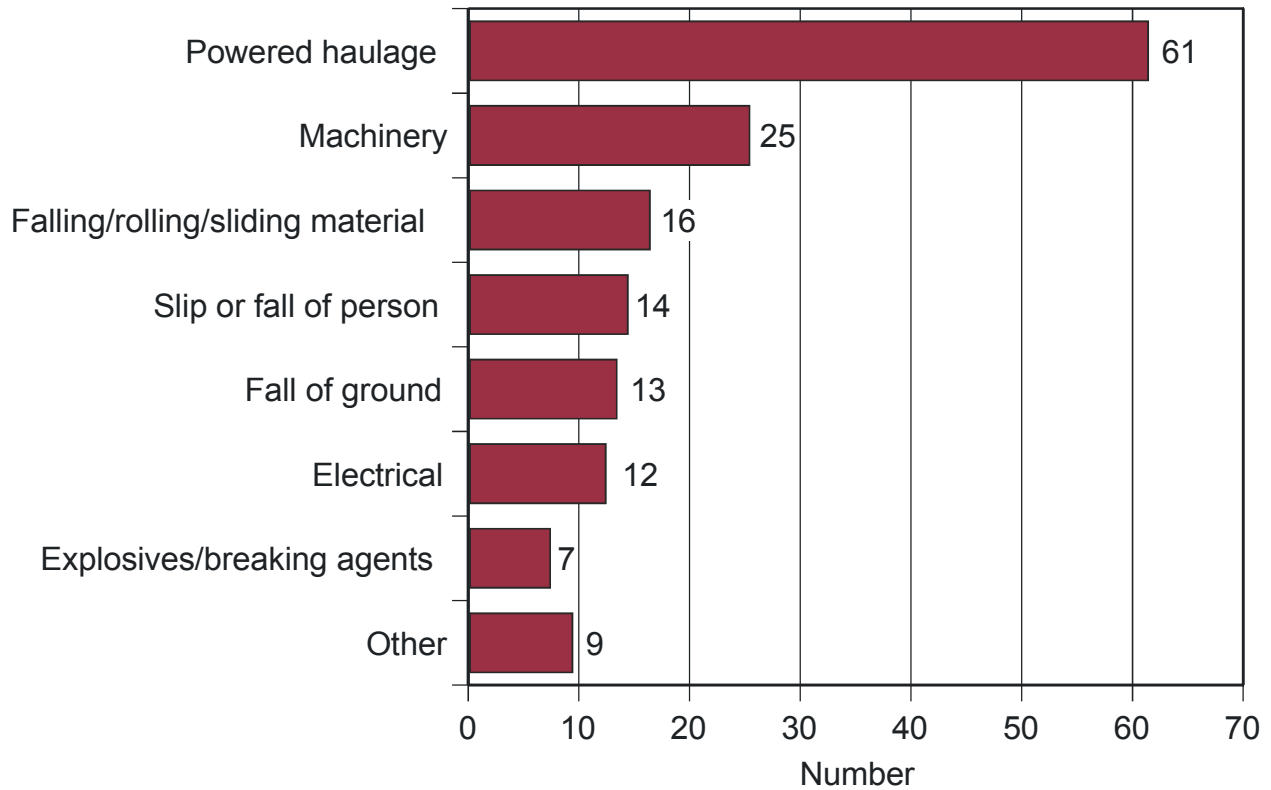


Figure 4D-4.—Stone operators: number of fatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

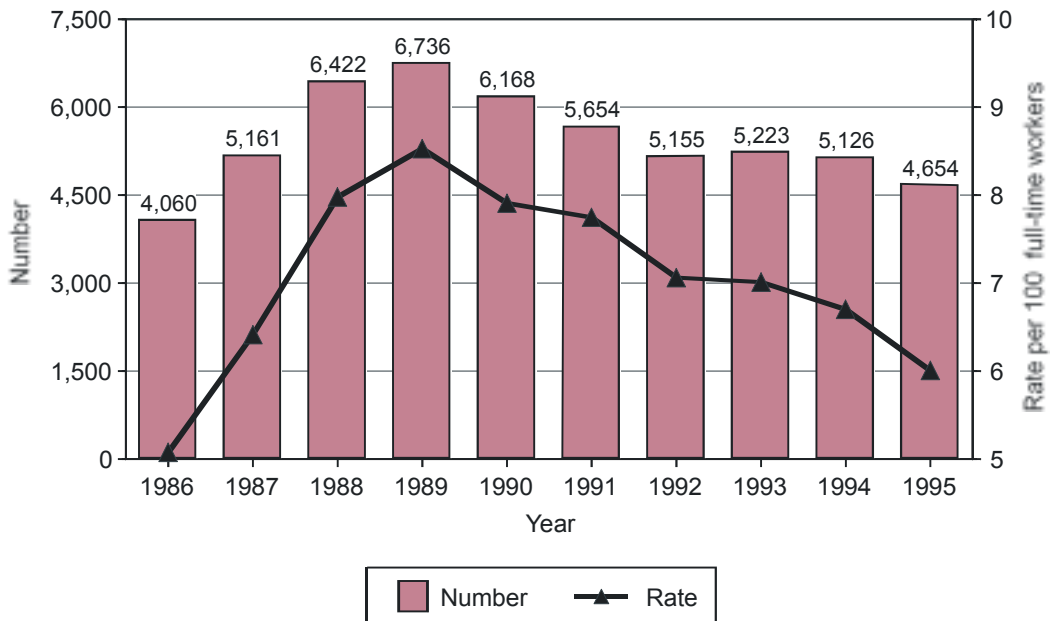


Figure 4D-5.—Stone operators: number and rate (per 100 workers) of nonfatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4D-2.—Stone operators: number and average annual rate (per 100 workers) of nonfatal injuries by subunit, 1986-1995.

| <b>Mining operation</b>        | <b>Number, 1986-1995</b> | <b>Average annual rate per 100 full-time workers</b> |
|--------------------------------|--------------------------|--|
| <b>Underground mines:</b>      |                          |  |
| Underground operations         | 1,173                    | 7.61   |
| Surface operations             | 450                      | 11.2   |
| <b>Surface mines:</b>          |                          |  |
| Strip                          | 21,982                   | 7.68   |
| Dredge                         | 93                       | 6.11   |
| <b>Independent shops/yards</b> | 168                      | 7.72   |
| <b>Mill</b>                    | 30,223                   | 8.39   |
| <b>Office</b>                  | 270                      | 0.26   |
| <b>Total</b>                   | <b>54,359</b>            | <b>7.03</b>  |

Source: Mine Safety and Health Administration data.

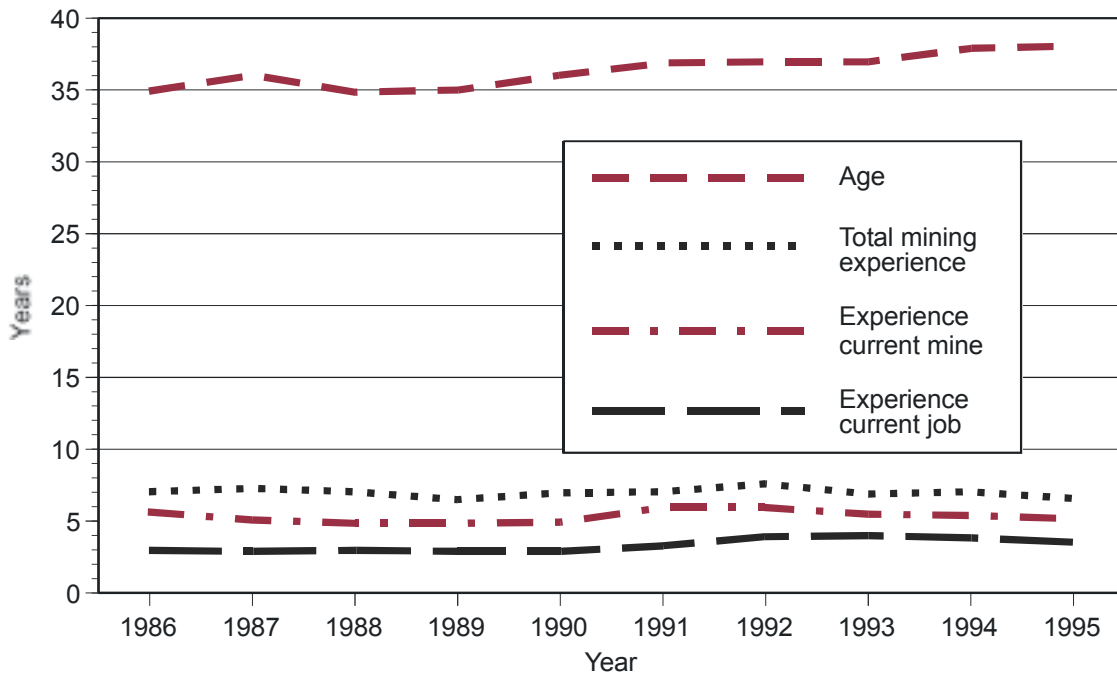


Figure 4D-6.—Stone operators: median values for age, total mining experience, experience in current mine, and experience in current job for workers with nonfatal injuries by year, 1986-1995. (Source: MSHA data)

**Table 4D-3.—Stone operators: nonfatal injuries, 1986-1995, by nature of injury. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days work lost for all cases, and statutory days charged for all cases.**

| Nature of injury                                    | Number of cases | Lost workday cases (%) | Mean days lost work | Total days lost | Total statutory days |
|---|-----------------|------------------------|---------------------|-----------------|----------------------|
| Sprains and strains                                 | 17,793          | 62.0                   | 16.19               | 288,117         | 19,890               |
| Fracture  | 5,080           | 53.9                   | 23.51               | 119,430         | 44,276               |
| Contusions  | 4,956           | 51.3                   | 8.09                | 40,087          | 1,470                |
| Lacerations   | 10,552          | 21.3                   | 2.78                | 29,257          | 4,410                |
| Hernia  | 564             | 78.2                   | 27.25               | 15,367          | 22,050               |
| Burn, heat  | 1,619           | 43.2                   | 8.62                | 13,950          | 13,500               |
| Amputation, enucleation                             | 326             | 60.7                   | 30.72               | 10,016          | 189,483              |
| Crushing  | 955             | 42.0                   | 8.77                | 8,375           | 3,950                |
| Dislocation   | 296             | 64.2                   | 21.65               | 6,407           | 0                    |
| Joint, tendon, or muscle inflammation or irritation | 418             | 40.2                   | 9.61                | 4,015           | 0                    |
| Burn, chemical                                      | 1,132           | 40.2                   | 3.30                | 3,740           | 5,400                |
| Noncontact electric arc burn                        | 560             | 53.2                   | 4.61                | 2,583           | 1,800                |
| Abrasions   | 833             | 33.9                   | 2.78                | 2,317           | 0                    |
| Electrical burn                                     | 57              | 61.4                   | 21.79               | 1,242           | 0                    |
| Dust in eyes  | 1,616           | 21.7                   | 0.66                | 1,073           | 0                    |
| Electric shock                                      | 72              | 63.9                   | 14.22               | 1,024           | 0                    |
| Poisoning   | 217             | 41.5                   | 4.36                | 946             | 0                    |
| Brain concussion                                    | 81              | 82.7                   | 11.38               | 922             | 0                    |
| Other specified causes                              | 938             | 46.6                   | 10.92               | 10,243          | 1,800                |
| Multiple injuries, unspecified                      | 3,944           | 53.6                   | 16.98               | 66,966          | 13,650               |
| Other unspecified injuries                          | 2,350           | 63.0                   | 17.56               | 41,269          | 2,820                |
| <b>Total</b>  | <b>54,359</b>   | <b>48.4</b>            | <b>12.28</b>        | <b>667,346</b>  | <b>324,499</b>       |

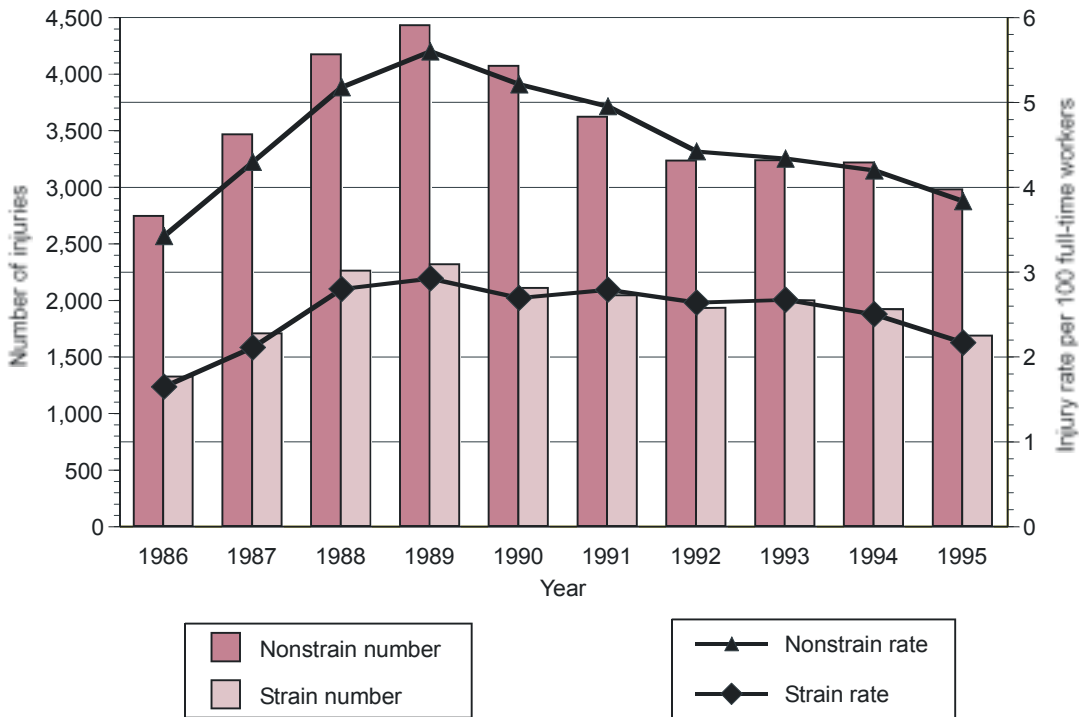
Source: Mine Safety and Health Administration data.



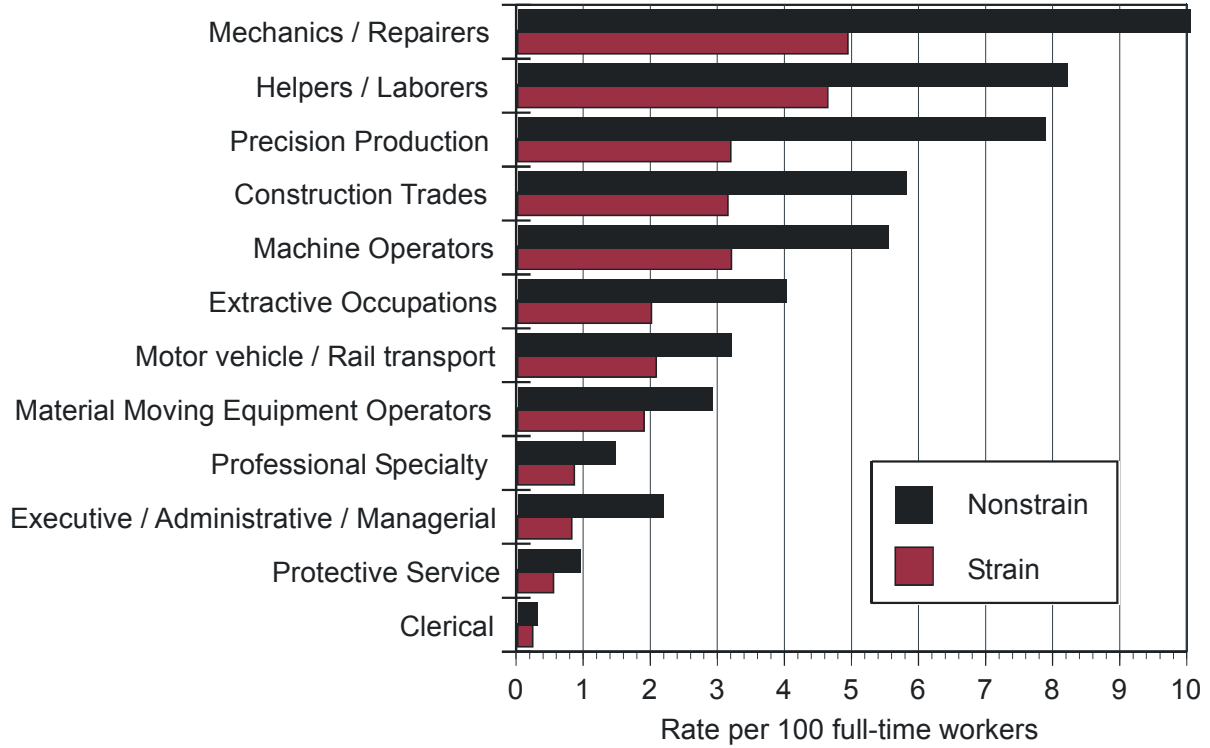
**Table 4D-4.—Stone operators: nonfatal injuries, 1986-1995, by work activity. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days work lost for all cases, and statutory days charged for all cases.**

| Work activity                           | Number of cases | Lost workday cases (%) | Mean days lost work | Total days lost | Total statutory days |
|---|-----------------|------------------------|---------------------|-----------------|----------------------|
| Materials handling                      | 15,502          | 51.5                   | 12.25               | 189,919         | 80,678               |
| Constructing, repairing, or cleaning    | 11,347          | 44.1                   | 12.03               | 136,518         | 98,815               |
| Using or operating tools or machinery   | 15,021          | 39.9                   | 8.75                | 131,505         | 81,181               |
| Vehicular and transportation operations | 5,876           | 61.7                   | 17.35               | 101,949         | 45,020               |
| Bodily movement                         | 4,983           | 55.1                   | 14.99               | 74,695          | 7,350                |
| Other                                   | 1,229           | 55.8                   | 18.47               | 22,696          | 10,605               |
| Unspecified                             | 401             | 66.6                   | 25.10               | 10,064          | 850                  |
| <b>Total</b>                            | <b>54,359</b>   | <b>48.4</b>            | <b>12.28</b>        | <b>667,346</b>  | <b>324,499</b>       |

Source: Mine Safety and Health Administration data.



**Figure 4D-7.—Stone operators: nonfatal injuries 1986-1995. Number and rate (per 100 workers) of strain and nonstrain injuries by year, 1986-1995. (Source: MSHA data)**



**Figure 4D-8.—Stone operators: nonfatal injuries, 1986-1995. Rate (per 100 workers) of strain and nonstrain injuries by U.S. Bureau of the Census Occupation Division, 1986-1995. (Data on occupations were missing for 1,237 out of 54,360 cases (2.3%).) (Source: MSHA data)**

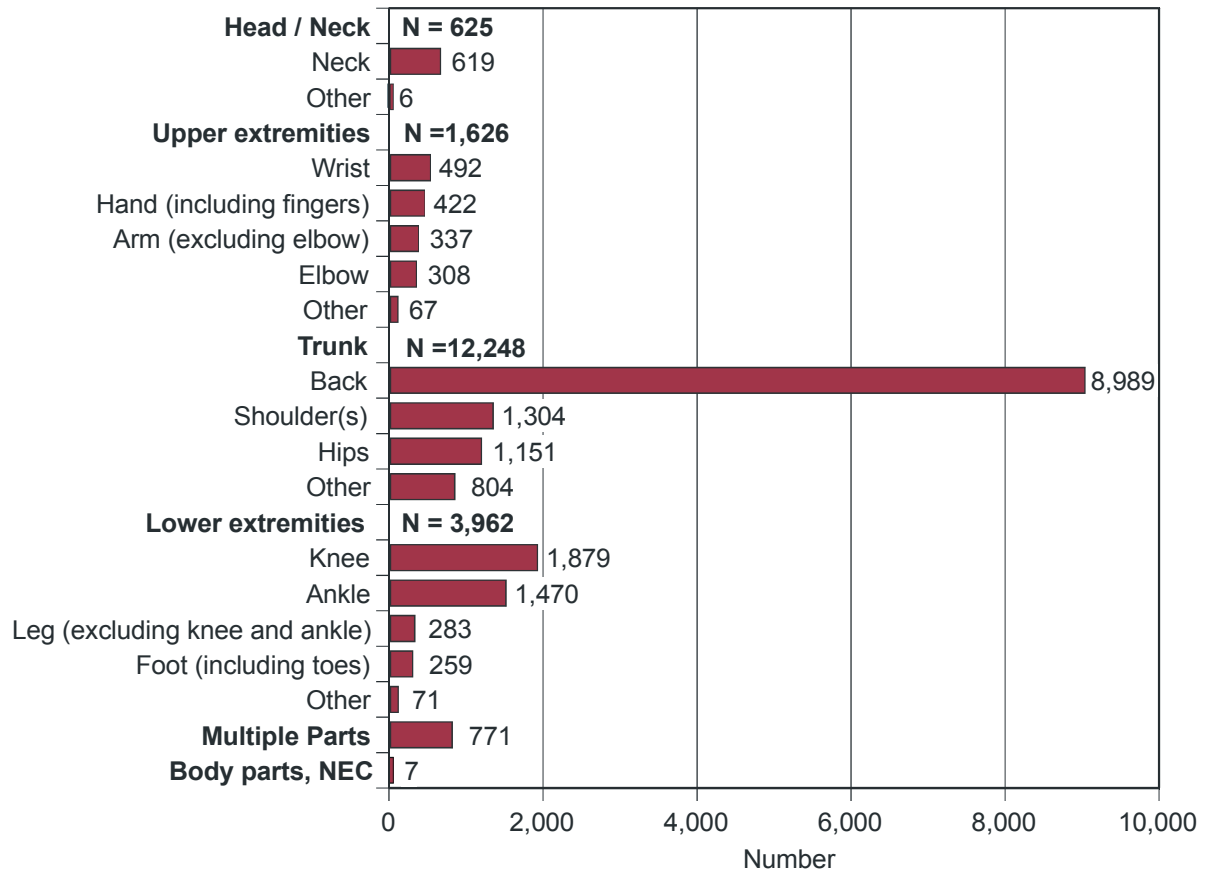


Figure 4D-9.—Stone operators: number of (nonfatal) strain injuries by body part injured, 1986-1995. (Source: MSHA data)

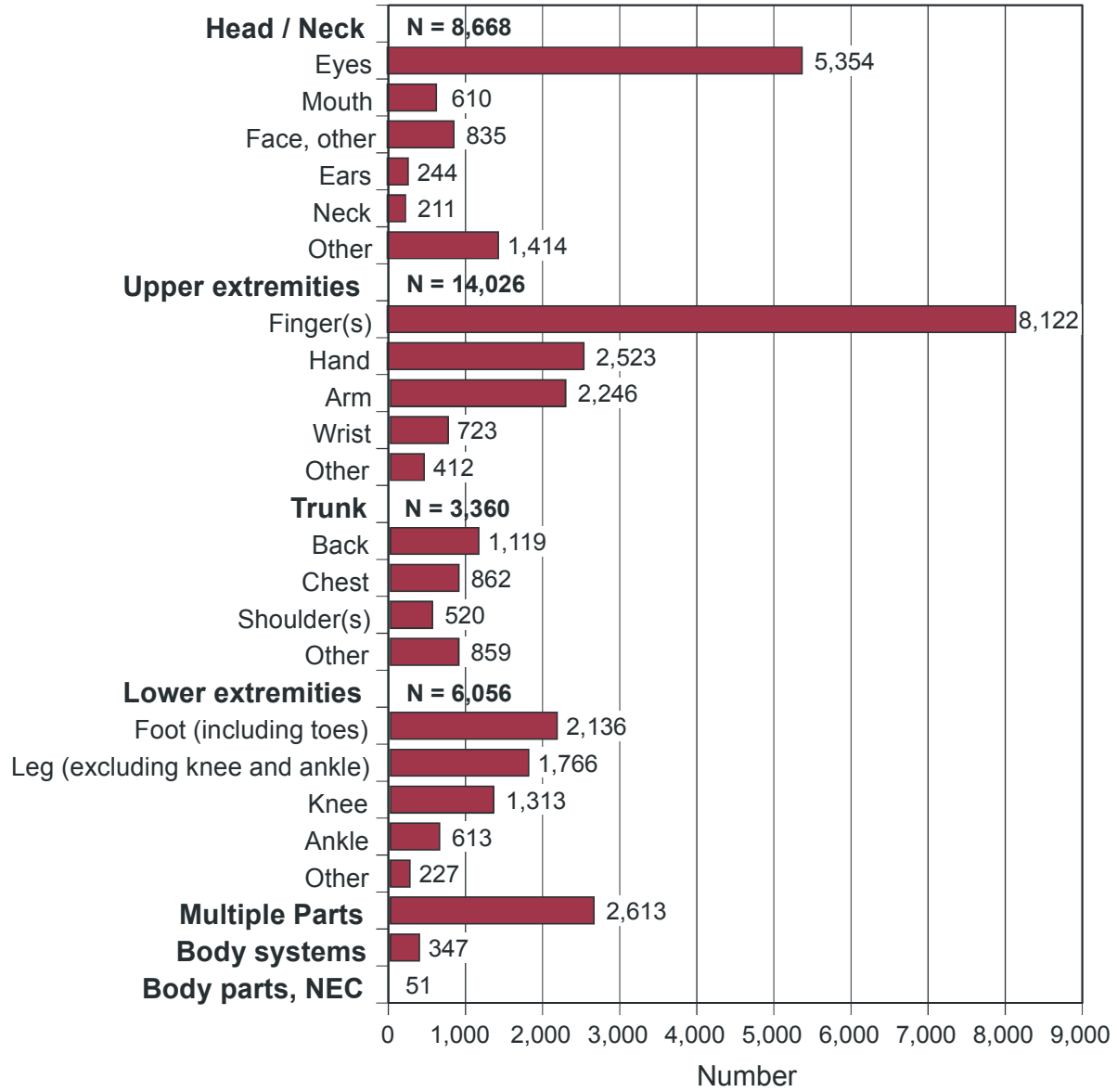


Figure 4D-10.—Stone operators: number of (nonfatal) nonstrain injuries by body part injured, 1986-1995. (Source: MSHA data)

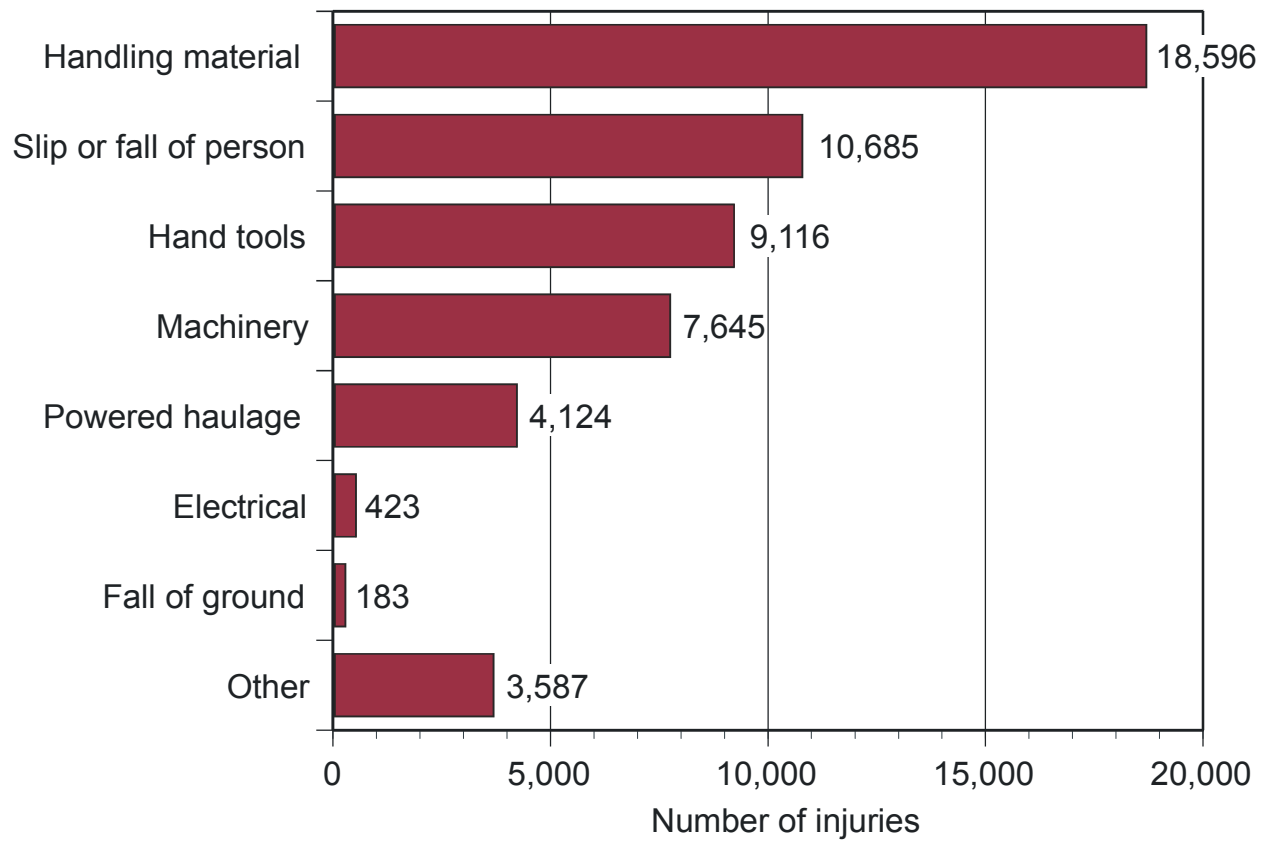


Figure 4D-11.—Stone operators: number of nonfatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

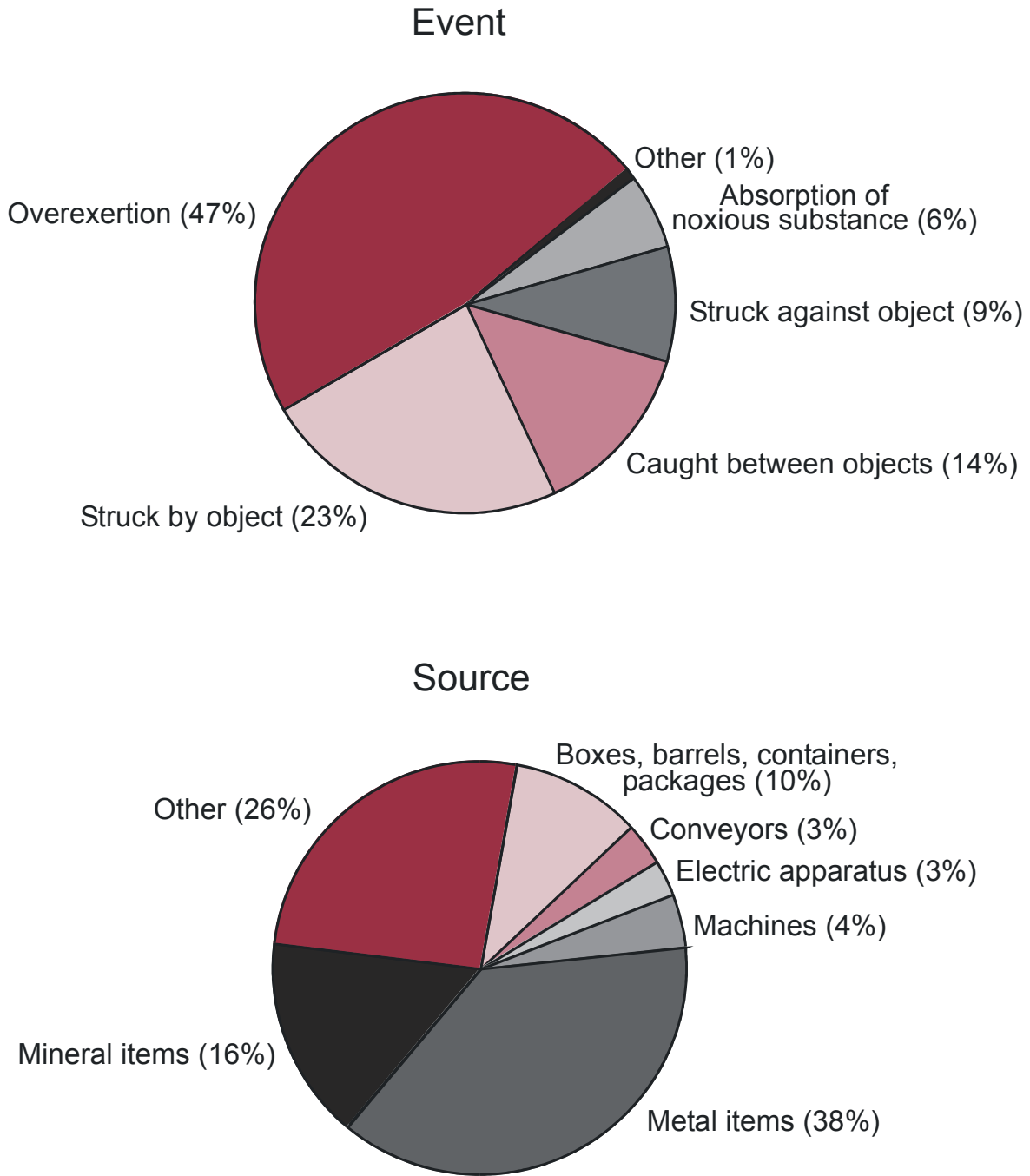


Figure 4D-12.—Stone operators: nonfatal material handling injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 18,596). (Source: MSHA data)

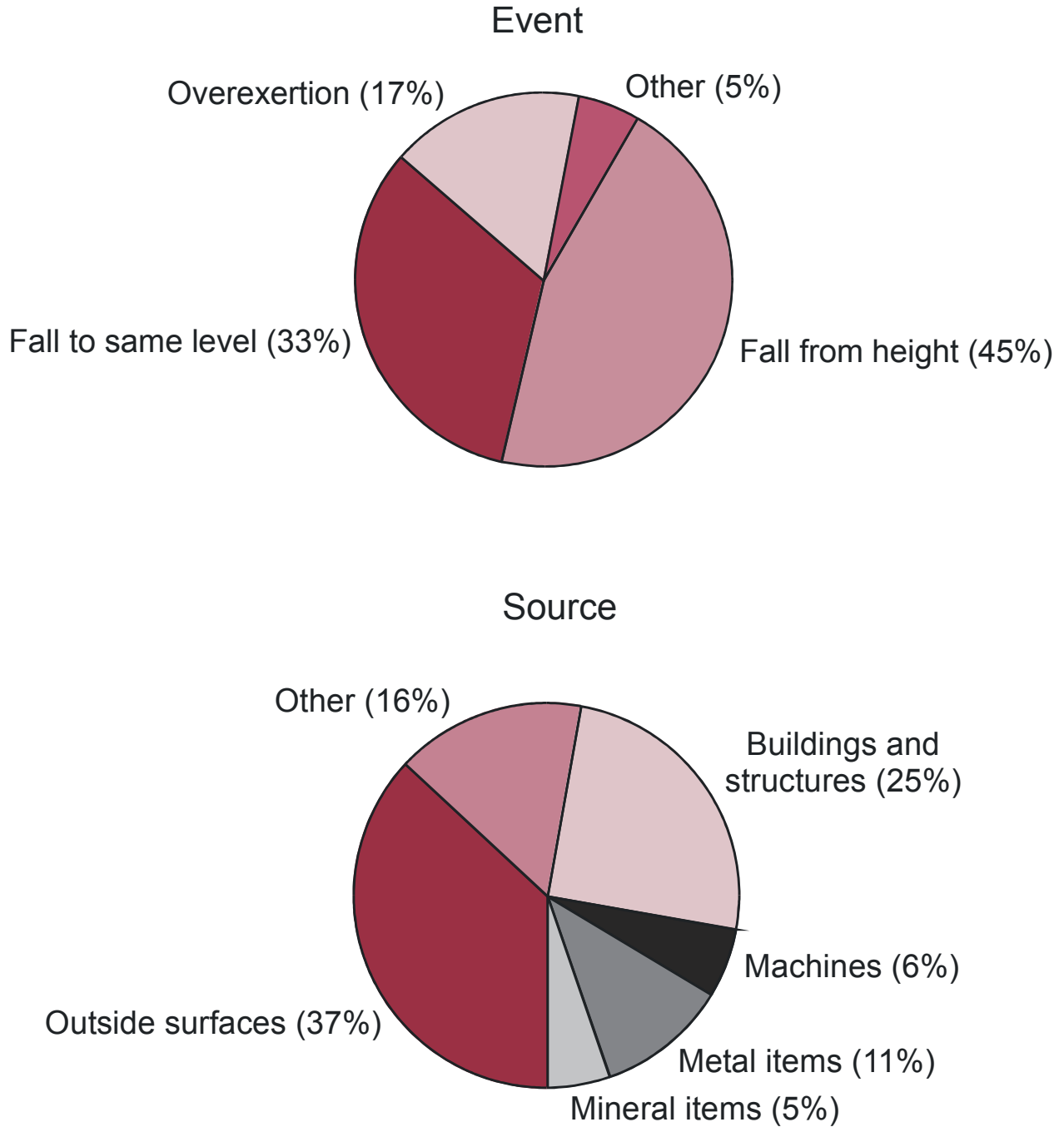


Figure 4D-13.—Stone operators: nonfatal fall injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 10,685). (Source: MSHA data)

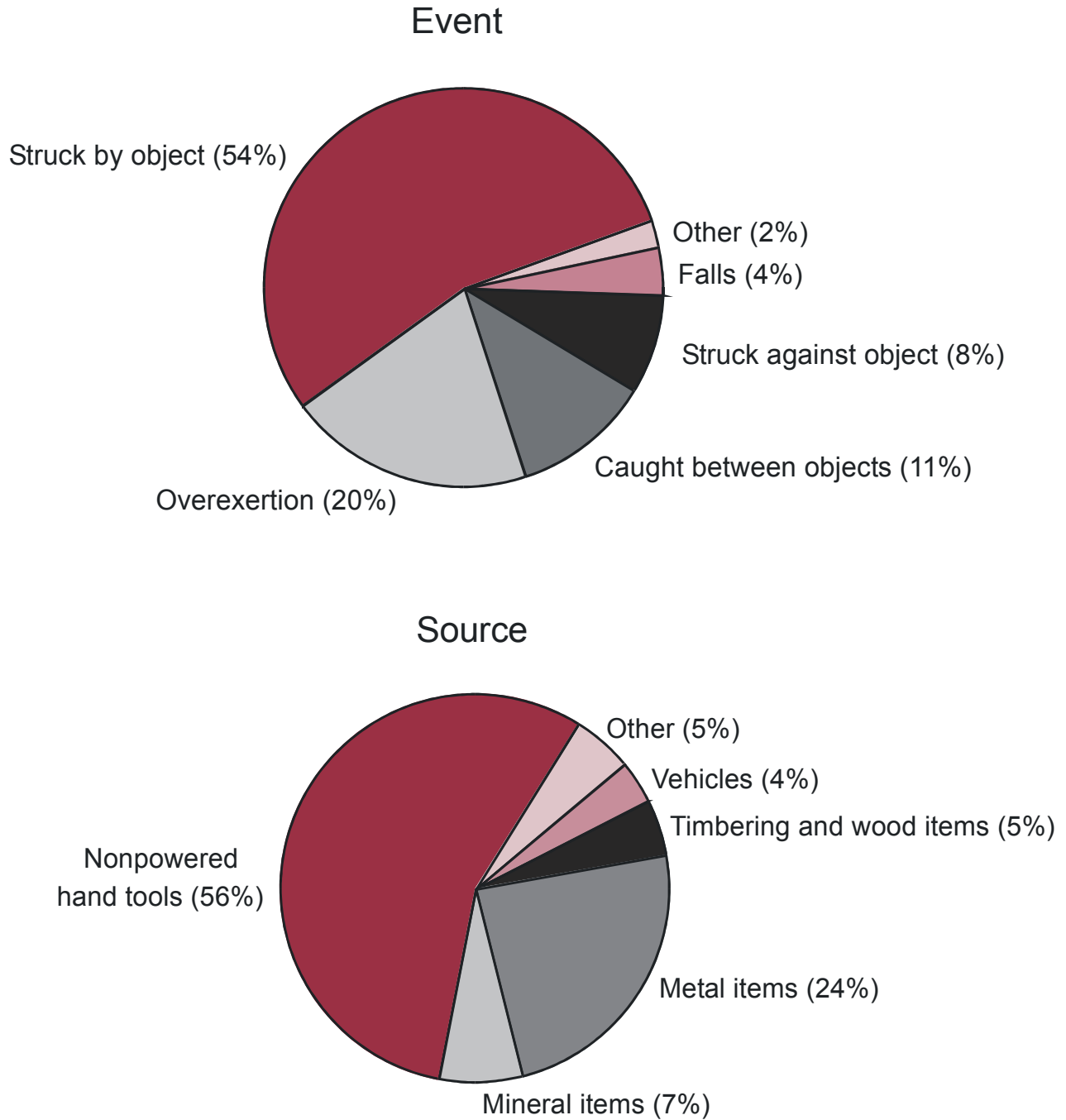
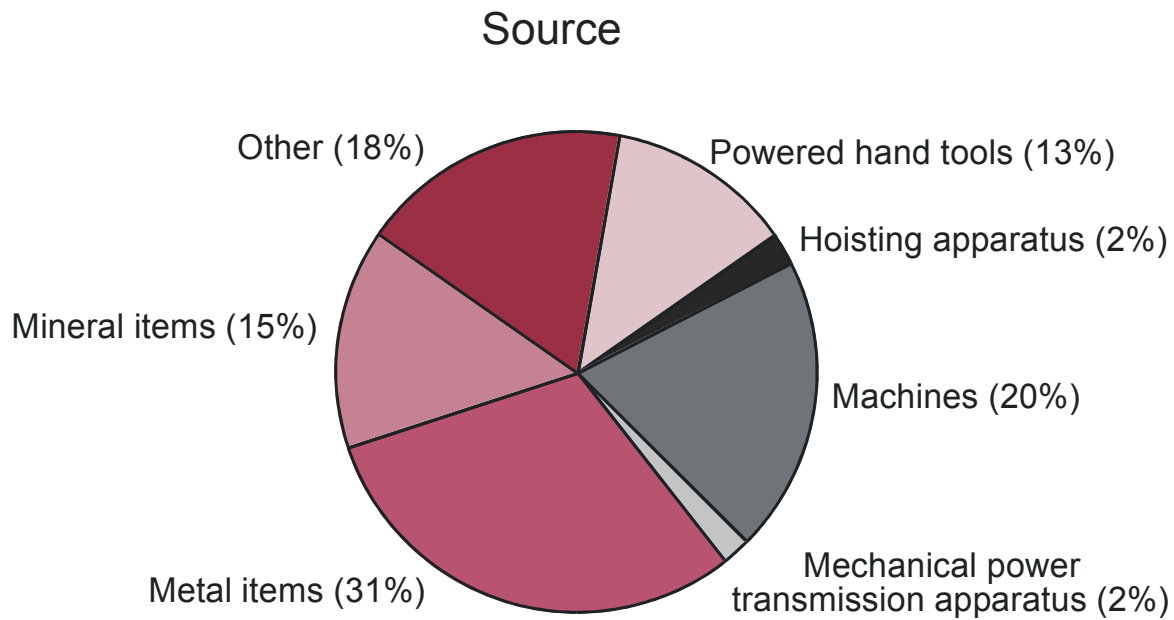
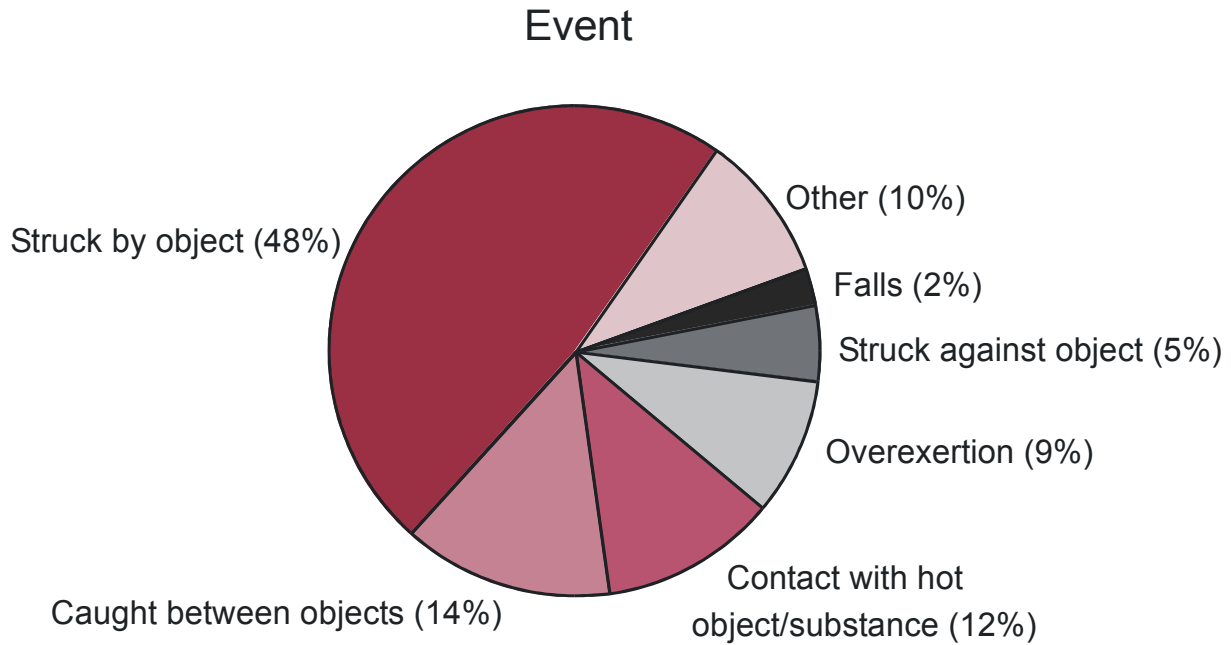
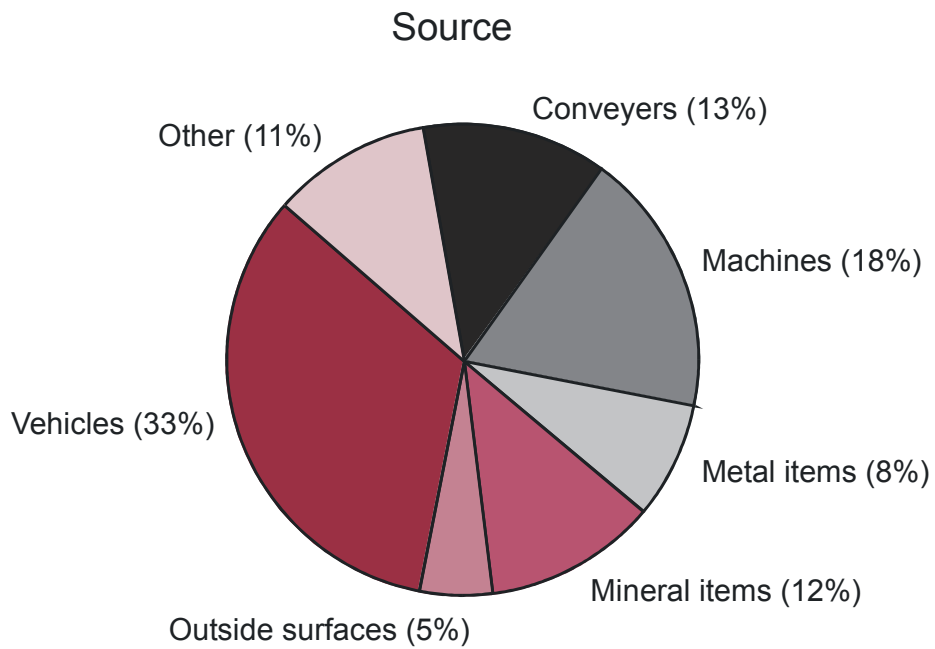
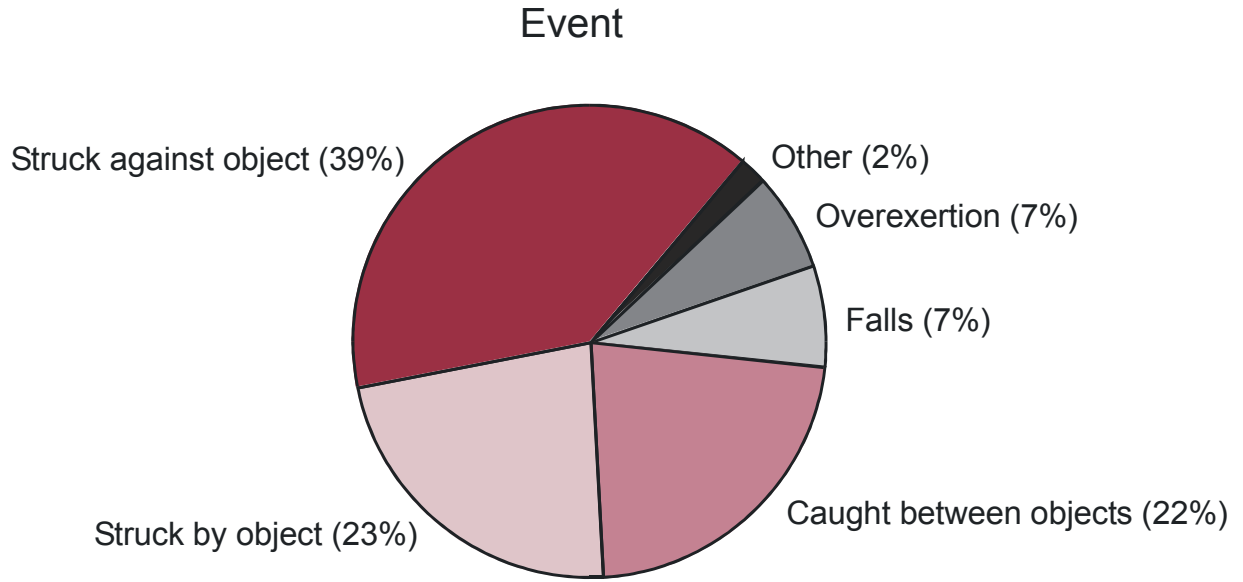


Figure 4D-14.—Stone operators: nonfatal hand tool injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 9, 116). (Source: MSHA data)





**Figure 4D-15.—Stone operators: nonfatal machine injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 7,645). (Source: MSHA data)**



**Figure 4D-16.—Stone operators: nonfatal powered haulage injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 4,124). (Source: MSHA data)**

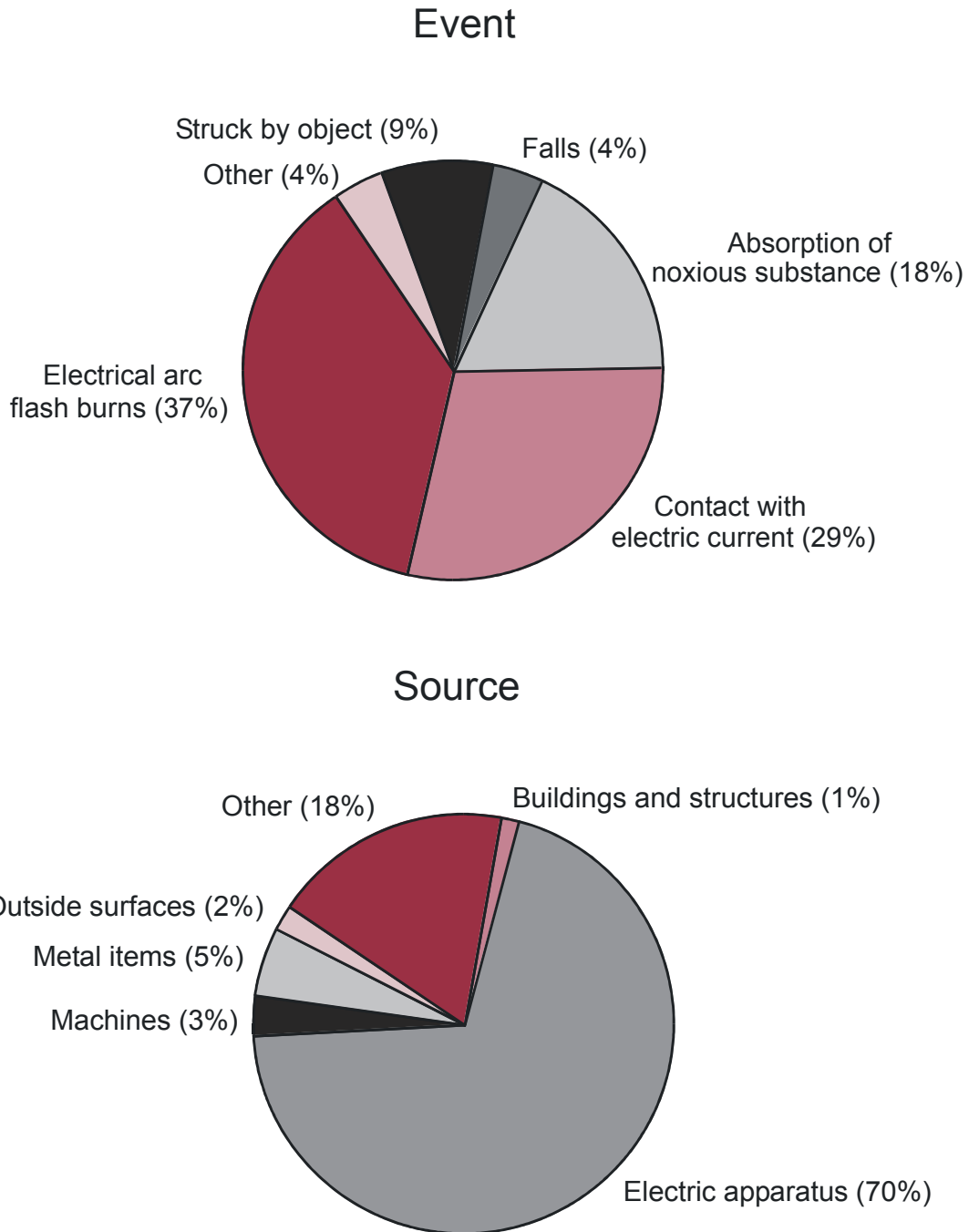


Figure 4D-17.—Stone operators: nonfatal electrical injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 423). (Source: MSHA data)

### 4E. INJURIES IN SAND AND GRAVEL MINING

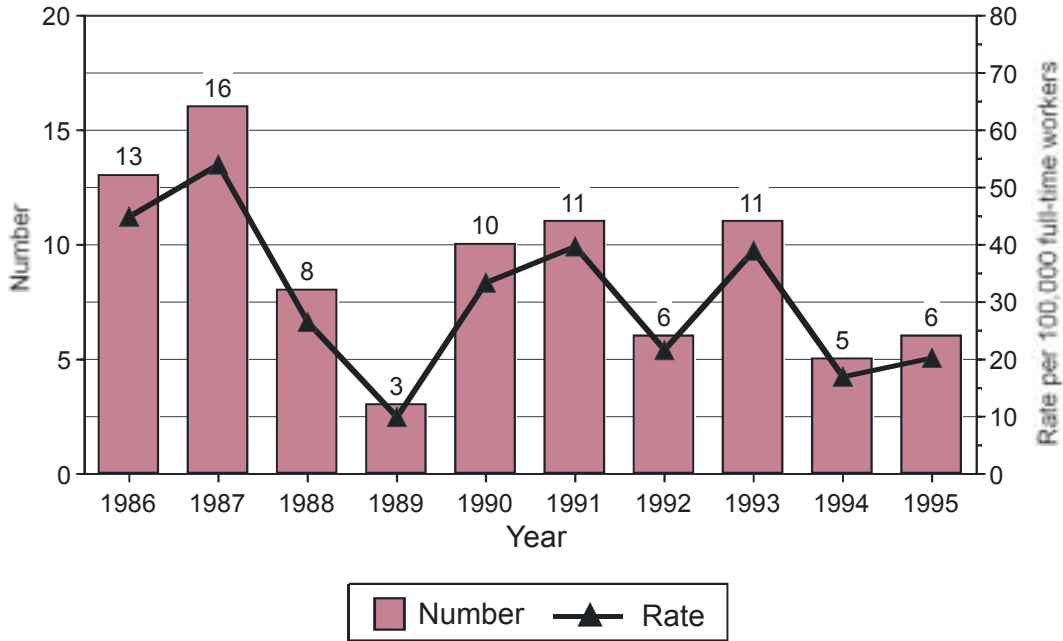


Figure 4E-1.—Sand and gravel operators: number and rate (per 100,000 workers) of fatal injuries by year, 1986-1995. (Source: MSHA data)

Table 4E-1.—Sand and gravel operators: number and average annual rate (per 100,000 workers) of fatal injuries by subunit, 1986-1995.

| <u>Mining operation</u> | <u>Number, 1986-1995</u> | <u>Average annual rate per 100,000 full-time workers</u> |
|-------------------------|--------------------------|--|
| <b>Surface mines:</b>   |                          |  |
| Strip                   | 67                       | 27.3   |
| Dredge                  | 22                       | 47.3   |
| Office                  | 0                        | *  |
| <b>Total</b>            | <b>89</b>                | <b>26.2</b>  |

\* Rate not calculated because there were fewer than 3 fatalities

Source: Mine Safety and Health Administration data.

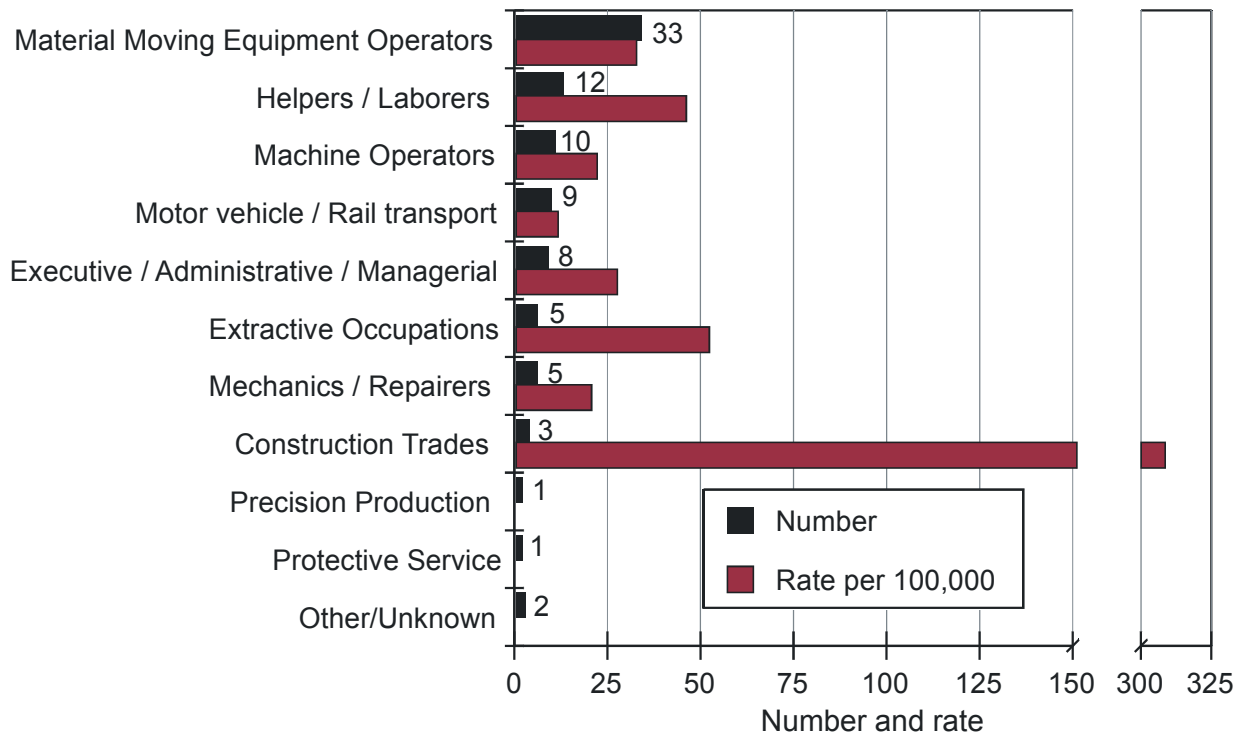


Figure 4E-2.—Sand and gravel operators: number and rate (per 100,000 workers) of fatal injuries by U.S. Bureau of the Census Occupation Division, 1986-1995. (Source: MSHA data)

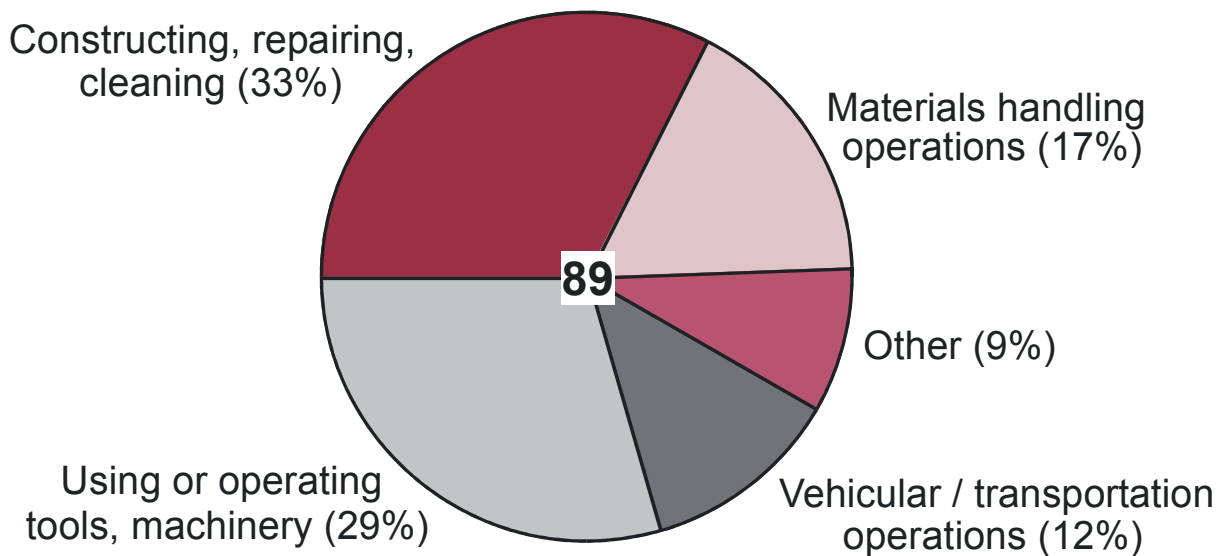


Figure 4E-3.—Sand and gravel operators: number of fatal injuries by work activity, 1986-1995. (Source: MSHA data)

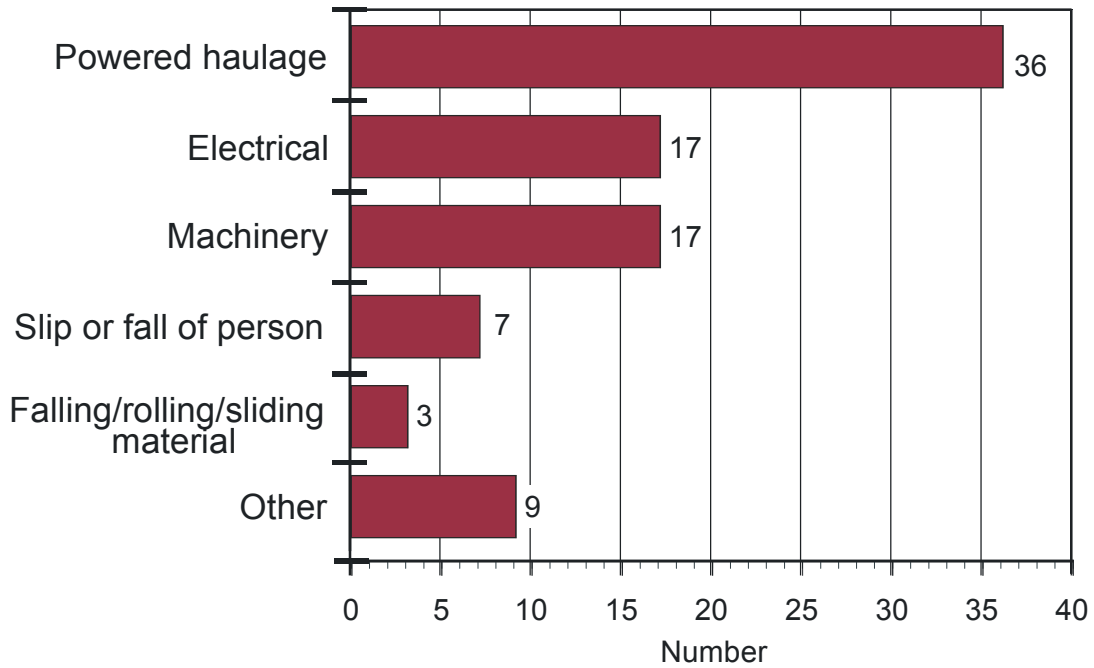


Figure 4E-4.—Sand and gravel operators: number of fatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

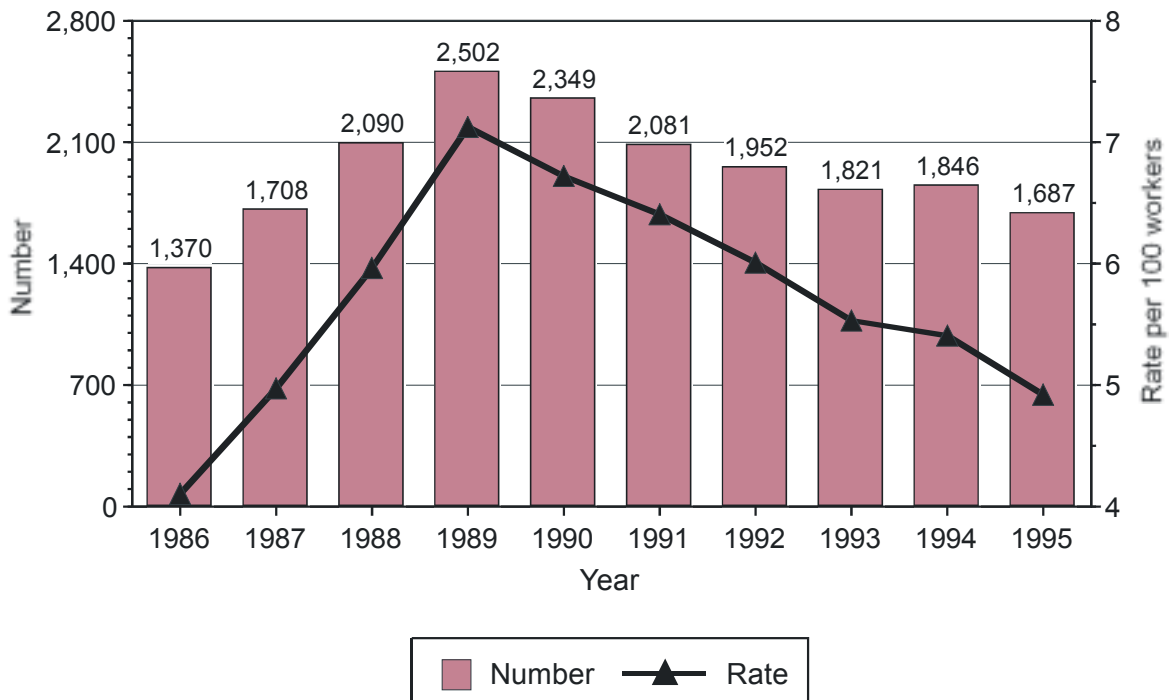
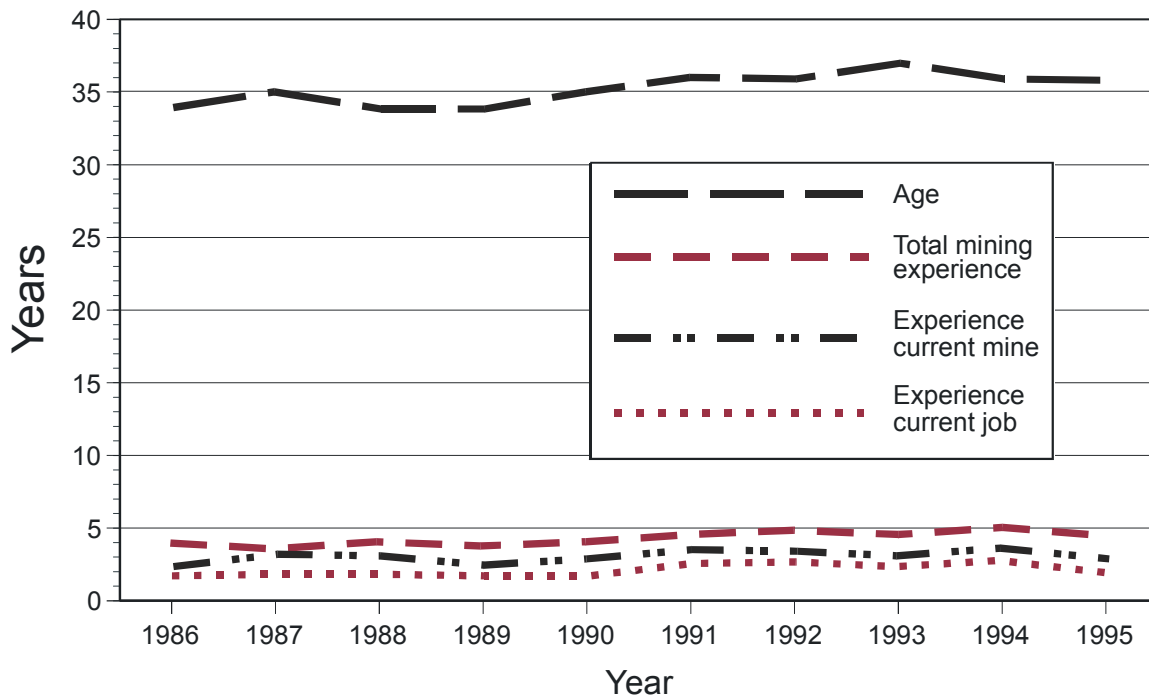


Figure 4E-5.—Sand and gravel operators: number and rate (per 100 workers) of nonfatal injuries by year, 1986-1995. (Source: MSHA data)

**Table 4E-2.—Sand and gravel operators: number and average annual rate (100 workers) of nonfatal injuries by subunit, 1986-1995.**

| <u>Mining operation</u> | <u>Number, 1986-1995</u> | <u>Average annual rate per 100 full-time workers</u> |
|-------------------------|--------------------------|--|
| <b>Surface mines:</b>   |                          |  |
| Strip                   | 16,045                   | 6.55   |
| Dredge                  | 3,252                    | 6.99   |
| <b>Office</b>           | 109                      | 0.23   |
| <b>Total</b>            | <b>19,406</b>            | <b>5.72</b>  |

Source: Mine Safety and Health Administration data.



**Figure 4E-6.—Sand and gravel operators: median values for age, total mining experience, experience in current mine, and experience in current job for workers with nonfatal injuries by year, 1986-1995. (Source: MSHA data)**

**Table 4E-3.—Sand and gravel operators: nonfatal injuries, 1986-1995, by nature of injury. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days work lost for all cases, and statutory days charged for all cases.**

| Nature of injury                                    | Number of cases | Lost workday cases (%) | Mean days lost work | Total days lost | Total statutory days |
|---|-----------------|------------------------|---------------------|-----------------|----------------------|
| Sprains and strains                                 | 5,768           | 71.2                   | 16.08               | 92,773          | 7,920                |
| Fracture  | 1,793           | 65.1                   | 24.62               | 44,138          | 6,600                |
| Contusions  | 1,775           | 59.5                   | 8.53                | 15,135          | 1,200                |
| Lacerations   | 4,111           | 29.9                   | 3.47                | 14,269          | 4,018                |
| Amputation, enucleation                             | 173             | 59.0                   | 23.85               | 4,126           | 154,590              |
| Hernia  | 183             | 68.9                   | 20.63               | 3,776           | 7,700                |
| Crushing  | 378             | 48.4                   | 9.84                | 3,720           | 3,270                |
| Burn, heat  | 492             | 48.2                   | 5.65                | 2,780           | 0                    |
| Joint, tendon, or muscle inflammation or irritation | 111             | 55.0                   | 17.66               | 1,960           | 0                    |
| Dislocation   | 114             | 62.3                   | 17.11               | 1,951           | 6,000                |
| Electric shock                                      | 38              | 76.3                   | 34.11               | 1,296           | 6,000                |
| Noncontact electric arc burn                        | 311             | 60.8                   | 3.77                | 1,171           | 0                    |
| Dust in eyes  | 586             | 29.9                   | 1.23                | 723             | 0                    |
| Brain concussion                                    | 47              | 87.2                   | 14.55               | 684             | 0                    |
| Abrasions   | 252             | 42.1                   | 1.95                | 491             | 0                    |
| Electrical burn                                     | 23              | 69.6                   | 18.70               | 430             | 0                    |
| Burn, chemical                                      | 127             | 55.1                   | 3.02                | 383             | 0                    |
| Poisoning   | 141             | 40.4                   | 2.15                | 303             | 0                    |
| Other specified causes                              | 300             | 58.7                   | 12.65               | 3,795           | 5,400                |
| Multiple injuries, unspecified                      | 1,539           | 67.6                   | 20.83               | 32,043          | 22,530               |
| Other unspecified injuries                          | 1,144           | 65.1                   | 18.08               | 20,679          | 5,650                |
| <b>Total</b>  | <b>19,406</b>   | <b>56.6</b>            | <b>12.71</b>        | <b>246,626</b>  | <b>230,878</b>       |

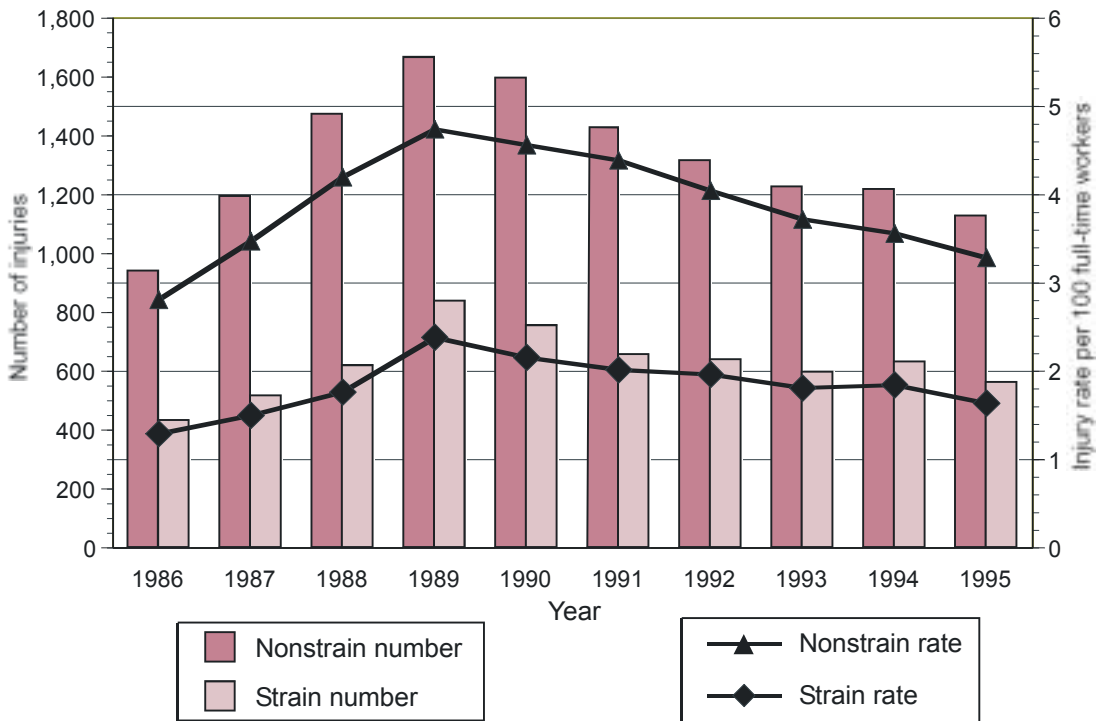
Source: Mine Safety and Health Administration data.



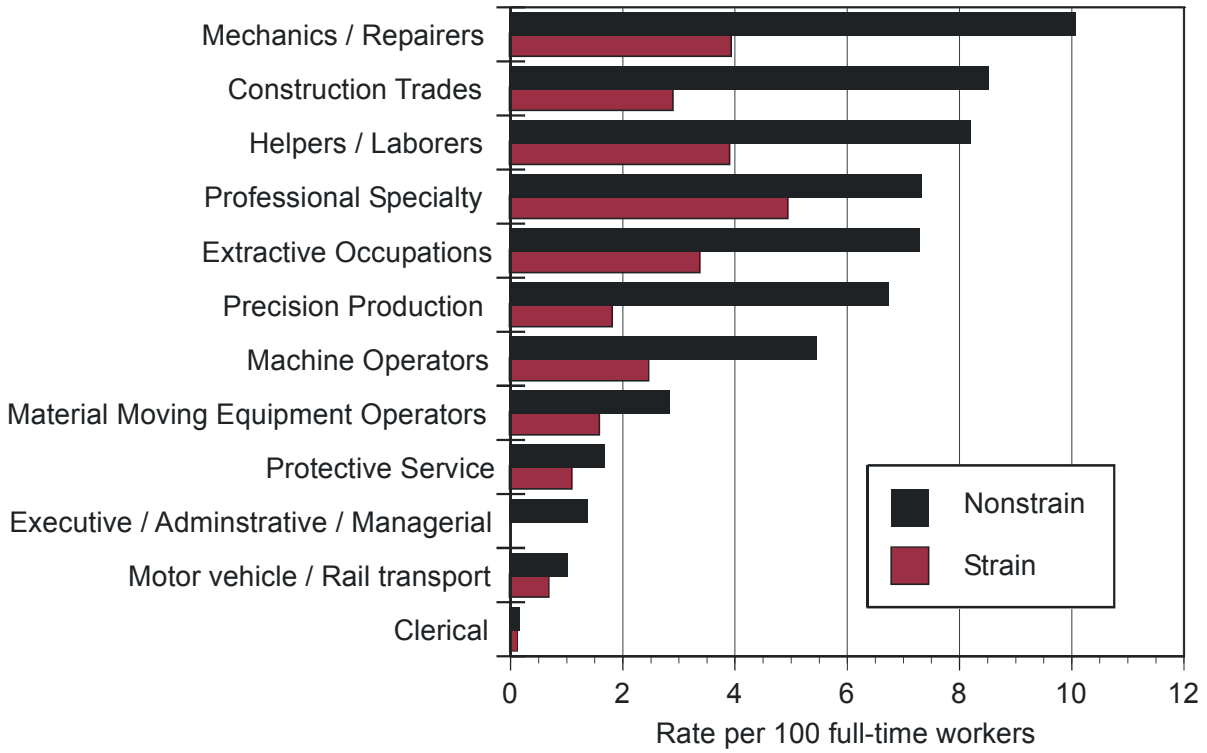
**Table 4E-4.—Sand and gravel operators: nonfatal injuries, 1986-1995, by work activity. Number of cases, percentage of cases with one or more lost workdays, mean days lost work per case, total days work lost for all cases, and statutory days charged for all cases.**

| Work activity                           | Number of cases | Lost workday cases (%) | Mean days lost work | Total days lost | Total statutory days |
|---|-----------------|------------------------|---------------------|-----------------|----------------------|
| Materials handling                      | 5,115           | 60.2                   | 12.51               | 63,967          | 52,815               |
| Constructing, repairing, or cleaning    | 4,518           | 54.2                   | 13.23               | 59,754          | 98,590               |
| Using or operating tools or machinery   | 5,313           | 46.6                   | 9.04                | 48,033          | 42,000               |
| Vehicular and transportation operations | 2,412           | 68.5                   | 16.91               | 40,798          | 18,578               |
| Bodily movement                         | 1,477           | 65.9                   | 16.42               | 24,256          | 8,840                |
| Other                                   | 417             | 61.9                   | 16.43               | 6,851           | 9,855                |
| Unspecified                             | 154             | 59.7                   | 19.27               | 2,967           | 200                  |
| <b>Total</b>                            | <b>19,406</b>   | <b>56.6</b>            | <b>12.71</b>        | <b>246,626</b>  | <b>230,878</b>       |

Source: Mine Safety and Health Administration data.



**Figure 4E-7.—Sand and gravel operators: nonfatal injuries 1986-1995. Number and rate (per 100 workers) of strain and nonstrain injuries by year, 1986-1995. (Source: MSHA data)**



**Figure 4E-8.—Sand and gravel operators: nonfatal injuries, 1986-1995. Rate (per 100 workers) of strain and nonstrain injuries by U.S. Bureau of the Census Occupation Division, 1986-1995. (Data on occupations were missing for 610 out of 19,406 cases (3.1%).) (Source: MSHA data)**

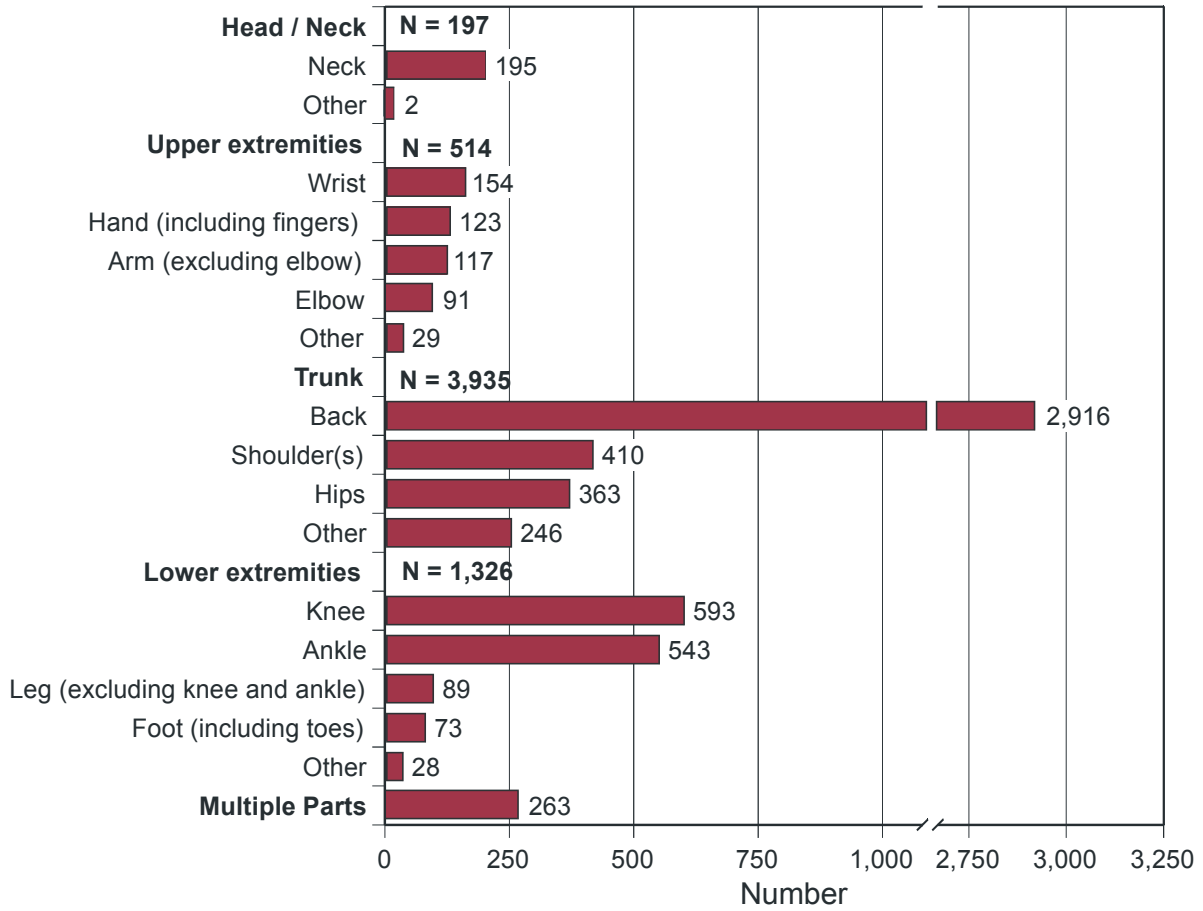


Figure 4E-9.—Sand and gravel operators: number of (nonfatal) strain injuries by body part injured, 1986-1995. (Source: MSHA data)

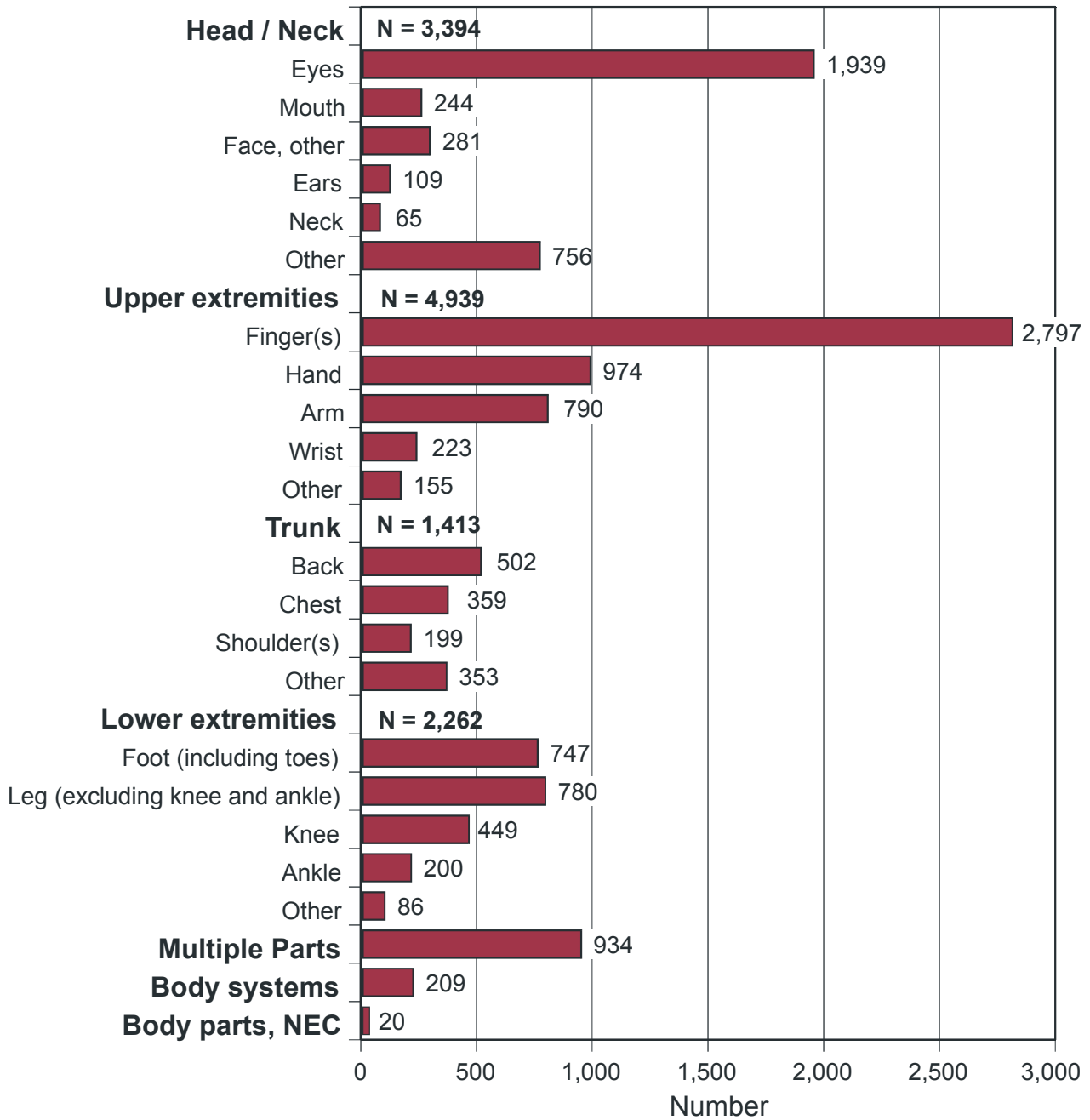


Figure 4E-10.—Sand and gravel operators: number of (nonfatal) nonstrain injuries by body part injured, 1986-1995. (Source: MSHA data)

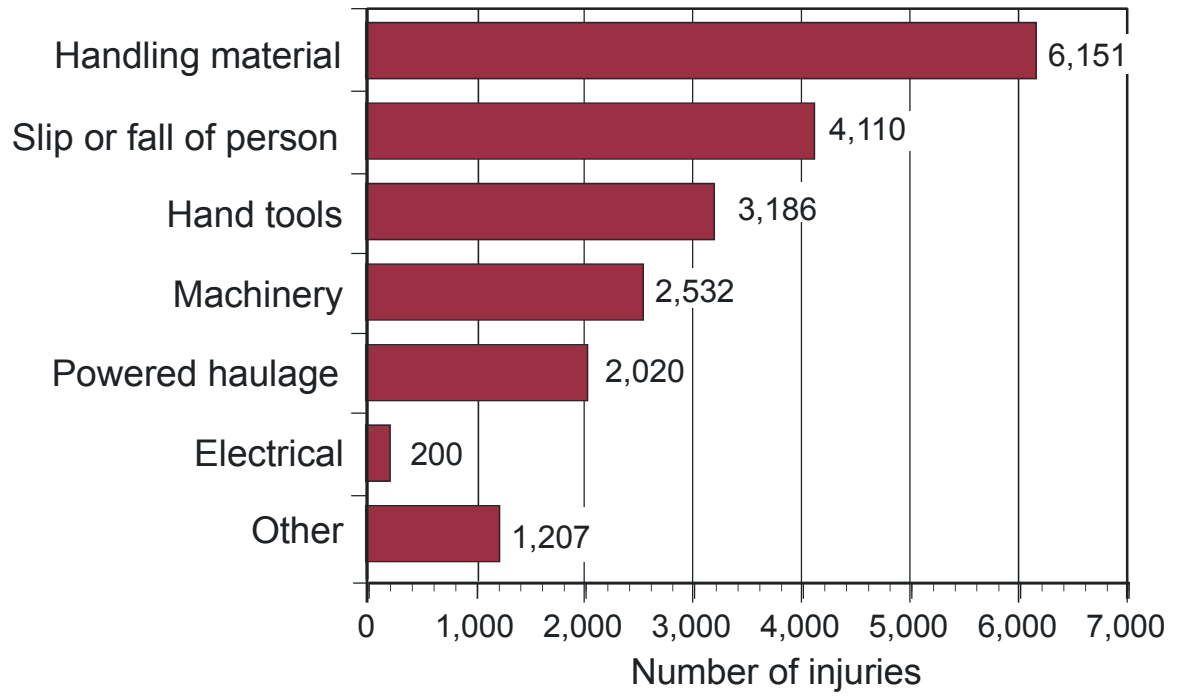


Figure 4E-11.—Sand and gravel operators: number of nonfatal injuries by MSHA accident classification, 1986-1995. (Source: MSHA data)

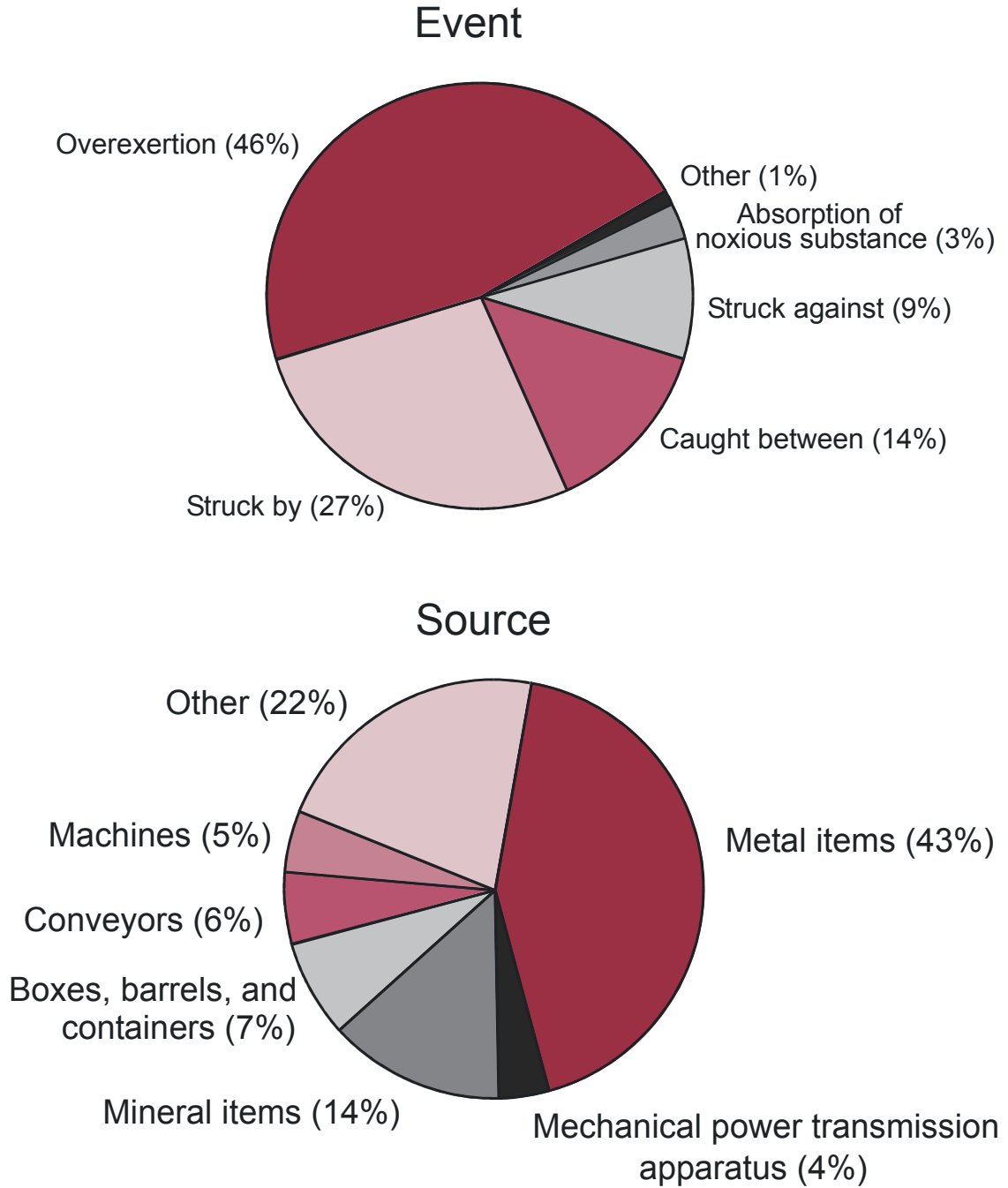
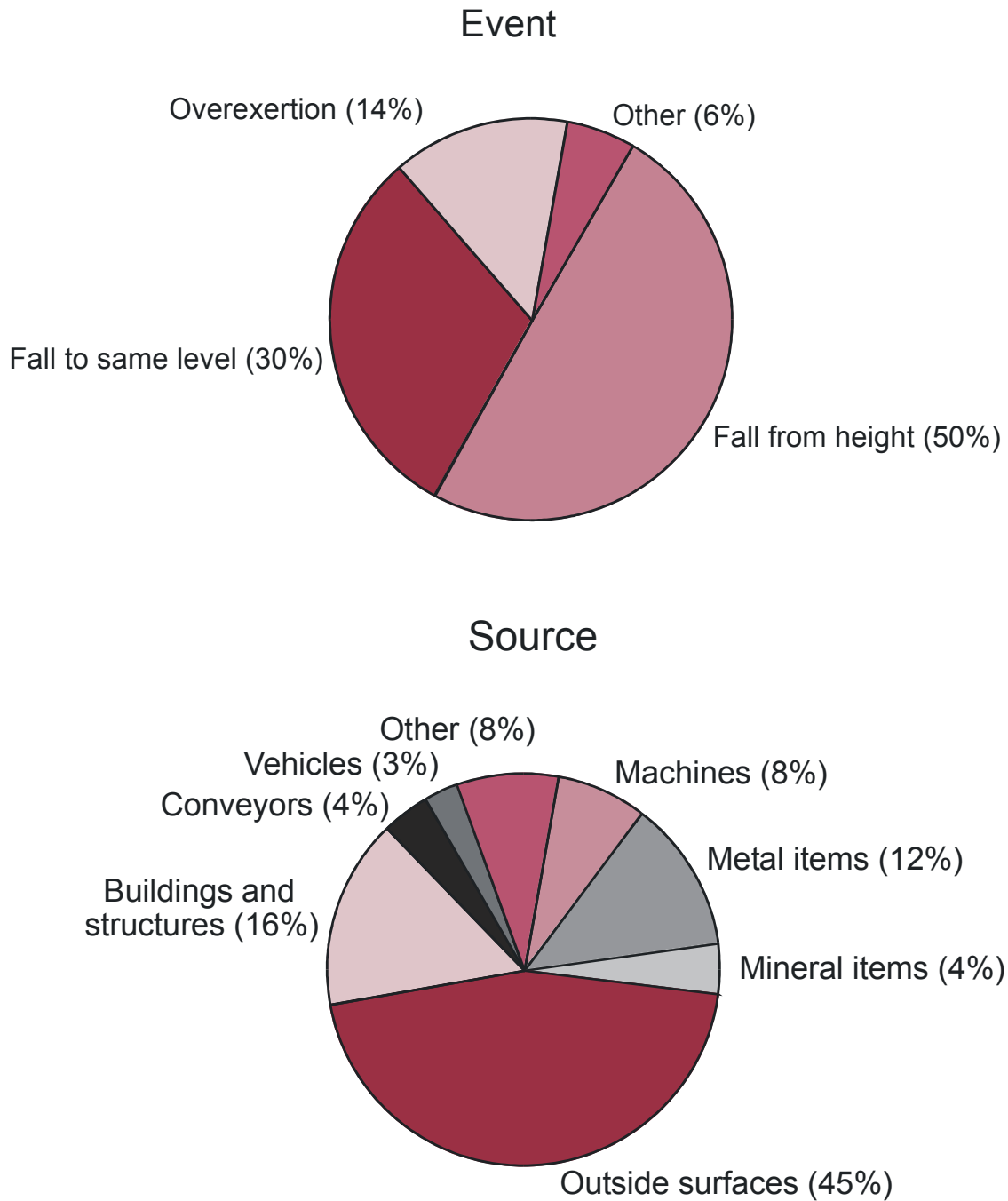


Figure 4E-12.—Sand gravel operators: nonfatal material handling injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 6,151). (Source: MSHA data)



**Figure 4E-13.—Sand and gravel operators: nonfatal fall injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 4,110). (Source: MSHA data)**

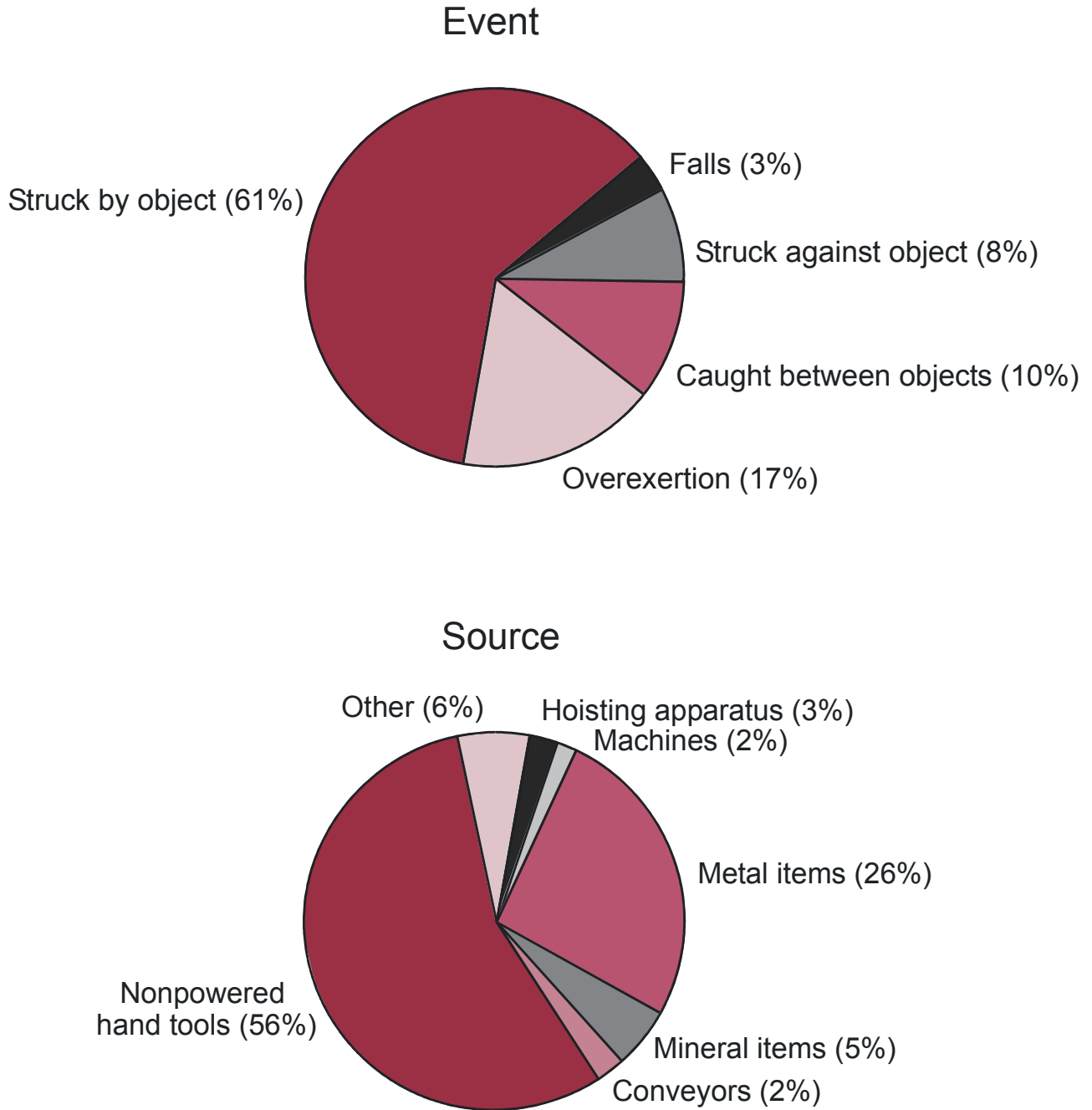
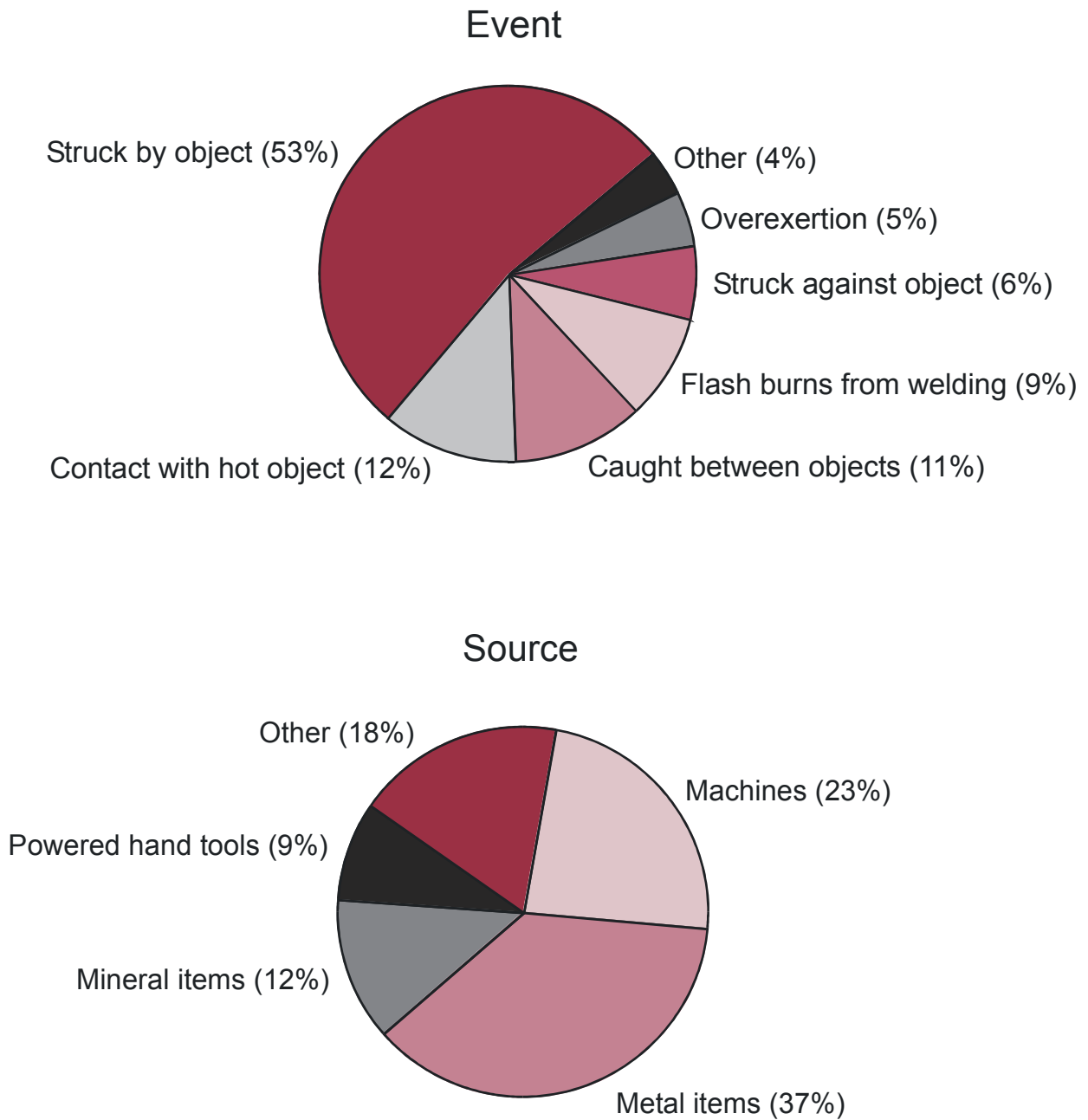


Figure 4E-14.—Sand and gravel operators: nonfatal hand tool injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 3,186). (Source: MSHA data)





**Figure 4E-15.—Sand and gravel operators: nonfatal machine injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 2,532). (Source: MSHA data)**

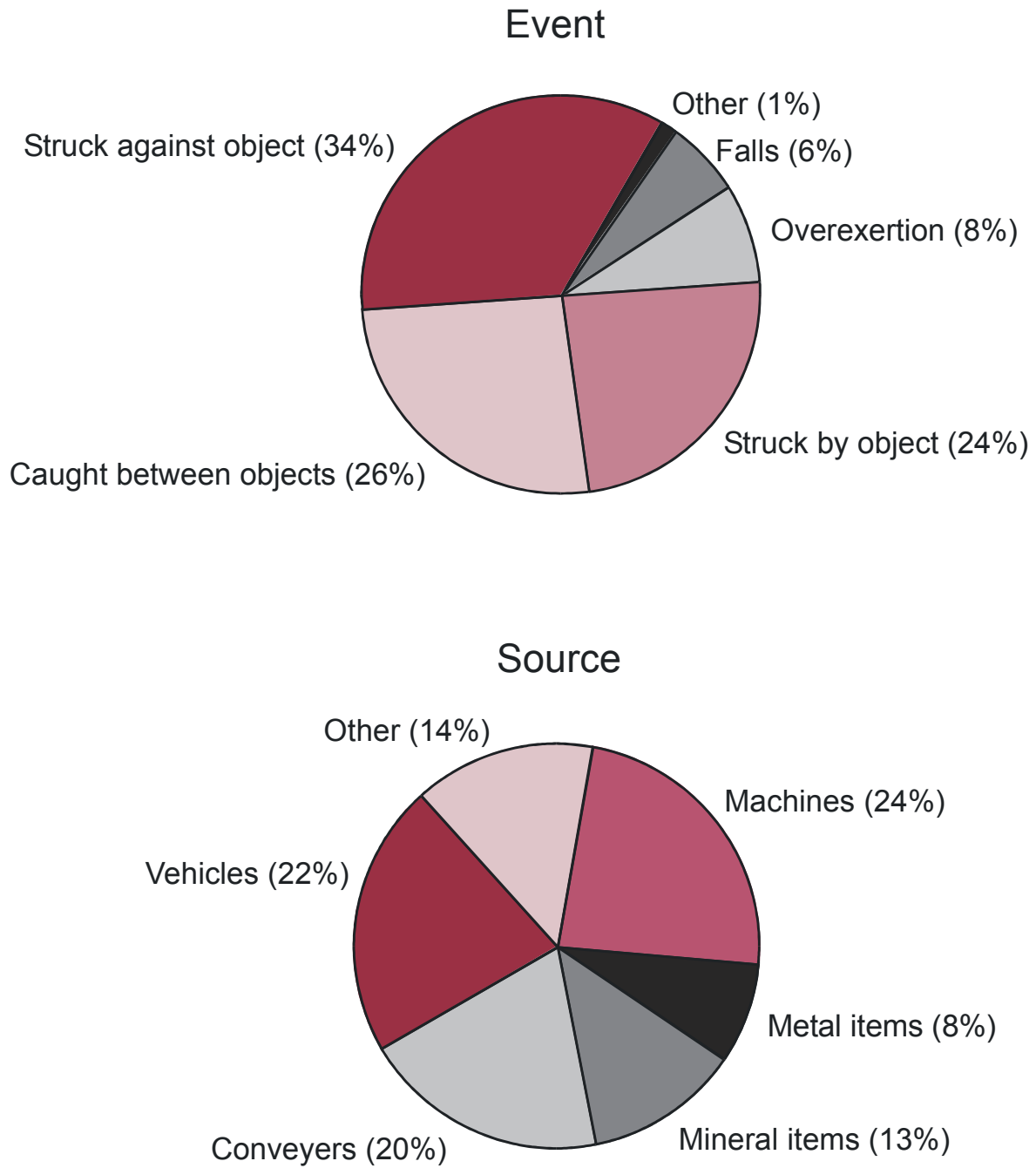
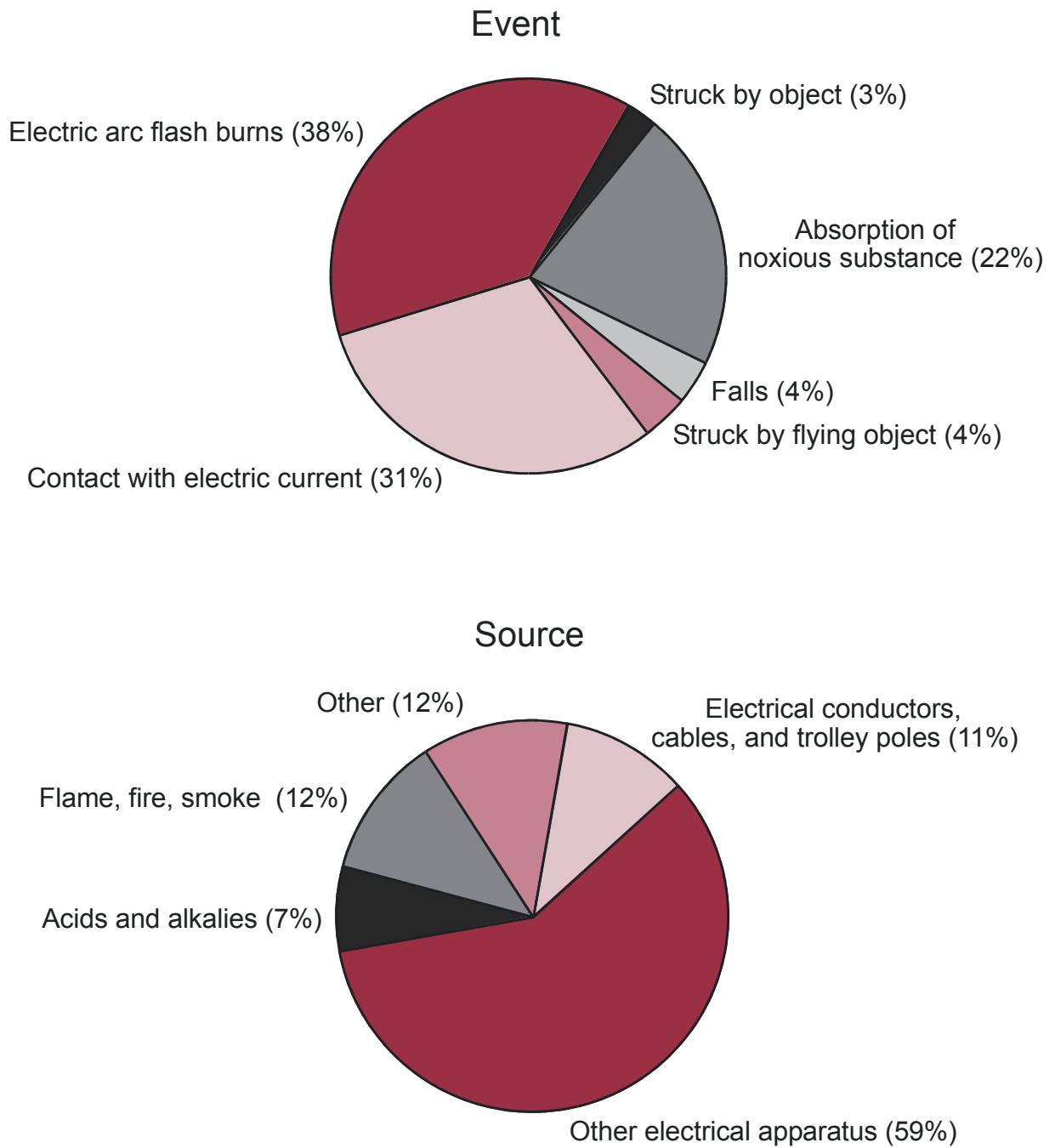


Figure 4E-16.—Sand and gravel operators: nonfatal powered haulage injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 2,020). (Source: MSHA data)



**Figure 4E-17.—Sand and gravel operators: nonfatal electrical injuries, 1986-1995. Percent of injuries by event resulting in injury and by source of injury (n = 200). (Source: MSHA data)**

## CHAPTER 5. OCCUPATIONAL ILLNESSES

Occupational illnesses are more difficult to identify than on-the-job injuries. Many illnesses related to occupational exposures may not be diagnosed until years after exposure; by that time, exposed workers may have changed jobs or left the workforce. Other approaches to identifying occupationally related illness are analysis of death certificate data (see chapter 2) and medical examination studies of workers known to have high exposures to hazardous agents.

Figures 5-1, 5-3, 5-4, 5-6, 5-8, and 5-10 show, for each commodity, the percent of illness conditions reported to MSHA by nature of condition. Heart attacks that occurred on the job are reported without regard to work-relatedness. Figures 5-2, 5-5, 5-7, 5-9, and 5-11 show rates by year during 1986-1995 for selected conditions. *Since there are many limitations on the accuracy of illness reporting, the frequencies and rates shown here should not be considered directly comparable across commodities.*

Figure 5-12 shows estimates for hearing loss by age among coal miners compared to a nonoccupationally noise-exposed population. These data come from a study by Franks [1996] of a group of audiograms obtained on coal miners by a

commercial company. Using the NIOSH definition of hearing impairment, i.e., an average hearing threshold level for both ears that exceeds 25 dB at frequencies of 1,000, 2,000, 3,000 and 4,000 Hz, the figure shows that by age 30, more than 10% of miners suffer hearing impairment; by age 50, 90% of miners have hearing impairment. In contrast, only 10% of the nonoccupationally noise-exposed population suffer hearing impairment at age 51, and 50% of the nonoccupationally exposed population have hearing impairment at age 69.

Figure 5-13 shows a similar analysis of commercial audiograms on male metal/nonmetal miners [Franks 1997]. At age 20, approximately 2% have hearing impairment using the NIOSH definition of hearing impairment described above. This increases to 7% at age 30, 25% at age 40, and 49% at age 50. In contrast, only 9% of the nonoccupationally noise-exposed comparison population have hearing impairment at age 50. Franks' analysis showed a different pattern for female metal/nonmetal miners; they developed hearing loss at the same rate as would be expected for a non-noise-exposed female population.

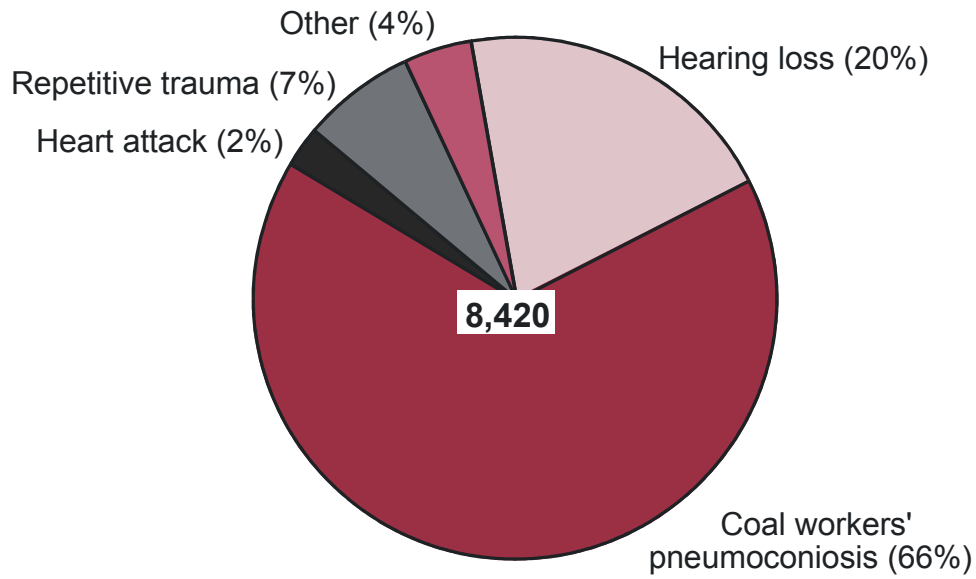


Figure 5-1.—Coal operators: percent of illness conditions reported by nature of condition, 1986-1995. (Source: MSHA data)

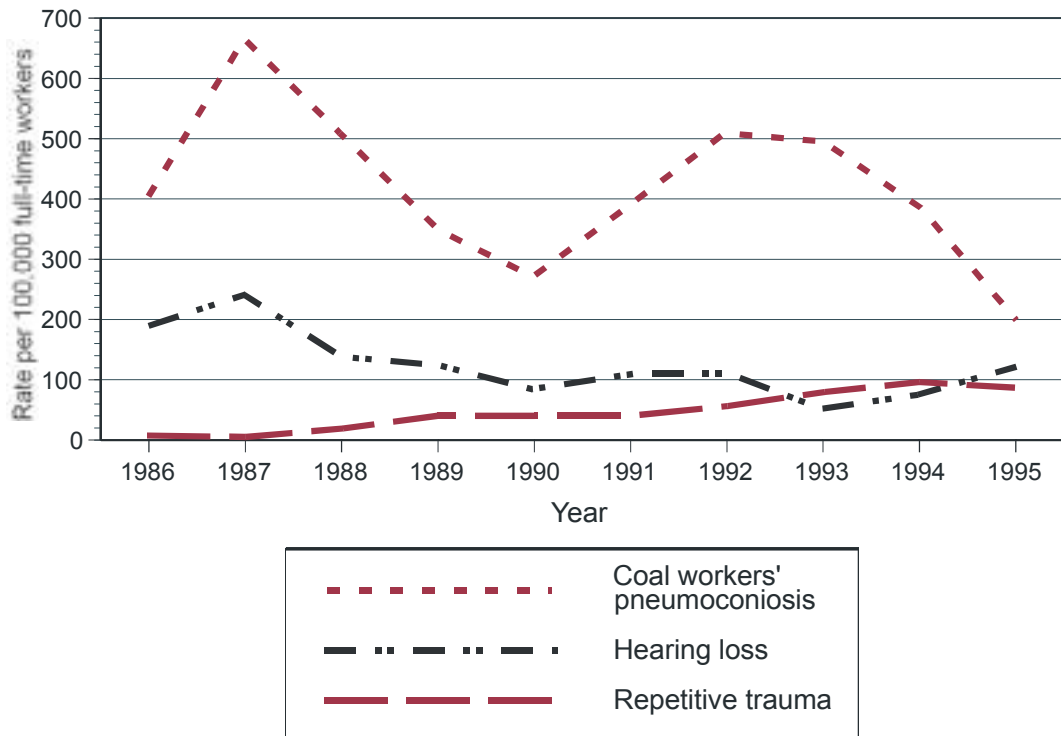


Figure 5-2.—Coal operators: rate of illness conditions reported (per 100,000 workers) for selected conditions by year, 1986-1995. (Source: MSHA data)

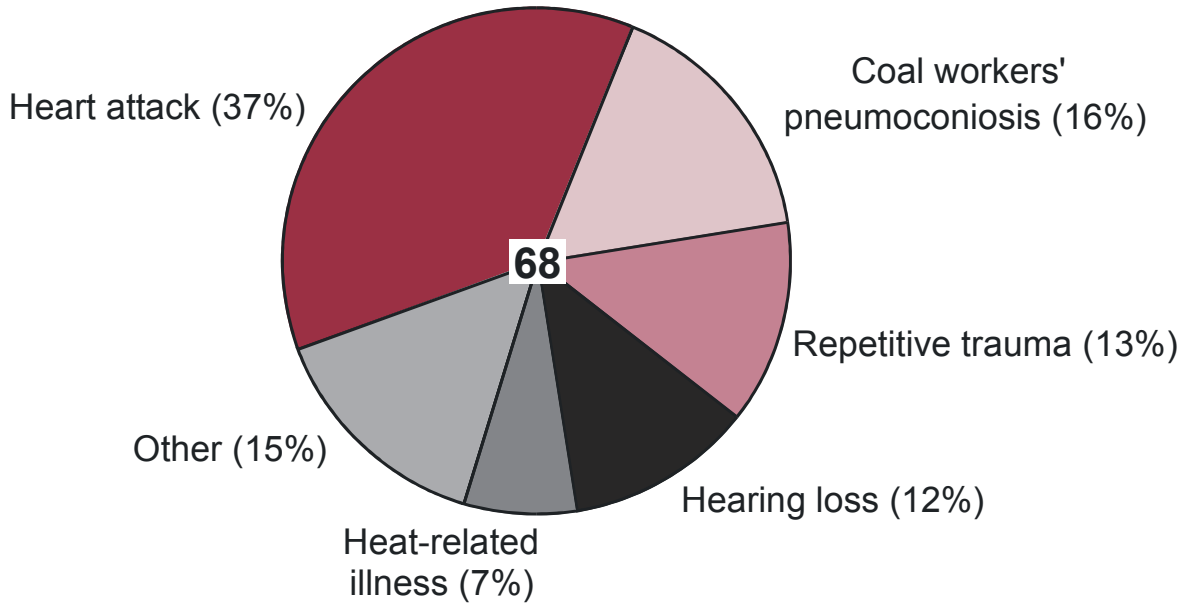


Figure 5-3.—Coal contractors: percent of illness conditions reported by nature of condition, 1986-1995. (Source: MSHA data)

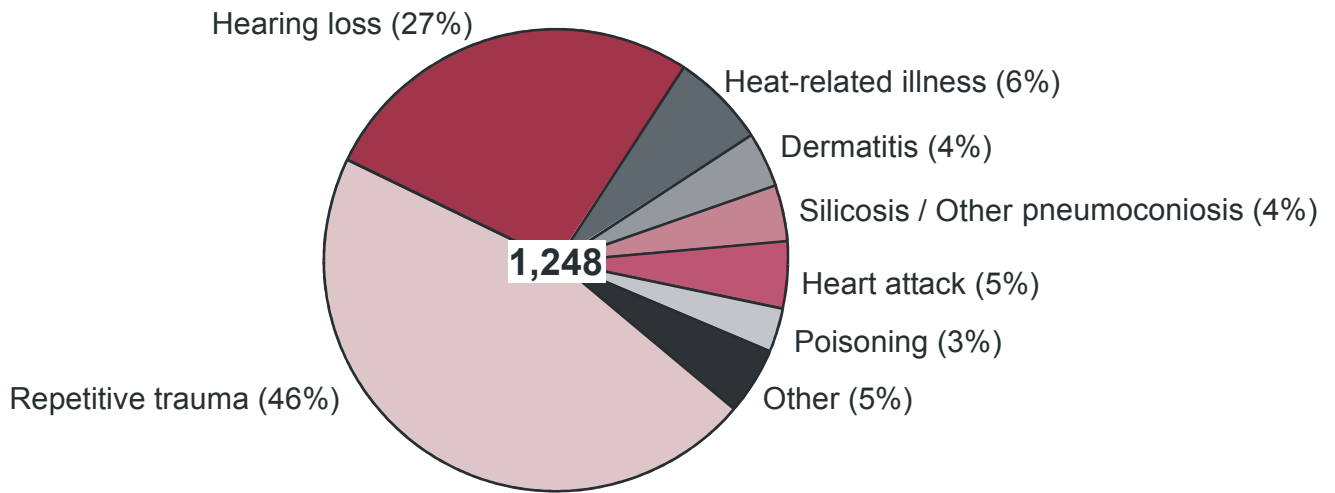


Figure 5-4.—Metal operators: percent of illness conditions reported by nature of condition, 1986-1995. (Source: MSHA data)

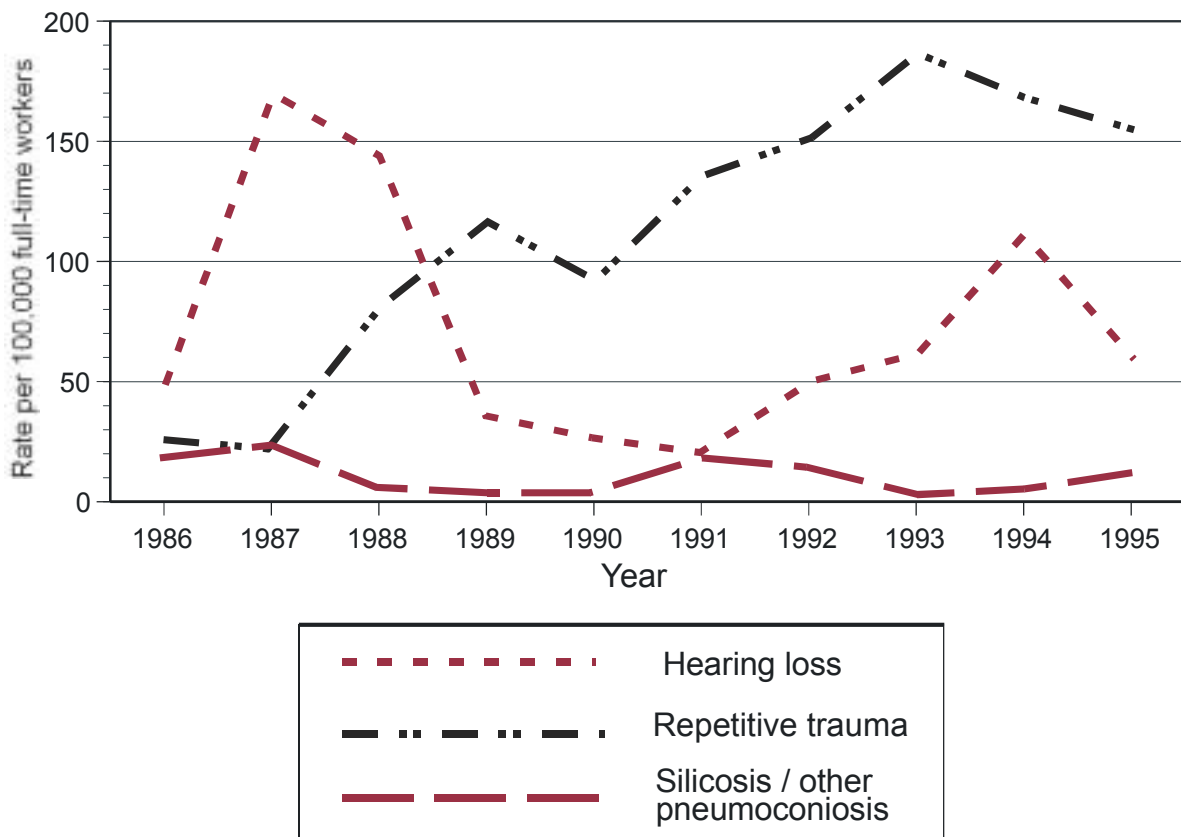


Figure 5-5.—Metal operators: rates of illness conditions reported (per 100,000 workers) for selected conditions by year, 1986-1995. (Source: MSHA data)

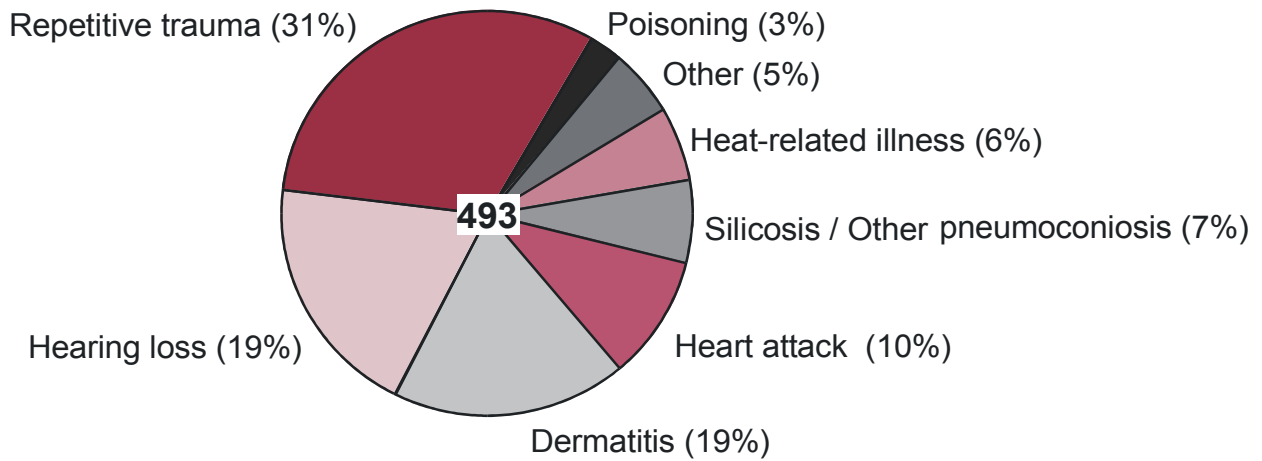


Figure 5-6.—Nonmetal operators: percent of illness conditions reported by nature of condition, 1986-1995. (Source: MSHA data)

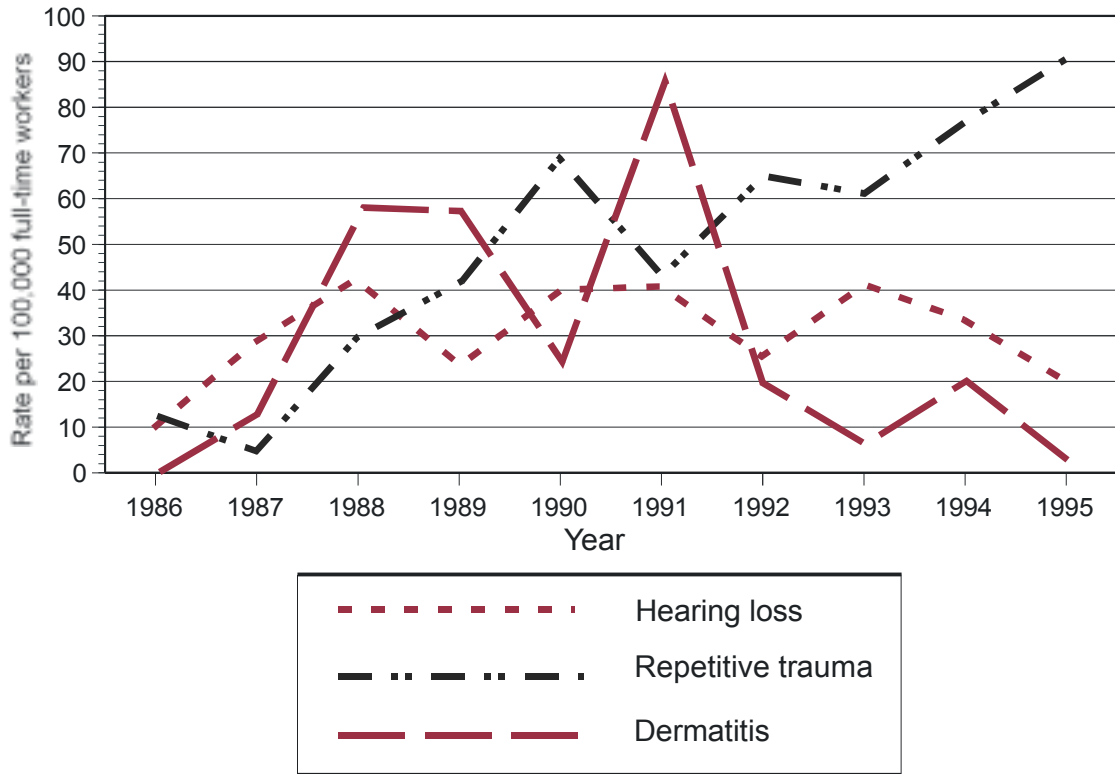


Figure 5-7.—Nonmetal operators: rates of illness conditions reported (per 100,000 workers) for selected conditions by year, 1986-1995. (Source: MSHA data)



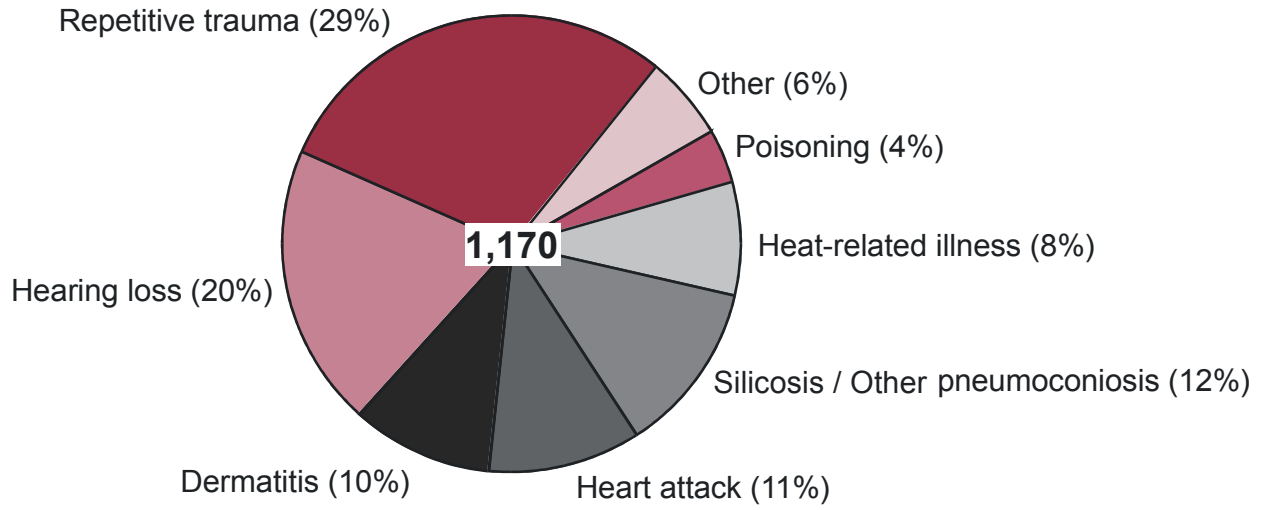


Figure 5-8.—Stone operators: percent of illness conditions reported by nature of condition, 1986-1995. (Source: MSHA data)

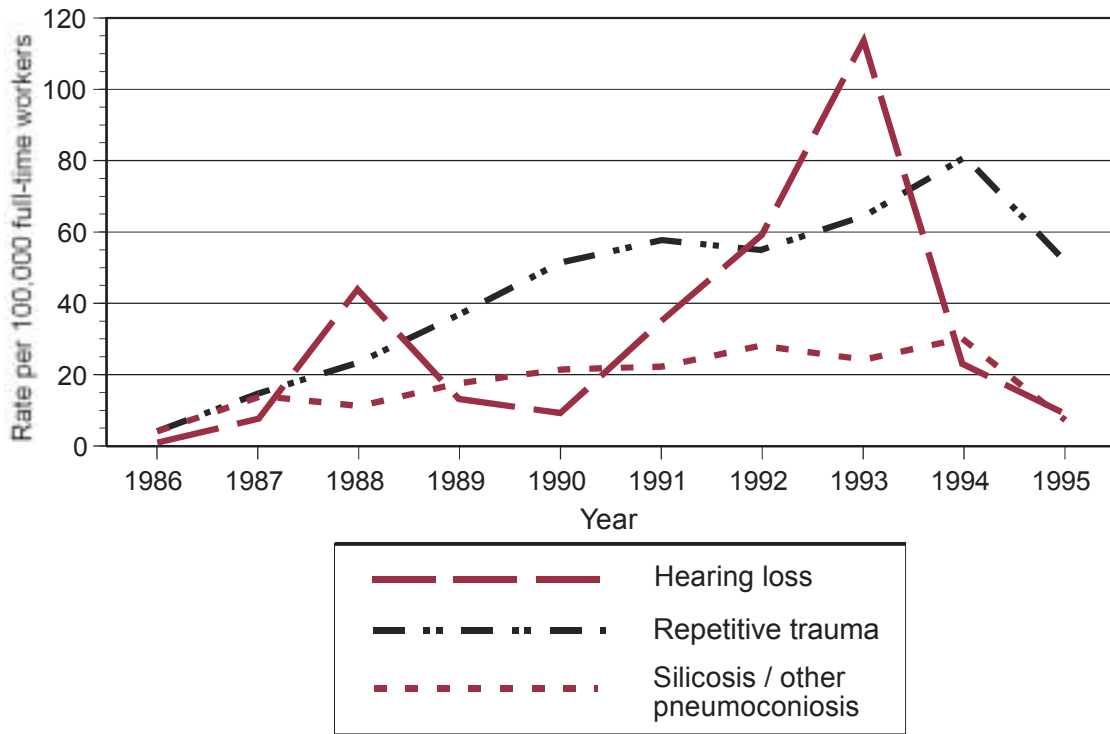


Figure 5-9.—Stone operators: rates of illness conditions reported (per 100,000 workers) for selected conditions by year, 1986-1995. (Source: MSHA data)

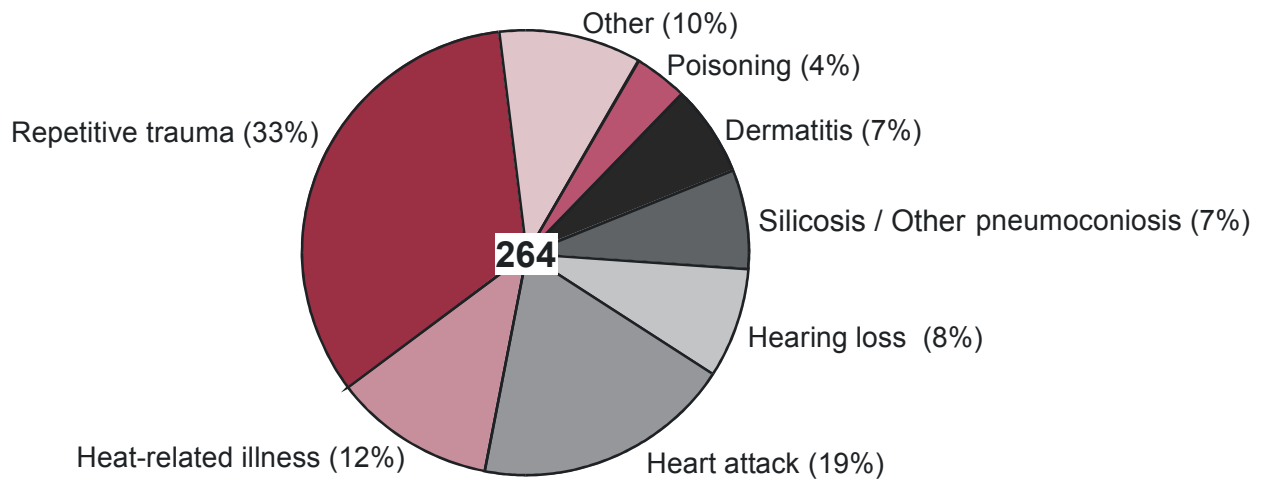


Figure 5-10.—Sand and gravel operators: percent of illness conditions reported by nature of condition, 1986-1995. (Source: MSHA data)

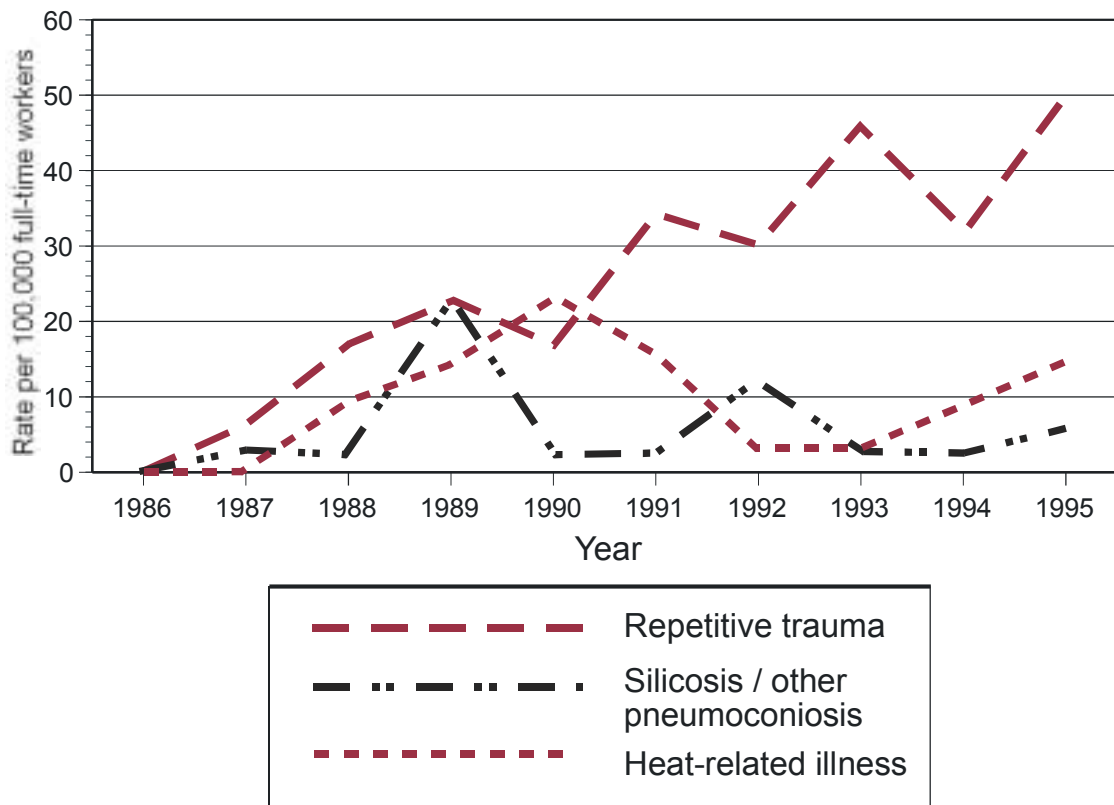


Figure 5-11.—Sand and gravel operators: rates of illness conditions reported (per 100,000 workers) for selected conditions by year, 1986-1995. (Source: MSHA data)

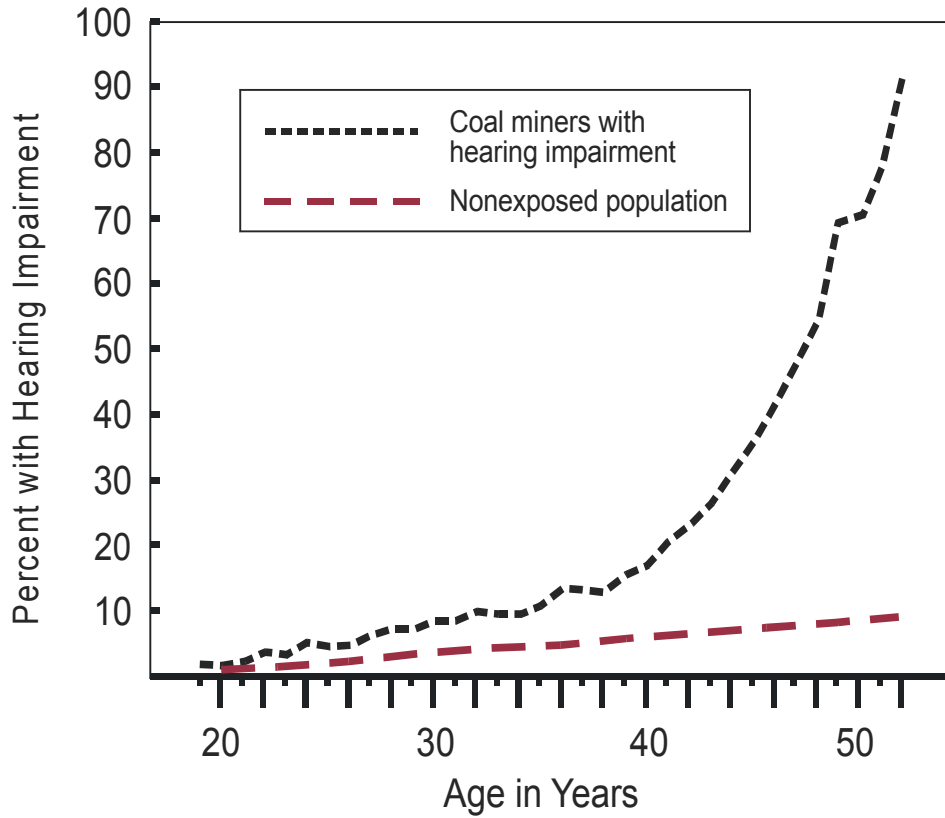


Figure 5-12.—Percent of coal miners with NIOSH-defined hearing impairment by age compared to the percent of the nonoccupationally noise-exposed population having hearing impairment as calculated from ISO-1999. (Source: Franks [1996])

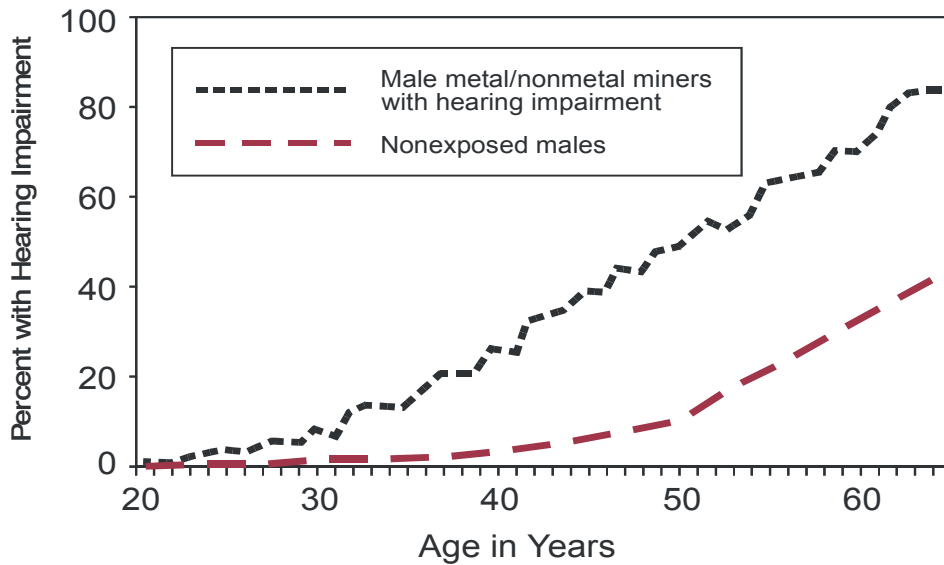


Figure 5-13.—Percent of male metal/nonmetal miners with NIOSH-defined hearing impairment by age compared to the percent of the nonoccupationally noise-exposed male population having hearing impairment as calculated from ISO-1999. (Source: Franks [1997])

## CHAPTER 6. OCCUPATIONAL EXPOSURES

This chapter presents data on occupational exposures from several sources. Data from compliance samples obtained by MSHA inspectors are presented in table 6-1 for coal mine dust and silica dust, and in tables 6-2 through 6-6 for metal fumes. Since these samples were taken for compliance monitoring rather than as part of a survey of the industry, it is difficult to predict how well they indicate actual exposures for all mining operations.

In the coal industry, 7.8% of all respirable dust samples during 1986-1995 were above the permissible exposure limit (PEL). Of silica dust samples obtained during the 10-year period, 23.7% were above the PEL in coal, 16% in metal, 10.8% in nonmetal, 9.1% in stone, and 7.6% in sand and gravel. Of metal fume samples, silver samples showed the largest percentage above the PEL—approximately 48% of samples in both metal and nonmetal.

Tables 6-7 and 6-8 present data on noise exposures from the MSHA “dual threshold” survey, which was published in the *Federal Register* [61 Fed. Reg. 66347 (1996)] as part of a proposed rule change for occupational noise exposure in mining. This study examined a group of samples obtained

during 1991-1995 and compared the percent of samples that were above two separate specified limits. The first limit was the current noise standard, a time-weighted average of 90 dBA, calculated to include only exposures at 90 dBA and above. The second limit was a time-weighted average of 85 dBA, calculated to include exposures at 80 dBA and above.

Tables 6-8 and 6-9 refer to musculoskeletal overload conditions examined in the National Occupational Health Survey of Mining (NOHSM) [NIOSH 1996]. Table 6-8 shows the operational definitions for each condition; table 6-9 shows the percentage of the workforce potentially exposed, by commodity. Across all commodities, a large proportion of workers were exposed to musculoskeletal overloads due to positioning of the neck and back; positioning and motion of the forearms, arms, and shoulders; heavy lifting; and positioning and movement of the lower limbs.

The recorded overloads were defined in the survey and did not exceed any NIOSH, MSHA, or OSHA guidelines for musculoskeletal overloads. Further information on this survey appears in appendix A.

**Table 6-1.—Dust samples, 1986-1995. Number of samples, number and percent under permissible exposure limit (PEL), number and percent 1-2 times PEL, and number and percent 2 or more times PEL.**

| Sample type                 | Total samples | Samples under PEL |      | Samples > PEL and <2 × PEL |      | Samples >2 × PEL |     |
|-----------------------------|---------------|-------------------|------|----------------------------|------|------------------|-----|
|                             |               | No.               | %    | No.                        | %    | No.              | %   |
| Coal respirable dust        | 194,682       | 179,584           | 92.2 | 11,751                     | 6.0  | 3,347            | 1.7 |
| Coal silica dust            | 49,044        | 37,434            | 76.3 | 7,213                      | 14.7 | 4,397            | 9.0 |
| Metal silica dust           | 9,044         | 7,593             | 84.0 | 873                        | 9.7  | 578              | 6.4 |
| Nonmetal silica dust        | 10,347        | 9,230             | 89.2 | 668                        | 6.4  | 449              | 4.3 |
| Stone silica dust           | 45,608        | 41,453            | 90.9 | 2,435                      | 5.3  | 1,720            | 3.7 |
| Sand and gravel silica dust | 34,924        | 32,275            | 92.4 | 1,487                      | 4.3  | 1,162            | 3.3 |

Source: Mine Safety and Health Administration data.

**Table 6-2.—Metal industry: metal fume samples, 1986-1995. Number of samples, number and percent under permissible exposure limit (PEL), number and percent 1-2 times PEL, and number and percent 2 or more times PEL.**

| Fume type             | Total samples | Samples < PEL |         | Samples > PEL and < 2 × PEL |      | Samples > 2 × PEL |         |
|-----------------------|---------------|---------------|---------|-----------------------------|------|-------------------|---------|
|                       |               | Number        | Percent |                             |      | Number            | Percent |
| Aluminum oxide        | 778           | 776           | 99.7    | 0                           | 0.0  | 2                 | 0.3     |
| Arsenic               | 379           | 379           | 100.0   | 0                           | 0.0  | 0                 | 0.0     |
| Beryllium             | 465           | 464           | 99.8    | 1                           | 0.2  | 0                 | 0.0     |
| Cadmium oxide         | 495           | 494           | 99.8    | 0                           | 0.0  | 1                 | 0.2     |
| Chromic acid/chromate | 444           | 419           | 94.4    | 15                          | 3.4  | 10                | 2.3     |
| Cobalt                | 483           | 481           | 99.6    | 0                           | 0.0  | 2                 | 0.4     |
| Copper                | 858           | 812           | 94.6    | 16                          | 1.9  | 30                | 3.5     |
| Fluoride              | 4             | 4             | 100.0   | 0                           | 0.0  | 0                 | 0.0     |
| Iron oxide            | 1,038         | 1,008         | 97.1    | 13                          | 1.3  | 17                | 1.6     |
| Lead                  | 797           | 757           | 95.0    | 22                          | 2.8  | 18                | 2.3     |
| Magnesium oxide       | 743           | 743           | 100.0   | 0                           | 0.0  | 0                 | 0.0     |
| Manganese             | 793           | 793           | 100.0   | 0                           | 0.0  | 0                 | 0.0     |
| Mercury               | 156           | 137           | 87.8    | 10                          | 6.4  | 9                 | 5.7     |
| Molybdenum            | 453           | 452           | 99.8    | 1                           | 0.2  | 0                 | 0.0     |
| Nickel                | 559           | 559           | 100.0   | 0                           | 0.0  | 0                 | 0.0     |
| Silver                | 248           | 129           | 52.0    | 25                          | 10.1 | 94                | 37.9    |
| Titanium dioxide      | 602           | 601           | 99.8    | 1                           | 0.2  | 0                 | 0.0     |
| Vanadium              | 512           | 511           | 99.8    | 1                           | 0.2  | 0                 | 0.0     |
| Zinc oxide            | 698           | 697           | 99.9    | 1                           | 0.1  | 0                 | 0.0     |

Source: Mine Safety and Health Administration data.

**Table 6-3.—Nonmetal industry: metal fume samples, 1986-1995. Number of samples, number and percent under permissible exposure limit (PEL), number and percent 1-2 times PEL, and number and percent 2 or more times PEL.**

| Fume type             | Total | Samples < PEL |         | Samples > PEL<br>and < 2 × PEL |         | Samples > 2 × PEL |         |
|-----------------------|-------|---------------|---------|--------------------------------|---------|-------------------|---------|
|                       |       | Number        | Percent | Number                         | Percent | Number            | Percent |
| Aluminum oxide        | 2,460 | 2,454         | 99.8    | 2                              | 0.1     | 4                 | 0.2     |
| Arsenic               | 1,309 | 1,309         | 100.0   | 0                              | 0.0     | 0                 | 0.0     |
| Beryllium             | 1,550 | 1,547         | 99.8    | 3                              | 0.2     | 0                 | 0.0     |
| Cadmium oxide         | 1,513 | 1,512         | 99.9    | 1                              | 0.1     | 0                 | 0.0     |
| Chromic acid/chromate | 1,467 | 1,297         | 88.4    | 65                             | 4.4     | 105               | 7.2     |
| Cobalt                | 1,609 | 1,607         | 99.9    | 2                              | 0.1     | 0                 | 0.0     |
| Copper                | 2,453 | 2,378         | 96.9    | 29                             | 1.2     | 46                | 1.9     |
| Iron oxide            | 3,220 | 3,148         | 97.8    | 39                             | 1.2     | 33                | 1.0     |
| Lead                  | 1,941 | 1,898         | 97.8    | 25                             | 1.3     | 18                | 0.9     |
| Magnesium oxide       | 2,555 | 2,555         | 100.0   | 0                              | 0.0     | 0                 | 0.0     |
| Manganese             | 2,824 | 2,761         | 97.8    | 40                             | 1.4     | 23                | 0.8     |
| Mercury               | 113   | 94            | 83.2    | 10                             | 8.8     | 9                 | 8.0     |
| Molybdenum            | 1,532 | 1,531         | 99.9    | 1                              | 0.1     | 0                 | 0.0     |
| Nickel                | 1,974 | 1,967         | 99.6    | 4                              | 0.2     | 3                 | 0.2     |
| Silver                | 249   | 130           | 52.2    | 25                             | 10.0    | 94                | 37.8    |
| Tin oxide             | 3     | 3             | 100.0   | 0                              | 0.0     | 0                 | 0.0     |
| Titanium dioxide      | 2,182 | 2,181         | 100.0   | 1                              | 0.0     | 0                 | 0.0     |
| Vanadium              | 1,593 | 1,590         | 99.8    | 3                              | 0.2     | 0                 | 0.0     |
| Zinc oxide            | 2,099 | 2,097         | 99.9    | 2                              | 0.1     | 0                 | 0.0     |

Source: Mine Safety and Health Administration data.

**Table 6-4.—Stone industry: metal fume samples, 1986-1995. Number of samples, number and percent under permissible exposure limit (PEL), number and percent 1-2 times PEL, and number and percent 2 or more times PEL.**

| Fume type             | Total samples | Samples < PEL |         | Samples > PEL and < 2 × PEL |         | Samples > 2 × PEL |         |
|-----------------------|---------------|---------------|---------|-----------------------------|---------|-------------------|---------|
|                       |               | Number        | Percent | Number                      | Percent | Number            | Percent |
| Aluminum oxide        | 1,164         | 1,162         | 99.8    | 1                           | 0.1     | 1                 | 0.1     |
| Arsenic               | 538           | 538           | 100.0   | 0                           | 0.0     | 0                 | 0.0     |
| Beryllium             | 666           | 666           | 100.0   | 0                           | 0.0     | 0                 | 0.0     |
| Cadmium oxide         | 619           | 619           | 100.0   | 0                           | 0.0     | 0                 | 0.0     |
| Chromic acid/chromate | 795           | 667           | 83.9    | 44                          | 5.5     | 84                | 10.6    |
| Cobalt                | 704           | 704           | 100.0   | 0                           | 0.0     | 0                 | 0.0     |
| Copper                | 1,065         | 1,044         | 98.0    | 9                           | 0.8     | 12                | 1.1     |
| Iron oxide            | 1,512         | 1,478         | 97.8    | 20                          | 1.3     | 14                | 0.9     |
| Lead                  | 708           | 705           | 99.6    | 3                           | 0.4     | 0                 | 0.0     |
| Magnesium oxide       | 1,254         | 1,254         | 100.0   | 0                           | 0.0     | 0                 | 0.0     |
| Manganese             | 1,424         | 1,367         | 96.0    | 37                          | 2.6     | 20                | 1.4     |
| Mercury               | 6             | 6             | 100.0   | 0                           | 0.0     | 0                 | 0.0     |
| Molybdenum            | 664           | 663           | 99.8    | 1                           | 0.2     | 0                 | 0.0     |
| Nickel                | 967           | 961           | 99.4    | 3                           | 0.3     | 3                 | 0.3     |
| Silver                | 1             | 1             | 100.0   | 0                           | 0.0     | 0                 | 0.0     |
| Tin oxide             | 3             | 3             | 100.0   | 0                           | 0.0     | 0                 | 0.0     |
| Titanium dioxide      | 1,085         | 1,084         | 99.9    | 1                           | 0.1     | 0                 | 0.0     |
| Vanadium              | 688           | 686           | 99.7    | 2                           | 0.3     | 0                 | 0.0     |
| Zinc oxide            | 950           | 948           | 99.8    | 2                           | 0.2     | 0                 | 0.0     |

Source: Mine Safety and Health Administration data.

**Table 6-5.—Sand and gravel industry: metal fume samples, 1986-1995. Number of samples, number and percent under permissible exposure limit (PEL), number and percent 1-2 times PEL, and number and percent 2 or more times PEL.**

| Fume type             | Total samples | Samples < PEL |         | Samples > PEL and < 2 × PEL |     | Samples > 2 × PEL |         |
|-----------------------|---------------|---------------|---------|-----------------------------|-----|-------------------|---------|
|                       |               | Number        | Percent |                             |     | Number            | Percent |
| Aluminum              | 346           | 346           | 100.0   | 0                           | 0.0 | 0                 | 0.0     |
| Arsenic               | 240           | 240           | 100.0   | 0                           | 0.0 | 0                 | 0.0     |
| Beryllium             | 254           | 252           | 99.2    | 2                           | 0.8 | 0                 | 0.0     |
| Cadmium oxide         | 250           | 250           | 100.0   | 0                           | 0.0 | 0                 | 0.0     |
| Chromic acid/chromate | 144           | 136           | 94.4    | 3                           | 2.1 | 5                 | 3.5     |
| Cobalt                | 264           | 264           | 100.0   | 0                           | 0.0 | 0                 | 0.0     |
| Copper                | 325           | 322           | 99.1    | 2                           | 0.6 | 1                 | 0.3     |
| Iron oxide            | 432           | 427           | 98.8    | 3                           | 0.7 | 2                 | 0.5     |
| Lead                  | 271           | 271           | 100.0   | 0                           | 0.0 | 0                 | 0.0     |
| Magnesium oxide       | 338           | 338           | 100.0   | 0                           | 0.0 | 0                 | 0.0     |
| Manganese             | 387           | 386           | 99.7    | 1                           | 0.3 | 0                 | 0.0     |
| Mercury               | 2             | 2             | 100.0   | 0                           | 0.0 | 0                 | 0.0     |
| Molybdenum            | 247           | 247           | 100.0   | 0                           | 0.0 | 0                 | 0.0     |
| Nickel                | 280           | 280           | 100.0   | 0                           | 0.0 | 0                 | 0.0     |
| Titanium dioxide      | 321           | 321           | 100.0   | 0                           | 0.0 | 0                 | 0.0     |
| Vanadium              | 250           | 250           | 100.0   | 0                           | 0.0 | 0                 | 0.0     |
| Zinc oxide            | 303           | 303           | 100.0   | 0                           | 0.0 | 0                 | 0.0     |

Source: Mine Safety and Health Administration data.



**Table 6-6.—Coal industry: MSHA “dual-threshold” study, 1991-1995. Number of samples by occupation, percent of samples over 90 dBA based on 90-dBA threshold for time-weighted average, and percent of samples over 85 dBA based on 80-dBA threshold for time-weighted average.**

| Occupation                    | Number of samples | % of samples over 90 dBA with time-weighted average based on 90-dBA threshold | % of samples over 85 dBA with time-weighted average based on 80-dBA threshold |
|-------------------------------|-------------------|---|---|
| Continuous miner helper       | 68                | 33.8  | 88.2  |
| Continuous miner operator     | 262               | 49.6  | 96.2  |
| Roof bolter operator (single) | 234               | 21.8  | 85.5  |
| Roof bolter operator (twin)   | 92                | 31.5  | 98.9  |
| Shuttle car operator          | 260               | 13.5  | 78.5  |
| Scoop car operator            | 94                | 18.1  | 74.5  |
| Cutting machine operator      | 22                | 36.4  | 63.6  |
| Headgate operator             | 20                | 40.0  | 100.0   |
| Longwall operator             | 34                | 70.6  | 100.0   |
| Jack setter (longwall)        | 25                | 32.0  | 68.0  |
| Cleaning plant operator       | 107               | 36.4  | 77.6  |
| Bulldozer operator            | 225               | 48.9  | 94.2  |
| Front-end loader operator     | 244               | 16.0  | 76.6  |
| Highwall drill operator       | 83                | 21.7  | 77.1  |
| Refuse/backfill truck driver  | 162               | 13.6  | 78.4  |
| Coal truck driver             | 28                | 17.9  | 64.3  |

**Table 6-7.—Metal/nonmetal industry: MSHA “dual-threshold” study, 1991-1994. Number of samples by occupation, percent of samples over 90 dBA based on 90-dBA threshold for time-weighted average, and percent of samples over 85 dBA based on 80-dBA threshold for time-weighted average.**

| Occupation                                 | Number of samples | % of samples over 90 dBA with time-weighted average based on 90-dBA threshold | % of samples over 85 dBA with time-weighted average based on 80-dBA threshold |
|--|-------------------|---|---|
| Front-end loader operator                  | 12,812            | 12.9  | 67.7  |
| Truck driver                               | 6,216             | 13.1  | 73.7  |
| Crusher operator                           | 5,357             | 19.9  | 65.1  |
| Bulldozer operator                         | 1,440             | 50.7  | 86.5  |
| Bagger                                     | 1,308             | 10.2  | 65.0  |
| Sizing/washing plant operator              | 1,246             | 13.2  | 59.7  |
| Dredge/barge attendant                     | 1,124             | 27.2  | 78.7  |
| Clean-up person                            | 927               | 19.3  | 71.3  |
| Dry screen operator                        | 871               | 11.7  | 57.6  |
| Utility worker                             | 846               | 12.4  | 60.6  |
| Mechanic                                   | 761               | 3.8   | 43.9  |
| Supervisors/administrators                 | 730               | 9.0   | 32.2  |
| Laborer                                    | 642               | 17.1  | 65.7  |
| Dragline operator                          | 583               | 34.0  | 82.5  |
| Backhoe operator                           | 546               | 8.4   | 52.6  |
| Dryer/kiln operator                        | 517               | 10.5  | 55.5  |
| Rotary drill operator (electric/hydraulic) | 543               | 39.6  | 83.1  |
| Rotary drill operator (pneumatic)          | 489               | 64.4  | 89.0  |

**Table 6-8.—Operational definitions for musculoskeletal overload conditions in the National Occupational Health Survey of Mining (NOHSM).**

|                               |   |
|-------------------------------|---|
| Awkward lifting               | Lifting above head level, or lifting while twisting, or lifting while reaching excessively.   |
| Heavy lifting                 | Lifting greater than 50 lb unaided.   |
| Frequent lifting              | Lifting an object heavier than 25 lb, 5 or more times per minute.   |
| Fingers and hands             | Forceful finger actions (except grasping with the whole hand), grasping with wet or poorly fitting gloves, tool handles that end in the central part of the palm.     |
| Wrist movement                | Forceful movements or finger manipulations with wrist bent, using repeated wrist motions, or clothes-wringing motion.   |
| Forearms, arms, and shoulders | Elbows unsupported and/or abducted, or forearms resting on sharp edges, or working with hands above the shoulders, or tossing motions at extremes of range of motion. |
| Neck and/or back              | Bent forward, or bent to the side, or hyperextended, or twisted neck and back.  |
| Lower limb movement           | Kneeling, or squatting (bearing the body weight on the knee, flexed to an acute angle), or crawling on hands and knees.   |
| Sitting                       | Sitting in a cramped position, or with feet dangling, or without low back support, or in a seat tilted forward or to one side.  |
| Standing                      | Standing without movement for 4 or more min or operating foot pedals while standing, or standing in a restricted space for 2 hr or more without sitting or leaning.   |
| Prone or supine               | Lying flat on back, or lying on abdomen, or lying on one side supported by one hip and one shoulder or elbow.   |

**Table 6-9.—Percent of workers potentially exposed to musculoskeletal overload conditions by condition and commodity, National Occupational Health Survey of Mining (NOHSM), 1984-1989.**

| Musculoskeletal overload condition | Percentage of workforce potentially exposed |       |          |       |                 |
|------------------------------------|---|-------|----------|-------|-----------------|
|                                    | Coal  | Metal | Nonmetal | Stone | Sand and Gravel |
| Awkward lifting                    | 22  | 29    | 16       | 17    | 19              |
| Heavy lifting                      | 41  | 37    | 24       | 30    | 21              |
| Frequent lifting                   | 9   | 3     | 8        | 8     | 5               |
| Fingers and hands                  | 24  | 35    | 24       | 14    | 12              |
| Wrist movement                     | 21  | 29    | 16       | 12    | 11              |
| Forearms, arms, and shoulders      | 44  | 39    | 30       | 25    | 23              |
| Neck and/or back                   | 42  | 50    | 35       | 34    | 30              |
| Lower limb movement                | 31  | 26    | 15       | 16    | 13              |
| Sitting                            | 19  | 10    | 8        | 9     | 11              |
| Standing                           | <1  | 2     | 3        | 1     | 4               |
| Prone or supine                    | 10  | 5     | 5        | 4     | 3               |

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## APPENDIX A. SOURCES OF DATA

### National Occupational Mortality Surveillance (NOMS) System

The National Occupational Mortality Surveillance (NOMS) System was developed by NIOSH in collaboration with the National Center for Health Statistics and the National Cancer Institute. NOMS is based on mortality data from the National Vital Statistics system, with the addition of occupation and industry information coded by selected State health departments. The NOMS data include all conditions listed on the death certificate, both underlying and contributing, for each decedent. Additional data include age, race, sex, State, and county of residence at the time of death.

The number of States included in NOMS varies by year. A total of 28 States have contributed data since 1979. The States included in the analyses presented in this report and the years for which those States provided data are: Alaska (1987-88), Colorado (1985-1993), Georgia (1985-1993), Hawaii (1993), Idaho (1988-1993), Indiana (1986-1993), Kansas (1985-1993), Kentucky (1985-1993), Maine (1985-1993), Missouri (1985-1986), Nebraska (1985), Nevada (1985-1993), New Hampshire (1985-1993), New Jersey (1988-1993), New Mexico (1986-1993), New York (1985-1987; New York City excluded in 1985) North Carolina (1987-1993), Ohio (1985-1993), Oklahoma (1985-1993), Pennsylvania (1985-1991), Rhode Island (1985-1993), South Carolina (1985-1993), Tennessee (1985-1988), Utah (1985-1993), Vermont (1986-1993), Washington (1990-1992), West Virginia (1988-1993), and Wisconsin (1985-1993).

### Census of Fatal Occupational Injuries (CFOI)

The Census of Fatal Occupational Injuries (CFOI) was developed by the U.S. Bureau of Labor Statistics (BLS) to compile comprehensive and timely information on fatal work injuries occurring in the 50 States and the District of Columbia. Because no single source of information is capable of identifying all fatalities that occur at work, the CFOI system cross-references nearly 25 different sources of information to compile a complete roster. These sources include (but are not limited to) death certificates, workers' compensation files, motor vehicle reports, the news media, and data collected by State and Federal agencies such as the Occupational Safety and Health Administration, the Mine Safety and Health Administration, and the Employment Standards Administration. To ensure an accurate count of fatal occupational injuries, the program requires that for each case, the injury's work-relatedness be substantiated by at least two independent sources, or a source document and a followup questionnaire.

Data collection is a cooperative process between BLS and the States. The States are responsible for data collection and coding, while BLS concatenates the national database and provides for additional verification of fatality reports that have only one source of information. A work-related case in CFOI is required to meet the following criteria: "The decedent must have been employed (working for pay, compensation, or profit or in the family business) at the time of the event and engaged in a legal work activity or present at the site of the incident as a job requirement" [U.S. Bureau of Labor Statistics 1995]. Fatalities that resulted from motor vehicle crashes while driving as part of work and from violent acts at work such as homicide and suicide are included in the data.

### Current Population Survey (CPS)

The Current Population Survey (CPS) is a monthly survey of approximately 60,000 households. The CPS is a probability sample, and the survey is conducted by the U.S. Bureau of the Census for the U.S. Bureau of Labor Statistics. The survey collects information about each employed member of a household, including age and sex, class of worker, and industry and occupation. Data on number of hours worked the week prior to the survey are also collected.

The criteria for reporting number of hours worked changed in 1994. For this reason, rate calculations in this report that use the CPS denominator are based on the number of employees in a particular subgroup, rather than on the number of hours worked.

### Mine and Employment Data: MSHA

These data include all work hours reportable to MSHA. Mine operators must report quarterly all hours worked at any operation where any individual worked during any day in that calendar quarter. Independent contractors must report quarterly hours related to the following activities:

- Mine development, including shaft and slope sinking
- Construction/reconstruction of mine facilities including building/rebuilding preparation plants and mining equipment, and building additions to existing facilities
- Demolition of mine facilities
- Construction of dams
- Excavation or earth-moving activities involving mobile equipment
- Installation of equipment, such as crushers and mills
- Equipment service or repair on mine property for a period exceeding 5 consecutive days at a particular mine

### **Accident, Injury, and Illness Data: MSHA**

The MSHA accident, injury, and illness database includes all occupational injuries and illnesses reportable to MSHA. For mine operators, reportable occupational injuries include any onsite injury to an employee for which medical treatment is administered or that results in death or loss of consciousness, inability to perform all job duties on any day after the injury, restriction of work or motion, lost workdays, temporary assignment to other duties on any day after the injury, transfer to another job, or termination. First-aid injuries are not reportable provided that there are no lost workdays, restricted work activity, or transfer because of the injury. Reportable occupational illnesses include any illness or disease of an employee that *may* have resulted from work or exposure at a mine or for which an award of compensation is made. Independent contractors working on mine property must report injuries and illnesses in the activities for which they are required to report work hours (listed above).

### **1986 Mining Industry Population Survey (MIPS): U.S. Bureau of Mines**

This survey obtained information on job title or occupation, principal equipment operated, work location at the mine, experience at present job, experience at present company, total mining experience, job-related training during the preceding 2 years, age, sex, race, and education.

The MIPS covered all workers employed in anthracite coal (SIC 111), bituminous coal (SIC 121), metal (SIC 101-106, 109, 281), stone (SIC 141, 142, 324, 327), sand and gravel (SIC 144), and nonmetal (SIC 131, 145, 147, 149, 289, 299) mining during March through September 1986. The survey design used a two-stage stratified random sampling. The primary sampling units (first stage) were the mine establishments; the secondary sampling units were the employees within each sampling unit. The characteristics used to stratify the primary units were the industry (anthracite coal, bituminous coal, metal, stone, nonmetal), mine type (underground, surface, plant or mill), employment size class (1-19, 20-49, 50-99, 100-249, 500-999, 1,000 and above), and status code (active, intermittent). The sampling frame used was the 1985 preliminary address and employment file maintained by MSHA.

### **Respirable Coal Mine Dust Data: MSHA**

These data were obtained from MSHA and represent respirable coal mine dust levels measured by MSHA inspectors at surface and underground mines beginning in

1970. The data include the sample collection date, dust concentration, occupation associated with the sample, an MSHA designator as to the validity of the sample, and the mine at which the sample was obtained.

The MSHA respirable coal mine dust samples are obtained by drawing mine air through a filter at the rate of 2 L/min, with a cyclone used to extract nonrespirable particles prior to the filter. The dust weight collected on the filter is multiplied by 1.38 to complete the conversion to Mines Research Establishment (MRE) units. The "MRE" designation indicates that measurements obtained by MSHA were converted so that they would be equivalent to those obtained with an instrument on which the U.K. standards have been based (Isleworth type 113A gravimetric dust sampler).

### **Respirable Coal Mine Quartz Dust Data: MSHA**

These data were obtained from MSHA and represent respirable quartz levels derived from respirable coal mine dust samples collected by MSHA inspectors at surface and underground coal mines beginning in 1982. The data include the sampling date, sampling time, initial and final weights, percent quartz, production level during sampling, the occupation associated with the sample, and the mine at which the sample was obtained.

### **National Occupational Health Survey of Mining (NOHSM): NIOSH**

The National Occupational Health Survey of Mining was designed by NIOSH to characterize health-related agents found at U.S. mines. A sample of mines representing 66 different mineral commodities was surveyed during 1984-1989. A total of 491 mines employing 59,734 miners were surveyed during that period, including 431 metal/nonmetal mines and 60 coal mines. The mines surveyed were selected from a total of 2,131 mines that employed 297,322 miners. Although NIOSH surveyed only a representative sample of mines in each mineral commodity, the data were projected over all of the mines in each of those mineral commodities. Each mine's survey included three phases: questionnaire, chemical inventory, and worksite visit. During the worksite visit, surveyors (1) made observations of the numbers of potential exposures (by sex and occupation of workers) to chemical and physical agents; musculoskeletal overload conditions; welding, brazing, and soldering processes; and abrasive grinding processes; (2) obtained samples of bulk dust from selected worksites within each mine; and (3) made observations of the controls associated with the potential exposures.

## APPENDIX B. METHODS

### Injury and Illness Rates: CFOI Data

Numerator data for these rates came from CFOI data files; denominator data came from the Current Population Survey (CPS). To compute the fatality rates for each year, the total number of deaths that occurred during the year in each industry sector was divided by the number of employees in that sector. For presentation purposes, fatal injury rates were then multiplied by 100,000 to obtain the rate per 100,000 workers.

### Injury and Illness Rates: MSHA Data

Numerator data for the rates came from MSHA accident and injury file. Denominator data came from the MSHA employment files, and for the variable occupation only, from the Mining Industry Population Survey. To compute the average annual rates during 1986-1995, the total number of deaths during the 10-year period was divided by the total number of hours worked during 1986-95 to obtain the injury rate per hour worked for 1986-1995. Average annual rates for subunits were calculated as the total number of deaths in a specified subunit during 1986-1995, divided by the number of hours worked in the subunit during 1986-1995, to obtain the injury rate per hour worked for each subunit. Yearly rates were computed as the total number of deaths in the specified year divided by the total hours worked in that year to obtain the injury rate per hour worked for that year. All injury and illness rates per hour worked were then multiplied by 2,000, the typical number of hours worked in 1 year by an employee working a 40-hr week, to obtain the rate per full-time equivalent worker. For presentation purposes, fatal injury rates and illness rates were then multiplied by 100,000 to obtain the rate per 100,000 full-time equivalent workers; nonfatal injury rates were multiplied by 100 to obtain the rate per 100 full-time equivalent workers. Occupations were grouped into BOC categories. Data on occupation were available for 1986 only. Estimates on the incidence of injury by occupational group for the entire 10-year period were made by determining the proportion of workers in each occupational group in the 1986 data and applying these proportions to the data on hours worked for all years. This type of extrapolation assumes that the proportion of workers in each occupational group was constant over the 10-year period.

### Proportionate Mortality Ratio

The proportionate mortality ratio (PMR) is defined as the observed number of deaths with the condition of interest (mentioned as underlying or contributing cause) in a specified occupation or industry divided by the expected number of deaths caused by that condition. The expected number of deaths is the total number of deaths in the occupation or industry of interest multiplied by the proportion, defined as

the number of cause-specific deaths for the condition of interest divided by the total number of deaths in the population. The PMRs in the report have been internally adjusted for age (i.e., 15-34, 35-54, 55-74, and 75 years and over) and for race. Confidence intervals were calculated assuming a Poisson distribution of the data.

### Exposure Data Selection

MSHA respirable coal mine dust samples selected for analysis were restricted to those samples that met *all three* of the following criteria:

- (1) Samples obtained in the 50 States or Washington, DC (the U.S. Virgin Islands and Puerto Rico were excluded);
- (2) Samples designated by MSHA as valid; and
- (3) Samples coded as “designated occupation,” “non-designated occupation,” or “designated work position” with valid occupation codes, or “designated area” other than “intake air.”

MSHA coal mine quartz samples selected for analysis are those samples that met all five of the following criteria:

- (1) Samples obtained in the 50 States or Washington, DC (the U.S. Virgin Islands and Puerto Rico were excluded);
- (2) Samples designated by MSHA as valid;
- (3) Samples with sampling time greater than 0;
- (4) Samples with quartz concentration greater than 0; and
- (5) Samples coded as “designated occupation,” “non-designated occupation,” or “designated work position” with valid occupation codes, or “designated area” other than “intake air.”

Since December 1972, the PEL for respirable coal mine dust has been 2 mg/m<sup>3</sup> MRE unless the quartz concentration at the particular mine has been found in excess of 5%. MSHA has no specific PEL for quartz in coal mines. MSHA’s respirable coal mine quartz data are based on its analysis of respirable coal mine dust samples. However, for the period covered by this report, inspector samples with less than 0.45-mg net-weight gain were not analyzed for quartz. When the quartz content has been found to be in excess of 5% in dust from a particular mine, the 2 mg/m<sup>3</sup> MRE PEL is reduced based on the following formula:

$$\text{PEL} = \frac{10 \text{ mg/m}^3 \text{ MRE}}{\% \text{ quartz}}$$

Using this formula, one sees that at 100% quartz the PEL would be 0.1 mg/m<sup>3</sup> MRE.



## APPENDIX C. WORK ACTIVITY CATEGORIES USED FOR INJURIES IN MSHA ACCIDENT, INJURY, AND ILLNESS DATABASE

### Vehicular and Transportation Operations

Conveyer belt (not riding)  
 Forklift  
 Haulage truck  
 Jitney  
 Load-haul-dump  
 Locomotive (air trammer)  
 Mantrip  
 Shuttle car  
 Utility truck  
 Ride equipment  
 Get on or off equipment, machines, etc.  
 Spot cars, drop cars  
 Couple/uncouple mine car/tractor/jeep, etc.  
 Barge, boat, dredge  
 Sprag/block/chock mine cars or other track  
 equipment

### Using or Operating Tools/Machinery

Drill face/rib/side/down/rise (not roof bolter)  
 Auger (surface mine)  
 Auger (underground mine)  
 Bulldozer  
 Continuous miner  
 Cutting machine  
 Front-end loader  
 Grader  
 Hoist  
 Loading machine  
 Longwall, shear, plow  
 Mucking machine  
 Power shovel/dragline/backhoe  
 Shortwall  
 Slusher  
 Remove or position hydraulic jack  
 Sand fill (backfilling stopes with sand, gob,  
 etc.)  
 Grinding  
 Impactor  
 Mill equipment  
 Blow gun to blow out drilled holes  
 Hand tools (powered)  
 Bar down face, rib, or side, etc.  
 Double jack  
 Hand tools (not powered)  
 Environmental tests/checks  
 Welding and cutting  
 Advance longwall roof support  
 Coal tipple/crusher/cleaning plant/breaker  
 Rock dust machine  
 Scraper (rig), cans, etc.

|                                   |  |
|-----------------------------------|--|
|                                   | Surface equipment, NEC<br>Underground equipment, NEC<br>Roof bolter, drilling<br>Roof bolter, inserting bolt<br>Roof bolter, NEC   |
| Constructing, Repairing, Cleaning | Hang or reposition tubing/pipe/rope/wire,<br>etc.<br>Lay or repair railroad track/roadbed,<br>switching tracks, etc.<br>Moving equipment<br>Set brattice<br>Set/remove/relocate props<br>Surface construction, NEC<br>Timbering (includes lagging and cribbing)<br>Ventilation (maintenance/installation)<br>Chute, pull or free<br>Electrical maintenance/repair<br>Machine maintenance/repair<br>Rerail equipment<br>Skip pocket (pull/free)<br>Inspect equipment<br>Brush floor<br>Clean up<br>Cement work; gunite crew, etc.<br>Investigate, enter, or work in bins, tanks, etc.<br>Wetting down working place |
| Protective Service Activities     | Accident recovery (equipment and workers)  |
| Materials Handling Operations     | Handling supplies or material, load/unload<br>Working with solvents<br>Working with chemicals<br>Working with noxious materials, NEC<br>Hand load, hand shoveling/mucking<br>Handling coal, rock, waste, or ore<br>Handling explosives<br>Handling timber<br>Move power cable  |
| Bodily Movement                   | Climb in raise/shaft/manway<br>Climb scaffolds/ladders/platforms,<br>headframes/derrick/towers<br>Climb on piled material/ore/rock/<br>timber/stone<br>Walking/running<br>Crawling/kneeling  |
| Other, NEC                        | Office and laboratory work<br>Blasting; shoot coal<br>Caging; operate elevator, manlift; etc.<br>Change house, bathing, changing clothes,<br>etc.  |

Cross-over (conveyer)  
Escaping a hazard  
Horseplay  
Idle (eat lunch, coffee break, etc.)  
Observe operations  
Supervise  
Travel to and from work location  
Other, NEC

Activity, Unspecified

Unknown

## APPENDIX D. U.S. BUREAU OF THE CENSUS OCCUPATION DIVISIONS

### U.S. Bureau of the Census Grouping of Job Titles for Coal Operators

Source: U.S. Bureau of the Census [1982]

|   |  |
|---|--|
| Executive, Administrative, and Managerial | Mine Foreman/Mine Manager/Mine Owner<br>Fire Boss/Preshift Examiner<br>Inspector<br>Superintendent<br>Union Representative<br>Safety Representative<br>Training Specialist   |
| Professional Specialty                    | Surveyor<br>Engineer—Electrical, Ventilation, Mining<br>Safety Director<br>Education Specialist  |
| Technicians and Support                   | Transit Man  |
| Administrative Support                    | Dispatcher<br>Weighman<br>Timekeeper/Clerk/Office Help   |
| Protective Service                        | Watchman/Guard   |
| Mechanics and Repairers                   | Mechanic/Repairman<br>Belt Vulcanizer<br>Oiler/Greaser<br>Master Mechanic<br>Maintenance Foreman   |
| Construction Trades                       | Electrician<br>Stoping Builder/Ventilation/Mason<br>Wireman/Communications Man/Repairman<br>Brattice Man<br>Mason<br>Carpenter<br>Master Electrician   |
| Extractive Occupations                    | Rock Duster<br>Shotfirer/Shooter/Blaster<br>Timberman/Propman/Jacksetter<br>Trainee<br>Drill Operator<br>Continuous Miner Operator/Mole<br>Cutting Machine Operator/Ripper<br>Headgate Operator<br>Jacksetter/Longwall/Advanceman<br>Longwall Shear Operator/Plow Operator |

|   |  |
|---|--|
|   | <ul style="list-style-type: none"> <li>Rockman/Hang-Up Man/Chute</li> <li>Roof Bolter/Rock Bolter</li> <li>Roof Bolter Mounted</li> <li>Section Foreman/Shift Boss</li> <li>Tailgate Operator</li> <li>Utility Man</li> <li>Clean-Up Man</li> <li>Labor Foreman/Bullgang Foreman</li> <li>Belt Cleaner</li> <li>Rock Driller</li> <li>Rock Machine Operator</li> <li>Miner, NEC/Quarry Worker</li> <li>Auger Operator</li> <li>Highwall Drill Operator</li> <li>Lampman</li> <li>Assistant Mine Foreman/Assistant Mine Manager</li> <li>Outside Foreman</li> </ul> |
| Precision Production Occupations              | <ul style="list-style-type: none"> <li>Pumper</li> <li>Shopman/Machinist</li> <li>Battery Station Operator</li> <li>Fan Attendant</li> <li>Boom Operator</li> <li>Machinist</li> <li>Preparation Plant Foreman/Mill Foreman</li> </ul>   |
| Machine Operators, Assemblers, and Inspectors | <ul style="list-style-type: none"> <li>Coal Sampler</li> <li>Welder/Cement Man</li> <li>Welder</li> <li>Cleaning Plant Operator/Media Plant Operator/Boney Preparation Plant Operator/Crusher Worker</li> <li>Driver Operator</li> <li>Fine Coal Plant Operator</li> <li>Scalper/Screen Operator</li> <li>Dust Sampler/Laboratory Technician</li> </ul>  |
| Motor Vehicle and Rail Transport              | <ul style="list-style-type: none"> <li>Brakeman/Rope Rider/Snapper</li> <li>Motorman/Swamper/Switchman</li> <li>Driver/Tractor Operator/Jeep Driver</li> <li>Brakeman/Trip Rider</li> <li>Truck Driver</li> <li>Refuse Truck Driver</li> <li>Water Truck Operator</li> <li>Yard Engineer Operator/Fireman</li> </ul>   |
| Material Moving Equipment Operators           | <ul style="list-style-type: none"> <li>Belt/Conveyor Man</li> <li>Scoop Tram-Load Haul Operator</li> <li>Haul Loader/Hand Trammer</li> <li>Loading Machine Operator/St. Joe Shovel Operator</li> <li>Shuttle Car Operator/Ram Car Operator</li> </ul>  |

|  |   |
|--|---|
|  | Stall Driver                                  |
|  | Scoop Car Operator/Unitrac Operator           |
|  | Hoistman/Engineer                             |
|  | Transportation Trainee                        |
|  | Skip Tender                                   |
|  | Loader Head Operator/Roscoe Operator          |
|  | Buggy Pusher                                  |
|  | Dump Operator                                 |
|  | Shuttle Car Operator                          |
|  | Power Shovel Operator/Pitman                  |
|  | Bulldozer Operator/Tractor/Heavy<br>Equipment |
|  | Barge Attendant/Boat/Dredge                   |
|  | Car Dropper                                   |
|  | Grader Operator/Roadgrader Operator           |
|  | Crane Operator/Dragline/Backhoe               |
|  | Highlift Operator/Front-End Loader            |
|  | Rotary Bucket Excavator Operator              |
|  | Silo Operator                                 |
|  | Stripping Shovel Operator                     |
|  | Tipple Operator/Topman/Binman                 |
| Handlers, Equipment Cleaners, Helpers, and<br>Laborers | Electrician Helper                            |
|  | Mechanic Helper                               |
|  | Supplyman                                     |

## U.S. Bureau of the Census Grouping of Job Titles for Metal/Nonmetal Operators

Source: U.S. Bureau of the Census [1982]

|   |   |
|---|---|
| Executive, Administrative, and Managerial | Mine Foreman/Mine Manager/Mine Owner<br>Fire Boss/Preshift Examiner<br>Inspector<br>Superintendent<br>Union Representative<br>Safety Representative<br>Training Specialist  |
| Professional Specialty                    | Surveyor<br>Engineer—Electrical, Ventilation, Mining<br>Safety Director<br>Education Specialist   |
| Technicians and Support                   | Transit Man   |
| Administrative Support                    | Dispatcher<br>Weighman<br>Timekeeper/Clerk/Office Help  |
| Protective Service                        | Watchman/Guard  |
| Mechanics and Repairers                   | Mechanic/Repairman<br>Oiler/Greaser<br>Master Mechanic<br>Maintenance Foreman   |
| Construction Trades                       | Electrician<br>Stoping Builder/Ventilation/Mason<br>Brattice Man<br>Wireman/Communications Man/Repairman<br>Carpenter<br>Master Electrician   |
| Extractive Occupations                    | Shotfirer/Shooter/Blaster<br>Timberman/Propman/Jacksetter<br>Trainee<br>Slusher Operator<br>Drill Operator<br>Continuous Miner Operator/Mole<br>Cutting Machine Operator/Ripper<br>Headgate Operator<br>Jacksetter/Longwall/Advanceman<br>Longwall Shear Operator/Plow Operator<br>Rockman/Hang-Up Man/Chute<br>Roof Bolter/Rock Bolter<br>Roof Bolter Mounted<br>Section Foreman/Shift Boss<br>Tailgate Operator |

|   |   |
|---|---|
|   | Utility Man   |
|   | Stope Miner   |
|   | Drift Miner   |
|   | Raise Miner   |
|   | Miner, NEC  |
|   | Contract Miner  |
|   | Rock Duster   |
|   | Clean-Up Man  |
|   | Labor Foreman/Bullgang Foreman  |
|   | Rock Driller  |
|   | Rock Machine Operator   |
|   | Surface Miner   |
|   | Claw Operator   |
|   | Drill Operator  |
|   | Miner, NEC/Quarry Worker  |
|   | Auger Operator  |
|   | Highwall Drill Operator   |
|   | Lampman   |
|   | Stone Finishing/Sizing Personnel  |
|   | Dimension Stone Cutter/Polisher   |
|   | Assistant Mine Foreman/Assistant Mine<br>Manager  |
|   | Outside Foreman   |
| Precision Production Occupations              | Pumper  |
|   | Shopman/Machinist   |
|   | Battery Station Operator  |
|   | Fan Attendant   |
|   | Boom Operator   |
|   | Machinist   |
|   | Preparation Plant Foreman/Mill Foreman  |
| Machine Operators, Assemblers, and Inspectors | Metal/Nonmetal Sampler  |
|   | Welder/Cement Man   |
|   | Welder  |
|   | Cleaning Plant Operator/Media Operator/<br>Boney Preparation Plant Operator/Crusher<br>Operator |
|   | Driver Operator   |
|   | Scalper/Screen Operator   |
|   | Stone Finishing/Sizing Personnel  |
|   | Dimension Stone Cutter/Polisher   |
|   | Dust Sampler/Laboratory Technician  |
| Motor Vehicle and Rail Transport              | Truck Driver  |
|   | Brakeman/Rope Rider/Snapper   |
|   | Motorman/Swamper/Switchman  |
|   | Refuse Truck Driver   |
|   | Water Truck Operator  |
|   | Yard Engineer Operator/Fireman  |



## Material Moving Equipment Operators

Belt/Conveyor Man  
 Bobcat Operator  
 Scoop Tram-Load Haul Operator  
 Mucking Machine Operator  
 Hand Loader/Hand Trammer  
 Loading Machine Operator/Joy Loader  
 Operator/St. Joe Shovel Operator  
 Shuttle Car Operator/Ram Car  
 Scoop Car Operator/Unitrac Operator  
 Crane Operator/Dragline Operator/Backhoe  
 Operator  
 Front-End Loader Operator  
 Dump Operator  
 Load-Haul-Dump Operator/Gizmo Operator  
 Grader Operator  
 Hoistman/Engineer  
 Transportation Trainee  
 Skip Tender  
 Loader Head Operator/Roscoe Operator  
 Power Shovel Operator/Pitman  
 Bulldozer Operator/Tractor Operator/Heavy  
 Equipment Operator  
 Barge Attendant/Boat Operator/Dredge  
 Operator  
 Car Dropper  
 Grader Operator/Roadgrader Operator  
 Highlift Operator/Front-End Loader  
 Rotary Bucket Excavator Operator  
 Forklift Operator  
 Silo Operator  
 Tipple Operator/Topman/Binman

Handlers, Equipment Cleaners, Helpers,  
and Laborers

Electrician Helper  
 Mechanic Helper  
 Supplyman  
 Laborer/Faceman/Move-Up Man/Pumpman  
 Grizzly Man/Car Dump Operator  
 Drill Helper  
 Continuous Miner Helper  
 Cutting Machine Helper  
 Loading Machine Helper  
 Roof Bolter Helper/Rock Helper  
 Laborer/Mucking Machine Operator/  
 Pipeman/Ginman  
 Trackman  
 Cager  
 Supplyman/Supply Truck Driver/  
 Warehouseman  
 Laborer/Utility Man/Pumper  
 Rodman  
 Cager/Cage Attendant/Aerial  
 Chainman  
 Auger Helper  
 Hoist Operator Helper  
 Highwall Drill Helper

## APPENDIX E. MSHA ACCIDENT CLASSIFICATIONS

Source: [MSHA 1997]

*Electrical.*—Accidents in which the electric current is most directly responsible for the resulting accident.

*Entrapment.*—Accidents involving entrapment of persons.

*Exploding Vessels Under Pressure.*—Accidents involved with bursting of air hoses, air tanks, hydraulic lines, hydraulic hoses, standpipes, etc., due to internal pressure.

*Explosives and Breaking Agents.*—Accidents involving the detonation of manufactured explosives; includes Airdox or Cardox.

*Falling, Rolling, or Sliding Rock or Material of Any Kind.*—Accidents caused directly by falling material other than materials from the roof or face. Or, if material was set in motion by machinery, by haulage, by hand tools, or while being handled or disturbed, etc., the force that set the material in motion determines the classification. For example, where a rock was pushed over a highwall by a bulldozer and the rock hit another rock that hit and injured a worker—the accident is classified as machinery; machinery (a bulldozer) most directly caused the resulting accident.

*Fall of Face, Rib, Pillar, Side, or Highwall (from in place).*—Accidents in this classification include falls of material while barring down or placing props; also, pressure bumps and bursts. Not included are accidents in which the motion of machinery or haulage equipment caused the fall either directly or by knocking out support.

*Fall of Roof, Back, or Brow (from in place).*—Underground only - Accidents that include falls while barring down or placing props; also, pressure bumps and bursts. Not included are accidents in which the motion of machinery or haulage equipment caused the fall either directly or by knocking out support.

*Fire.*—Accidents related to uncontrolled burning of material or mineral in the mine environment. Not included are fires initiated by electricity or by explosion of gas or dust.

*Handling Material.*—Accidents related to handling packaged or loose material while lifting, pulling, pushing, or shoveling.

*Hand tools.*—Accidents related to nonpowered tools.

*Nonpowered Haulage.*—Accidents related to the motion of nonpowered haulage equipment. Included are accidents

involving wheelbarrows, manually pushed mine cars, timber trucks, etc.

*Powered Haulage.*—Accidents related to the motion of powered haulage equipment. Included are accidents involving conveyors, front-end loaders, forklifts, shuttle cars, load-haul-dump units, locomotives, railroad cars, haulage trucks, pickups, automobiles, and personnel carriers.

*Hoisting.*—Accidents involving cages, skips, ore buckets, and elevators. The accident results from the action, motion, or failure of the hoisting equipment or mechanism. Included are equipment such as cranes and derricks only when used in shaft sinking; also, suspended work platforms in shafts. Not included is equipment such as chain hoists, come-alongs, and winches.

*Ignition or Explosion of Gas or Dust.*—Accidents resulting as a consequence of the ignition or explosion of gas or dust.

*Impoundment.*—Accidents caused by an unstable condition or failure of an impoundment, refuse pile, or culm bank requiring emergency preventative action or evacuation of an area.

*Inundation.*—Accidents caused by inundation of a surface or underground mine by a liquid (or semisolid) or a gas.

*Machinery.*—Accidents related to the motion of machinery. Included are all electric and air-powered tools and mining machinery such as drills, tuggers, winches, slushers, draglines, power shovels, loaders, and compressors.

*Slip or Fall of Person (from an elevation or on the same level).*—Accidents include slips or falls while getting on or off machinery and haulage equipment that is not moving, and slips or falls while servicing or repairing equipment or machinery.

*Stepping or Kneeling on Object.*—Accidents are classified in this category only where the object stepped or kneeled on contributed most directly to the accident.

*Striking or Bumping.*—This classification is restricted to those accidents in which an individual, while moving about, strikes or bumps an object, but is not handling material, using hand tools, or operating equipment.

*Other.*—Accidents not elsewhere classified.