Suppression Method

Table 14 shows the number of fires by suppression method for each time period. The most common method was water alone, followed by manual techniques with or without portable fire extinguishers and portable fire extinguishers alone. In three instances the fires destroyed or heavily damaged facilities because of failure of firefighting methods, undetected fire, or fire size.

During the first period, the largest number of fires were suppressed manually with or without portable fire extinguishers. During subsequent periods, the fires were extinguished with portable fire extinguishers alone (second period), water alone (third and fifth periods), and portable fire extinguishers or water alone (sixth period).

Equipment Involved

Table 15 shows the number of fires by equipment involved for each time period. The equipment most often involved was oxyfuel torches (at times electrical arc welding equipment was used), followed by facilities (considered equipment in this report), a heater, and a ventilation fan.

During the first and third periods, the largest number of fires involved oxyfuel torches. During the other periods, the fires involved oxyfuel torches and facilities (second period), facilities and a heater (fifth period), and an oxyfuel torch and a ventilation fan (sixth period).

Location

Table 16 shows the number of fires by location for each time period. The most common locations were flame cutting/welding areas (at shops, junction boxes, facilities, handrails, head frames, walkways, and maintenance areas), followed by facilities, garages, trailers and storage areas, and a ventilation fan housing.

During the first and third periods, the largest number of fires occurred at the flame cutting/welding areas. During the other periods, the fires occurred at flame cutting/welding areas and at facility, garage, trailer, and storage areas (second period), facilities (fifth period), and flame cutting/welding areas and fan housing (sixth period).

Burning Materials

Table 17 shows the number of fires by burning material for each time period. The materials most often involved were oxyfuel/clothing/grease and other materials (including electrical junction boxes, handrails, rubber tires, flammable liquids, and equipment mechanical components). Other burning materials involved facilities and their contents, and wood.

During the first and third periods, the largest number of fires involved oxyfuel, clothing, grease, and other materials. During the other periods, the fires involved oxyfuel and facilities and their contents (second period), wood and facilities (fifth period), and oxyfuel and wood (sixth period).

Fire Injuries

Table 18 shows the number of fire injuries per number of fires causing injuries and total fires by year, ignition source, equipment involved, and location during 1990–2001. In 1990, 1991, 1993, 1994, and 2000, there was one injury caused by one fire for each year. The cause of these fires was the flame cutting/welding spark/slag/flame ignition source.

SURFACE METAL/NONMETAL MINE FIRES

Table 19 and figure 7 show the number of fires and fire injuries for surface metal/nonmetal mines by state during 1990–2001. Table 19 also shows the injury risk rates, employees' working hours, and lost workdays. A total of 79 fires occurred in 16 states during 1990–2001 for these mines.

Forty-five of the fires caused 44 injuries and 2 fatalities (including 9 fires and 7 injuries involving contractors). The yearly average was 6.6 fires and 3.7 injuries. Sixty-five fires with 31 injuries and 2 fatalities occurred at metal mines, and 14 fires with 13 injuries occurred at nonmetal mines. The Ewhr value was 546×10^6 hr (Irr = 0.016), and the LWD value was 13,134.

Nevada and Arizona had the most fires (19 fires, 10 injuries, and 1 fatality; and 19 fires and 11 injuries, respectively). They were followed by Minnesota (11 fires, 4 injuries, and 1 fatality) and Alaska (6 fires and 4 injuries). Of these states, Alaska had the highest injury risk rate value (Irr = 0.079).

Table 20, partly illustrated in figure 8, shows the number of fires, fire injuries, fire fatalities, risk rates, employees' working hours, and lost workdays by time period. The number of fires increased during the second period, then decreased during most of the remaining periods. The number of fire injuries decreased during most of the periods (a small increase is seen during the last period), accompanied by a decline in employees' working hours during most of the periods (a small increase is seen during the third and fourth periods). The Irr values follow patterns similar to those shown by the number of fire injuries.

Tables 21–26 show the number of fires by ignition source, method of detection and suppression, equipment involved, location, and burning material by time period. Figure 9 shows the major variables related to fires for 1990–2001. Table 27 shows the number of fire injuries per number of fires causing injuries and total fires by year, ignition source, equipment involved, and location.

Ignition Source

Table 21 shows the number of fires and fire injuries by ignition source for each time period. The leading source was hydraulic fluid/fuel sprayed onto equipment hot surfaces (35 fires or 44%), followed by flame cutting/welding spark/slag/flame (13 fires or 17%) and electrical short/arcing (8 fires or 10%). Other sources were heat source-flammable liquid/vapors, flammable liquid/combustible material/refueling fuel on hot surfaces, overheated oil, hot material, and conveyor belt friction. Three ignition sources were unknown. Twenty-two of the 35 equipment hydraulic/fuel fires became large fires because of continuous flow of fluids from the pumps due to engine shutoff failure, difficulty in activating available emergency systems at ground level, lack of an emergency line drainage system, or lack of effective and rapid local firefighting response capabilities. In at least five instances, the cab was suddenly engulfed in flames, probably due to the ignition of flammable vapors and mists that penetrated the cab. Of note is that the hydraulic fluid fires subsequently involved the fuel system.

During the first through fourth and the sixth periods, the largest number of fires were caused by hydraulic fluid/fuel sprayed onto equipment hot surfaces. During the fifth period, the largest number of fires were caused by flame cutting/welding spark/slag/flame.

Table 19.—Number of fires, fire injuries, fire fatalities, and risk rates for surface metal/nonmetal mines by state, employees' working hours, and lost workdays, 1990–2001

State[1]	No. fires[1]	No. fire injuries[1]	LWD[2]	Ewhr,[2] 10^6 hr	Irr[3]
Alabama	1	1	—	1.6	0.125
Alaska	6	4	72	10.1	0.079
Arizona	19	11	243	88.4	0.025
California	5	1	—	25.7	0.008
Florida	3	3	52	42.4	0.014
Georgia	3	4	17.6	15.4	0.052
Idaho	2	1	—	7.7	0.026
Michigan	1	—	—	7.3	—
Minnesota[4]	11	4	6,236	12.3	0.065
Missouri	2	1	—	1	0.2
Nevada[4]	19	10	6,419	109	0.018
New Mexico	2	—	—	21.2	—
North Carolina	2	2	46	10.2	0.039
South Carolina	1	1	36	2	0.1
Texas	1	1	12	6.4	0.031
Wyoming	1	—	—	4.5	—
All other states	—	—	—	181	—
Total	79	44	13,134	546	[3]0.016

[1]Derived from MSHA "Fire Accident Abstract" internal publications.
[2]Derived from MSHA "Injury Experience in Mining" publications.
[3]Calculated according to MSHA formula reported in the "Methodologies" section.
[4]Minnesota and Nevada each had a fire fatality. These were caused by hydraulic fluid/fuel fires involving a dozer and a truck, respectively.

Table 20.—Number of fires, fire injuries, fire fatalities, and risk rates for surface metal/nonmetal mines by time period, employees' working hours, and lost workdays, 1990–2001

	Time period						
	90-91	92-93	94-95	96-97	98-99	00-01	1990-2001
Number of fires[1]	16	22	15	13	6	7	79
Number of fire injuries[1]	11	10	8	5	4	6	44
Number of fatalities[1]	—	—	1	—	—	1	2
LWD[2]	224	281	6,109	132	44	6,344	13,134
Ewhr,[2] 10^6 hr	97	93	95	98	83	80	546
Irr[3]	0.023	0.021	0.017	0.01	0.01	0.015	[3]0.016

[1]Derived from MSHA "Fire Accident Abstract" internal publications.
[2]Derived from MSHA "Injury Experience in Mining" publications.
[3]Calculated according to MSHA formula reported in the "Methodologies" section.

Table 21.—Number of fires for surface metal/nonmetal mines by ignition source and time period, 1990–2001

Ignition source	Time period						
	90-91 No. fires	92-93 No. fires	94-95 No. fires	96-97 No. fires	98-99 No. fires	00-01 No. fires	1990-2001 No. fires
Hydraulic fluid/fuel/oil on equipment hot surfaces	7	11	6	8	—	3	35
Flame cutting/welding spark/slag/flame	3	4	2	—	2	2	13
Electrical short/arcing	2	2	2	1	—	1	8
Heat source-flammable liquid/vapors	1	1	2	1	1	1	7
Flammable liquid/combustible material/refueling fuel on hot surfaces	2	2	2	—	1	—	7
Overheated oil	1	1	—	—	—	—	2
Hot material	—	—	—	1	1	—	2
Conveyor belt/equipment friction	—	—	1	1	—	—	2
Unknown/other	—	1	—	1	1	—	3
Total	16	22	15	13	6	7	79

Table 22.—Number of fires for surface metal/nonmetal mines by method of detection and time period, 1990–2001

Method of detection	Time period 90-91 No. fires	92-93 No. fires	94-95 No. fires	96-97 No. fires	98-99 No. fires	00-01 No. fires	1990-2001 No. fires
Visual:							
Flames/flash fires	6	11	8	7	1	4	37
Smoke	5	4	4	4	1	2	20
Sparks	3	3	2	—	2	1	11
Late smoke detection	2	2	1	2	1	—	8
Undetected	—	2	—	—	1	—	3
Total	16	22	15	13	6	7	79

Table 23.—Number of fires for surface metal/nonmetal mines by suppression method and time period, 1990–2001

Suppression method	Time period 90-91 No. fires	92-93 No. fires	94-95 No. fires	96-97 No. fires	98-99 No. fires	00-01 No. fires	1990-2001 No. fires
FE-foam-DCP-water	3	5	6	9	—	3	26
FE	6	5	5	1	3	2	22
Manual with or without FE[1]	3	3	2	1	1	1	11
Water	2	2	—	1	1	1	7
FSS-DCP-water	1	1	2	—	—	—	4
FSS-HD[2]	1	—	—	—	—	—	1
Destroyed/HD[3]	—	6	—	1	1	—	8
Total	16	22	15	13	6	7	79

DCP Dry chemical powder.
FE Portable fire extinguisher.
FSS Machine fire suppression system.
HD Heavily damaged.
[1]Method used by welders to extinguish clothing and oxyfuel/grease fires.
[2]Heavy damage to equipment due to FSS activation failure.
[3]Usually due to failure of firefighting methods, late fire detection, undetected fires, or fire size.

Table 24.—Number of fires for surface metal/nonmetal mines by equipment involved and time period, 1990–2001

Equipment	Time period 90-91 No. fires	92-93 No. fires	94-95 No. fires	96-97 No. fires	98-99 No. fires	00-01 No. fires	1990-2001 No. fires
Mobile equipment[1]	9	14	10	10	1	3	47
Oxyfuel torch[2]	3	4	2	—	2	2	13
Heater	2	1	1	—	1	2	7
Maintenance equipment	1	1	1	—	—	—	3
Generator	1	—	1	—	—	—	2
Facility[3]	—	1	—	—	1	—	2
Beltline	—	—	—	1	—	—	1
Chute	—	—	—	—	1	—	1
Sump	—	1	—	—	—	—	1
Other	—	—	—	2	—	—	2
Total	16	22	15	13	6	7	79

[1]Includes loaders, dozers, trucks, shovels, drills, and scrapers.
[2]At times, electrical arc welding equipment was used.
[3]Considered equipment in this report.

Table 25.—Number of fires for surface metal/nonmetal mines by location and time period, 1990–2001

Location	Time period 90-91 No. fires	92-93 No. fires	94-95 No. fires	96-97 No. fires	98-99 No. fires	00-01 No. fires	1990-2001 No. fires
Mobile equipment working areas[1]	8	13	10	10	—	3	44
Flame cutting/welding areas[2]	3	4	2	—	2	2	13
Maintenance/storage/refuse areas	3	3	2	—	3	1	12
Facility/shop/roofing areas	2	—	—	—	1	1	4
Generator housing/crusher/fire training areas	—	—	1	2	—	—	3
Waste dump/sump areas	—	2	—	1	—	—	3
Total	16	22	15	13	6	7	79

[1]Includes mining, haulage, drilling, loading, and excavating areas.
[2]Includes pipeline, dump rope, crowd platform, and maintenance areas.

Table 26.—Number of fires for surface metal/nonmetal mines by burning material and time period, 1990–2001

Burning material	Time period						
	90-91 No. fires	92-93 No. fires	94-95 No. fires	96-97 No. fires	98-99 No. fires	00-01 No. fires	1990-2001 No. fires
Hydraulic fluid/fuel/oil	7	11	5	8	—	3	34
Oxyfuel/clothing/grease/other[1]	3	4	2	—	2	2	13
Flammable liquid/combustible material	2	2	3	1	2	1	11
Electrical wires/cables	2	2	2	1	—	1	8
Refuse/wood/tires/chute liner	1	1	—	2	1	—	5
Equipment mechanical components	1	1	2	—	—	—	4
Facility/content	—	1	—	—	1	—	2
Belt material	—	—	1	1	—	—	2
Total	16	22	15	13	6	7	79

[1]Includes rubber hoses, pipeline, dump rope cables, grease, screen liner, shaft material, and equipment mechanical components.

Table 27.—Number of fire injuries per number of fires causing injuries and total fires for surface metal/nonmetal mines by year, ignition source, equipment involved, and location, 1990–2001

Year	No. total fires	No. fires causing injuries	No. fire injuries	Ignition source	Equipment	Location
1990	5	3	1	Flame cutting/welding spark/slag/flame	Oxyfuel torch	Flame cutting/welding areas.
			1	Hydraulic fluid/fuel on equipment hot surfaces	Truck	Haulage area.
			1	Oil on hot surfaces	Truck	Haulage area.
1991	11	7	2	Flame cutting/welding spark/slag/flame	Oxyfuel torch	Flame cutting/welding areas.
			1	Flammable liquid on hot surfaces	Maintenance equipment	Refuse pile area.
			5	Hydraulic fluid/fuel on equipment hot surfaces	Loader/truck/dozer	Loading/haulage/mining areas.
1992	13	5	2	Flame cutting/welding spark/slag/flame	Oxyfuel torch	Flame cutting/welding areas.
			1	Flammable liquid on hot surfaces	Maintenance equipment	Maintenance area.
			1	Heat source-flammable vapors	Heater	Maintenance area.
			1	Hydraulic fluid/fuel on equipment hot surfaces	Loader	Loading area.
1993	9	5	1	Flame cutting/welding spark/slag/flame	Oxyfuel torch	Flame cutting/welding areas.
			1	Refueling fuel on hot surfaces	Truck	Maintenance area.
			2	Hydraulic fluid/fuel on equipment hot surfaces	Scraper/loader	Mining/loading areas.
			1	Electrical short/arcing	Truck	Haulage area.
1994	10	4	1	Flame cutting/welding spark/slag/flame	Oxyfuel torch	Flame cutting/welding areas.
			1	Electrical short/arcing	Generator	Generator housing.
			1	Heat source	Heater	Maintenance area.
			1	Hydraulic fluid/fuel on equipment hot surfaces	Truck	Haulage area.
1995[1]	5	5	1	Flame cutting/welding spark/slag/flame	Oxyfuel torch	Flame cutting/welding areas.
			1	Flammable liquid on hot surfaces	Maintenance equipment	Storage facility.
			2	Hydraulic fluid/fuel on equipment hot surfaces	Truck	Haulage area.
1996	6	4	3	Hydraulic fluid/fuel on equipment hot surfaces	Truck	Haulage area.
			1	Oil on hot surfaces	Truck	Dump area.
1997	7	1	1	Heat source-flammable liquid	Matches	Fire training facility.
1998	1	1	1	Flame cutting/welding spark/slag/flame	Oxyfuel torch	Flame cutting/welding areas.
1999	5	3	1	Heat source	Heater	Maintenance areas.
			1	Flammable liquid on hot surfaces	Truck	Maintenance area.
			1	Flame cutting/welding spark/slag/flame	Oxyfuel torch	Flame cutting/welding areas.
2000[1]	5	5	1	Heat source	Heater	Maintenance area.
			2	Hydraulic fluid/fuel on equipment hot surfaces	Truck	Haulage area.
			1	Flame cutting/welding spark/slag/flame	Oxyfuel torch	Flame cutting/welding areas.
2001	2	2	2	Flame cutting/welding spark/slag/flame	Oxyfuel torch	Flame cutting/welding areas.
Total	79	45	44			

[1]A fire fatality occurred in 1995 and 2000. These were caused by hydraulic fluid/fuel fires involving a truck and a dozer, respectively.

Method of Detection

Table 22 shows the number of fires by method of detection for each time period. The most frequent methods were operators who saw the fires when they started as flames/flash fires, miners who saw smoke shortly after the fires had started, and welders who saw sparks. Other methods of detection were miners who saw smoke long after the fires had started. Three fires were undetected. During the first through fourth and the sixth periods, the largest number of fires were detected by operators as flames/flash fires. During the fifth period, the largest number of fires were detected by welders as sparks.

Suppression Method

Table 23 shows the number of fires by suppression method for each time period. The most common methods were portable fire extinguishers with foam, dry chemical powder, and water, followed by portable fire extinguishers alone and manual techniques with or without portable fire extinguishers. Other methods were water alone and machine fire suppression systems with dry chemical powder, foam, and water. Five of the 35 pieces of mobile equipment involved in the hydraulic fluid/ fuel fires had machine fire suppression systems. Dual activation (one activaion) of machine fire suppression and engine shutoff systems succeeded in temporarily abating the fires; however, the flames reignited, fueled by the flow of pressurized fluids entrapped in the lines. On three other occasions (one of which resulted in a fatality), the fires raged out of control because of machine fire suppression system failure. In another instance the fire was detected late.

On at least five occasions, including one mobile equipment fire, fire brigades and fire departments fought the fires with foam, dry chemical powder, and water. However, eight fires destroyed or heavily damaged equipment (including seven pieces of mobile equipment) because of failure of firefighting methods, late fire detection, undetected fires, or fire size.

During the first and fifth periods, the largest number of fires were suppressed with portable fire extinguishers alone. During the second period, the largest number of fires were suppressed with portable fire extinguishers together with foam, dry chemical powder, and water and with portable fire extinguishers alone. During the third, fourth, and sixth periods, the largest number of fires were suppressed with portable fire extinguishers, foam, dry chemical powder, and water.

Equipment Involved

Table 24 shows the number of fires by equipment involved for each time period. The equipment most often involved was mobile equipment (trucks, dozers, loaders, shovels, drills, and scrapers), followed by oxyfuel torches (at times electrical arc welding equipment was used) and heaters. Other equipment included maintenance equipment, beltlines, generators, chutes, a sump, and facilities (considered equipment in this report). During the first through fourth and the sixth periods, the largest number of fires involved mobile equipment. During the fifth period, the largest number of fires involved oxyfuel torches.

Table 28.—Number of fires, fire injuries, and risk rates for surface sand and gravel mines by state, employees' working hours, and lost workdays, 1990–2001

State[1]	No. fires[1]	No. fire injuries[1]	LWD[2]	Ewhr,[2] 10^6 hr	Irr[3]
Arizona	3	3	63	15	0.04
Arkansas	1	1	—	10	0.02
California	9	5	160	89.4	0.011
Colorado	2	2	6	24	0.017
Florida	2	2	—	15	0.027
Illinois	3	3	54	20.7	0.029
Indiana	2	2	22	21.3	0.019
Kansas	1	1	—	8	0.025
Kentucky	1	1	7	6	0.033
Louisiana	4	4	29	15	0.053
Maryland	1	1	3	11.2	0.018
Michigan	6	6	69	33.5	0.036
Mississippi	3	3	54	6.3	0.095
Missouri	1	1	32	10	0.02
Nebraska	2	2	34	11	0.036
New Hampshire	2	2	8	26.5	0.015
New York	3	2	16	28	0.014
Ohio	4	2	65	37	0.011
Oklahoma	1	—	—	10	—
Oregon	1	1	16	13.7	0.015
Pennsylvania	5	5	76	19.3	0.052
South Carolina	1	—	—	10.2	—
South Dakota	2	2	35	5.8	0.069
Texas	1	1	30	60	0.003
Utah	3	3	6,075	15.6	0.039
Virginia	1	—	—	10.4	—
Washington	1	1	20	25	0.008
Wisconsin	2	2	39	22	0.018
Wyoming	2	2	8	4.4	0.091
All other states	—	—	—	157	—
Total	70	60	6,921	741	[3]0.016

[1]Derived from MSHA "Fire Accident Abstract" internal publications.
[2]Derived from MSHA "Injury Experience in Mining" publications.
[3]Calculated according to MSHA formula reported in the "Methodologies" section.

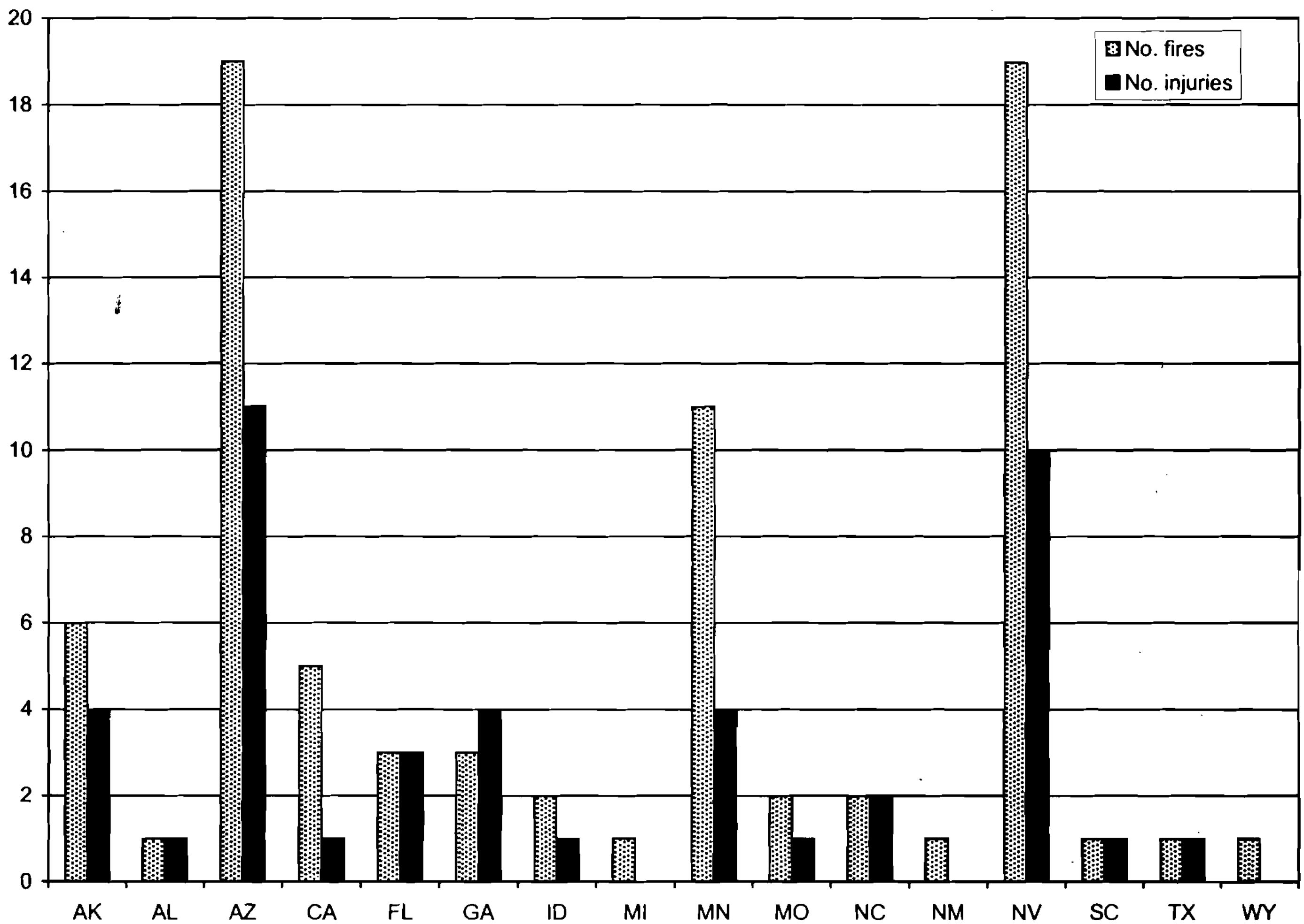

Figure 7.—Number of fires and fire injuries for surface metal/nonmetal mines by state, 1990–2001.

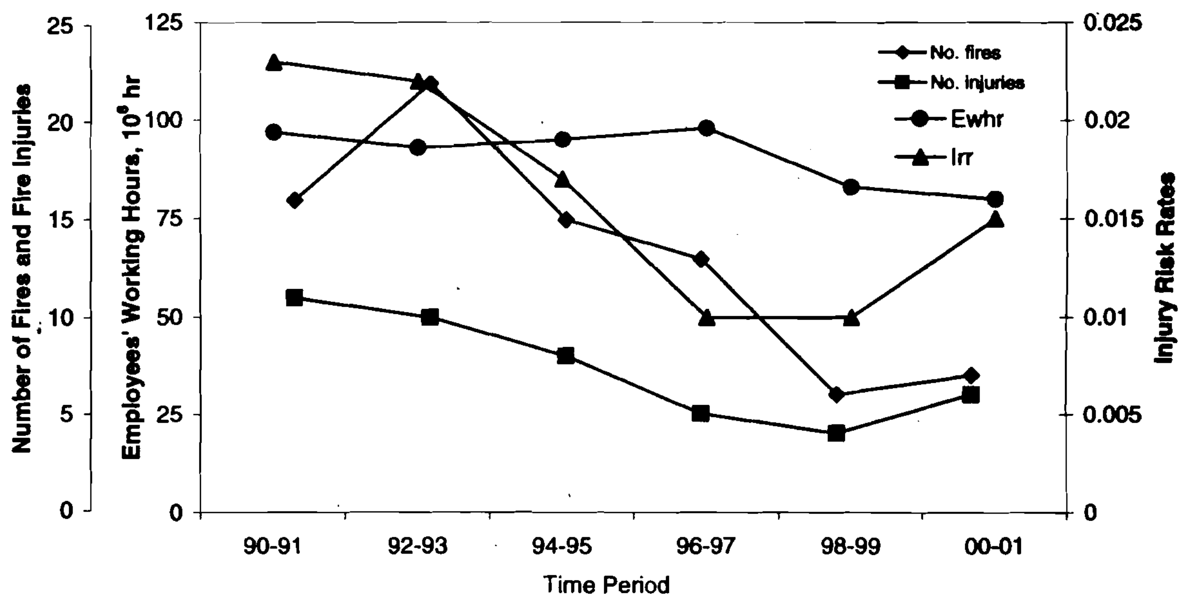

Figure 8.—Number of fires, fire injuries, risk rates, and employees' working hours for surface metal/nonmetal mines by time period, 1990–2001.

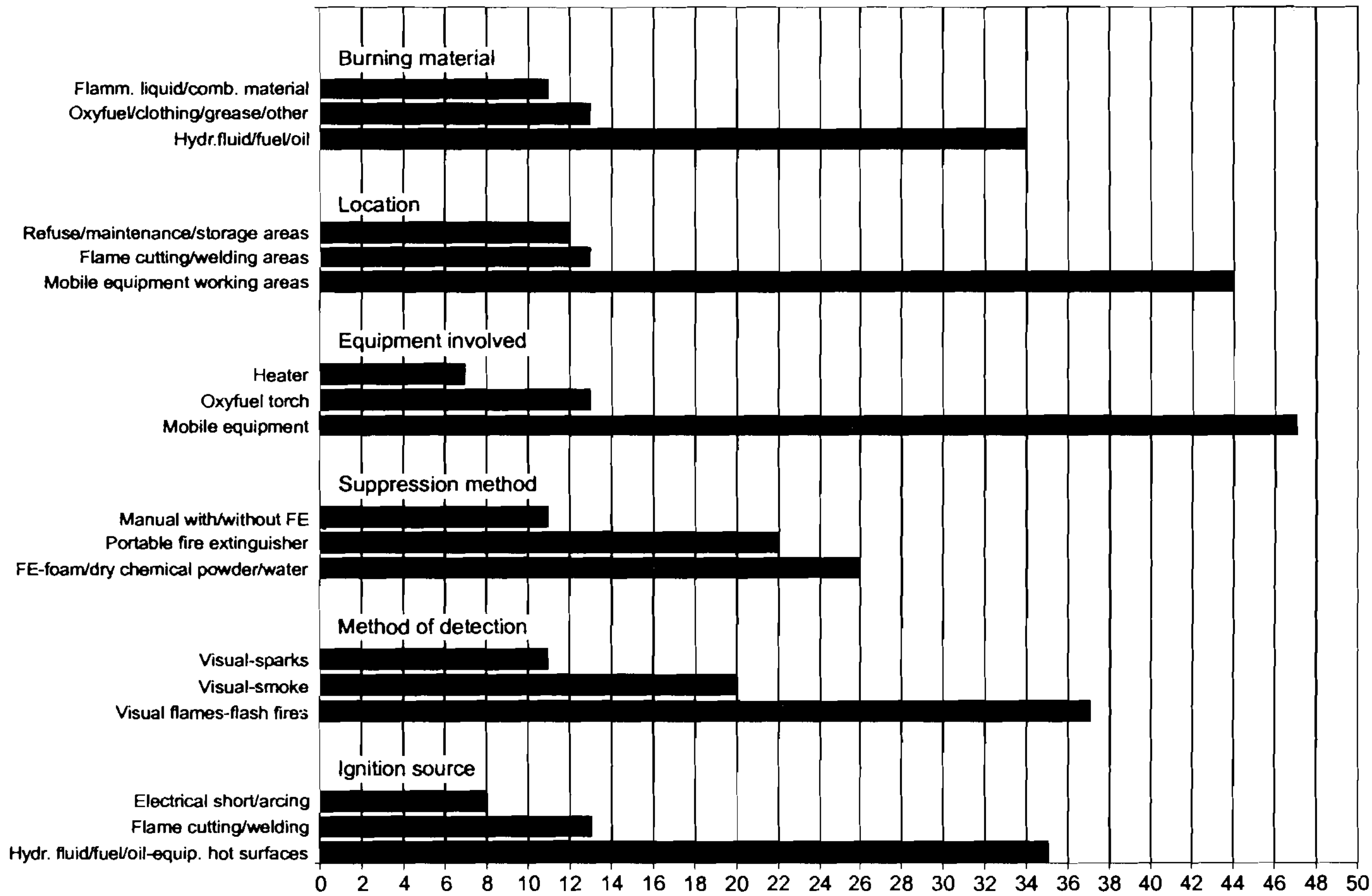

Figure 9.—Major variables for surface metal/nonmetal mine fires, 1990–2001. (FE = portable fire extinguisher)

Location

Table 25 shows the number of fires by location for each time period. The most common locations were mobile equipment working areas (mining, haulage, loading, drilling, and excavating areas). This was followed by flame cutting/welding areas (at pipeline, dump rope, crowd platform, and maintenance areas) and maintenance, storage, and refuse areas. Other fire locations included facilities and roofing areas, waste dump and sump areas, and generator housing, crusher, and fire training areas. During the first through fourth and the sixth periods, the largest number of fires occurred at mobile equipment working areas. During the fifth period, the largest number of fires occurred at maintenance, storage, and refuse areas.

Burning Materials

Table 26 shows the number of fires by burning material for each time period. The material most often involved was hydraulic fluid/fuel, followed by oxyfuel/clothing/grease and other materials (including rubber hoses, pipelines, grease, equipment mechanical components, dump rope cables, screen liner, and shaft material), flammable liquids, and combustible materials. Other burning materials involved electrical wires and cables, refuse, wood, tires and chute liner, equipment mechanical components, facilities and their content, and belt material. During the first through fourth and the sixth periods, the largest number of fires involved hydraulic fluid/fuel and oil. During the fifth period, the largest number of fires involved oxyfuel, flammable liquids, and combustible materials.

Fire Injuries

Table 27 shows the number of fire injuries per number of fires causing injuries and total fires by year, ignition source, equipment involved, and location for 1990–2001. Overall, there were 44 injuries and 2 fatalities caused by 45 fires. The greatest number of fire injuries occurred in 1991 (eight injuries caused by seven fires). The ignition sources that caused most of the fire injuries were hydraulic fluid/fuel sprayed onto equipment hot surfaces and flame cutting/welding spark/slag/flame. Other ignition sources causing injuries were flammable liquid/refueling fuel on hot surfaces, heat source-vapors/flammable liquid, electrical short/arcing, and oil on hot surfaces. The equipment most often involved in fire injuries included mobile equipment, oxyfuel torches, and maintenance equipment, followed by heaters, electrical systems, and air compressors. The locations where the fire injuries occurred were mobile equipment working areas, flame cutting/welding areas, maintenance and fire training areas, and generator housing.

Nevada and Minnesota each had a fire fatality [MSHA 1995e, 2000e]. These were caused by hydraulic fluid/fuel fires involving a truck and a dozer, respectively. The victims were severely burned while exiting the cab.

SURFACE SAND AND GRAVEL MINE FIRES

Table 28 and figure 10 show the number of fires and fire injuries for surface sand and gravel mines by state during 1990–2001. Table 28 also shows the injury risk rates, employees' working hours, and lost workdays. At surface sand and gravel mines, a total of 70 fires with 60 injuries occurred in 29 states during 1990–2001. Fifty-nine of the fires caused 60 injuries (none of the fires involved contractors). The yearly average was 5.8 fires and five injuries. The Ewhr value was 741 × 10^6 hr (Irr = 0.016), and the LWD value was 6,921. California had the most fires (nine fires and five injuries), followed by Michigan (six fires and six injuries) and Pennsylvania (five fires and five injuries). Of these states, Pennsylvania had the highest injury risk rate value (Irr = 0.052).

Table 29, partly illustrated in figure 11, shows the number of fires, fire injuries, risk rates, employees' working hours, and lost workdays by time period. The number of fires and fire injuries show an increase during the second period followed by a decrease during the fourth period followed by a small increase during the fifth period and a sharp decrease during the last period. Employees' working hours increased during most of the periods. The Irr values follow patterns similar to those shown by the injury values.

Tables 30–35 show the number of fires by ignition source, method of detection and suppression, equipment involved, location, and burning material by time period. Figure 12 shows the major variables related to fires for 1990–2001. Table 36 shows the fire injuries per number of fires causing injuries and total fires by year, ignition source, equipment involved, and location.

Ignition Source

Table 30 shows the number of fires by ignition source for each time period. The leading source was flame cutting/welding spark/slag/flame (29 fires or 41%), followed by heat source/explosion (15 fires or 21%) involving pressurized cans and flammable liquids and by hydraulic fluid/fuel sprayed onto equipment hot surfaces (14 fires or 20%). Other ignition sources were flammable liquid/gas/refueling fuel on hot surfaces/collision (in one instance, the fuel ignited upon equipment collision) and electrical short/arcing/explosion (involving a pump). Two ignition sources were unknown. At least 5 of the 14 mobile equipment hydraulic fluid/fuel fires became large fires because of the continuous flow of fluids from the pumps due to engine shutoff failure, difficulty in activating available emergency systems at ground level, lack of an emergency drainage system, or lack of effective and rapid local firefighting response capabilities. On two occasions, the cab was suddenly engulfed in flames, probably due to the ignition of flammable vapors and mists that penetrated the cab. Of note is that the hydraulic fluid fires subsequently involved the fuel system. During all of the periods, the largest number of fires were caused by flame cutting/welding spark/slag/flame.

Table 29.—Number of fires, fire injuries, and risk rates for surface sand and gravel mines by time period, employees' working hours, and lost workdays, 1990–2001

	Time period						
	90-91	92-93	94-95	96-97	98-99	00-01	1990-2001
Number of fires[1]	8	16	16	11	13	6	70
Number of fire injuries[1]	7	13	15	8	11	6	60
LWD[2]	73	193	218	6,089	234	114	6,921
Ewhr,[2] 10^6 hr	115	112	118	122	134	140	741
Irr[3]	0.012	0.023	0.025	0.013	0.016	0.009	[3]0.016

[1]Derived from MSHA "Fire Accident Abstract" internal publications.
[2]Derived from MSHA "Injury Experience in Mining" publications.
[3]Calculated according to MSHA formula reported in the "Methodologies" section.

Table 30.—Number of fires for surface sand and gravel mines by ignition source and time period, 1990–2001

Ignition source	Time period						
	90-91 No. fires	92-93 No. fires	94-95 No. fires	96-97 No. fires	98-99 No. fires	00-01 No. fires	1990-2001 No. fires
Flame cutting/welding spark/slag/flame	4	6	6	5	5	3	29
Heat source/explosion[1]	2	3	5	2	1	2	15
Hydraulic fluid/fuel on equipment hot surfaces	—	5	4	2	2	1	14
Flammable liquid/gas/refueling fuel on hot surfaces/ equipment collision	2	2	—	1	1	—	6
Electrical short/arcing/explosion[2]	—	—	1	1	2	—	4
Unknown	—	—	—	—	2	—	2
Total	8	16	16	11	13	6	70

[1]Involving pressurized cans and flammable liquid.
[2]Involving a pump.