



IC 9365

Haulage-Related Accidents in Metal and Nonmetal Surface Mines

By Jean M. Kenney



UNITED STATES DEPARTMENT OF THE INTERIOR

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HAULAGE-RELATED ACCIDENTS IN METAL AND NONMETAL SURFACE MINES

By Jean M. Kenney¹

ABSTRACT

Frequencies of haulage-related accidents in metal and nonmetal surface mines for the years 1988 through 1990 were investigated and compared with those of non-haulage-related accidents. This study was part of the U.S. Bureau of Mines program to improve mining haulage safety. Data were obtained through the U.S. Bureau of Mines Accident Data Analysis (ADA) program. The chi-square test was used to compare frequencies of haulage-related and non-haulage-related accidents for each of the following variables: degree of injury, age, total number of years of mining experience, and shift time. Significance was determined for degree of injury between haulage-related and non-haulage-related accidents. Age of injured did not vary significantly between haulage-related and non-haulage-related accidents, but total number of years of mining experience was found to be significant. Shift time for the accident proved to vary significantly between haulage- and non-haulage-related accidents. Events causing injury for haulage-related accidents were tabulated, and the most frequent determinants of haulage-related accidents were identified. Accident descriptions for both fatalities and permanent disabilities were studied, and the primary causes of these accidents were identified. These findings suggest that haulage-related jobs are among the most dangerous when considering accidents experienced by all workers in the metal and nonmetal surface mining work force.

¹Engineering research psychologist, Twin Cities Research Center, U.S. Bureau of Mines, Minneapolis, MN.

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INTRODUCTION

Haulage trucks enjoy widespread use in surface mining operations and are a major cause of death and injury among surface miners. The last known analysis of accidents involving haulage trucks in metal and nonmetal accidents was made by Miller nearly 20 years ago.²

The purpose of the present analysis is to ascertain whether haulage truck drivers continue to be at higher risk

of accident and injury than other mine workers in metal and nonmetal surface mines. Data from 3 years, 1988 through 1990, are combined in this analysis and are presented below. This work was done as part of the U.S. Bureau of Mines program to improve mining haulage safety.

METHOD

PROCEDURE

The U.S. Bureau of Mines Accident Data Analysis (ADA) program was used to obtain information about all accidents in metal and nonmetal surface mines for the years 1988 through 1990.³ The ADA program is an information system that includes all accident data for both metal and nonmetal and coal industries dating back to the year 1975 reported to the Mine Safety and Health Administration (MSHA). All mining operations are required to report accidents to MSHA under the provisions of Part 50, CFR 30; however, the number of mines reported in the data base varies from year to year; the data base usually includes between 10,000 and 12,000 mining sites in a given year.

In addition to defining metal and nonmetal and the years 1988 through 1990 as parameters, two variables were used to define both haulage-related and non-haulage-related accidents: location and mining machine. The variable location was chosen to define all surface-related data for both haulage-related and non-haulage-related accidents. Haulage-related and non-haulage-related data were determined by the variable mining machine. Under this variable, haulage-related accidents were defined using the subvariables load haul dump, scoop tram, off-highway, or ore-haulage truck. Non-haulage-related accidents were defined by choosing all subvariables other than those defined as haulage related. Several other variables were chosen for purpose of definition and analysis. These variables included degree of injury, event that caused the injury, age, total number of years of mine experience, and shift time.

Further, accident descriptions were tabulated for haulage-related fatalities and permanent disabilities. These descriptions, compiled from narratives reported to MSHA, are used in the ADA database. They are not based on the detailed investigation reports but rather on the description given by the mine site at the time of the accident.

ANALYSES

Data from the ADA data base were analyzed with a statistical software package.⁴ Results from a 2×2 chi-square test are presented. The first factor is degree of injury (broken into presence or absence of fatality) and the second, type of accident, either haulage or nonhaulage related. Results from a second chi-square analysis that further subdivides degree of injury are also presented. Specifically, a 10×2 chi-square was used with the following levels of degree of injury: fatality, permanent disability, days off, days off and restricted work, restricted work, no lost time, occupational illness, injuries due to natural causes while on company business, injuries involving nonemployees on mine property, and all other cases. Age of injured, grouped in 10-year increments, was used as a factor in a third 5×2 chi-square test. Total years of mine experience were tabulated and grouped in years similar to the grouping of mine experience used in Butani's normative data for the metal and nonmetal work force.⁵ An 8×2 chi-square test was then conducted to test this factor. A 4×2 chi-square was used to test shift time with the following start-of-shift times: day shift (6 a.m.-8 a.m.), evening shift (3 p.m.-5 p.m.), night shift (10 p.m.-12 a.m.), and variable shift.

²Miller, W. K. Analysis of Truck Related Fatalities and Disabling Injuries at Metal and Nonmetal Surface Mines. MSHA IR 1022. 1975, 8 pp.

³Bowers, E. T. Using ADA (Accident Data Analysis) in Mine Safety Research. BuMines OFR 72-86, 1986, 111 pp.

⁴Statistical Package for the Social Sciences (SPSS), Inc. (Chicago, IL). SPSS Reference Guide, version 4.0 for OS/2. 1990, 494 pp.

⁵Butani, S. J., and A. M. Bartholomew. Characterization of the 1986 Metal and Nonmetal Mining Workforce. BuMines IC 9193, 1988, 69 pp.

RESULTS

The likelihood for occurrence of fatality proved to be significant ($\chi^2 = 56.7$, $p < 0.001$) in comparing haulage-related and non-haulage-related accidents (table 1). Haulage-related accidents comprised 6% of total accidents, whereas non-haulage-related accidents comprised 94% of total accidents. However, fatalities comprised 1.5% of all haulage-related accidents and 0.2% of all non-haulage-related accidents.

Table 1.—Fatalities and nonfatalities compared in haulage-related and non-haulage-related accidents¹

	Haulage-related accidents	Non-haulage-related accidents
Fatalities	1.5% (20)	0.2% (50)
Nonfatalities	98.5% (1,291)	99.8% (18,891)
Total	100.0% (1,311)	100.0% (18,941)

¹ $\chi^2 = 56.7$, $p < 0.001$.

NOTE.—Numbers in parentheses denote actual frequencies.

Further defined, degree of injury (table 2) also proved to be significant ($\chi^2 = 141.7$, $p < 0.001$). Days off comprised 55.8% of all haulage-related accidents versus 46.0% of all non-haulage-related accidents. No lost time accounted for 28.0% of all haulage-related accidents and for 39.0% of non-haulage-related accidents. This suggests that severity of injury can be directly related to haulage-related

versus non-haulage-related accidents. Age of injured (see table 3) showed no significance ($\chi^2 = 2.16$, $p > 0.20$); the occurrence of haulage-related and non-haulage-related accidents is not dependent on age. Total number of years of mine experience, however, did prove to be significant ($\chi^2 = 25.4$, $p < 0.001$) in comparing haulage-related and non-haulage-related accidents (table 4), with a distinctly higher accident rate associated with 5 or less years of experience. Shift time (table 5) proved to be significant ($\chi^2 = 34.4$, $p < 0.001$), with night and evening shifts accounting for a greater percentage of haulage-related accidents than non-haulage-related accidents and day shift accounting for a greater percentage of non-haulage-related accidents. This indicates that shift worked is potentially a factor associated with haulage- and non-haulage-related accidents. In addition, events causing injury were grouped by frequency (fig. 1). "Struck against moving object" and "fall from machinery" are the most common events causing injury among haulage-related accidents. Accident descriptions for fatalities as well as for permanent disabilities were grouped by frequency for haulage-related accidents. Descriptions for fatalities (table 6) showed "traveled through berm and over embankment" and "runaway truck" to be the most frequent causes of haulage-related fatalities. Accident descriptions for permanent disabilities (table 7) showed "ingress-egress" accidents to be the leading cause of haulage-related permanent disabilities.

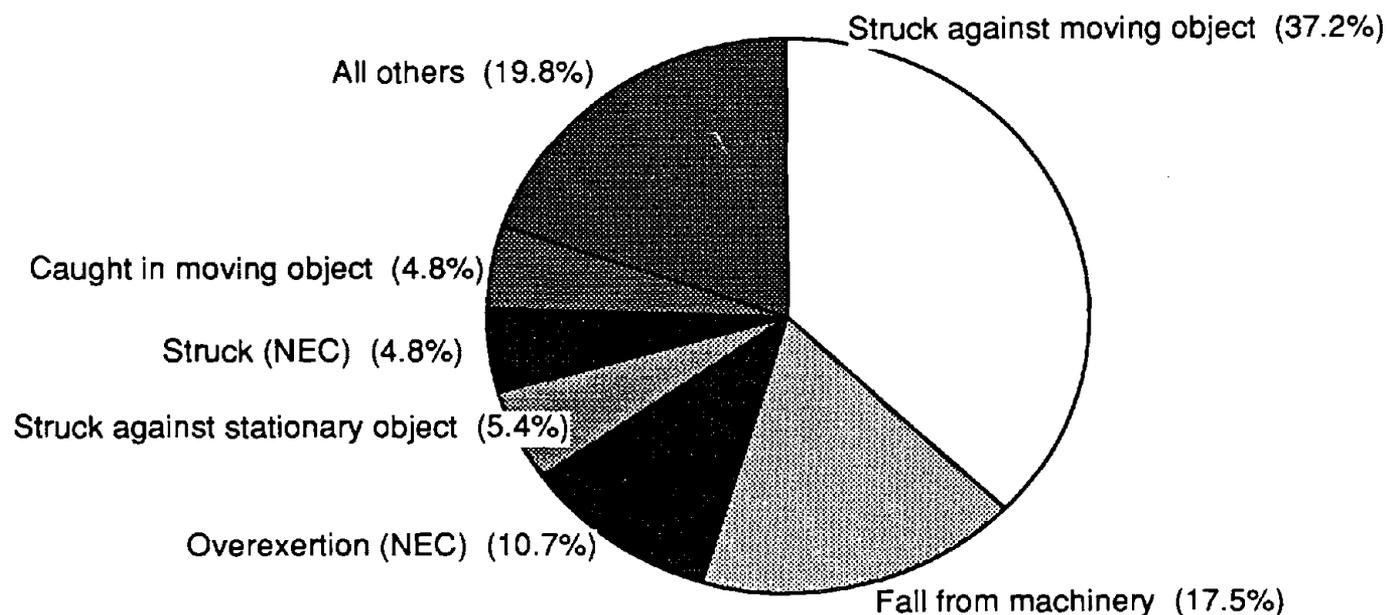


Figure 1.—Event causing injury in haulage-related accidents for 1988 through 1990. NEC = Not elsewhere classified.

Table 2.—Degree of injury compared in haulage-related and non-haulage-related accidents¹

	Haulage-related accidents	Non-haulage-related accidents
Fatalities	1.5% (20)	0.2% (50)
Permanent disability . .	1.1% (15)	2.0% (320)
Days off	55.8% (732)	46.0% (8,701)
Days off and restricted work	3.9% (51)	3.3% (626)
Restricted work	7.2% (94)	7.0% (1,311)
No lost time	28.0% (366)	39.0% (7,471)
Occupational illness . .	.7% (9)	1.3% (252)
Injury due to natural causes3% (4)	.3% (55)
Injuries of nonemployees3% (4)	.2% (31)
All other cases	1.2% (16)	.7% (124)
Total	100.0% (1,311)	100.0% (18,941)

¹ $\chi^2 = 141.7, p < 0.001.$

NOTE.—Numbers in parentheses denote actual frequencies.

Table 3.—Age of injured compared in haulage-related and non-haulage-related accidents¹

Age, years	Haulage-related accidents	Non-haulage-related accidents
16 to 24	15% (189)	14% (2,570)
25 to 34	32% (407)	34% (6,149)
35 to 44	27% (338)	27% (4,839)
45 to 54	17% (217)	16% (2,945)
55 and over	9% (116)	9% (1,649)
Total	100% (1,267)	100% (18,152)

¹ $\chi^2 = 2.16, p > 0.02.$

NOTE.—Numbers in parentheses denote actual frequencies.

Table 4.—Total number of years of mine experience compared in haulage-related and non-haulage-related accidents¹

Experience, years	Haulage-related accidents	Non-haulage-related accidents
0 to \leq 1	41% (532)	39% (7,182)
> 1 to \leq 5	26% (339)	23% (4,258)
> 5 to \leq 10	11% (137)	12% (2,314)
> 10 to \leq 15	9% (121)	10% (1,938)
> 15 to \leq 20	5% (58)	7% (1,243)
> 20 to \leq 25	4% (47)	4% (807)
> 25 to \leq 30	2% (20)	2% (411)
Greater than 30	2% (30)	3% (451)
Total	100% (1,284)	100% (18,604)

¹ $\chi^2 = 25.4, p < 0.001.$

NOTE.—Numbers in parentheses denote actual frequencies.

Table 5.—Time of shift compared in haulage-related and non-haulage-related accidents¹

Shift	Haulage-related accidents	Non-haulage-related accidents
Day	69% (916)	73% (13,876)
Evening	9% (116)	8% (1,492)
Night	5% (66)	2% (465)
Variable	17% (226)	17% (3,219)
Total	100% (1,324)	100% (19,052)

¹ $\chi^2 = 34.4, p < 0.001.$

NOTE.—Numbers in parentheses denote actual frequencies.

Table 6.—Accident descriptions for haulage-related fatalities

Accident description	Fatalities
Traveled through berm and over embankment	4
Runaway truck	4
Towing disabled vehicle	3
Backed over edge of stockpile	2
Head-on collision	2
Unknown	2
Run over pedestrian	1
Heart attack	1
Changing tire	1
Total	20

NOTE.—Accident descriptions were derived from narratives provided in ADA data base.

Table 7.—Accident descriptions for haulage-related permanent disabilities

Accident description	Permanent disability
Ingress-egress	7
Maintenance (miscellaneous)	5
Maintenance (strain or hernia)	2
Runaway truck	1
Total	15

NOTE.—Accident descriptions were derived from narratives provided in ADA data base.

DISCUSSION

The present analyses indicate a number of differences in the nature of haulage-related versus non-haulage-related mining accidents. The occurrence of fatality is greater for haulage-related accidents than for non-haulage-related accidents. In fact, the percentage of haulage-related fatalities is 7.5 times greater than the percentage of non-haulage-related fatalities. It is this factor in particular that appears to show a continuous trend from earlier studies of mining-related accidents and may illustrate an increased likelihood of a haulage-related accident's resulting in a fatality than a non-haulage-related accident. To further define haulage-related accidents, there are significant differences between the two types of accidents across several factors. Analysis for degree of injury shows that haulage-related accidents have a higher percentage for all lost-time accident categories except permanent disability and occupational illness. Haulage-related accidents thus display a larger percentage of days off categorizations than non-haulage-related accidents, and in turn, a higher percentage of no lost time accidents is shown in non-haulage-related accidents. This suggests that accidents involving haulage trucks result in more severe consequences. Although permanent disabilities are greater for non-haulage-related accidents, this may further indicate that a haulage-related accident is more likely to result in fatality than is a non-haulage-related accident.

Age is not a significant factor in considering differences between haulage- and non-haulage-related accidents; however, both haulage and nonhaulage groups show similar percentages for the age groups shown. The highest frequencies of accidents appear to occur within the 25 to 34 years of age range. This age range makes up approximately 46% of the metal and nonmetal work force population, whereas 16 to 24 years makes up approximately 6% of the population and the ranges of 45 to 54 years and 55 years and over make up approximately another 46% of the total population of metal and nonmetal work force.⁶ Total number of years of mining experience shows significance when comparing haulage-related and non-haulage-related accidents and is perhaps a better indicator of accidents and their likelihood. The greatest percentage of accidents occur with 1 year or less of total mining experience for both types of accidents. This accounts for approximately 8% of the total metal and nonmetal work force population.⁷ In addition, there is a consistent decline in accidents with greater total number of years of mining experience.

Time of shift proved to be significant in comparing haulage-related accidents with non-haulage-related accidents. Although day shift showed a greater percentage of

accidents occurring in non-haulage-related incidents, the relationship is reversed for the night shift. The amount of haulage-related work done at night may account for this difference, as well as the problem of poor visibility on haulage trucks; however, more in-depth investigation is needed to verify the accuracy of this interpretation.

Analysis for events causing injury in haulage-related accidents shows the greatest percentage of accidents are caused by "struck against moving object" followed by "fall from machinery." "Struck against moving object" refers to all injuries involving someone being struck by or against a moving object. In terms of haulage-related accidents, an example of this may be a truck bed's being hit by a shovel bucket during loading or being run over by a haulage truck. "Fall from machinery" largely includes ingress and egress accidents. A common example would be climbing down the ladder of a haulage truck and in the process slipping and falling from the ladder to the ground. Further investigation into the details surrounding these events may reveal more specific causes of haulage-related accidents and may further explain reasons for such a high incidence of these accidents.

A closer look at events causing injury in accident descriptions specific to fatal accidents presented four cases of "traveled through berm and over embankment." Within this category various contributing causes were noted. In one occurrence, the driver experienced a mechanical failure as he was hauling waste material to the dump point. The truck drifted backward, then went through the berm and over the embankment. In another case, the contributing cause was the driver's falling asleep at the wheel. In yet another event, the driver jumped from the truck after backing over the berm and the truck rolled over onto the driver. The final account did not give any additional information as to what possible contributing events were present.

In all four accounts of "runaway truck," the sole contributing factor was the driver's jumping from the vehicle. One example is a case in which a driver returning from dumping a load was unable to stop the truck to avoid an obstacle: The driver jumped from the truck and was run over by the rear wheels of the truck. However, there were no contributing factors to the three fatalities caused by "towing disabled vehicle." In all three cases, individuals were crushed between two trucks.

In both cases of "backed over edge of stockpile," the operator was crushed in the cab of the truck. Further investigation into the details of the accident may provide information on safety features such as rollover protective structures and the use of safety belts. The two cases of "head-on collision" resulted from the same accident in which two trucks collided.

⁶Work cited in footnote 5.

⁷Work cited in footnote 5.

There were two cases in which the cause of the accident was "unknown." In one account, the driver of the truck was found on the ground appearing as if he had been run over by the vehicle. "Run over pedestrian" accounted for one fatality. According to the narrative, the driver of a truck returning from the crusher area did not see an individual cross in front of his path and ran over him with the truck. In this case, a contributing factor was poor visibility on the part of the truck driver.

"Heart attack" resulted in one fatality. The contributing cause in this accident was loss of control of the truck after the driver became unconscious and drove into a water-filled pit, where he subsequently drowned.

Finally, there was one fatality from "changing tire." During the procedure, the victim was hit by the mounting hardware when the lock rim base weld separated and blew off.

Analysis of the accident descriptions for permanent disabilities presented four different primary causes. "Ingress-egress" accounted for seven cases of permanent disabilities. Contributing factors within this category included four

cases of slipping and falling either from loss of balance or wet and/or muddy ladder. In two other accounts, both of the individuals received a strain while climbing off a truck. There was one incident of an individual's getting his ring caught in the ladder while dismounting the vehicle.

"Maintenance (miscellaneous)" accounted for five permanent disabilities. Within this category all disabilities were caused by body parts being caught or crushed in equipment. In one of these cases a contributing cause was the lack of use of a flashlight. The individual was looking for an air leak on the truck, was not able to see what he was doing, and got his finger caught in the alternator belt.

There were two occurrences of "maintenance (strain or hernia)." Both events involved truck maintenance in which the individuals strained themselves lifting heavy equipment. There was one case of "runaway truck" resulting in permanent disability. The contributing causes of this accident were brake failure and the driver's jumping from the truck and having his right leg run over by one of the rear wheels.

CONCLUSIONS

These analyses show that accidents involving haulage trucks are more severe in nature than accidents involving other surface mining jobs and tasks. Further investigation as well as ongoing research of specific causes and factors

contributing to these accidents are crucial in order to determine what safety measures can be introduced to decrease the incidence of accidents, particularly fatalities, in haulage-related mine work.