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Analysis of Fatal Accidents Involving Front-End Loaders at Metal and Nonmetal Mines, 1972-74

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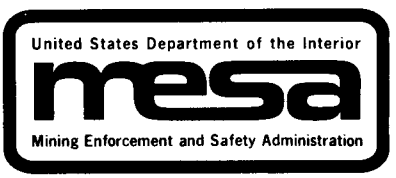

UNITED STATES DEPARTMENT OF THE INTERIOR
Stanley K. Hathaway, Secretary

Mining Enforcement and Safety Administration
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ANALYSIS OF FATAL ACCIDENTS INVOLVING FRONT-END LOADERS AT METAL AND NONMETAL MINES, 1972-74

by

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ABSTRACT

A critical accident trend has been identified which involves the front-end loader. The rubber-tired type of front-end loader that is widely used in metal and nonmetal mining is particularly involved in this trend. Eighteen fatal accidents occurred in 1972, 20 fatal accidents occurred in 1973, and 15 occurred in 1974. The sand and gravel industry accounted for 30 fatalities, or 56 percent of the total for the 36-month period of investigation. Analysis of the accident reports indicates that 74 percent of the total injuries probably could have been avoided had adequate protection been provided to the loader operator in the form of a roll-over protective structure (ROPS) and seat belts. More than half of the fatal accidents occurred as the result of backing off roadways or stockpiles and losing control of the loader while traveling downgrade. These accidents resulted in 31 fatalties, or 58 percent of the total for 1972-74. Usually, the loader overturned throwing the operator into the path of the machine. Operator error and lack of training are the primary factors in causing loader accidents. The analysis indicates that the installation of roll-over protection on the machines and the providing of adequate training for loader operators will contribute substantially towards a reduction of the accident rate.

INTRODUCTION

This report provides a preliminary analysis of 53 fatal accidents caused by front-end loaders at metal and nonmetal mines during 1972-74. This portion of the study is limited to the analysis of accident data and information obtained from Health and Safety Reports of Fatalities prepared by Mining Enforcement and Safety Administration (MESA) inspectors representing the Metal and Nonmetal Mine Health and Safety Districts in which the accidents occurred.

Ten factors related to front-end loader fatalities that were obtainable from the MESA fatality reports are analyzed. Those factors are: (1) cause of accident, (2) activity of loader, (3) presence or absence of roll-over protection and seat belts, (4) probability that the fatality could have been prevented with roll-over protection and seat belts, (5) experience of operator

[1]Mining engineer.

at running loaders, (6) experience of loader operator at mine, (7) occupation of operator, (8) mine product, (9) time of day that the fatality occurred, and (10) age of operator of loader.

There are other factors which may contribute to front-end loader accidents, but they are beyond the scope of this report because of the limited data available from the fatality reports. Some of those factors are (1) lack of standardization of controls on loaders, (2) loader center of gravity, and (3) design and construction of haul roads, loading ramps, and access roads. Sufficient information was not available from the reports to determine which manufacturers and models of loaders and mechanical deficiencies contribute to the accidents.

The number of fatalities from front-end loaders for 1974 is subject to change. Anyone injured by a front-end loader in 1974 who dies during 1975 as a result of that injury will be charged to 1974.

ANALYSIS

The following tables analyze 10 factors, all related to 53 fatalities associated with the operation of front-end loaders at metal and nonmetal mines during 1972-74.

Table 1 indicates that there are three principal causes that account for 39 of the fatalities, or 73 percent of the total; these being overturns as a result of backing off a stockpile, loss of control downgrade, and striking persons who were not operating the loaders.

TABLE 1. - Front-end loader fatalities, by cause

Cause	1972 fatals	1973 fatals	1974 fatals	Total	Percent
Operator backed loader off road or stockpile, causing it to overturn	5	8	3	16	30
Operator lost control of loader downgrade, causing it to overturn	7	4	4	15	28
Operator struck nearby pedestrian or worker with loader	5	0	3	8	15
Shoulder caved, loader overturned	1	1	2	4	7
Passenger fell off loader, crushed by wheels	0	1	2	3	6
Operator backed loader into other equipment	0	2	0	2	4
Bank caved knocking loader over bench	0	1	0	1	2
Operator drove loader forward over embankment	0	1	0	1	2
Operator drove loader into pond at night	0	0	1	1	2
Operator tossed off loader	0	1	0	1	2
Operator turned too sharply, caused loader to overturn	0	1	0	1	2
Total	18	20	15	53	100

Table 2 indicates that more than half of the front-end loader fatalities occurred outside the load-dump segment of the mining cycle. Activities other than loading and dumping included such operations as delivering supplies; pulling heavy equipment such as bins, draglines, and railroad cars; bulldozing with the bucket; back-leveling rough surfaces with the bucket; and driving from one work place to another or to or from the repair shop. Because front-end loaders can be used in many ways, they are driven not just on haul roads, but also on access roads and sometimes on trails intended only for dozers having crawlers. They often are driven and used on roads and in work areas neither designed nor constructed for them.

TABLE 2. - Front-end loader fatalities, by activity

In load-dump cycle	1972 fatals	1973 fatals	1974 fatals	Total	Percent
Yes.....	6	11	6	23	43
No.....	12	9	9	30	57
Total.....	18	20	15	53	100

The 41 front-end loaders in table 3 were involved in roll-over or cab-crushing types of accidents. None of the loaders had roll-over protection or a seat belt. As for the other 12 accidents in table 3, roll-over protective structures (ROPS) and seat belts would not have prevented the deaths. In 8 of those 12 accidents, the victim was a pedestrian or worker near the loader and was crushed. In three accidents, a passenger fell off the loader and was crushed under the wheels. In one accident, the operator drove into a pond at night and drowned.

TABLE 3. - Front-end loader fatalities related to presence or absence of safety devices

Roll-over protection and seat belts	1972 fatals	1973 fatals	1974 fatals	Total	Percent
Not on loader.....	13	19	9	41	77
On loader.....	0	0	0	0	0
Not applicable to accident.....	5	1	6	12	23
Total.....	18	20	15	53	100

Table 4 indicates that out of the total of 53 fatal accidents involving front-end loaders, 29 had a high probability of being prevented by the use of roll-over protective structures (ROPS) and seat belts. In each instance, the operator was crushed as a result of being thrown into the path of the overturning loader. The slope drops ranged from 1 to 15 feet, involving a relatively short overturn distance.

As listed in the table, 10 additional fatal accidents were of such a nature that the operators might have survived had roll-over protection, including seat belts, been installed on the machines. In most of those accidents, the loader rolled over more than once on slope drops greater than 15 feet. In overturns involving near vertical drops or steep slopes of great length, the value of the safety devices probably are minimal considering the weight of

the machine. In two accidents, the operators could have survived the overturn, but might have drowned in the ponds where the loaders stopped rolling.

TABLE 4. - Probability of prevention of fatal injury with use of roll-over protection and seat belts

Probability	1972 fatals	1973 fatals	1974 fatals	Total	Percent
High	10	12	7	29	55
Moderate	2	6	2	10	19
Low	1	1	0	2	4
Not applicable	5	1	6	12	22
Total	18	20	15	53	100

Two fatalities listed in the table had a very low, if any, chance of being prevented by ROPS. In one accident, the loader went off a 74-foot high face at a quarry. In the other accident, the loader went off an access road and traveled out of control a distance of 568 feet, bouncing and rolling often, before stopping demolished.

The 12 fatal accidents listed as not applicable involved the crushing of 11 workers other than loader operators who, in some manner, were working or walking, or fell into the path of the loader, and one loader operator who drowned.

The distribution in table 5 tends to justify the comments written by several mine inspectors in their fatality reports concerning the lack of operating experience of many of the victims. The operating experience of 11 victims, or 21 percent of the total for 1972-74, apparently was not available to the investigating personnel. Several of the 11 might be expected to fall in the less than 1 year experience category.

TABLE 5. - Operating experience of front-end loader operators involved in fatalities

Years operating experience	1972 fatals	1973 fatals	1974 fatals	Total
<1	2	8	4	14
1 <2	2	1	1	4
2 <3	1	0	0	1
3 <4	0	0	0	0
4 <5	1	2	1	4
>5	3	3	2	8
Unknown[1]	9	6	7	22
Total	18	20	15	53

[1]Includes a total of 11 operator-victims whose experience was not given in the fatality reports and a total of 11 nonoperator victims. Reports of nonoperator fatalities do not give the experience of the operator involved.

The distribution in table 6 parallels that of table 5 with regard to the correlation of the first year of operating experience and the first year of mine experience at the mines where the accidents occurred. Obviously, the

first year of operating a front-end loader is the most critical time for the operator expecially when that year is his first year at a mine.

TABLE 6. - Total experience of loader operator at mine where fatality occurred

Years at mine	1972 fatals	1973 fatals	1974 fatals	Total
<1	2	8	5	15
1 <2	2	2	0	4
2 <3	4	1	1	6
3 <4	1	0	1	2
4 <5	0	2	1	3
>5	4	3	0	7
Unknown[1]	5	4	7	16
Total	18	20	15	53

[1]Includes a total of 5 operator-victims whose experience was not given in the fatality reports and a total of 11 nonoperator victims. Reports of nonoperator fatalities do not give the experience of the operator involved.

According to the distribution in table 7, 14 victims of the 42 who were actually operating the machines were not classified as loader operators, thus prompting the question of operator qualification.

TABLE 7. - Front-end loader fatalities, by occupation of operator

Occupation	1972 fatals	1973 fatals	1974 fatals	Total		Percent
Loader operator	9	12	7	28		= 53
Equipment operator[1]	0	3	0	3		
Truck driver	0	1	2	3		
Foreman	1	1	0	2		
Maintenance man	1	1	0	2	14	= 26
Laborer	0	0	1	1		
Scraper operator	1	0	0	1		
Shovel operator	1	0	0	1		
Rotary operator	0	1	0	1		
Unknown[2]	5	1	5	11		= 21
Total	18	20	15	53		100

[1]Operated more than one kind of equipment.

[2]These are accidents in which the operator was not the victim. Only the victim's occupation is given in the MESA fatality reports.

Table 8 indicates that most of the fatalities are associated with the sand and gravel industry, followed by limestone and traprock mining to a lesser extent.

TABLE 8. - Front-end loader fatalities, by mine product

Product	1972 fatals	1973 fatals	1974 fatals	Total	Percent
Sand and gravel.....	8	13	9	30	56
Limestone.....	5	1	4	10	19
Traprock.....	1	3	1	5	9
Sandstone.....	1	0	1	2	4
Lead-zinc.....	1	0	0	1	2
Phosphate.....	1	0	0	1	2
Salt.....	1	0	0	1	2
Talc.....	0	1	0	1	2
Clay.....	0	1	0	1	2
Copper.....	0	1	0	1	2
Total.....	18	20	15	53	100

The distribution in table 9, as might be expected, indicates that most of the fatalities occurred on the day shift; that being the period of greatest loader activity.

TABLE 9. - Front-end loader fatalities, by time of day

Time of day	1972 fatals	1973 fatals	1974 fatals	Total
8-12 a.m.....	6	6	4	16
12-4 p.m.....	6	5	6	17
4-8 p.m.....	1	3	3	7
8-12 p.m.....	2	0	1	3
12-4 a.m.....	2	2	0	4
4-8 a.m.....	1	4	1	6
Total.....	18	20	15	53

Table 10 presents the distribution of fatalities by age of operator and indicates no trend using data that are not normalized.

TABLE 10. - Front-end loader fatalities, by age of operator

Age of operator	1972 fatals	1973 fatals	1974 fatals	Total
18-20.....	1	1	0	2
21-25.....	2	1	1	4
26-30.....	0	4	1	5
31-35.....	3	1	0	4
36-40.....	0	2	1	3
41-45.....	1	4	3	8
46-50.....	3	3	1	7
51-55.....	1	3	1	5
56-60.....	0	0	1	1
61-65.....	2	0	1	3
Unknown[1].....	5	1	5	11
Total.....	18	20	15	53

[1]These are accidents in which the operator was not the victim. Only the victim's age is given in the MESA fatality reports.

CONCLUSIONS

The following conclusions are based upon data and information available from the fatality reports and from qualified MESA personnel:

1. A reduction of fatalities is immediately possible by installing properly designed roll-over protective structure (ROPS) and seat belts on loaders.

2. Most front-end loader fatal accidents occur as the result of the operator error produced by haste, carelessness, or lack of training or by any combination of all three of these factors, particularly while operating in reverse and while traveling downgrade.

3. Reduction of fatalities can be achieved by providing adequate training for any employee who might be expected to operate a loader in any capacity.

4. The accident reports often cite the lack of berms on roadways and stockpiles. The safety values provided by extensive use of high berms should be stressed to mine operators.

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