Equipment Involved

Table 6 shows the number of fires by equipment involved for each time period. The equipment most often involved was mobile equipment (golf and ore carts, locomotives, shuttle cars, loaders, power scalers, scoops, tractors, trolleys, trucks, and drills), followed by oxyfuel torches (at times electrical arc welding equipment was used). Other equipment included belt-lines, electrical systems, batteries, chargers, heaters, cutting saws, explosive boxes, and air compressors. Six fires did not involve equipment. During all of the periods, the largest number of fires involved mobile equipment.

Location

Table 7 shows the number of fires by location for each time period. The most common locations were mobile equipment working areas (haulage, loading, mucking, transportation and drilling areas, decline slopes), followed by flame cutting/welding areas (at shops, mainways, boreholes, shafts, stations, slusher bucket and chute areas, and maintenance areas), and mine face, section, crosscut, and drift areas. Other fire locations were battery and pipeline areas, motor barns, belt entries, shops, refuse and maintenance areas, decline slopes, chute and crusher areas, panel and tunnel areas, and goblines and abandoned areas.

During the first, second, fourth, and sixth periods, the largest number of fires occurred at mobile equipment working areas. During the third period, the largest number of fires occurred at belt entries. During the fifth period, the largest number of fires occurred at flame cutting/welding areas.

Burning Materials

Table 8 shows the number of fires by burning material for each time period. The materials most often involved were hydraulic fluid/fuel, electrical cord, cables, wires, batteries, oxyfuel/clothing/grease, and materials such as rubber tires and hoses, hydraulic fluid, shop, refuse, wood, chute liner, and shaft material. Other burning materials included belt material, re-fueling fuel, flammable liquids, oil, grease, refuse, timber, pipe-lines, chute liners, equipment mechanical components, deto-nated explosives, and shops and their content.

During the first period, the largest number of fires involved electrical cord, cables, wires, and batteries. During the second period, the largest number of fires involved oxyfuel, clothing/grease, and other materials and electrical cord, cables, wires, and batteries. During the third period, the largest number of fires involved belt materials. During the fourth period, the largest number of fires involved hydraulic fluid/fuel. During the fifth period, the largest number of fires involved hydraulic fluid/fuel and oxyfuel. During the sixth period, the largest number of fires involved hydraulic fluid/fuel and electrical materials.

Fire Injuries

Table 9 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. Overall, there were nine injuries caused by six fires. The greatest number of fire injuries occurred in 1997 (four injuries caused by one fire). The ignition sources that caused the fire injuries were hydraulic fluid/fuel sprayed onto equipment hot surfaces, flame cutting/welding spark/slag/flame, and overheated oil. The equipment involved in fire injuries included mobile equipment, oxyfuel torches, and air compressors. The locations where the fire injuries occurred were mobile equipment working areas, flame cutting/welding areas, and mining areas.

SURFACE OF UNDERGROUND METAL/NONMETAL AND STONE MINE FIRES

Table 10 and figure 4 show the number of fires and fire injuries occurring at the surface of underground metal/nonmetal and stone mines by state during 1990–2001. Table 10 also shows the injury risk rates, employees' working hours, and lost workdays.

A total of 12 fires occurred in 11 states; 5 of the fires caused 5 injuries. The yearly average was one fire and 0.42 injury. Five fires with two injuries occurred at metal mines, five fires with two injuries occurred at nonmetal mines, and two fires with one injury occurred at stone mines. None of the fires involved contractors. The Ewhr value was 58×10^6 hr (Irr = 0.017), and the LWD value was 75.

Nevada had the most fires (two fires and no injuries). Ohio, New Mexico, Missouri, South Dakota, and Idaho each had one fire with one injury. Of these states, Missouri had the highest injury risk rate value (Irr = 0.25).

Table 11, partly illustrated in figure 5, shows the number of fires, fire injuries, risk rates, employees' working hours, and lost workdays by time period. The number of fires decreased during most of the six time periods. The number of fire injuries and employees' working hours decreased during all of the periods. The Irr values follow patterns similar to those shown by the injury values.

Tables 12–17 show the number of fires by ignition source, method of detection and suppression, equipment involved, location, and burning material by time period. Figure 6 shows the major variables related to fires for 1990–2001. 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.

Ignition Source

Table 12 shows the number of fires and fire injuries by ignition source for each time period. The leading source was flame cutting/welding spark/slag/flame (seven fires or 58%), followed by electrical short/arcing and heat source (one fire for each ignition). The ignition sources for three fires were unknown.

During the first through third periods, the fires were caused by the flame cutting/welding spark/slag/flame source. During the fifth period, the fire was caused by a heat source. During the sixth period, the fires were caused by flame cutting/welding spark/slag/flame and electrical short/arcing sources. No fires occurred during the fourth period.

Method of Detection

Table 13 shows the number of fires by method of detection for each time period. The most frequent method was welders who saw sparks. This was followed by miners who saw smoke long after the fires had started and miners who saw smoke shortly after the fires had started. Three fires were undetected.

During the first period, the largest number of fires were detected by welders as sparks. During subsequent periods, the fires were detected by welders as sparks (second period), by miners as smoke shortly or long after the fires had started and by welders as sparks (third period), by miners as smoke (fifth period), and by welders and miners as sparks and as smoke (sixth period).

Table 10.—Number of fires, fire injuries, and risk rates for surface of underground metal/nonmetal and stone 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]
California	1	—	—	0.7	—
Idaho	1	1	10	2.43	0.082
Kansas	1	—	—	0.26	—
Kentucky	1	—	—	3.1	—
Missouri	1	1	21	0.8	0.25
Montana	1	—	—	4	—
Nevada	2	—	—	3.1	—
New Mexico	1	1	16	2.6	0.077
Ohio	1	1	15	2.1	0.095
South Dakota	1	1	13	4	0.05
Utah	1	—	—	0.7	—
All other states	—	—	—	34.21	—
Total	12	5	75	58	[3]0.017

[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 11.—Number of fires, fire injuries, and risk rates for surface of underground metal/nonmetal and stone 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]	3	2	3	—	2	2	12
Number of fire injuries[1]	2	1	1	—	—	1	5
LWD[2]	16	—	56	—	—	3	75
Ewhr,[2] 10^6 hr	12	11	10	9	8	8	58
Irr[3]	0.033	0.018	0.02	—	—	0.025	[3]0.017

[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 12.—Number of fires for surface of underground metal/nonmetal and stone 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	2	1	3	—	—	1	7
Electrical short/arcing	—	—	—	—	—	1	1
Heat source	—	—	—	—	1	—	1
Unknown	1	1	—	—	1	—	3
Total	3	2	3	—	2	2	12

Table 13.—Number of fires for surface of underground metal/nonmetal and stone mines by method of detection and time period, 1990–2001

Method of detection	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:							
Sparks	2	1	1	—	—	1	5
Smoke	—	—	1	—	—	1	2
Late smoke detection	—	—	1	—	1	—	2
Undetected	1	1	—	—	1	—	3
Total	3	2	3	—	2	2	12

Table 14.—Number of fires for surface of underground metal/nonmetal and stone mines by suppression method and time period, 1990–2001

Suppression method	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
Water	—	—	2	—	1	1	4
Manual with or without FE[1]	2	—	1	—	—	—	3
FE	—	1	—	—	—	1	2
Destroyed/HD[2]	1	1	—	—	1	—	3
Total	3	2	3	—	2	2	12

FE Portable fire extinguisher.
HD Heavily damaged.
[1]Method used by welders to extinguish clothing and oxyfuel/grease fires.
[2]Usually due to failure of firefighting methods, undetected fires, or fire size.

Table 15.—Number of fires for surface of underground metal/nonmetal and stone mines by equipment involved and time period, 1990–2001

Equipment	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
Oxyfuel torch[1]	2	1	3	—	—	1	7
Facilities[2]	1	1	—	—	1	1	3
Ventilation fan	—	—	—	—	—	1	1
Heater	—	—	—	—	1	—	1
Total	3	2	3	—	2	2	12

[1]At times, electrical arc welding equipment was used.
[2]Considered equipment in this report.

Table 16.—Number of fires for surface of underground metal/nonmetal and stone mines by location and time period, 1990–2001

Location	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 areas[1]	2	1	3	—	—	1	7
Facility/garage/trailer/storage areas	1	1	—	—	2	—	4
Fan housing	—	—	—	—	—	1	1
Total	3	2	3	—	2	2	12

[1]Includes shop, junction box, facilities, handrail, head frame, walkway, and maintenance areas.

Table 17.—Number of fires for surface of underground metal/nonmetal and stone mines by burning material and time period, 1990–2001

Burning material	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
Oxyfuel/clothing/grease/other[1]	2	1	3	—	—	1	7
Facility/content	1	1	—	—	1	—	3
Wood	—	—	—	—	1	1	2
Total	3	2	3	—	2	2	12

[1]Includes electrical junction boxes, handrails, grease, flammable liquids, rubber tires, and equipment mechanical components.

Table 18.—Number of fire injuries per number of fires causing injuries and total fires for surface of underground metal/nonmetal and stone 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	2	1	1	Flame cutting/welding spark/slag/flame	Oxyfuel torch	Flame cutting/welding areas.
1991	1	1	1	Flame cutting/welding spark/slag/flame	Oxyfuel torch	Flame cutting/welding areas.
1992	1	—	—	—	—	—
1993	1	1	1	Flame cutting/welding spark/slag/flame	Oxyfuel torch	Flame cutting/welding areas.
1994	2	1	1	Flame cutting/welding spark/slag/flame	Oxyfuel torch	Flame cutting/welding areas.
1995	1	—	—	—	—	—
1996	—	—	—	—	—	—
1997	—	—	—	—	—	—
1998	1	—	—	—	—	—
1999	1	—	—	—	—	—
2000	2	1	1	Flame cutting/welding spark/slag/flame	Oxyfuel torch	Flame cutting/welding areas.
2001	—	—	—	—	—	—
Total	12	5	5			

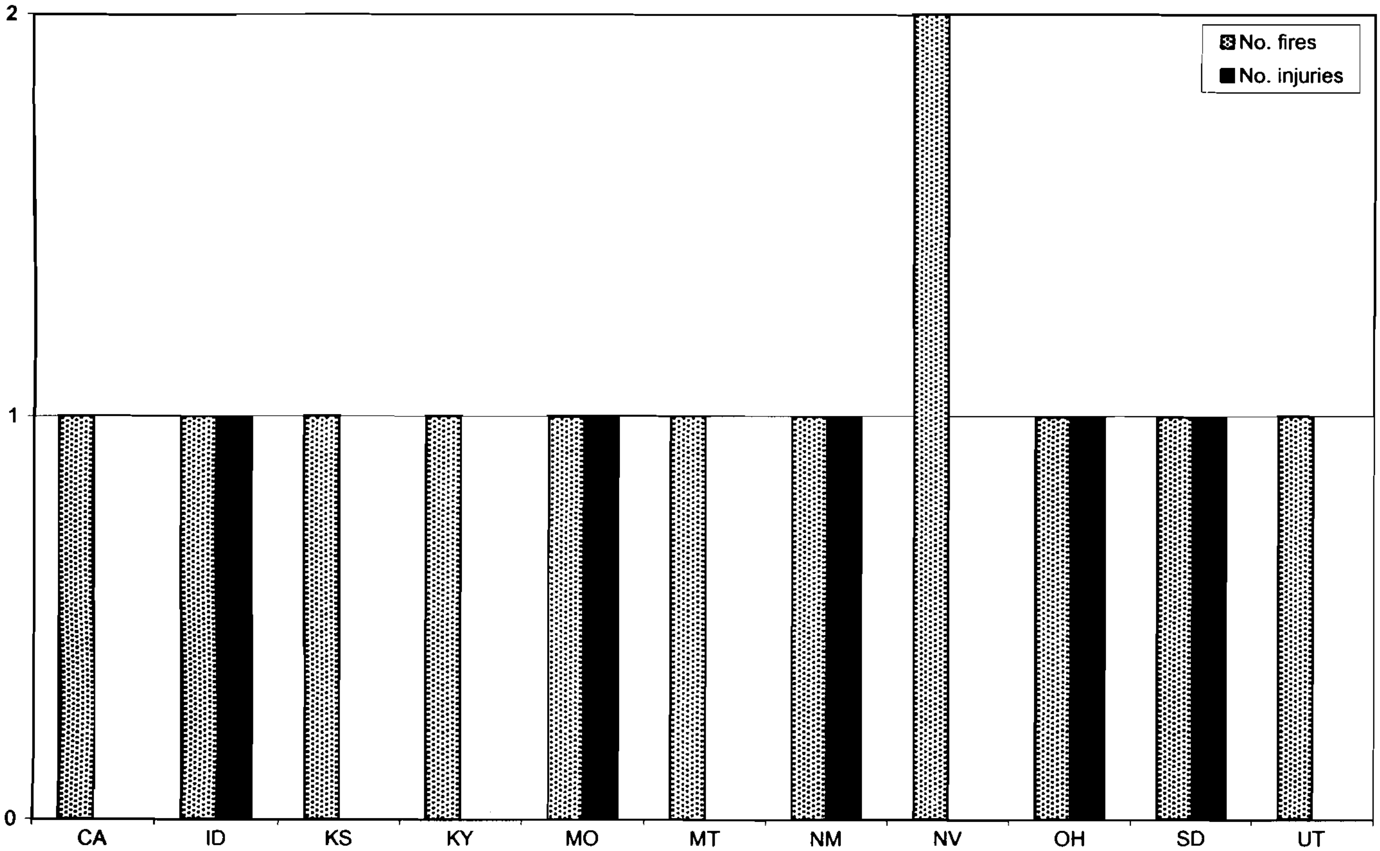

Figure 4.—Number of fires and fire injuries for surface of underground metal/nonmetal and stone mines by state, 1990–2001.

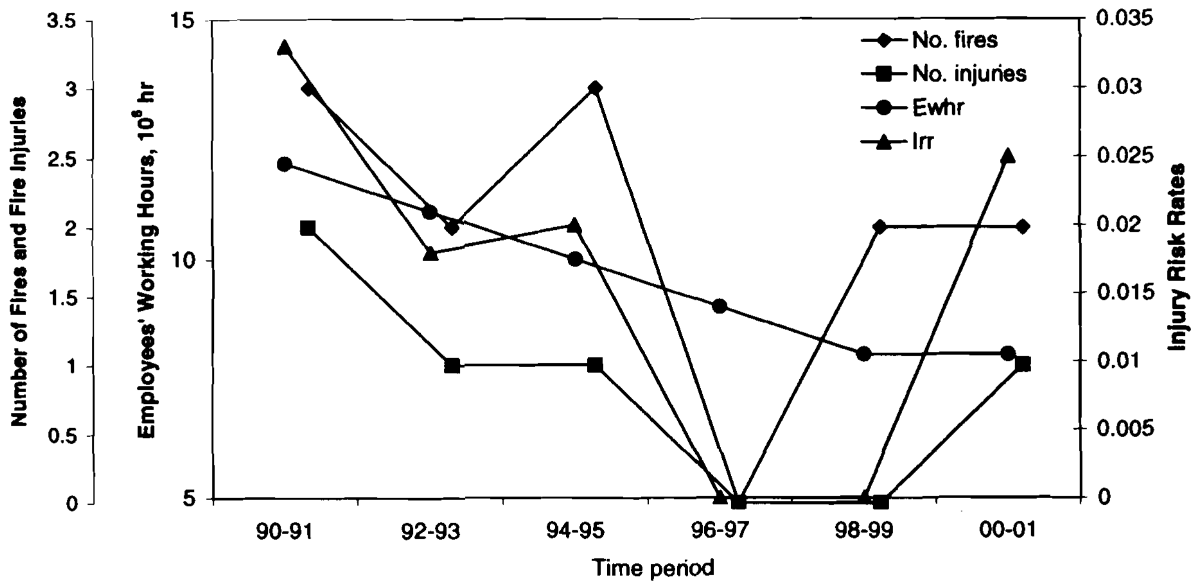

Figure 5.—Number of fires, fire injuries, risk rates, and employees' working hours for surface of underground metal/nonmetal and stone mines by time period, 1990–2001.

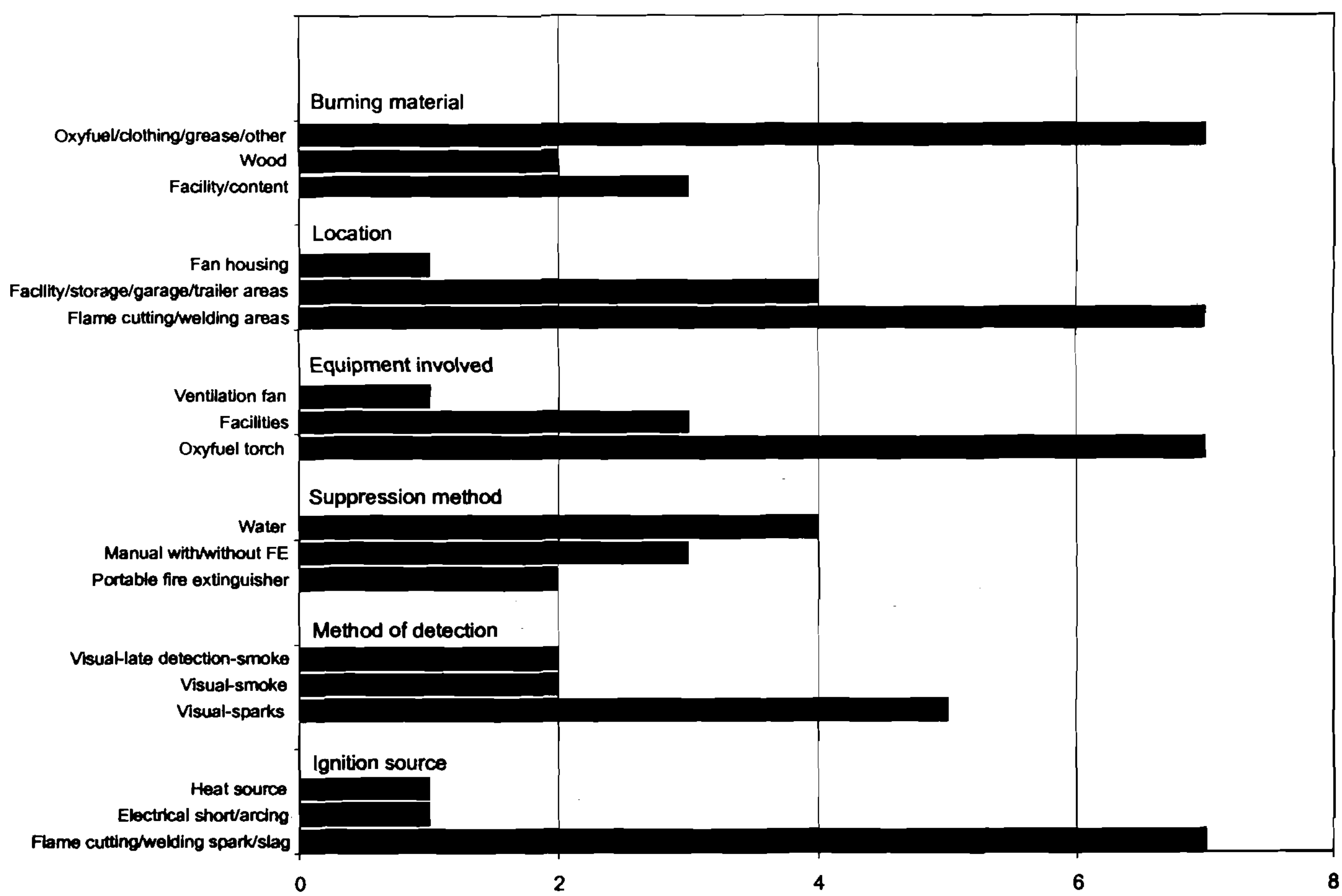

Figure 6.—Major variables for surface of underground metal/nonmetal and stone mine fires, 1990–2001. (FE = portable fire extinguisher)

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