IC 8723

Bureau of Mines Information Circular/1976

Roof-Fall Resupport Accidents, A Study

UNITED STATES DEPARTMENT OF THE INTERIOR

Information Circular 8723

Roof-Fall Resupport Accidents, A Study

By Juel H. Stears, John P. Conway, and Robert C. Bates
Spokane Mining Research Center, Spokane, Wash.

UNITED STATES DEPARTMENT OF THE INTERIOR
Thomas S. Kleppe, Secretary

U.S. BUREAU OF MINES
Thomas V. Falkie, Director

This publication has been cataloged as follows:

Stears, Juel H

Roof-fall resupport accidents, a study / by Juel H. Stears, John P. Conway, and Robert C. Bates. [Washington] : Bureau of Mines, 1976.

94 p. : ill. ; 26 cm. (Information circular - Bureau of Mines ; 8723)

1. Mine accidents - Prevention. I. Conway, John P , joint author. II. Bates, Robert C , joint author. III. United States. Bureau of Mines. IV. Title. V. Series: United States. Bureau of Mines. Information circular - Bureau of Mines ; 8723.

TN23.U71 no. 8723 622.06173

U.S. Dept. of the Int. Library

CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS--Continued

TABLES

TABLES--Continued

ROOF-FALL RESUPPORT ACCIDENTS, A STUDY

by

Juel H. Stears,[1] John P. Conway,[1] and Robert C. Bates[2]

ABSTRACT

The Bureau of Mines analyzed data from 47 coal mine roof-fall resupport accidents that occurred from 1966 through 1974 to identify critical hazards and problems. These accidents resulted in 62 injuries or fatalities. It was concluded that the majority of the accidents might have been prevented by observance of recommended practices and use of available technology such as setting temporary supports, adequate roof testing, etc.

Additional work is needed in the following problem areas where present technology is inadequate: (1) warning of impending roof falls shortly before they occur, (2) better methods of detecting unsafe roof and ribs, (3) providing access to and temporary support of high roofs for testing and bolting, (4) reducing the noise level of stopers, (5) developing temporary roof supports that have greater stability and can be remotely installed, and (6) reducing the number of roof falls through better permanent support.

INTRODUCTION

Resupporting previously fallen roof is one of the more hazardous jobs in underground coal mining. Most roof falls are left in place rather than removed because of the danger and expense involved. However, cleanup and resupport is required when roof falls occur in areas that must be kept open, such as haulageways, aircourses, and travel routes. The roof in fall areas is generally less stable than that in normal areas of the mine and, consequently, a greater-than-normal hazard is associated with work on these areas. Roof-to-floor heights often exceed 8 feet, which makes scaling and resupport operations extremely difficult. Temporary support is usually provided by placing long timbers against the roof and wedging them at the bottom. The miners are exposed to falling rocks while installing these timbers. Bolting machines are not designed to operate at these excessive roof heights, and supplementary platforms must often be constructed for bolting.

---

[1]Mining engineer.
[2]Supervisory mining engineer.

Preliminary analyses indicated that approximately 5 percent of the total roof-fall fatalities occurred while resupporting fallen roof. This amounts to about six lives per year. As part of the Bureau's effort to increase coal-mining safety, a study was initiated in an effort to obtain possible insight into the causes of resupport accidents and to develop methods of reducing fatalities. Forty-seven coal mine roof-fall resupport accidents that occurred from 1966 through 1974 were reviewed and summarized. All resupport accidents that could be obtained were included in the study. Resupport accidents are defined as those that occur while removing the fallen material or resupporting the roof or ribs. Several accidents that occurred while performing construction work were included in the analysis. Construction work is defined as that where roof rock is deliberately removed for some purpose such as to provide additional height for overcast construction. In this situation, a roof fall is deliberately contrived. This is similar to natural falls in that the fallen material must be removed and the roof adequately resupported. In addition, the roof may be more dangerous than normal as its structural integrity has been interrupted. Data was compiled from the reports, tabulated by categories, such as State or seam, and analyzed by computer to identify critical hazards and problems. Causes of the accidents such as unsafe actions and conditions as described in the reports, were also tabulated and analyzed. Discussions were held with personnel at several offices of the Mining Enforcement and Safety Administration (MESA) to solicit their views and recommendations regarding the problem. Several mines were visited to observe resupport procedures.

Tables containing the accident statistics and a discussion of these data are presented, along with a suggested resupport procedure as derived from discussions with MESA personnel. A brief summary of each accident plus a sketch of the accident area is presented in the appendix.

ACKNOWLEDGMENTS

The cooperation of MESA personnel in providing advice and assistance is greatly appreciated. Many of the categories used in the statistical analysis of the data are similar to those developed by Theodore Barry and Associates in its study of underground coal mine hazards under Bureau of Mines contract S0110601.

ANALYSIS AND DISCUSSION OF ACCIDENT DATA

Data were compiled from the accident reports and tabulated by categories such as State or seam. Forty-one categories were analyzed. Causes of accidents such as unsafe actions and conditions as described in the reports were also tabulated and analyzed.

The percentage of accidents occurring in various subcategories were calculated, such as different States, month of year, hour of day, etc. In addition, the data for the year were normalized with respect to annual production, and the data for the two categories of State and month were normalized with respect to 1972 production. Unfortunately, data permitting normalization of the other categories were not available. The data for some categories, such as number of underground employees, occurred on a continuous numerical scale. For these cases, the data were ordered from smallest to largest value and a cumulative percentage for each value was calculated. The total is not the same for all tables because complete information was not contained in all of the reports.

It must be remembered in looking at the following statistics that they are for only one class of roof-fall accidents. The intent of an analysis like this is to identify particularly hazardous jobs or weaknesses in ground-control technology. By this, mining research personnel can see where technological improvements are needed and thereby plan their research activities more effectively. Training and enforcement personnel can also see where their efforts might be placed to decrease the number of accidents. This analysis also raises questions like, why should one State appear worse on a production basis than another? Questions like this should lead to a closer examination of these areas by the enforcement personnel or additional data collection by research engineers.

General

Analysis of number of accidents by State indicates that Pennsylvania and West Virginia ranked the highest with 29 percent, followed by Kentucky and Virginia with 23 and 10 percent, respectively (table 1). However, using 1972 production information to normalize the data by forming the ratio of the accident percentage to the production percentage, it is found that Pennsylvania has the highest ratio of 1.7, followed by Tennessee with 1.6. Kentucky and Virginia are in third place with ratios of 1.2. All other States have a ratio less than 1, indicating a better-than-expected performance.

TABLE 1. - Analysis of accident data by State

State	Frequency[1]	Percent	Percentage of 1972 underground production	Ratio of accident percentage to production percentage
Alabama	1	1.6	2.6	0.6
Illinois	2	3.2	10.8	.3
Kentucky	14	22.6	19.3	1.2
Ohio	1	1.6	5.6	.3
Pennsylvania	18	29.0	16.8	1.7
Tennessee	2	3.2	2.0	1.6
Virginia	6	9.7	8.2	1.2
West Virginia	18	29.0	34.7	.8
Total	62	[2]99.9	100.0	-

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.
[2]Total does not equal 100.0 percent of because of individual rounding.

Analysis by number of employees shows the greatest frequency in the smaller mines (table 2). The cumulative frequency values show that 22 percent of the accidents occurred in mines employing 13 or less people. Employment data for 1974 (obtained from MESA records) shows that 15 percent of the miners worked in smaller mines employing 14 or less people. These figures imply that a larger percentage of accidents occur in the smaller mines.

TABLE 2. - Analysis of accident data by number of underground employees

Number of employees[1]	Frequency[2]	Percent	Cumulative percentage	Number of employees[1]	Frequency[2]	Percent	Cumulative percentage
3.......	2	3.4	3.4	171.......	3	5.2	60.3
4.......	1	1.7	5.2	187.......	2	3.4	63.8
7.......	2	3.4	8.6	199.......	1	1.7	65.5
9.......	2	3.4	12.1	207.......	1	1.7	67.2
10.......	4	6.9	19.0	208.......	2	3.4	70.7
11.......	1	1.7	20.7	223.......	2	3.4	74.1
13.......	1	1.7	22.4	246.......	1	1.7	75.9
18.......	1	1.7	24.1	265.......	1	1.7	77.6
19.......	1	1.7	25.9	298.......	1	1.7	79.3
54.......	1	1.7	27.6	305.......	1	1.7	81.0
63.......	2	3.4	31.0	317.......	1	1.7	82.8
81.......	1	1.7	32.8	329.......	2	3.4	86.2
92.......	1	1.7	34.5	333.......	1	1.7	87.9
96.......	1	1.7	36.2	352.......	2	3.4	91.4
104.......	2	3.4	39.7	406.......	1	1.7	93.1
119.......	1	1.7	41.4	430.......	1	1.7	94.8
120.......	4	6.9	48.3	440.......	1	1.7	96.6
130.......	1	1.7	50.0	566.......	1	1.7	98.3
140.......	1	1.7	51.7	654.......	1	1.7	100.0
147.......	1	1.7	53.4	Total..	[3]58	[4]98.9	-
150.......	1	1.7	55.2				

[1]Average number of employees = 168; median number of employees = 135.

[2]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

[3]Total frequency is less than 62 because data for some of the accidents were unavailable. In order to prepare frequency histograms, the available data were considered representative and analyzed without accounting for the "unknowns."

[4]Total does not equal 100.0 percent because of individual rounding.

The data for daily production (table 3) shows that 31 percent of the accidents occurred in mines producing 1,000 tons or less. Employment data for 1974 (obtained from MESA records) show that 30 percent of the total man-hours were worked in mines producing 1,000 tons or less. These figures indicate that the smaller mines have an average accident frequency on a man-hour basis. An additional breakdown of the data, which is not shown in table 3, shows that a reduction in frequency occurred for the smaller mines after passage of the coal mine health and safety act. Of the resupport accidents occurring before 1969, 38 percent were in the smaller mines; only 24 percent of those after 1969 were in the smaller mines.

TABLE 3. - Analysis of accident data by daily production, tons

Daily production,[1] tons	Frequency[2]	Percent	Cumulative percentage	Daily production,[1] tons	Frequency[2]	Percent	Cumulative percentage
8......	1	1.7	1.7	3,400......	2	3.4	59.3
20......	1	1.7	3.4	3,500......	5	8.5	67.8
60......	1	1.7	5.1	3,823......	1	1.7	69.5
75......	1	1.7	6.8	4,000......	1	1.7	71.2
125......	1	1.7	8.5	4,250......	1	1.7	72.9
150......	2	3.4	11.9	4,500......	2	3.4	76.3
160......	1	1.7	13.6	5,000......	3	5.1	81.4
180......	4	6.8	20.3	5,200......	1	1.7	83.1
200......	1	1.7	22.0	5,800......	1	1.7	84.7
250......	1	1.7	23.7	6,000......	1	1.7	86.4
500......	1	1.7	25.4	7,800......	1	1.7	88.1
700......	1	1.7	27.1	8,000......	1	1.7	89.8
1,000......	2	3.4	30.5	8,300......	1	1.7	91.5
1,200......	4	6.8	37.3	9,300......	2	3.4	94.9
1,800......	2	3.4	40.7	9,500......	1	1.7	96.6
2,500......	4	6.8	47.5	10,000......	1	1.7	98.3
3,000......	3	5.1	52.5	12,000......	1	1.7	100.0
3,300......	2	3.4	55.9	Total....	[3]59	[4]98.6	-

[1]Average production = 3,232.0; median production = 3,000.0.

[2]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

[3]Total frequency is less than 62 because data for some of the accidents were unavailable. In order to prepare frequency histograms, the available data were considered representative and analyzed without accounting for the "unknowns."

Time

Analysis by year shows little improvement with time, with a frequency of 0.015 occurring in both 1966 and 1973 (table 4). Production information for 1972 was used to normalize the monthly accident data. The percent accident/ percent production ratios for each month show that September has the highest with 3.1, followed by August and December with 1.5, and April with 1.3 (table 5). All other months have a ratio of 1 or less.

Analysis by day of the week (table 6) indicates that the highest percentage of accidents occurs on Thursday and the lowest percentage on Tuesday (excepting Sunday). Since many mines do not work on Saturday, it is interesting to note that Saturday had the third highest percentage of accidents. One possible explanation is that resupport work is often done on nonproducing shifts. Analysis of time of day showed a peak of 14.5 percent between 8 and 9 a.m. (table 7). The second highest frequency (9.7 percent) occurred during three periods, which were 9 to 10 a.m., 1 to 2 p.m., and 3 to 4 p.m.

TABLE 4. - Analysis of accident data by year

Year	Frequency[1]	Underground bituminous coal production, million tons	Frequency rate per million tons
1966....................	8	533.881	0.015
1967....................	3	552.626	.005
1968....................	4	545.245	.007
1969....................	11	560.505	.020
1970....................	14	602.932	.023
1971....................	8	552.192	.014
1972....................	1	595.386	.002
1973....................	8	525.956	.015
1974....................	5	541.881	.009
Total..............	62	5,010.604	-

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

TABLE 5. - Analysis of accident data by month

Month	Frequency[1]	Percent	Percentage of 1972 production	Ratio of accident percentage to production percentage
January..............	2	3.2	8.3	0.4
February.............	2	3.2	8.3	.4
March................	3	4.8	9.1	.5
April................	7	11.3	8.4	1.3
May..................	4	6.5	8.9	.7
June.................	3	4.8	8.4	.6
July.................	4	6.5	6.9	.9
August...............	8	12.9	8.8	1.5
September............	16	25.8	8.3	3.1
October..............	1	1.6	8.7	.2
November.............	5	8.1	8.5	1.0
December.............	7	11.3	7.5	1.5
Total...........	62	100.0	-	-

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

TABLE 6. - Analysis of accident data by weekday

Day	Frequency[1]	Percent
Not stated	4	6.5
Monday	8	12.9
Tuesday	3	4.8
Wednesday	13	21.0
Thursday	15	24.2
Friday	6	9.7
Saturday	12	19.4
Sunday	1	1.6
Total	62	[2]100.1

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.
[2]Total does not equal 100.0 percent because of individual rounding.

TABLE 7. - Analysis of accident data by time of day

Hour	Frequency[1]	Percent	Hour	Frequency[1]	Percent
12-1 a.m.	1	1.6	1-2 p.m.	6	9.7
2-3 a.m.	1	1.6	2-3 p.m.	3	4.8
3-4 a.m.	1	1.6	3-4 p.m.	6	9.7
5-6 a.m.	5	8.1	4-5 p.m.	3	4.8
6-7 a.m.	2	3.2	5-6 p.m.	3	4.8
7-8 a.m.	1	1.6	6-7 p.m.	2	3.2
8-9 a.m.	9	14.5	7-8 p.m.	2	3.2
9-10 a.m.	6	9.7	9-10 p.m.	2	3.2
10-11 a.m.	2	3.2	10-11 p.m.	1	1.6
11-12 noon	3	4.8	Total	62	[2]99.7
12-1 p.m.	3	4.8			

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.
[2]Total does not equal 100.0 percent because of individual rounding.

Geology

The Pittsburgh seam had the highest percentages of accidents with 21 percent (table 8). The Eagle and Kentucky No. 9 seams were tied for second place with 13 percent each. The seam height data show two peaks, one at 48 inches and the other at 60 inches (table 9). The median was 60 inches, indicating that one-half of the accidents occurred in seams either thinner or thicker than this figure.

Analysis by type of immediate roof indicates that most accidents occurred under shale roof (table 10). This is logical since more coal is mined under shale roof, and shale is a weaker rock than sandstone or limestone and thus more susceptible to failure.

TABLE 8. - Analysis of accident data by seam

Seam[1]	Frequency[2]	Percent	Seam[1]	Frequency[2]	Percent
Black Creek......	1	1.6	Norton............	1	1.6
Brookville.......	2	3.2	Pittsburgh........	13	21.0
Cedar Grove......	3	4.8	Redstone..........	1	1.6
Clintwood........	1	1.6	Rich Mountain.....	1	1.6
Eagle............	8	12.9	Sewanee...........	1	1.6
Freeburn.........	1	1.6	Sewickly..........	1	1.6
Kentucky No. 6...	2	3.2	Stearns No. 2.....	1	1.6
Kentucky No. 9...	8	12.9	Pocahontas No. 3..	3	4.8
Kentucky No. 11..	3	4.8	Freeport..........	5	8.1
Lower Kittanning.	6	9.7	Total........	62	[3]99.8

[1]Accidents occurring on the following seams have been combined: Brookville and Dorothy, Kentucky No. 9 and Illinois No. 5, Lower Kittanning and No. 5 Block.

[2]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

TABLE 9. - Analysis of accident data by seam height

Seam height, in[1]	Frequency[2]	Percent	Cumulative percentage	Seam height, in[1]	Frequency[2]	Percent	Cumulative percentage
24..........	1	1.7	1.7	56..........	1	1.7	42.4
26..........	1	1.7	3.4	58..........	1	1.7	44.1
32..........	1	1.7	5.1	60..........	15	25.4	69.5
36..........	1	1.7	6.8	61..........	1	1.7	71.2
42..........	1	1.7	8.5	62..........	3	5.1	76.3
43..........	1	1.7	10.2	66..........	2	3.4	79.7
44..........	2	3.4	13.6	72..........	4	6.8	86.4
45..........	4	6.8	20.3	78..........	2	3.4	89.8
48..........	6	10.2	30.5	84..........	4	6.8	96.6
50..........	1	1.7	32.2	90..........	1	1.7	98.3
52..........	2	3.4	35.6	96..........	1	1.7	100.0
53..........	1	1.7	37.3	Total....	[3]59	[4]100.2	-
54..........	2	3.4	40.7				

[1]Average seam height = 58.19· median seam height = 60.00.

[2]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

[3]Total frequency is less than 62 because data for some of the accidents were unavailable. In order to prepare frequency histograms, the available data were considered representative and analyzed without accounting for the "unknowns."

TABLE 10. - Analysis of accident data by type of immediate roof

Roof type	Frequency[1]	Percent
Laminated shale	20	32.3
Fractured shale	1	1.6
Sandstone	1	1.6
Sandstone and shale	3	4.8
Coal	1	1.6
Roof coal and shale	4	6.5
Firm shale	5	8.1
Fragile shale	14	22.6
Sandy shale	1	1.6
Not stated	12	19.4
Total	62	[2]100.1

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.
[2]Total does not equal 100.0 percent because of individual rounding.

Job

Analysis by victim's job shows that general laborers, roof bolters, and general supervisors are most frequently killed (table 11). Working supervisors are next, followed by shuttle car operators. This reflects the job types that are involved with resupport operations.

TABLE 11. - Analysis of accident data by victim's job

Job	Frequency[1]	Percent	Job	Frequency[1]	Percent
Continuous miner operator	1	1.6	Shot firer	3	4.8
Continuous miner helper	3	4.8	Shuttle car operator	4	6.5
Cutting machine operator	1	1.6	Timberman	2	3.2
General laborer	8	12.9	Tractor operator	1	1.6
Handloader	3	4.8	Supplyman	2	3.2
Loading machine operator	2	3.2	Working supervisor	5	8.1
Loading machine helper	1	1.6	General supervisor	8	12.9
Mechanic	3	4.8	Autotruck driver	1	1.6
Mainline motorman	1	1.6	Scoop operator	1	1.6
Roof bolter	8	12.9	Miner	2	3.2
			Apprentice miner	1	1.6
			Not stated	1	1.6
			Total	62	[2]100.2

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.
[2]Total does not equal 100.0 percent because of individual rounding.

Analysis by what the victim was doing at the time of the accident showed that the subcategory of "hand-load loose rock" was far in the lead with

21 percent (table 12). Observing operations was second with 10 percent, followed by installing arch supports with 8 percent.

TABLE 12. - Analysis of accident data by what the victim was doing at time of accident

Task	Frequency[1]	Percent
Drill roof	3	4.8
Hand-load loose rock	13	21.0
Operate loading machine	4	6.5
Move cable	1	1.6
Scale roof	2	3.2
Test roof	1	1.6
Operate shuttle car	1	1.6
Supervise	1	1.6
Observe operations	6	9.7
Escaping hazard	1	1.6
Run into dangerous area	1	1.6
Remove rock from cable	1	1.6
Install arch supports	5	8.1
Drill blastholes in fallen rock	2	3.2
Attach chain to debris in fall area	3	4.8
Place explosives on fallen rock	1	1.6
Hang phone wire	1	1.6
Instruct workmen	1	1.6
Unknown	1	1.6
Starting rib pin hole	1	1.6
Clearing site for crib	2	3.2
Returning from unsupported area	1	1.6
Receiving instructions	2	3.2
Operating lifting jack	1	1.6
Charging blastholes	1	1.6
Installing supports	1	1.6
Examining area	3	4.8
Building crib	1	1.6
Total	62	[2]99.7

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.
[2]Total does not add to 100.0 percent because of individual rounding.

Analysis by total mining experience shows that miners with 25 to 30 years experience are most often killed, followed by those with over 30 years experience (table 13). Normalization of these data, for which data are not available, might change the rankings since most of the mining work force is probably in the older age brackets.

Analysis by victim's job experience shows the greatest percentage for miners with 1 to 3 years of experience, followed by those with 1 month to 1 year and 5 to 10 years (table 14).

TABLE 13. - Analysis of accident data by victim's total mining experience

Experience, years	Frequency[1]	Percent
Less than 0.5	3	4.8
0.5-3	5	8.1
3-5	4	6.5
5-10	3	4.8
10-15	4	6.5
15-20	5	8.1
20-25	6	9.7
25-30	11	17.7
Over 30	7	11.3
Not stated	14	22.6
Total	62	[2]100.1

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

[2]Total does not equal 100.0 percent because of individual rounding.

TABLE 14. - Analysis of accident data by victim's experience at his job

Experience, years	Frequency[1]	Percent
Less than 1/12	2	3.2
1/12-1	9	14.5
1-3	11	17.7
3-5	1	1.6
5-10	8	12.9
10-15	5	8.1
15-20	1	1.6
20-25	1	1.6
25-30	1	1.6
Not stated	23	37.1
Total	62	[2]99.9

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

[2]Total does not equal 100.0 percent because of individual rounding.

Analysis by victim's job level showed that the subcategory of worker or operator had by far the highest percentage, followed by equipment helper and general supervisor (table 15).

The ages of the victims ranged from 19 to 64 (table 16). The data show that the greatest frequency occurred for miners that were 43 and 49 years old.

TABLE 15. - Analysis of accident data by job level of victim

Job level	Frequency[1]	Percent
Trainee	1	1.6
Equipment helper	8	12.9
Worker or operator	40	64.5
Working supervisor	5	8.1
General supervisor	7	11.3
Owner	1	1.6
Total	62	100.0

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

TABLE 16. - Analysis of accident data by victim's age

Age, yr[1]	Frequency[2]	Percent	Cumulative percentage	Age, yr[1]	Frequency[2]	Percent	Cumulative percentage
19	1	1.8	1.8	44	2	3.5	57.9
20	1	1.8	3.5	46	2	3.5	61.4
22	2	3.5	7.0	47	1	1.8	63.2
23	3	5.3	12.3	48	1	1.8	64.9
24	2	3.5	15.8	49	5	8.8	73.7
25	1	1.8	17.5	51	1	1.8	75.4
26	1	1.8	19.3	52	2	3.5	78.9
27	1	1.8	21.1	53	1	1.8	80.7
30	2	3.5	24.6	54	1	1.8	82.5
31	1	1.8	26.3	56	2	3.5	86.0
32	1	1.8	28.1	57	1	1.8	87.7
33	1	1.8	29.8	58	1	1.8	89.5
35	1	1.8	31.6	59	1	1.8	91.2
36	2	3.5	35.1	60	2	3.5	94.7
37	1	1.8	36.8	61	1	1.8	96.5
39	3	5.3	42.1	62	1	1.8	98.2
41	1	1.8	43.9	64	1	1.8	100.0
42	1	1.8	45.6	Total	[3]57	[4]100.1	-
43	5	8.8	54.4				

[1]Average age = 41.5; median age = 43.0.

[2]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

[3]Total frequency is less than 62 because data for some of the accidents were unavailable. In order to prepare frequency histograms, the available data were considered representative and analyzed without accounting for the "unknowns."

The crews were engaged in the following tasks when the accident occurred (table 17). Twenty-three percent were removing falls to clear access routes in working areas, nineteen percent were cleaning up falls to maintain haulageways, and thirteen percent were recovering continuous miners. The tasks of cleaning up old entries accounted for 11 percent of the accidents. All other subcategories each contained 5 percent or less of the accidents.

TABLE 17. - Analysis of accident data by the task that the crew was doing at the accident site

Task	Frequency[1]	Percent
Recover cable from under fall..................	3	4.8
Clean up old entry.............................	7	11.3
Mine across an old entry.......................	3	4.8
Clear access route in working area.............	14	22.6
Recover continuous miner.......................	8	12.9
Load roof rock blasted for additional height...	3	4.8
Maintain haulageway............................	12	19.4
Mine in advance area...........................	2	3.2
Load roof rock blasted for overcast............	3	4.8
Clean up fall to reroute air...................	2	3.2
Not stated.....................................	5	8.1
Total....................................	62	[2]99.9

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.
[2]Total does not equal 100.0 percent because of individual rounding.

Supervision

Eighty-four percent of the victims were under section foreman or higher supervision when killed (table 18). In 21 percent of the accidents, the supervisor himself was the victim (table 15). In 65 percent of the accidents, the supervisor was present when it occurred, indicating the dangerous nature of resupport work and the possible willingness on the part of the supervisors and miners to overlook violations of safe working practices or inability to correctly analyze roof conditions (table 19). The supervisor's instructions were not being followed in 8 percent of the accidents (table 20).

TABLE 18. - Analysis of accident data by type of immediate supervision

Type of supervisor	Frequency[1]	Percent
None................................	7	11.3
Crew leader.........................	3	4.8
Section foreman.....................	21	33.9
Shift foreman.......................	2	3.2
Mine foreman........................	20	32.3
Owner acting as foreman.............	7	11.3
Grade foreman.......................	1	1.6
Assistant mine foreman..............	1	1.6
Total...........................	62	100.0

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

TABLE 19. - Analysis of accident data by whether supervisor was present at time of accident

Supervisor present	Frequency[1]	Percent
No	21	33.9
Yes	40	64.5
Not stated	1	1.6
Total	62	100.0

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

TABLE 20. - Analysis of accident data by whether supervisor's instructions were followed

Instructions followed	Frequency[1]	Percent
No	5	8.1
Yes	32	51.6
Definite instructions were not given.	4	6.5
Unknown	21	33.9
Total	62	[2]100.1

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.
[2]Total does not equal 100.0 percent because of individual rounding.

Roof Testing

The roof or rib had been tested in 61 percent of the accidents, and 5 percent of the accidents occurred under untested roof or rib (table 21). The victims themselves, either worker or supervisor, had tested the roof in 23 percent of the accidents (table 22). The supervisor (nonvictim) had tested the roof in another 23 percent of the cases, but no roof test was made for 3 percent of the accidents.

TABLE 21. - Analysis of accident data by whether roof or rib was examined and tested

Roof or rib tested	Frequency[1]	Percent
No	3	4.8
Yes	38	61.3
Unknown	21	33.9
Total	62	100.0

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

TABLE 22. - Analysis of accident data by who last tested the roof

Who tested roof	Frequency[1]	Percent
Not stated	28	45.2
Victim, worker level	8	12.9
Victim, supervisor level	6	9.7
Other worker	3	4.8
Supervisor	14	22.6
No one	3	4.8
Total	62	100.0

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

Exactly how the roof was tested was not stated in 63 percent of the accidents (table 23). A definite statement that the roof had been tested properly by the sound-and-vibration method using a proper tool was made for only 11 percent of the accidents, indicating a possible laxity in proper roof testing. However, in many cases, it is impossible to reach the roof for testing without special equipment after the fall is cleaned up.

TABLE 23. - Analysis of accident data by roof-testing method

Method used	Frequency[1]	Percent
Not stated	39	62.9
Visual test only	4	6.5
Sound and vibration using proper tool	7	11.3
Sound and vibration using improper tool	1	1.6
Sound and vibration using unknown tool	5	8.1
Sound method only	3	4.8
Not tested	3	4.8
Total	62	100.0

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

Twenty-four percent of the accidents occurred under roof that was not considered safe to work under, indicating that unsafe practices are often being followed (table 24). Another 21 percent occurred under roof that had been examined and was considered safe to work under, indicating a need for the application of better roof-testing procedures or equipment.

TABLE 24. - Analysis of accident data by whether roof was considered safe to work under after thorough testing

Considered safe	Frequency[1]	Percent
No	14	22.6
Yes	12	19.4
Not clearly stated	32	51.6
Permanent supports had been installed	4	6.5
Total	62	[2]100.1

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

[2]Total does not equal 100.0 percent because of individual rounding.

Hazard Warning

Most of the miners killed had no warning of impending danger from either fellow miners or from the mine environment (tables 25-26), indicating the need for an impending roof-fall warning device. Some of the miners were warned but had no time to escape; a smaller percentage ignored the warnings. Only 5 percent of the fatalities were working alone when killed (table 27). Three percent of the victims delayed their escape in an effort to save equipment (table 28).

TABLE 25. - Analysis of accident data by whether victim was warned of dangerous situation by other men

Victim warned	Frequency[1]	Percent
No	51	82.3
Yes, ignored	4	6.5
Unknown	2	3.2
Yes, no time to escape	5	8.1
Total	62	[2]100.1

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

[2]Total does not equal 100.0 percent because of individual rounding.

TABLE 26. - Analysis of accident data by whether mine environment gave any warning of impending danger

Victim warned	Frequency[1]	Percent
No	47	75.8
Yes, ignored	2	3.2
Unknown	3	4.8
Yes, no time to escape	10	16.1
Total	62	[2]99.9

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

[2]Total does not equal 100.0 percent because of individual rounding.

TABLE 27. - Analysis of accident data by whether victim was working alone

Victim alone	Frequency[1]	Percent
No	59	95.2
Yes	3	4.8
Total	62	100.0

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

TABLE 28. - Analysis of accident data by whether victim delayed his escape in an effort to save equipment

Escape delayed	Frequency[1]	Percent
No	57	91.9
Yes	2	3.2
Unknown	3	4.8
Total	62	[2]99.9

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.
[2]Total does not equal 100.0 percent because of individual rounding.

Supports

No temporary supports had been set in 65 percent of the accidents, and only one support was used in 11 percent (table 29). Temporary supports were knocked out in 5 percent (three) of the accidents (table 30). One support was knocked out in one of the accidents, and two supports were knocked out in the other two. While this is not much of a problem from the statistical viewpoint, it still indicates a need for better designed temporary supports. One problem with temporary supports is that they are susceptible to being knocked out sideways when located near the edge of a fall.

TABLE 29. - Analysis of accident data by number of temporary supports set

Number of supports	Frequency[1]	Percent
0	40	64.5
1	7	11.3
2	2	3.2
3	1	1.6
4	1	1.6
5	1	1.6
6	2	3.2
Within permanent support	4	6.5
Not stated	4	6.5
Total	62	100.0

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

TABLE 30. - Analysis of accident data by number of temporary supports knocked out by the fall

Number knocked out	Frequency[1]	Percent
None	6	9.7
1	1	1.6
2	2	3.2
None set, or had no bearing on accident	44	71.0
Not stated	9	14.5
Total	62	100.0

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

Analysis of victim's location with respect to supports shows that 87 percent of the accidents occurred beyond the temporary supports (table 31). Three percent of these occurred while the victims were testing roof or setting temporary supports. This indicates that temporary supports are not being installed as they should, and that work is being performed beyond them in violation of safe working procedures. More training in and enforcement of the use of temporary supports is needed. Another 10 percent were killed within temporary and permanent supports, indicating that supports are not adequately supporting the roof in some instances. These data suggest the need for better supports and remote installation techniques.

TABLE 31. - Analysis of accident data by victim's location with respect to supports

Location	Frequency[1]	Percent
Beyond supports unnecessarily	51	82.3
Beyond supports necessarily (test roof, set supports)	2	3.2
Within temporary support	3	4.8
Within permanent support	4	6.5
No supports set; roof considered self-supporting	1	1.6
Not stated	1	1.6
Total	62	100.0

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

In 39 percent of the accidents, the victims were more than 4 feet beyond the supports with one victim being 60 feet from the nearest support (table 32) Analysis by support spacing is not too informative because only four of the victims were within temporary or permanent supports when killed (table 33). The maximum spacing between supports at victim's location for these accidents were 4, 5, 6, and 7 feet.

TABLE 32. - Analysis of accident data by distance from the nearest support when victim was beyond supports

Distance, feet	Frequency[1]	Percent
Victim within supports	7	11.3
1-2	2	3.2
2-3	5	8.1
3-4	4	6.5
4-5	5	8.1
5-6	4	6.5
6-7	3	4.8
7-8	3	4.8
8-9	1	1.6
14-15	2	3.2
17-18	1	1.6
19-20	2	3.2
20-25	2	3.2
50-60	1	1.6
No supports set, roof considered self-supporting	1	1.6
Not stated	19	30.6
Total	62	[2]99.9

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

[2]Total does not equal 100.0 percent because of individual rounding.

TABLE 33. - Analysis of accident data by maximum spacing between supports at victim's location if victim was within supports

Spacing, feet	Frequency[1]	Percent
No supports set or victim outside of them	55	88.7
4	1	1.6
5	1	1.6
6	1	1.6
7	3	1.6
Unknown	3	4.8
Total	62	[2]99.9

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

[2]Total does not equal 100.0 percent because of individual rounding.

Fall Statistics

Analysis by fall location shows that most accidents occur when reopening abandoned areas; maintenance of haulage lines are second in frequency (table 34). The original falls that were being cleaned up at the time of the accident ranged from 5 to 300 feet in length, from 4 to 50 feet in width, and from 6 inches to 30 feet in thickness (tables 35-37). The median values for length, width, and thickness were 46 feet, 19 feet, and 70 inches, respectively. The data show that the size of these falls is quite massive--88 percent were longer than 20 feet, and 81 percent were thicker than 23 inches.

TABLE 34. - Analysis of accident data by fall location

Location	Frequency[1]	Percent
Face area in advance mining..........	9	14.5
Crosscut in advance mining...........	3	4.8
Face area in retreat mining..........	2	3.2
Intersection in retreat mining.......	2	3.2
Mainline haulageway..................	10	16.1
Secondary haulageway.................	2	3.2
Abandoned mine area..................	12	19.4
Entry in advance mining..............	6	9.7
Slope development....................	3	4.8
Construction site....................	2	3.2
Airway...............................	1	1.6
Not stated...........................	10	16.1
Total...........................	62	[2]99.8

[1]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

[2]Total does not equal 100.0 percent because of individual rounding.

TABLE 35. - Analysis of accident data by length of original fall

Length, feet[1]	Frequency[2]	Percent	Cumulative percentage	Length, feet[1]	Frequency[2]	Percent	Cumulative percentage
5.....	1	3.8	3.8	55.....	1	3.8	65.4
20.....	2	7.7	11.5	58.....	1	3.8	69.2
30.....	2	7.7	19.2	60.....	1	3.8	73.1
33.....	1	3.8	23.1	70.....	1	3.8	76.9
34.....	1	3.8	26.9	75.....	1	3.8	80.8
35.....	1	3.8	30.8	80.....	1	3.8	84.6
36.....	1	3.8	34.6	90.....	1	3.8	88.5
38.....	1	3.8	38.5	165.....	1	3.8	92.3
40.....	2	7.7	46.2	240.....	1	3.8	96.2
42.....	1	3.8	50.0	300.....	1	3.8	100.0
50.....	2	7.7	57.7	Total	[3]26	[4]99.2	-
52.....	1	3.8	61.5				

[1]Average length = 67.2; median length = 46.0.

[2]Frequency indicates the number of injuries or fatalities that occurred in each category.

[3]Total frequency is less than 62 because data for some of the accidents were unavailable. In order to prepare frequency histograms, the available data were considered representative and analyzed without accounting for the "unknowns."

[4]Total does not equal 100.0 percent because of individual rounding.

TABLE 36. - Analysis of accident data by width of original fall

Width, feet[1]	Frequency[2]	Percent	Cumulative percentage	Width, feet[1]	Frequency[2]	Percent	Cumulative percentage
4......	1	4.0	4.0	22......	2	8.0	76.0
10......	2	8.0	12.0	24......	1	4.0	80.0
14......	1	4.0	16.0	25......	1	4.0	84.0
15......	3	12.0	28.0	26......	1	4.0	88.0
16......	1	4.0	32.0	28......	1	4.0	92.0
18......	4	16.0	48.0	30......	1	4.0	96.0
19......	1	4.0	52.0	50......	1	4.0	100.0
20......	4	16.0	68.0	Total	[3]25	100.0	-

[1]Average width = 19.9; median width = 19.0.
[2]Frequency indicates the number of injuries or fatalities that occurred in each category.
[3]Total frequency is less than 62 because data for some of the accidents were unavailable. In order to prepare frequency histograms, the available data were considered representative and analyzed without accounting for the "unknowns."

TABLE 37. - Analysis of accident data by thickness of original fall

Thickness, inches[1]	Frequency[2]	Percent	Cumulative percentage	Thickness, inches[1]	Frequency[2]	Percent	Cumulative percentage
6.......	1	3.8	3.8	84.......	2	7.7	61.5
7.......	1	3.8	7.7	90.......	1	3.8	65.4
10.......	1	3.8	11.5	96.......	1	3.8	69.2
20.......	1	3.8	15.4	108.......	1	3.8	73.1
23.......	1	3.8	19.2	120.......	2	7.7	80.8
32.......	1	3.8	23.1	168.......	1	3.8	84.6
36.......	1	3.8	26.9	180.......	2	7.7	92.3
60.......	4	15.4	42.3	198.......	1	3.8	96.2
68.......	2	7.7	50.0	360.......	1	3.8	100.0
72.......	1	3.8	53.8	Total..	[3]26	[4]99.4	-

[1]Average thickness = 91.15; median thickness = 70.00.
[2]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.
[3]Total frequency is less than 62 because data for some of the accidents were unavailable. In order to prepare frequency histograms, the available data were considered representative and analyzed without accounting for the "unknowns."
[4]Total does not equal 100.0 percent because of individual rounding.

The void heights (height of roof above floor in fall area) were given in 34 of the accidents (table 38). These heights ranged from 3 to 30 feet, and 77 percent were higher than 8 feet. This indicates one of the major problems in resupport work; roof at these heights is extremely difficult to reach for testing and resupporting.

TABLE 38. - Analysis of accident data by roof to floor height in fall area

Void height, feet[1]	Frequency[2]	Percent	Cumulative percentage	Void height, feet[1]	Frequency[2]	Percent	Cumulative percentage
3..........	1	2.9	2.9	14..........	2	5.9	61.8
4..........	1	2.9	5.9	15..........	4	11.8	73.5
5..........	1	2.9	8.8	17..........	2	5.9	79.4
6..........	2	5.9	14.7	18..........	1	2.9	82.4
7..........	1	2.9	17.6	20..........	2	5.9	88.2
8..........	2	5.9	23.5	21..........	1	2.9	91.2
9..........	3	8.8	32.4	22..........	1	2.9	94.1
10..........	4	11.8	44.1	25..........	1	2.9	97.1
11..........	1	2.9	47.1	30..........	1	2.9	100.0
13..........	3	8.8	55.9	Total....	[3]34	[4]99.7	-

[1]Average height = 13.0; median height = 13.0.

[2]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

[3]Total frequency is less than 62 because data for some of the accidents were unavailable. In order to prepare frequency histograms, the available data were considered representative and analyzed without accounting for the "unknowns."

[4]Total does not equal 100.0 percent because of individual rounding.

The dimensions of the second or injury-causing fall ranged from 1 to 65 feet long, 1 to 21 feet wide, and 2 to 48 inches thick (tables 39-41). All the distributions are skewed toward the smaller values. The median values are 7.5 feet in length, 5 feet in width, and 8 inches in thickness. About 75 percent of these falls were less than 14 feet long, 7 feet wide, and 12 inches thick. A rock mass this size would contain 98 cubic feet and weigh about 17,000 pounds.

TABLE 39. - Analysis of accident data by length of second fall

Length, feet[1]	Frequency[2]	Percent	Cumulative percentage	Length, feet[1]	Frequency[2]	Percent	Cumulative percentage
1......	1	2.3	2.3	15......	2	4.5	79.5
3......	4	9.1	11.4	16......	1	2.3	81.8
4......	3	6.8	18.2	19......	1	2.3	84.1
5......	2	4.5	22.7	20......	1	2.3	86.4
6......	9	20.5	43.2	21......	1	2.3	88.6
7......	3	6.8	50.0	24......	2	4.5	93.2
8......	2	4.5	54.5	30......	1	2.3	95.5
9......	2	4.5	59.1	31......	1	2.3	97.7
10......	4	9.1	68.2	65......	1	2.3	100.0
13......	2	4.5	72.7	Total	[3]44	100.0	-
14......	1	2.3	75.0				

[1]Average length = 11.5; median length = 7.5.

[2]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

[3]Total frequency is less than 62 because data for some of the accidents were unavailable. In order to prepare frequency histograms, the available data were considered representative and analyzed without accounting for the "unknowns."

TABLE 40. - Analysis of accident data by width of second fall

Width, feet[1]	Frequency[2]	Percent	Cumulative percentage	Width, feet[1]	Frequency[2]	Percent	Cumulative percentage
1......	1	2.3	2.3	8......	2	4.5	81.8
2......	5	11.4	13.6	9......	1	2.3	84.1
3......	6	13.6	27.3	12......	1	2.3	86.4
4......	5	11.4	38.6	14......	3	6.8	93.2
5......	9	20.5	59.1	20......	2	4.5	97.7
6......	5	11.4	70.5	21......	1	2.3	100.0
7......	3	6.8	77.3	Total	[3]44	[4]100.1	-

[1]Average width = 6.5; median width = 5.0.

[2]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

[3]Total frequency is less than 62 because data for some of the accidents were unavailable. In order to prepare frequency histograms, the available data were considered representative and analyzed without accounting for the "unknowns."

[4]Total does not equal 100.0 percent because of individual rounding.

TABLE 41. - Analysis of accident data by thickness of second fall

Thickness, inches[1]	Frequency[2]	Percent	Cumulative percentage	Thickness, inches[1]	Frequency[2]	Percent	Cumulative percentage
2........	2	4.7	4.7	12........	4	9.3	76.7
3........	9	20.9	25.6	13........	1	2.3	79.1
4........	3	7.0	32.6	15........	1	2.3	81.4
5........	2	4.7	37.2	18........	2	4.7	86.0
6........	3	7.0	44.2	21........	1	2.3	88.4
7........	2	4.7	48.8	24........	1	2.3	90.7
8........	1	2.3	51.2	30........	1	2.3	93.0
9........	3	7.0	58.1	36........	1	2.3	95.3
10........	3	7.0	65.1	48........	2	4.7	100.0
11........	1	2.3	67.4	Total..	[3]43	[4]100.1	-

[1]Average thickness = 11.2; median thickness = 8.0.

[2]Frequency indicates the number of injuries or fatalities that occurred in each subcategory.

[3]Total frequency is less than 62 because data for some of the accidents were unavailable. In order to prepare frequency histograms, the available data were considered representative and analyzed without accounting for the "unknowns."

[4]Total does not equal 100.0 percent because of individual rounding.

Unsafe Acts and Conditions

The data were also analyzed with respect to unsafe acts and conditions in order to determine underlying causes. Most of the accidents involved more than one unsafe act, and the number of accidents in which a given unsafe act occurred was counted. The results are shown in table 42.

TABLE 42. - Unsafe acts and conditions involved in accidents

Unsafe act or condition	Frequency[1]
Proceeded beyond supports into area of unsupported roof unnecessarily	38
Roof and ribs not adequately tested	33
No temporary supports set	33
Failure to follow safe procedure (start at supported side of fall, resupport and clean up in cycle)	22
Failure to detect dangerous roof or rib condition (adequate testing supposedly done and area considered safe)	10
Permanent supports not installed as fall cleaned up	9
Did not set enough temporary supports for situation	9
Potentially dangerous rock mass not removed or supported	6
Removal of support without installing a replacement	6
Proceeded under unsupported roof necessarily (to test roof or install temporary supports)	4
Inadequate temporary support that did not prevent the fall	3
Unsafe bolting practice (right to left instead of left to right)	3
Attempting to save machine instead of escaping when a fall was known to be starting	2
Inadequate training for assigned task	2
Inadequate permanent support that did not prevent the fall	2
Continuing to work under working roof without setting additional supports	1
Permanent supports not installed as mining advanced	1
Part of permanent supports omitted	1
Knocked out supports by mistake	1
Use of improper scaling tool	1

[1]Frequency indicates the number of accidents in which a given unsafe act or condition occurred.

NOTE.--Frequencies in this table may not agree with those of previous tables because each event was only counted once per accident. For example, this table gives a frequency of 33 for "no temporary supports set," whereas table 29 gives a frequency of 40 for this situation. The difference occurs because multiple counts were made when more than one victim was involved in an accident in table 29.

Unnecessarily proceeding beyond supports into an area of unsupported roof occurred 38 times. Roof or ribs not adequately tested by sound-and-vibration method occurred 33 times; this includes those instances of failure to detect relatively thin slabs that might reasonably be expected to have been found. Temporary supports were not set in 33 of the accidents. Failure to follow safe procedure occurred in 22 of the accidents. In 10 of the accidents, a thorough sound-and-vibration test failed to detect a dangerous roof or rib condition, and the roof was considered safe. Permanent supports were not installed because the fall was cleaned up in nine of the accidents. Too few temporary supports for the situation were set in nine of the accidents. A potentially dangerous rock mass was not removed or supported in six of the accidents. Removal of support without installing a replacement occurred six times. Proceeding under unsupported roof to test roof or install temporary supports occurred four times. Three of the accidents involved inadequate temporary support and unsafe bolting practice.

Other violations of recognized safe procedures include attempting to save machines, inadequate training or supervision, failure to install all of the permanent supports as work advanced, failure to reset dislodged supports, and use of improper scaling tools.

These data indicate several evident problems. Failure to set temporary supports, working under unsupported roof, and other violations of recommended procedures indicates a willingness on the part of miners and supervisors to take chances and disregard safe working practices. Mining personnel must understand the need for and use available technology such as setting temporary supports, allowing no one to work beyond them, frequent and adequate roof testing by the sound-and-vibration method, barring down rocks that are known to be loose, and following safe resupport procedure. Utilization of recommended practices might have prevented the majority of the accidents.

Two accidents involved the victim delaying his escape in order to attempt saving a machine. Perhaps some additional miner education is needed in this area. In some of the accidents, the miners were digging a trench across the fall to recover buried cables. Adequate protection for these situations could probably be attained by installing posts and crossbars along the trench line.

The high roofs in fall areas create special problems. These heights are often much greater than normal and make the available roof support equipment ineffective. After the fall is cleaned up, it is extremely difficult to reach the roof for testing, scaling, and resupporting. The long timbers used for temporary support are dangerous to place and relatively ineffective. Miners are exposed to both the danger of timber falling over or a piece of rock being jarred loose from the roof while wedging the posts. If the roof is permanently supported with timbers instead of bolts, the problem is more difficult because the fall must be removed before permanent supports are installed.

Another evident problem created by the excessive heights involved is that of rib falls. Ribs can become extremely dangerous in fall areas since they may reach 20 feet or more in height. Adequate temporary support of high ribs is extremely difficult. The most commonly used method consists of lagging the rib behind a row of posts. Permanent rib support is usually provided by bolting the ribs.

Seven accidents in which thorough sound-and-vibration testing failed to detect dangerous roof or rib conditions present a different problem. According to eyewitness reports, the roof had been thoroughly tested by this method and was considered safe to work under. This indicates the need for the use of better roof-testing devices to locate dangerous roof conditions. They should be designed to reach high roofs. In several accidents, it was stated that the roof had been tested before relatively thin slabs (12 inches or less) fell. Whether this indicates that the sound-and-vibration method was not used, whether the roof was not tested at close enough intervals, or whether the sound-and-vibration method did not detect dangerous conditions is unknown. Perhaps the method cannot detect potentially dangerous roof if it is tight. Three of these accidents involved rib falls greater than 1 foot thick (perpendicular to rib). Present testing methods may be unable to detect the presence of thick slabs.

Inadequate temporary supports that did not prevent the fall were involved in two of the accidents. Temporary supports are usually installed on greater spacings than permanent supports to provide working room. Better temporary supports that cover more of the roof area, are less susceptible to being knocked out sideways, and are more adaptable to higher-than-normal roof heights would improve this situation. The miners must still proceed under unsupported roof to install temporary supports. Development of remotely installed supports would eliminate this exposure. In some instances, temporary supports, although installed, were not in the immediate vicinity of the miner. Temporary supports should be maintained close to the miner.

TYPES OF RESUPPORT WORK

Resupport work seems to fall into two main categories, according to the kinds of falls that are cleaned up. The first is where, for one reason or another, the fallen material is loaded out down to the floor before supports are installed. This is usually done with a loading machine with the operator remaining under supported roof, leaving a floor-to-roof height anywhere from 5 to 30 feet in which the miners must work to scale and resupport. Temporary support is usually provided by placing long timbers against the roof and wedging them at the bottom, with the attendant dangers of the timbers falling over or a slab falling from the roof while the miners are in the area. Roof bolting has been done with standard machines up to about 18 feet in height using special drill extensions and a man standing on top of the bolter. However, this is a questionable practice. Roofs higher than this are usually supported by building a set-and-lagging platform and then either cribbing to the roof or installing bolts from the platform.

The second procedure is to support the roof before cleaning up the fall. Many falls have an adequate working height of 3 to 8 feet between the fall top and the roof and are amenable to this procedure. The usual support method is to install temporary support, either posts or posts with crossbars or cribs, and then bolt the roof and ribs with a manual stoper. This is an acceptable practice, with regard to roof control, if adequate temporary support and safe work techniques are used. However, at the present time, manual stopers produce noise levels in excess of the mandatory limitations.

The second procedure is often applied to falls that are too tight against the roof (less than 3 feet) to provide adequate working room. This can create a dangerous situation because the miners must manually clean off the top of the fall to obtain working room before installing temporary supports. This is extremely difficult to do without exposing the miners to unsupported roof. Some form of forepoling should be used in these situations.

SUGGESTED RESUPPORT PROCEDURE

To conduct resupport work in a safe manner, the following procedure appears logical. This procedure can be stated only in general terms because of the highly varying conditions found in underground mines, and each mine manager should modify it to match his conditions.

Resupport work should be under the direct supervision of a qualified individual. This supervision should be constant unless the miners are specially trained to do resupport work. The roof where falls have occurred should be considered more hazardous than normal roof areas of the mine and additional precautions must be taken. The roof in these areas is actually unsupported and must be supported if persons are required to enter such areas, either to travel over the fall or clean it up. Frequent and thorough examinations of roof and ribs should be made in fall areas before and during cleanup operations. Both visual and sound-and-vibration examinations of the roof should be made before installing temporary supports. While testing the roof, the miners should stay within 5 feet of a temporary or permanent support.

Miners must not work inby supported areas without protection. Beginning at the edge of the fall where work is to be started, adequate temporary support should be set on not more than 5-foot centers. These temporary supports should be located so as to provide maximum protection for the miners. A minimum of four posts or jacks should usually be set at a time. Crossbars and posts usually provide better support than individual posts. Only those miners engaged in installing temporary supports should proceed beyond permanent supports until such temporary supports are installed. The temporary supports should be replaced by permanent supports as cleanup work progresses, and additional temporary supports set as work progresses into the fall area. Temporary supports should not be removed without setting a substitute, either a permanent support or another temporary support.

All loose or hanging material must be barred down to avoid possible exposure to falling rock. Where loose material is being taken down, a minimum of two temporary supports on not more than 5-foot centers should be installed between the miner and the material being removed unless such work can be done from an area supported adequately by permanent roof supports.

The support in the roof lip or brow line at the edge of the fall might have been damaged or loosened from the force of the fall. Consequently, additional permanent support should be installed in the lip before starting to clean up the fall. Supplies must be located on that side of the fall from which cleanup is to start. Where it is necessary to load material before supports can be set, such loading should be done from areas of permanent support with all personnel remaining under supported roof at all times.

In summary, good resupport procedure would be to work in proper sequence from the supply location progressively into the fall area. Testing the roof, setting temporary supports, and barring down loose material, followed by permanent support, step-by-step, working from solid roof into the caved area.

CONCLUSIONS AND RECOMMENDATIONS

The majority of the accidents studied might have been prevented by observance of recommended practices and use of available technology such as setting temporary supports, avoiding unsupported roof, adequate roof testing, etc. MESA is actively engaged in education and training of mining personnel and enforcement of safe procedures to improve mine safety.

Additional work is needed to develop solutions in those areas where present technology is inadequate or has not been applied. The problem areas can be briefly listed as (1) warning of impending roof falls shortly before they occur so that personnel can vacate the area; (2) better means for the detection of unsafe roof and ribs; (3) providing access to and temporary support of high roofs for testing and bolting; (4) reducing the noise level of stopers; (5) developing temporary roof supports that have greater stability and can be remotely installed; and (6) reducing the number of roof falls through better permanent support.

APPENDIX.--SUMMARY OF ACCIDENT REPORTS

Every roof-fall accident that results in injury or death to mining personnel is investigated by officials of the responsible Government agency, formerly the Health and Safety Branch of the Federal Bureau of Mines, currently MESA. Forty-seven reports on accidents that had occurred while cleaning up roof falls and resupporting the roof from January 1966 to April 1974 were examined for this study. Most of these accidents resulted in fatal injuries to the persons involved.

The conclusions and recommendations presented are those shown on the original MESA accident reports.

It was considered more informative to present a description of the accidents rather than relying on statistical data alone. As many of the reports are rather lengthy, they were condensed for the sake of brevity. Consequently, a summary of each accident along with a sketch of the accident site follows. The cause of the accident as determined by the investigating officials and their recommendations are also included.

Accident 1--Boone County, W. Va., January 28, 1966

A utility man was killed. He was 52 years old and had 26 years of mining experience, 9 years in his present occupation. The mine was located in the Dorothy seam that averages 84 inches thick. One hundred and eighty-seven underground employees produced 4,000 tons per day of coal. Main and cross entries were driven 18 feet wide. The immediate roof was laminated shale and bone coal, 30 to 60 inches thick. This roof was not uniform in quality, had little beam strength, and required extensive support. The main roof was firm shale, 6 to 8 feet thick, overlain with massive sandstone.

A rock fall that had occurred about 5 months previously was being removed with a loading machine and shuttle car (fig. A-1). A roof-bolting machine was available. The fall was 52 feet long, ranged from 18 feet wide in the entry to 29 feet wide in the intersection, and was 7-1/2 feet high. Four cars of rock had been loaded out on a previous shift, removing about 20 linear feet of the fall, and the roof was supported with roof bolts.

The victim and a coworker had loaded four cars of rock when the foreman came by and instructed them to examine the main roof and take down a piece of rock that was hanging on a roof bolt on the right side of the entry. After the foreman left, they began scaling and breaking the piece of rock on the roof bolt. The victim moved up on the fall, struck upward with his slate bar to sound the roof, and was immediately caught by a rock fall. The second fall measured 14-3/4 feet long, 19-3/4 feet wide, and ranged in thickness from 7 inches to a featheredge.

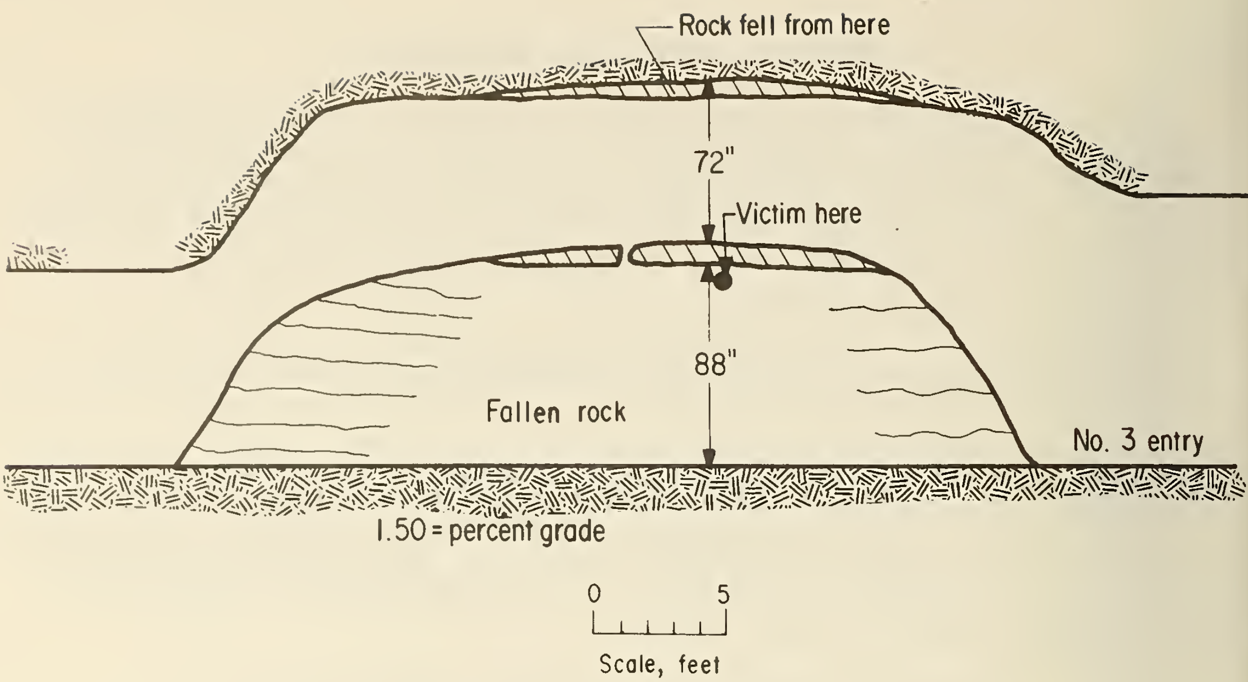

FIGURE A-1. - Accident 1.

Cause

The lack of definite plan of procedures in cleaning up falls of roof was the cause of the accident. The following contributed to the accident: Employees advanced inby permanent roof supports but did not install temporary support; and no preshift examination and suitable on-shift examinations were made in the accident area.

Recommendations

1. A plan of procedures to be followed when loading fallen roof material should be developed for this mine. The procedures should outline the necessary steps to be followed for testing the roof and the installing permanent and temporary roof supports.

2. Officials and employees should not be permitted to work inby permanent roof supports except to make the place safe.

3. A preshift examination should be made by a certified official in all areas of a mine where men are required to work or travel.

4. Thorough on-shift examinations of work areas should be made by certified persons. In addition to visual observations, the roof should be tested by the sound-and-vibration method during such examination. On-shift examinations should be made as often as necessary for the safety of employees.

Accident 2--Wise County, Va., March 19, 1966

One man was killed. The victim was 43 years old and had 24 years of mining experience, the last 5 years as a shot firer. The mine was located in the Norton coalbed that averages 32 inches thick. Seven underground employees produced 60 tons per day of coal. Entries were driven 22 feet wide. The immediate roof was fragile, slippery shale composed of two separate layers, each about 6 inches thick; the main roof was firm sandy shale or sandstone. The roof support plan required permanent posts, with crossbars where thought necessary, to be set on 4-foot centers on each side of the roadway to within a few feet of the face.

The crossbars at the accident location indicated considerable weight, and a decision was made to correct the condition by removing some of the crossbars and taking down the loose roof (fig. A-2). The outby crossbar was removed, and the legs on the right side were removed from three additional crossbars. Considerable roof was barred down. Two 1-1/2-ton mine cars were loaded out, and two large pieces of rock were pulled out with a locomotive. After loading the second car, two men removed a permanent timber on the left side of the roadway and set a safety post near the center of the rock brow, which they intended to leave in place and support with permanent timbers. A break in the roof was visible at this location. Some loose rock remained on the mine floor, and the two men were in the process of breaking and removing the rock when the roof fell without warning. The fall dislodged the three partially supported crossbars and the one safety post. The fall was 23-1/2 feet long, 6-6/10 feet wide, and up to 6 inches thick.

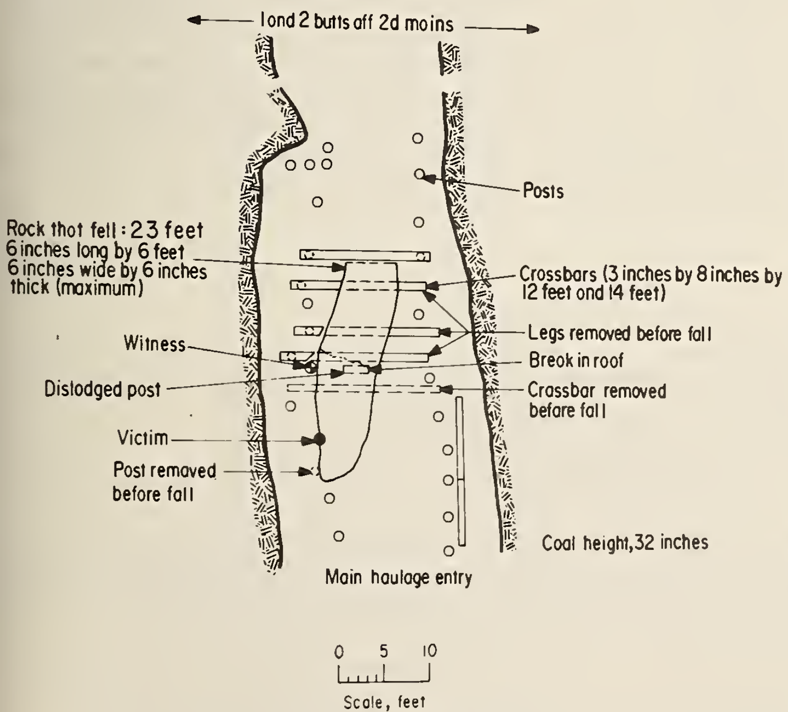

FIGURE A-2. - Accident 2.

Cause

This accident was caused by failure to install sufficient temporary roof supports while working in an area that was known to contain faulty roof. Failure to ascertain and carefully examine the roof was probably a contributing factor.

Recommendations

1. No person should work or be permitted to work under unsupported or inadequately supported mine roof.

2. When a known loose roof condition exists, sufficient temporary roof

supports should be installed to protect the workmen before any work is started to correct such condition.

3. A thorough and complete examination of the roof should be made before work is started and at frequent intervals thereafter; and, if dangerous conditions are found, they should be corrected promptly before any other work is done.

Accident 3--Jefferson County, Ohio, May 27, 1966

A shuttle car operator was killed. He was 44 years old and had 27 years of mining experience, 3 months at this occupation. The mine was located in the Lower Kittanning seam that averages 52 inches thick. One hundred and nineteen underground employees produced 3,333 tons per day. Entries were driven 16 feet wide. The immediate roof was firm shale and sandstone, and generally it was not difficult to support.

A loading-machine operator and the victim were assigned to load out an old fall to clear the area for the development of a new section and the erection of an overcast (fig. A-3). The fall had occurred several years ago and measured 70 feet long and the entire width of the entry. The sixth shift of cleanup work was being done at the time of the accident, and the fall had been loaded out for distance of about 60 feet. The equipment had been idled for most of the sixth shift from mechanical failure. Repairs had been made, and the second shuttle car had been loaded. The loading-machine operator signaled the victim to drive the shuttle car away. The victim turned and seated himself to pull away from the loading machine when rock from the roof and rib fell on him. The piece of rock that fell on the victim was sandstone, and measured 10 feet long, 6 feet wide, and 30 inches thick. The roof height at the accident location was 84 inches. The roof in the fall area had been originally bolted. However, the fall extended above the anchorage point of the bolts, and the roof had not been resupported in the accident area. Subsequent examination disclosed that roof and ribs where the men were working were unsafe.

Cause

Working under unsupported loose roof and in proximity to loose ribs was the direct cause of this accident. Failure to properly evaluate the true condition of the roof and ribs was a contributing factor.

Recommendations

1. The roof and ribs in all working places should be supported adequately to protect employees from falls of roof and ribs, and no person should be permitted to work or go under unsupported loose roof or overhangs.

2. A more careful examination of the roof and ribs should be made by officials and employees so that a true evaluation of the roof and ribs can be made; all loose overhangs should be either supported or taken down.

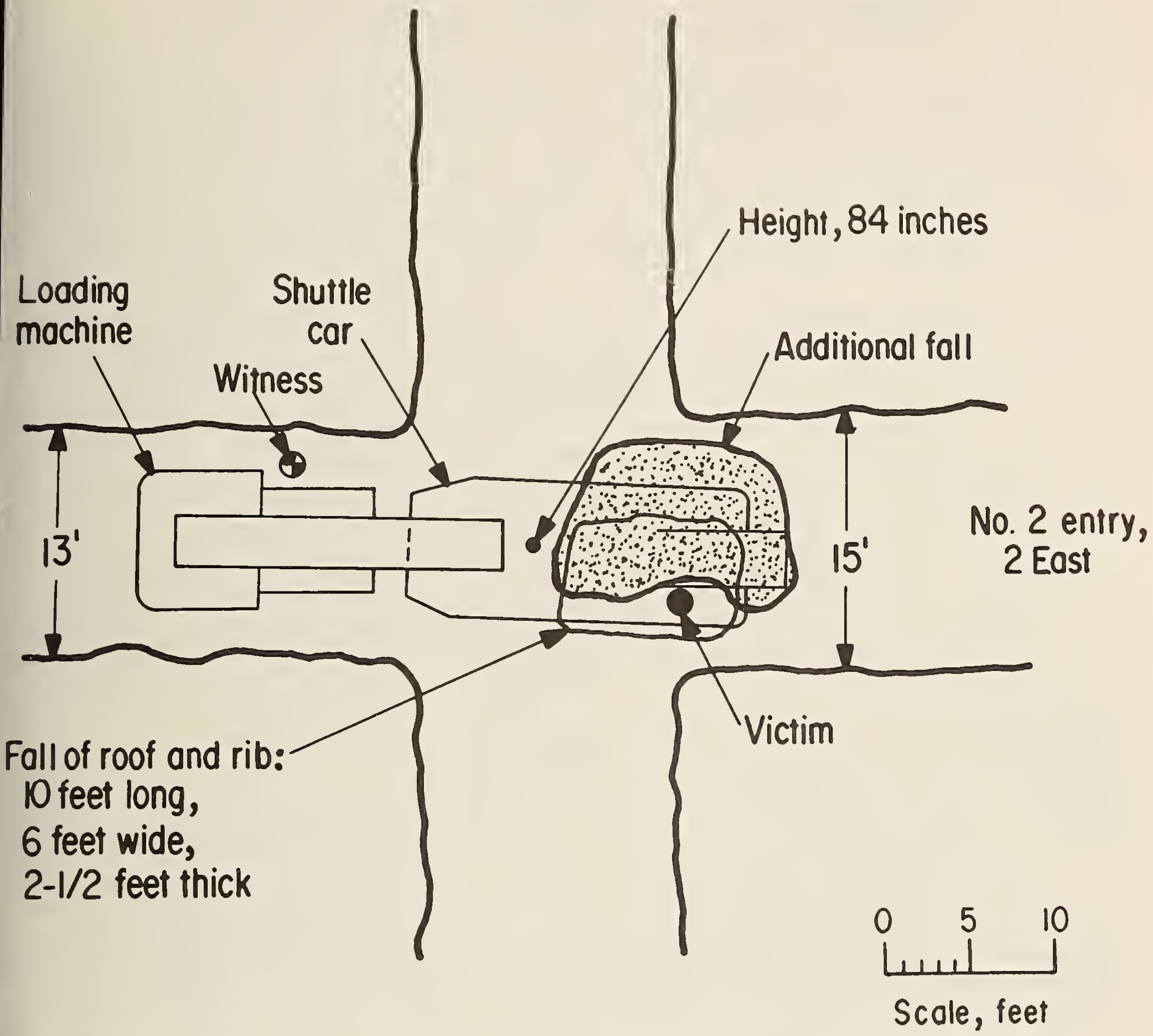

FIGURE A-3. - Accident 3.

Accident 4--Ohio County, Ky., June 3, 1966

One man was killed. He was 61 years old and had 30 years of mining experience. He was regularly employed as a shot firer and was assisting in the removal of a rock fall at the time of the accident. The mine was located in the Kentucky No. 9 seam that averages 60 inches thick. Thirteen underground employees produced 150 tons per day of coal. The immediate roof consisted of shale with occasional slips. The intersection in the area where the accident occurred had not been bolted owing to a defective electric switch on the bolting machine. This intersection and the adjacent crosscut subsequently caved.

After making several roof tests that failed to reveal any unusual conditions, the miners attempted to free, by breaking and moving rock, two trailing

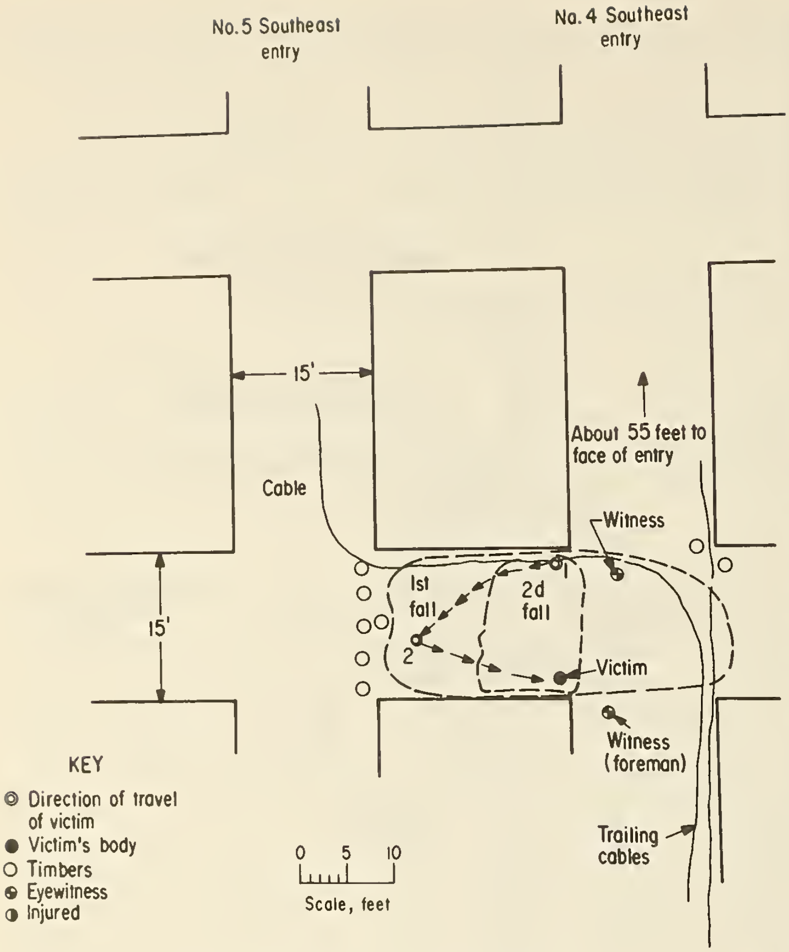

FIGURE A-4. - Accident 4.

cables caught under the fall (fig. A-4). They were working under the supervision of the mine foreman. When roof in the crosscut began working, the foreman instructed the miners to "get in the clear" and to observe the roof and attempt to determine what section of the roof was working. The victim walked from the right side of the crosscut (No. 1 position on the sketch) to the No. 5 entry side of the crosscut (No. 2 position) and informed the foreman that he was "in the clear." For no apparent reason, he ran from this position behind the oncoming fall directly into the path of the fall. The second fall measured 9-1/2 feet long, 14 feet wide, and from 0 to 30 inches thick.

Examination after the accident revealed a hidden slip plane nearly the width of the crosscut, angling upward about 45° from the middle of the crosscut toward the No. 4 entry. Considering the hidden slip and the dimensions of the rock that fell, it is doubtful if testing would have disclosed the condition.

Cause

Failure to install roof bolts at the intersection in accordance with the company's roof support plan was the direct cause of the accident. Failure to maintain the roof-bolting machine in operating condition was a contributing factor.

Recommendations

1. The company's roof-bolting plan, which requires clusters of four or more bolts at intersections, should be complied with at all times, and no work should be permitted in such areas until roof-bolting has been completed.

2. Electric equipment should be inspected as often as necessary to assure safe operating conditions, and any defect found should be corrected promptly.

Accident 5--Logan County, W. Va., August 20, 1966

One man was killed. He was 39 years old and had 11 years of mining experience as a general laborer. The mine was located in the Cedar Grove seam that averages 66 inches thick. Two hundred and seven underground employees produced 5,800 tons per day of coal. Main and cross entries were driven 22 feet wide. Pillars were being extracted in the area. The immediate roof was a medium-to-hard shale that ranges from 2 to 30 feet thick and sounds drummy when tested; the main roof was massive sandstone and shale beddings.

A massive fall had occurred on the previous shift in an intersection of the No. 3 entry (fig. A-5). The fall measured 20 feet long, 30 feet wide, and 18 to 28 inches thick. It covered the trailing cables of the face equipment. Coal production had been resumed after determining that the cables were not damaged. The victim and another miner were assigned the job of removing the trailing cables from under the fallen rock. Upon arrival at the fall area, they tested the roof, found it to be drummy, and set five or six safety posts on top of the rock and against the roof. They drilled 10 vertical holes in the fallen rock with a jackhammer, charged the holes, and fired them. They returned to the area and made a visual examination of the blasted rock. They retightened one safety post that had been loosened by the blast but did not replace two other posts that had been dislodged. The victim examined the roof with an ax and did not think it necessary to replace the two posts. The two men started removing the blasted rock, working on opposite sides of the trough. The two miners continued working for about 1-1/2 hours, during which time the roof was working badly. Suddenly the roof gave a big bump and a large piece of rock fell on the victim, who was on his knees pulling on a cable. The second fall measured 4 feet long, 14 feet wide, and 4 inches thick. The two safety posts that had been dislodged by blasting and not reset were in the vicinity of the second fall. The roof had not been tested for about 2 hours.

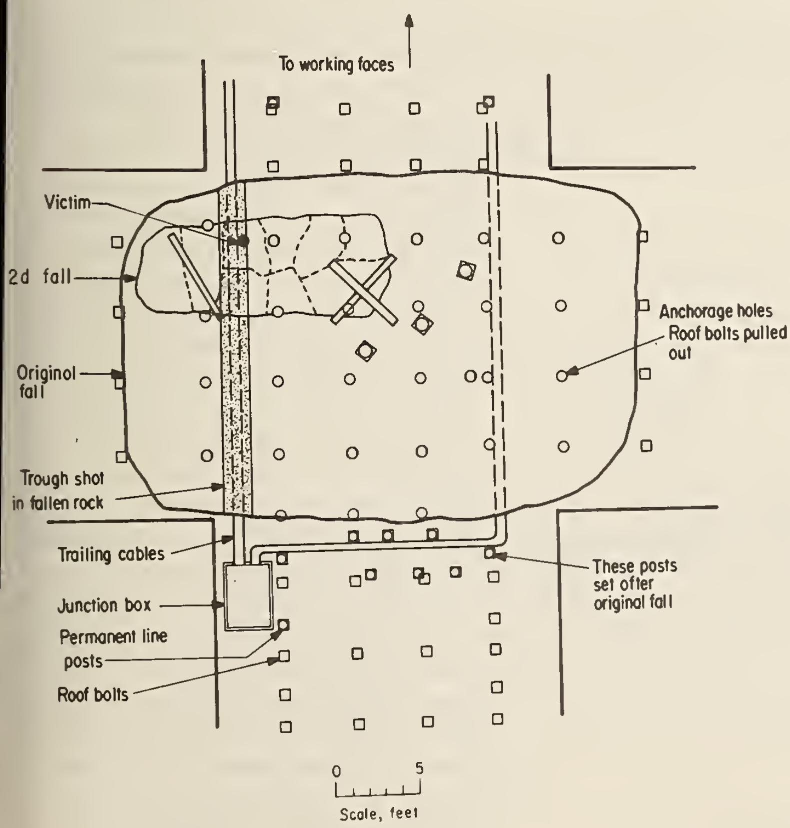

FIGURE A-5. - Accident 5.

Cause

Failure to reset promptly the temporary roof supports dislodged by blasting was the cause of the accident. Failure to properly evaluate a dangerous roof condition, and failure to examine the roof periodically and take corrective action were contributing factors.

Recommendations

1. Roof supports dislodged accidentally should be replaced before other work is performed.

2. Thorough and careful roof tests should be made using all the faculties of sight, sound, and vibration by workmen and officials at frequent intervals during the working period so that any change that might occur in the condition of the roof may be detected and corrective measures applied promptly.

Accident 6--Fayette County, Pa., December 9, 1966

A coal loader was killed. He was 56 years old and had 20 years of mining experience. The mine was located in the Pittsburgh seam that averages 95 inches thick. Eighteen underground employees produced 125 tons per day, manually loaded. Mining consisted of recovering barrier and chain pillars along the main entries. The working places were driven about 12 feet wide. The immediate roof consisted of 12 inches of roof coal overlain with 10 inches of draw rock, 10 inches of wild coal, and about 10 inches of shale; the main roof was sandstone.

The victim and two other miners had been instructed to timber, scale down loose roof material, and load the remaining gob material where the No. 4 room crosscut intersected an old entry that had caved 13 feet high (fig. A-6). All three miners had worked in the No. 4 room crosscut the previous day, loading five 2-ton cars of material. Prior to loading operations, the miners installed the inby crossbar and scaled down loose roof material in the old entry. During this time, the mine foreman visited the area on three occasions. He stated that conditions were normal; loose material was not observed, and he considered the place safe. On his last visit, the foreman suggested that another crossbar be installed and another safety post set. After eating lunch, the victim entered the accident area alone to prepare a place to set the safety post. Immediately after entering the area, he

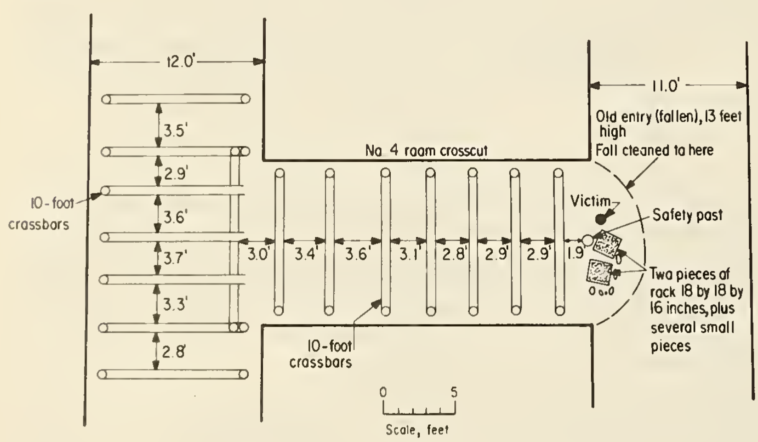

FIGURE A-6. - Accident 6.

was caught by a roof fall. There were no eyewitnesses to the accident. It was the concensus of the investigating committee that the victim was scaling loose roof material with a coal shovel when the fall occurred. The two large pieces of slickensided rock that struck the victim measured 16 inches long, 18 inches wide, and 18 inches thick.

Cause

Working inby the last permanent roof supports and attempting to pry down loose roof material with a coal shovel was the cause of the accident. Failure to evaluate properly dangerous roof conditions was a contributing factor.

Recommendations

1. No personnel should travel inby or perform any work under unsupported roof.

2. A thorough and complete examination of the mine roof, both visually and by the sound-and-vibration method, should be made at frequent intervals so that a true evaluation of the mine roof can be made.

3. When it is necessary to bar down loose material, only a bar of proper length should be used.

4. Extreme caution should be exercised where working places intersect abandoned areas and roof conditions have been subjected to weathering and/or deterioration.

Accident 7--Campbell County, Tenn., December 17, 1966

A coal loader was killed. The victim was 48 years old and had 26 years of mining experience. The mine was located in the Rich Mountain seam that ranges from 20 to 26 inches thick in the mine. Eleven underground employees produced 75 tons per day of coal. Entries were driven 14 to 18 feet wide. The immediate roof was firm shale. About 18 inches of roof rock was taken along the entries for additional height; this roof was then considered self-supporting.

A crew of seven men was taking roof rock at the entrance to the No. 2 room turnout off the No. 5 Left entry for additional height, so that a new shaker-conveyor drive could be installed (fig. A-7). About 18 inches of roof rock had already been taken in the No. 5 Left entry to the inby end of the No. 2 room turnout. A previously drilled blasthole was charged and fired, and, reportedly, all loose material was taken down in the blasted area. The foreman tested the roof and considered it safe. Five crewmen had begun loading rock on the pan line when a slab of rock fell on the victim. The rock measured 5 feet 8 inches long, 5 feet 4 inches wide, and 6 inches thick in the center, tapering to a featheredge.

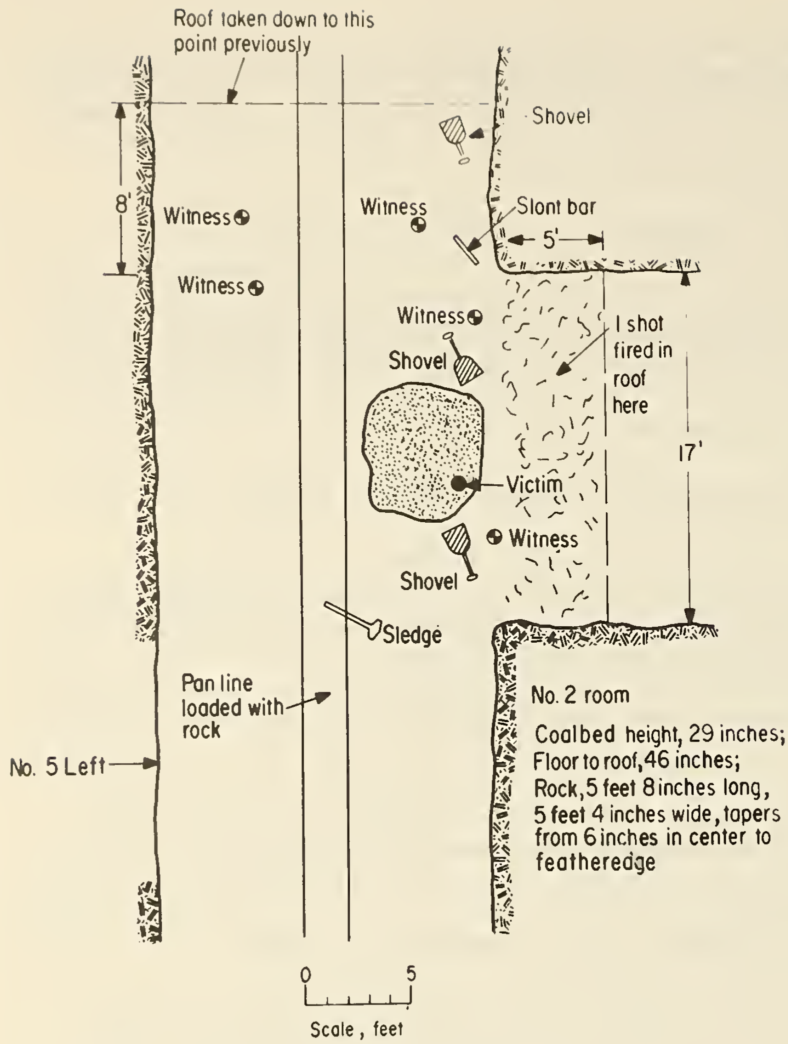

FIGURE A-7. - Accident 7.

Cause

This accident was caused by an error in judgment by the foreman and the workmen in not determining the true condition of the roof. A possible contributing factor was the blasting of roof in an unsupported area.

Recommendations

1. A more careful and thorough examination of roof should be made by the foreman and workmen.

2. Temporary posts should be set before any work is started as a precaution against hidden dangers, especially after a roof is blasted.

<u>Accident 8--Greene County, Pa., December 20, 1966</u>

A general laborer was injured so severely that he died 14 days later. He was 54 years old and had 29 years of mining experience. The mine was located in the Sewickly seam that averages 56 inches thick. One hundred and thirty underground employees produced 3,000 tons per day of coal. Entries were driven 18 feet wide.

A previous 6-foot-high fall had been partially cleaned up (fig. A-8). The victim, acting as roof-bolting machine operator, and a second miner, acting as his helper, were assigned to install additional support in the roof brow near the cavity. They installed four 3- by 8-inch by 16-foot planks near the edge of the roof cavity and drilled a hole in an overhanging lip at the edge of the cavity so that it could be blasted down. The victim then trammed the bolting machine farther ahead and started to remove a roof bolt that was still intact on the inby edge of the lip. His helper saw the overhanging lip start to move and shouted a warning. The victim was tramming the machine backwards when he was struck by a piece of shale rock and pinned against the machine. The piece of rock measured 13-1/2 feet long, 4-3/4 feet wide, and 6 inches thick, tapering to a featheredge. The fall dislodged a roof jack on the left

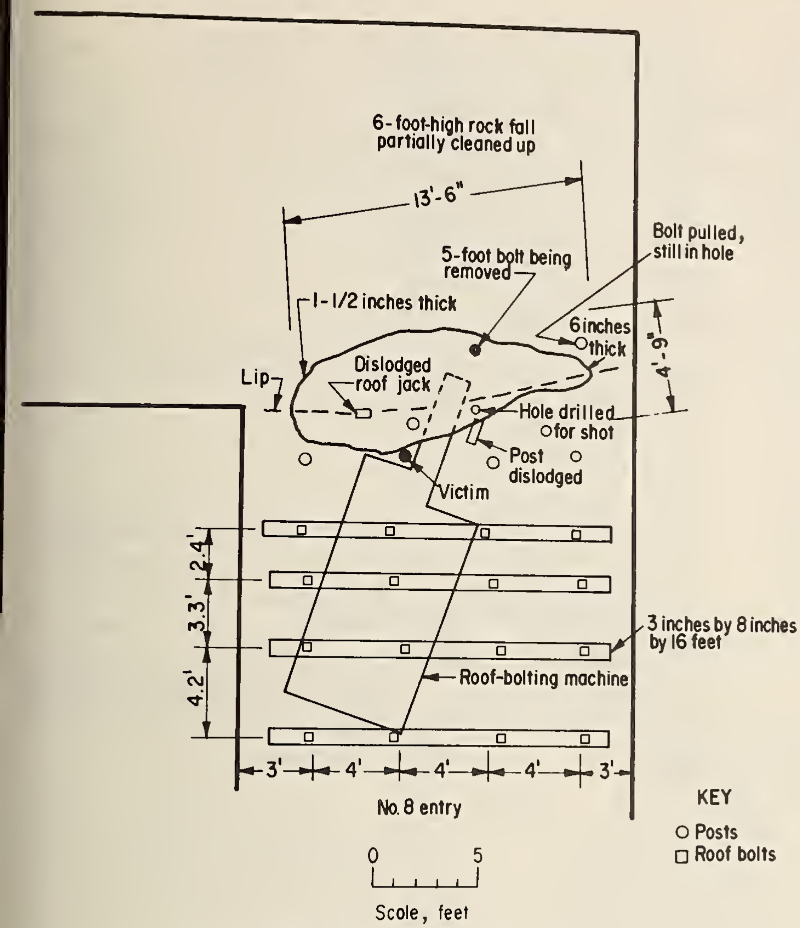

FIGURE A-8. - Accident 8.

side of the bolting machine and a safety post on the right side. The victim had not been instructed to remove any roof bolts; it is believed that he was trying to remove the bolt to aid the blasting operation.

Cause

This accident was caused by failure to provide adequate temporary roof support before permanent supports (roof bolts) are removed. Failure to evaluate a dangerous roof condition was a contributing factor.

Recommendations

1. Permanent roof support should not be removed unless equivalent protection is provided.

2. Persons should not advance or perform any work inby the last temporary roof supports.

3. All persons should practice extreme caution when working in areas where abnormal roof conditions exist.

Accident 9--Barbour County, W. Va., April 17, 1967

One man was injured so severely that he died 8 days later. He was 31 years old, had 5 years of mining experience, and 3 years as an autotruck driver and general laborer with this company. The mine was located in the Pittsburgh seam that averages 78 inches thick in the work area. Nine employees produced 200 tons per day of coal. Entries were driven 16 feet wide. The immediate roof was 8 to 12 feet of soft shale; the main roof was sandstone.

The crew of six men and the mine foreman were cleaning up a roof fall along the belt haulageway (fig. A-9). After completing his assigned duties on the surface, the victim joined the cleanup crew to complete his shift. Because of the restricted working room, the victim and two other miners were working on top of the fall, shoveling rock into the crosscuts. A piece of rock 30 inches long, 16 inches wide, and 6 inches thick fell from the cavity and struck the victim. A second miner, working alongside the victim, suffered

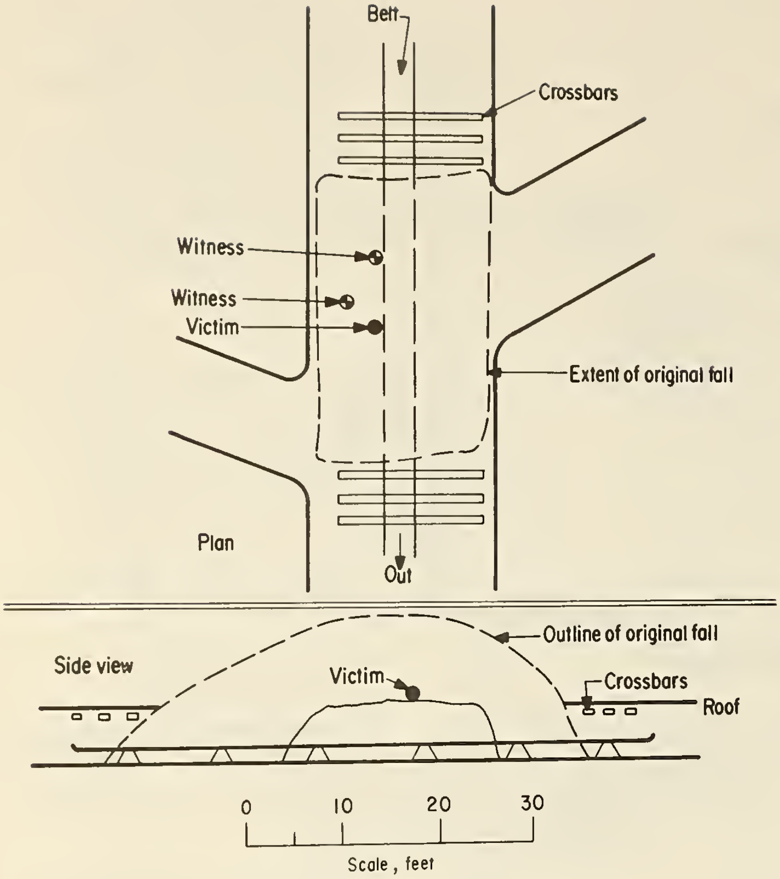

FIGURE A-9. - Accident 9.

a slight bruise on his leg. Reportedly, the mine foreman examined the roof in the accident area several times and had it scaled two or three times during the shift.

Cause

This accident was caused by working under unsupported roof.

Recommendations

1. The roof of all active underground haulageways should be supported adequately to protect workmen from roof falls. Workmen should not advance beyond the protection of supported roof.

2. Officials and employees should make a careful, thorough evaluation of existing roof conditions.

Accident 10--Logan County, W. Va., December 28, 1967

A utility man and a continuous-miner operator's helper were killed by a fall of rib rock while working to recover a continuous-mining machine buried under a roof fall that occurred 4 days earlier. The utility man was 43 years old and had 29 years of mining experience, several years as utility man. The other miner was 33 years old and had 14 years of mining experience, 1 year and 5 months as a continuous-miner operator's helper. The mine was located in the Eagle seam that averages 62 inches thick. One hundred and four underground employees produced 1,800 tons per day of coal. The section was engaged in retreat mining. The immediate roof was composed of 15 inches of weak shale, which is often taken or comes with the coal, 20 inches of dark shale, 103 inches of firm gray shale, and 40 inches of weak strata consisting of alternate beddings of shale and coal. This is overlain by firm sandy shale of undetermined thickness.

The recovery crew was continuing the work needed to uncover a continuous-mining machine and roof-drilling machine (fig. A-10). This equipment had been covered by a roof fall that had occurred 4 days earlier, during the preceding weekend. This fall was 300 feet long, 20 feet wide, and 15 feet high.

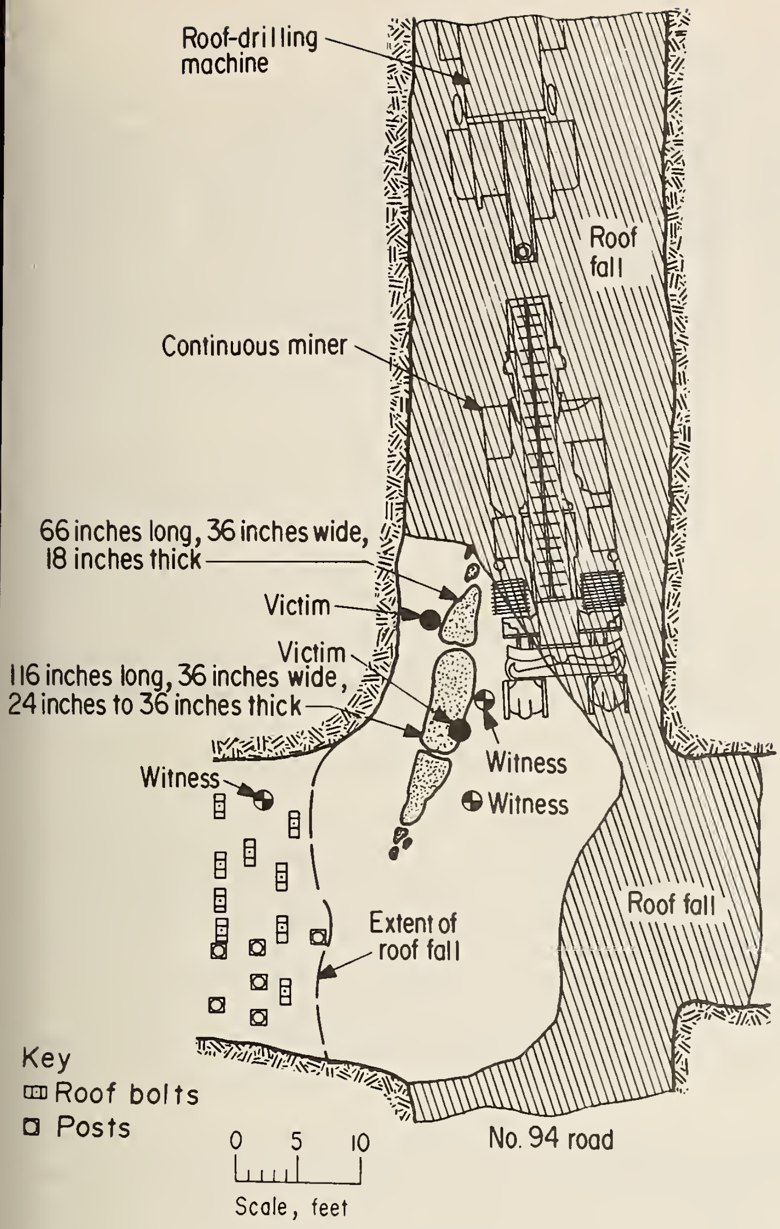

FIGURE A-10. - Accident 10.

Recovery work had progressed to where the front end of the continuous-mining machine was partially exposed. The two victims and a third miner, using picks and steel bars, were working loose rock off the machine, scaling visible loose ribs and roof, and gouging holes in the tight, fallen rock for blasting. Rock fell from the rib of the cavity (just above the coalbed), catching the two victims and brushing the third miner. The piece of rock that struck one victim was 66 inches long, 36 inches wide, and 18 inches thick. The second victim was caught by a piece measuring 9 feet 8 inches long, 3 feet wide, and 24 inches to 36 inches thick.

The work was being done under direct supervision of a superintendent. The superintendent and a third miner stated that signs of rib weakness were not observed, and that all visible loose rock was scaled as it was exposed. They did not detect audible sounds of rib action until just before the fall occurred. The ribs had been tested by the sound-and-vibration method and were considered safe.

It was observed that remanants of room pillars were left standing and provided the major resistance to a needed pillar fall in the room area. It appeared that excessive roof stresses inherent with hanging pillar falls impinged on the entry pillars in the abutment zone and caused the extensive roof fall that covered the equipment.

Cause

The accident resulted from forces initiated and developed by substandard pillar extraction. The intensification of stresses in the abutment zone that led to a major roof fall and entailed the recovery of buried mining equipment was not detected or recognized; it culminated in the failure of the rib, which was not deemed dangerous and was not secured by artificial means.

Recommendations

1. Sufficient timbers and/or roof bolts should be used to shore up and contain extensive exposed ribs subjected to intensive stresses.

2. Every effort should be made to remove all coal or nullify the capacity of pillar remnants to detail pillar falls and prevent the impingement of excessive roof stresses upon active areas.

3. Officials should make frequent examinations of extensive exposed ribs in stressed areas, using all the faculties of sight, sound, and vibration to detect dangerous conditions promptly. When such conditions are found, corrective measures should be taken immediately or the place should be dangered off.

Accident 11--Cambria County, Pa., February 5, 1968

One man was injured so severely that he died 7 days later. The victim was 59 years old and had 31 years mining experience, 7 years as a roof bolter. The mine was located in the Lower Kittanning seam that averages 60 inches thick. Three hundred and fifty-two underground employees produced 3,370 tons per day of coal. A ripper-type continuous-mining machine was used on the section. Entries and crosscuts were 14 feet wide. A major fall measuring 58 feet long and 16-1/2 feet high had previously occurred in the No. 3 entry. The roof in the fall area consisted of unconsolidated soft shales, coal, and fire clay.

The section foreman had visually examined the roof early in the shift. Twelve shuttle cars of rock had been loaded out (fig. A-11). The edge of the fall was 15 feet inby the last permanent arch support, and the operator controls of the loader were 5 feet inby this support at the end of the loading cycle. The crew was in the process of installing a yieldable steel arch support. The victim was standing at the right center of the arch cap and balancing the arch cap, which was being supported with a 4-inch by 5-3/4-inch by 13-foot-long timber used as a forepole. The forepole was attached to the underside of the two adjacent arch caps already installed. Three other men were installing spacers when a piece of rock fell onto the arch cap. The rock knocked the arch to the floor and came to rest on top of it with the victim being caught under the arch. The piece of rock was 5 feet long by 4-1/2 feet wide by 12 inches thick. The arch cap was 12-1/4 feet long and weighed 206 pounds.

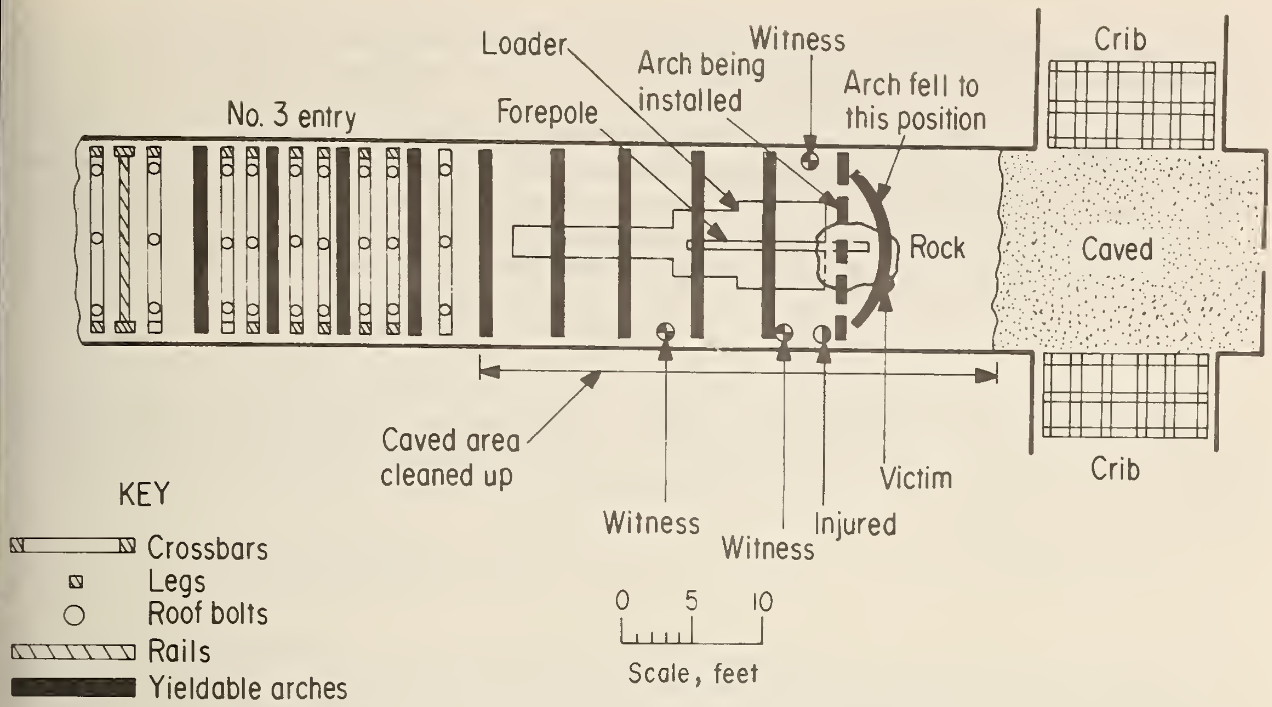

FIGURE A-11. - Accident 11.

Cause

Working under unsupported loose roof was the direct cause of the accident.

Recommendations

1. Only enough of the fallen material should be removed to allow work space to permit roof scaling, roof bolting, or crown timbering before any other work is done.

2. A more thorough examination and evaluation of roof conditions by workmen and officials should be made, especially when abnormal conditions are present.

3. In areas where abnormal roof is encountered, no person should advance beyond artificially supported roof, except to test the roof or to set temporary supports.

Accident 12--Washington County, Pa., August 14, 1968

A utility man, whose duties included the operation of loading machines, was killed. He was 49 years old, had 20 years of mining experience, 12 years as loading-machine operator. The mine was located in the Pittsburgh seam that averages 60 inches thick. Three hundred and thirty-three underground employees produced 9,500 tons per day of coal. Entries were driven 18 feet wide; crosscuts and rooms were not more than 20 feet wide. The No. 2 West entries off No. 1 South Mains had been idle for more than a year. Rehabilitation work, which included cleaning up roof falls, installing roof supports, and extending the haulage track, was in progress in the No. 4 entry, No. 2 West.

The work of rehabilitating and extending the track in the No. 4 entry required cleaning up several roof falls and installing roof support. The general foreman examined the roof in the area but detected no unsafe conditions. He then instructed the victim and a second miner to set a safety post along the right rib, on the loading-machine operator's side, ahead of the operator. After instructing the two miners to make the place safe as they advanced with the loading, the foreman left for other parts of the mine.

The victim, operating the loading machine, and the second miner, operating the shuttle car, loaded eight shuttle cars of rock during the next 4 hours. During this period, they had examined the roof several times and advanced the safety post twice. The victim had just finished loading a car of rock when the roof fell on him.

Cause

Working in an area of inadequately supported roof was the cause of this accident. Contributing factors could have been the failure to (1) examine and thoroughly test the roof, (2) to properly evaluate a dangerous condition, and (3) to remove and reset the safety post without first installing other roof supports.

Recommendations

1. The roof in all underground working places where necessary should be secured sufficiently to protect employees from falls of roof.

2. More careful and thorough examinations and tests of the roof should be made in order to properly evaluate the roof conditions, especially where abnormal roof conditions are evident.

3. Installed roof supports should not be removed, such as removing and advancing the safety posts, unless equivalent protection is provided.

4. Closer and stricter attention should be given to roof conditions and roof support practices by all supervisors and workmen.

Accident 13--Jefferson County, Ala., September 8, 1968

A mine operator was killed instantly by a roof fall. The victim was 47 years old and had 29 years of mining experience. The mine was located in the Black Creek seam that averages 24 inches thick. Four underground employees produced 8 tons per day of coal. The mine was in an early development stage, and the main entry had been driven about 60 feet. The immediate roof was shale, ranging from 3 to 9 inches thick, overlain by sandstone. The roof contained numerous faults. Roof and floor were removed in the main entry to provide a total height of 6 feet.

The victim, with another miner, entered the mine to clean up some rock that had been shot down near the face of the main entry and to lay a switch at the entrance to the first left crosscut off the main entry (fig. A-12). The location of the switch prevented the use of crossbars because of low overhead clearance, and straight posts would have been in the way. The victim examined and tested the roof, took down some loose roof scales, and started loading rock. Shortly thereafter, a section of the roof fell on him. The fall was 6-1/2 feet long, 5-3/4 feet wide, and 21 inches thick.

Cause

Failure to detect and take down loose roof caused by a hill seam was the cause of the accident.

Recommendations

1. Thorough examinations and testing of roof should be made before work is begun and frequently thereafter.

2. Loose roof should be taken down.

3. Safety posts should be set before work is begun and as needed thereafter.

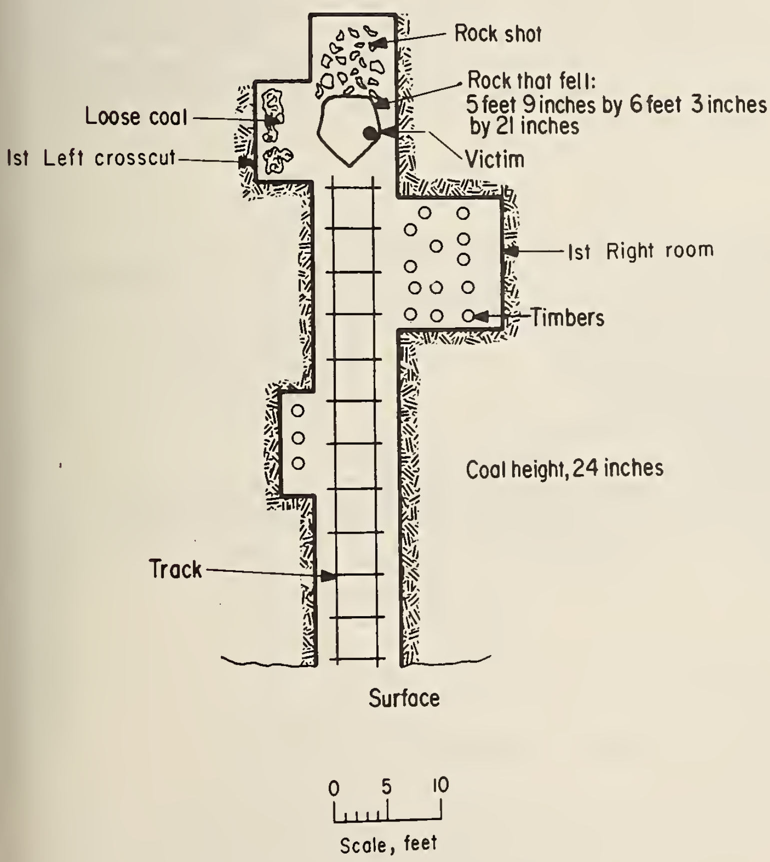

FIGURE A-12. - Accident 13.

Accident 14--Fayette County, Pa., March 21, 1969

One man was killed. He was 43 years old, had 8 years of mining experience at this mine; 2 years as a roof bolter, which was his occupation at the time of accident. The mine was located in the Pittsburgh coalbed that averages 90 inches thick. Two hundred and twenty-three underground employees produced 3,500 tons per day of coal. Retreat mining was being done in the section where the accident occurred. Pillars were being recovered by the pocket-and-wing method. Two entries and their connecting rooms had been developed several years ago, and the roof of these entries had caved. Prior to crossing these entries, the roof and angular sides in the caved areas were bolted and the fallen material loaded out. The immediate roof, as exposed in the roof cavity, consisted of 8 inches of coal and 36 inches of black shale overlain with alternate layers of sandstone and coal.

The roof of the cavity where the No. 2 room crossed the old No. 7 entry (accident area) had been bolted on a previous shift. The continuous-miner crew finished cleaning up loose coal in the No. 2 room on the inby side of the cavity, and the victim (roof-bolting machine operator) moved the roof-bolting machine into the place (fig. A-13). He set four safety jacks to temporarily support the newly exposed roof and was installing roof bolts when the assistant mine foreman sounded the inby shale lip about midway across the place. Although the lip was considered firm, the victim was instructed to install a bolt at that location. The victim completed the installation of eight roof bolts in the roof of the face area. The section foreman entered the place at that time, examined the lip, and instructed the victim to install a roof bolt under the lip at the location previously pointed out by the assistant mine foreman. The victim said that he would also install a bolt under the lip at the right side of the place. The section foreman then left the place. When he returned, about 40 minutes later, he found the victim pinned underneath fallen roof material. The rock that fell from the lip measured 3-1/2 feet long, 2-1/2 feet wide, and tapered from 18 inches thick to zero at the roof line. Observations revealed that a bolt hole had been drilled through the shale at the lip on the right side of the place and that the drill steel had contacted the sandstone immediately above the shale. It was deduced that when this occurred, the shale lip had broken loose and fallen. Apparently no attempt was made to drill a bolt hole under the lip near the center of the place, as the victim had been instructed to do.

Cause

The shale lip that fell had not been bolted before the victim was assigned to do it. Failure of management to recognize the need for this and provide an adequate plan of securing the roof lip before mining was started was the cause of this accident.

Recommendations

Where mining necessitates the crossing of caved areas, management should establish and follow a bolting plan of securing roof lips before mining is started in the next block of coal. Consideration should be given to installing the roof bolts on an angle.

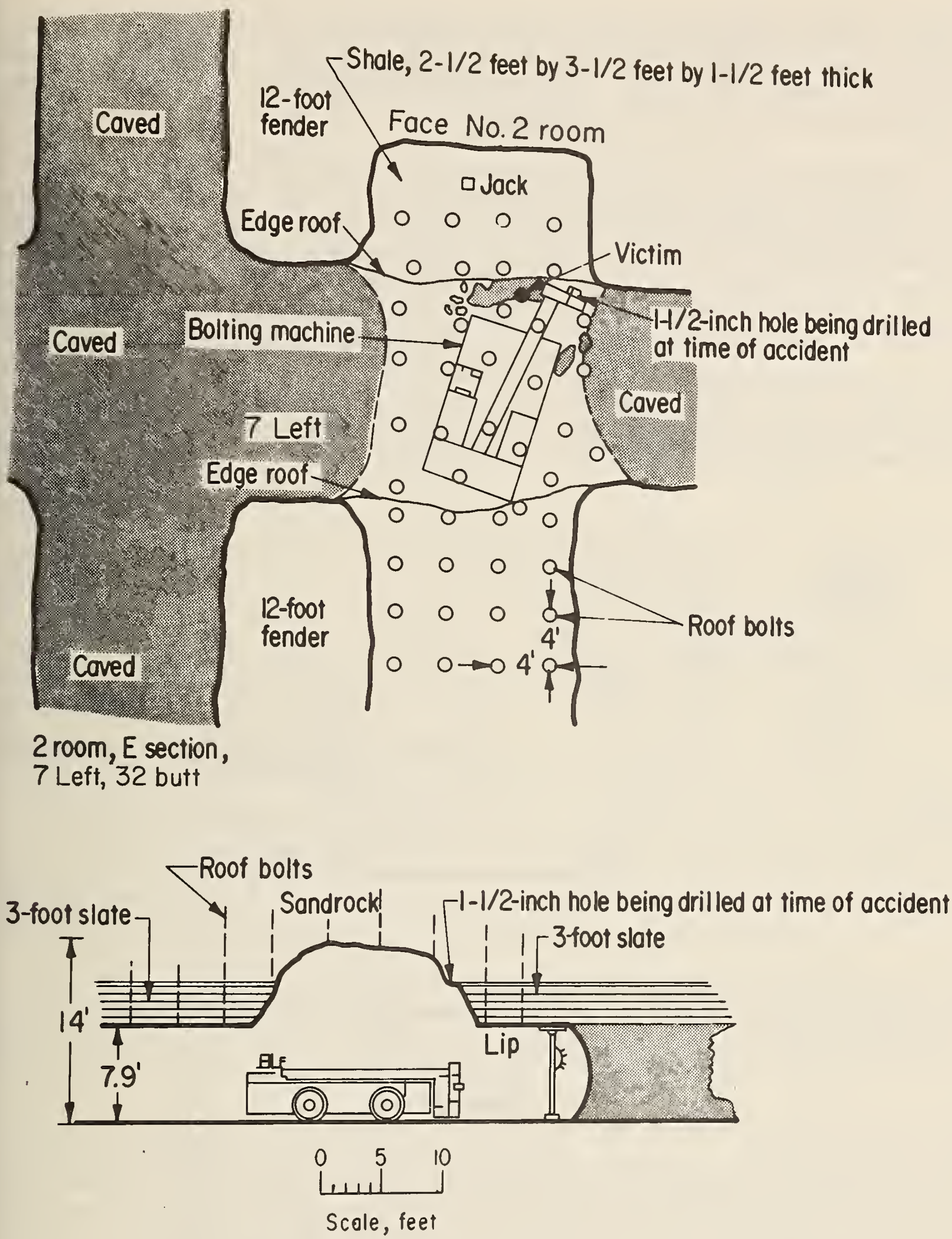

FIGURE A-13. - Accident 14.

<u>Accident 15--Barbour County, W. Va., March 24, 1969</u>

One man was killed. He was 64 years old; his total mining experience was unknown. He had been employed by this company for the last 5 years; 2 years as a shot firer. The mine was located in the Redstone seam that averages 72 inches thick. Nine underground employees produced 250 tons per day of coal. Entries and crosscuts were driven about 15 feet wide. The immediate roof was about 15 feet of sandy shale; the main roof was sandstone. Roof bolts were used as the principal means of roof support.

The cutting-machine crew had just completed a crosscut right off the No. 1 room and were tramming the machine out of the place when a piece of rock, measuring 5 feet long by 4 feet wide by 10 inches thick, fell near the face of the No. 1 room (fig. A-14). The victim was instructed to blast the rock before blasting the coal face so that the fallen rock could be loaded with the loading machine. The victim obtained a pick and proceeded to the No. 1 room to dig a hole in the fallen rock for blasting. Shortly thereafter, the cutting-machine operator helper returned to the No. 1 room and found the victim under a new fall of rock near the face. The victim was sent to the hospital where he died later that night. While at the hospital, the victim stated that he had tested the roof with the pick, had placed explosives on the

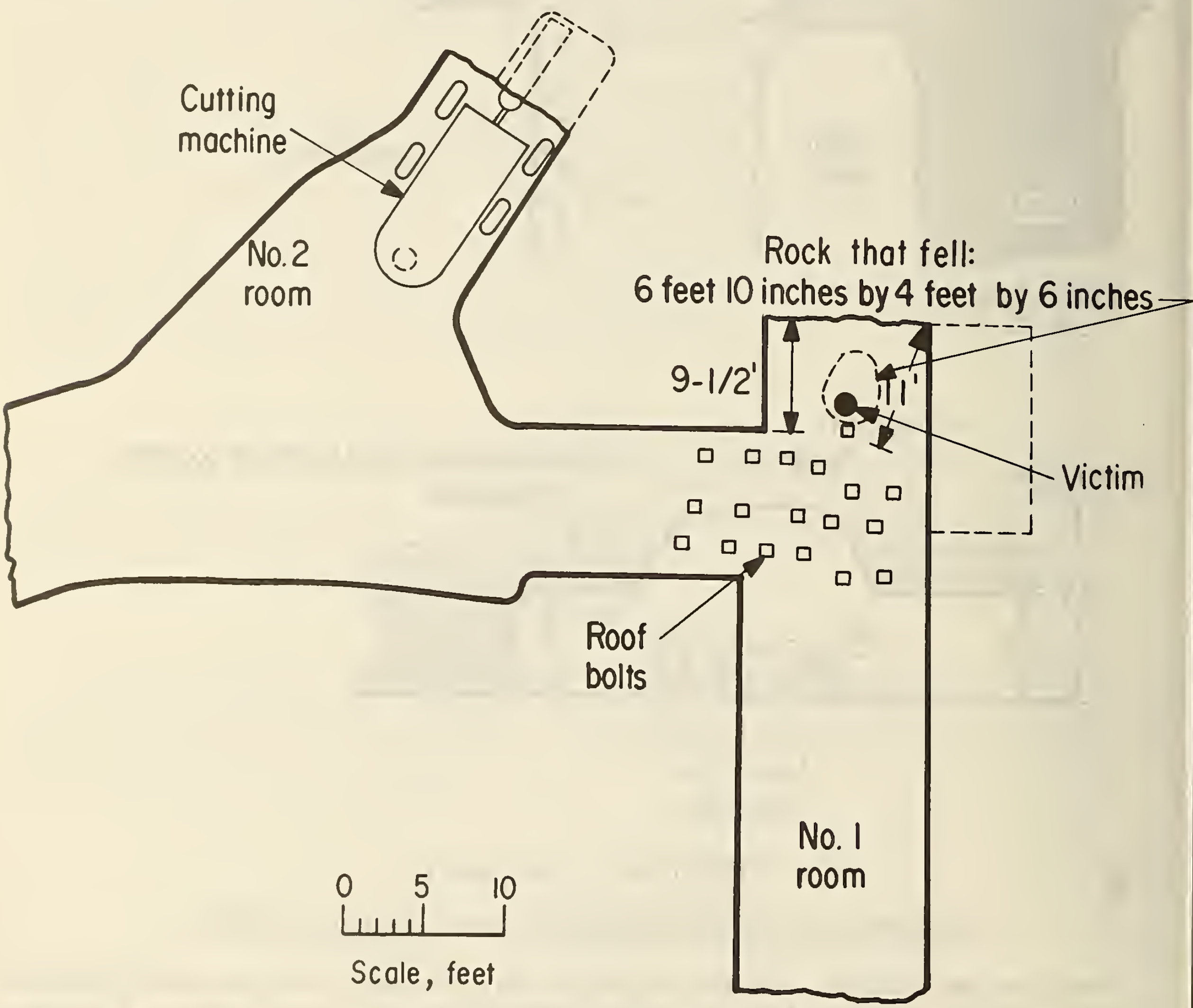

FIGURE A-14. - Accident 15.

fallen rock, and was placing a small piece of rock on the explosives when the rock fall occurred. The rock that fell on the victim was 6 feet 10 inches long, 4 feet wide, and from zero to 6 inches thick.

Cause

Failure to take down loose roof and to comply with the adopted roof-support plan was the cause of the accident. Contributory thereto was poor evaluation of the existing roof conditions in the fall area and failure of the official to have a condition known to be unsafe corrected and to enforce the minimum requirements of the adopted roof-support plan.

Recommendations

1. Supervisors should see that all unsafe conditions are corrected immediately and in their presence, or mining should be discontinued and the area dangered off.

2. Officials and employees should adhere strictly to the company's minimum standards for roof support; additional roof supports should be set when needed.

3. Closer and stricter supervision should be maintained, and management should train the employees to recognize dangerous conditions and to perform their duties in a safe manner.

Accident 16--Logan County, W. Va., June 5, 1969

An assistant mine foreman was killed. He was 44 years old and had 26 years of mining experience; 4 years as assistant mine foreman. The mine was located in the Eagle seam that averages 48 inches thick. One hundred and eighty-seven underground employees produced 3,300 tons per day of coal. The roof consisted of laminated shale with traces of sandstone.

A 7-foot-thick roof fall had occurred the previous day, covering the supply track and belt conveyor and interrupting coal production from four sections (fig. A-15). A fall 8 feet thick had occurred 4 months earlier at the same location.

After these two falls, the roof of the cavity was about 15 feet above the top of the coalbed. Two miners were hand loading rock from the fall onto the belt conveyor. The victim was assisting the telephone man with the telephone wire that had been broken by the fall. He had just secured a portion of the telephone wire to a roof bolt when a piece of roof rock fell on him. The piece of rock was 8 feet long, 3-1/3 feet wide, and 48 inches thick. There were two roof bolts in this piece of rock which, from all indications, had slipped from their original anchorage plane. The fact that this rock was supported by roof bolts but had broken away from the main roof for a distance of about 2 inches had been previously observed. It was stated that, owing to the vertical distance from the top of the fall to the roof and the nature of the fall, it was not feasible to bolt the roof above before starting cleanup work.

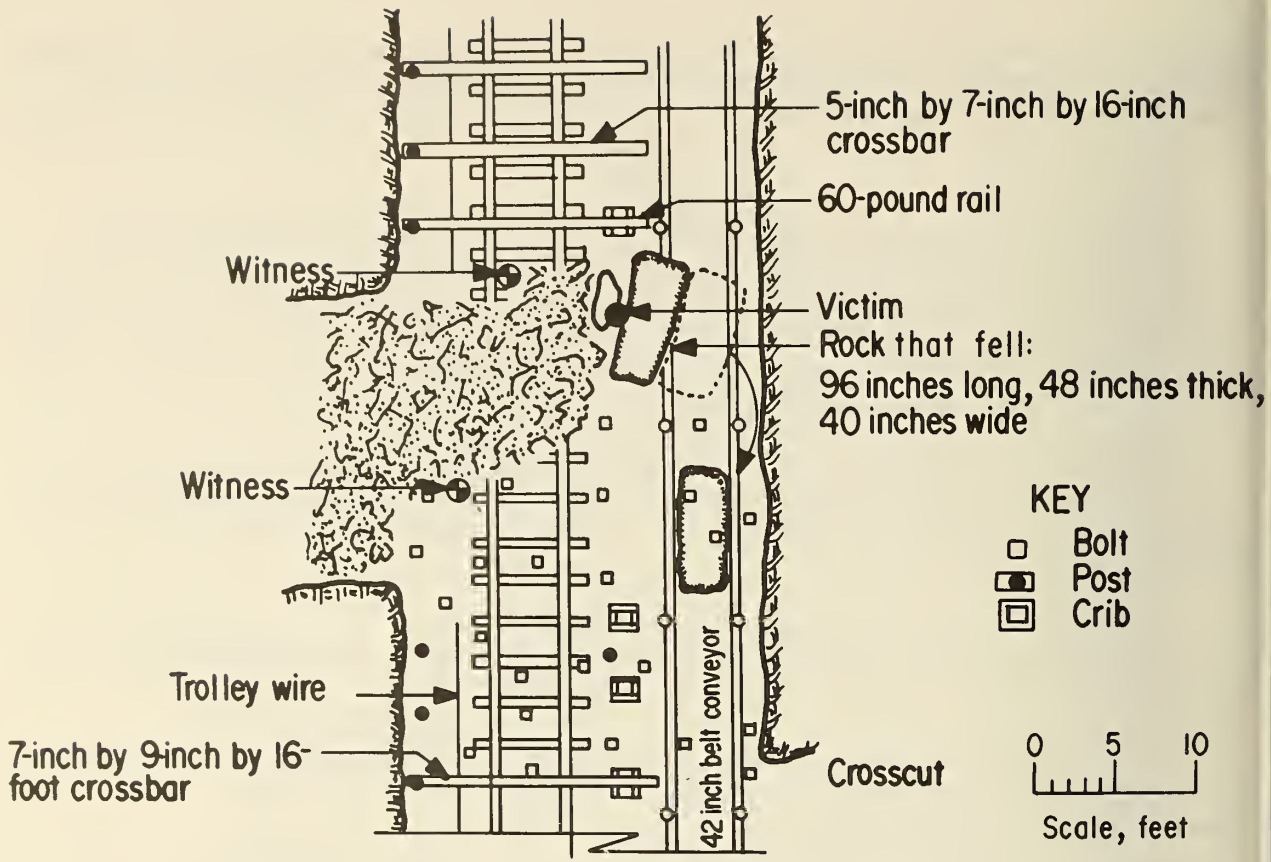

FIGURE A-15. - Accident 16.

Cause

The accident and fatality resulted from working under an improperly supported roof. Management's plan of work established to remove this fall contributed substantially to the accident because it did not afford the best means of supporting the roof as cleanup work on the fall progressed. From all indications, too much emphasis was placed on clearing the belt conveyor.

Recommendations

1. Management should establish plans of work to be followed when cleaning up roof falls that will provide the maximum roof support protection for the workmen as work on the fall progresses.

2. Management should establish the policy that all questionable roof shall be properly supported or taken down.

Accident 17--Mingo County, W. Va., July 31, 1969

One man, aged 52, with 33 years of mining experience, was killed. He had been a shuttle car operator for the past 18 years. The mine was located

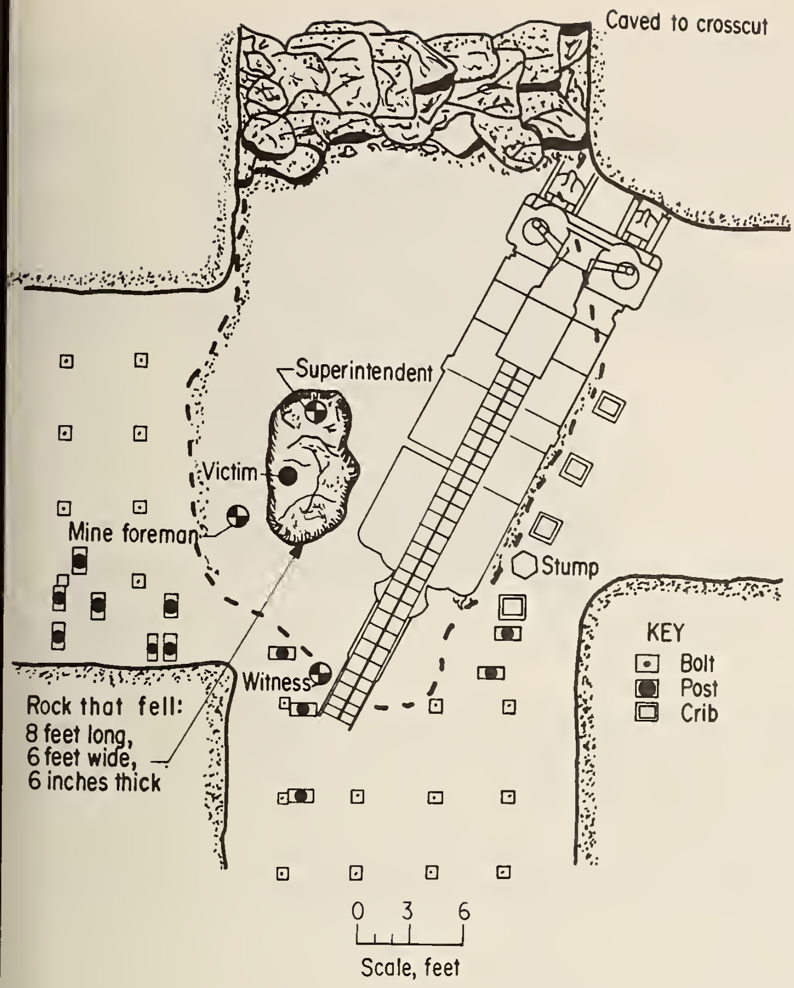

FIGURE A-16. - Accident 17.

in the Cedar Grove seam that averages 66 inches thick. Three hundred and seventeen underground employees produced 5,000 tons per day of coal. The immediate roof in accident area consisted of 72 to 97 inches of alternate layers of thin laminated shale and coal streaks; the main roof was weak to firm sandy shale.

A massive roof fall had occurred 2 days before the fatal accident. It was 60 feet long, 15 feet (180 inches) thick, and completely enveloped a continuous-mining machine that was being trammed out of a completed pillar split (fig. A-16). The roof in the fall area had been supported with 5/8-inch-diameter by 10-foot-long bolts. Work to release the miner was begun immediately and continued on a three-shift-per-day basis.

The victim, section foreman, and three other miners arrived at the fall area. They examined and scaled the roof with a 12-foot-long drill steel, drilled and blasted rock on top of the miner, manually removed loose material from the miner, and loaded rock with a loading machine. The crew was attempting to pull the miner out with the shuttle car when the roof bumped and fell. The section foreman, mine foreman, and superintendent were also in the fall area with the victim, but managed to escape.

The piece of rock that struck the victim was 8 feet long, 6 feet wide, and 6 inches thick. Temporary roof support had not been provided during recovery operations. The only additional support provided was a row of four wooden cribs constructed along the right side of the miner under roof that had not fallen.

Cause

This roof fall occurred in a cavity formed by a previous roof fall. The roof in the cavity was unsupported. Failure of management to require adequate roof support during the cleaning up of roof fall material and management's approval of men working under unsupported treacherous roof contributed substantially to the fatality. In addition, the fact that management officials exposed themselves under unsupported roof provided the victim with such a false sense of security that he positioned himself likewise with complete disregard to his personal safety.

Recommendations

1. Management should establish plans of work to be followed when cleaning up roof falls and recovering equipment that will provide the maximum roof support protection for the workmen.

2. Management should establish the policy that all questionable roof shall be properly supported or taken down.

3. Officials should set an example for workmen to follow that gives personal safety prime consideration.

4. Frequent examinations of the roof in fall areas should be made during cleanup and recovery operations by officials and employees.

Accident 18--Centre County, Pa., August 13, 1969

One man was killed and one man was injured. The fatally injured miner was a continuous-miner operator working as a timberman at the time of the accident. He was 23 years old and had 4 years of mining experience, 2 months at this mine. The mine was located in the Brookville seam that is 72 inches thick. Ninety-six underground employees produced 3,000 tons per day of coal. Entries were driven 20 feet wide.

A previous roof fall had occurred in the belt entry. It measured 165 feet long, 20 feet wide, and 8 feet thick, and covered the belt serving three coal-producing sections. The fall was being leveled to install the belt on top of it. Posts were not set under the roof in the high area near the center of the entry. Permanent support in the form of cribs and crossbars were to be installed when the position of the belt conveyor was determined. The fall occurred along the contact zone between sandstone and shale that was almost parallel with the entry in the accident area.

The miners had been working several shifts at leveling the fall and trimming the roof. The victim was standing on the left side of the fall under the sandstone roof watching another miner bar down a loose piece of rock near the left rib (fig. A-17). The overhanging sandstone roof was solid. The victim yelled a warning just before the roof fell from the narrow area above the first fall. The fall injured the second miner's foot. The victim was found under the fall near the center of the entry. The rock that was being barred was below and to the left of the secondary fall and had no bearing on the fall. The second fall was 65 feet long, 8 feet wide, and 10 inches thick.

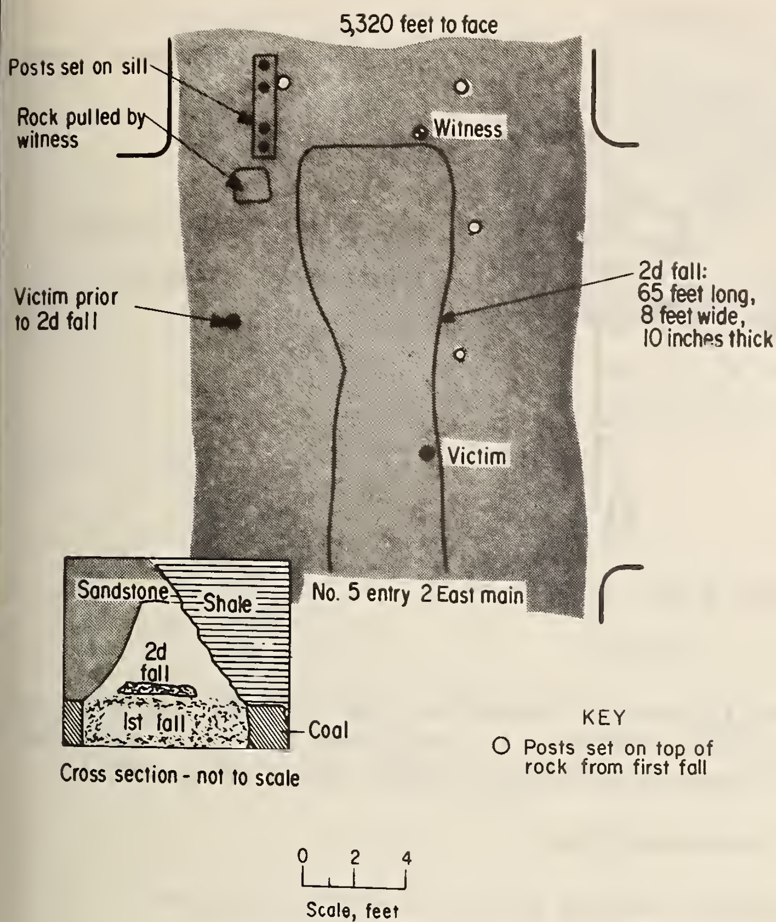

FIGURE A-17. - Accident 18.

Cause

The accident occurred because management permitted work and travel under unsupported roof in an area containing known irregularities and where the roof had partially fallen previously.

Recommendations

Officials should see that adequate roof support is provided in areas where men are required or permitted to work or travel, especially where unusual conditions exist.

Accident 19--Hopkins County, Ky., August 27, 1969

Two men, aged 23 and 36, were killed. One was a roof-bolting machine operator, and the other was a shuttle-car operator. They were engaged in drilling rock from a previous roof fall, preparatory to shooting and loading the rock. The mine was located in the Kentucky No. 6 seam that averages 44 inches thick. Sixty-three underground workers produced 1,000 tons per day of coal. The immediate roof consisted of a series of laminated shales containing unconformities, slip, and rolls.

The two victims were working by themselves, loading rock and timbering in a section that had been temporarily abandoned for 3 months and was being cleaned up in preparation for reactivating the section (fig. A-18). A fall had previously occurred in the first intersection outby the face, and the victims were drilling blastholes in it with a hand-held drill when they were caught by a second roof fall. The original fall was 60 inches thick and covered the entire intersection, extending toward the face and into each crosscut. The second fall measured 10 feet long, 20 feet wide, and ranged from 2 to 7 inches thick. Roof supports had not been installed in the intersection, and the victims were working beyond the last installed supports.

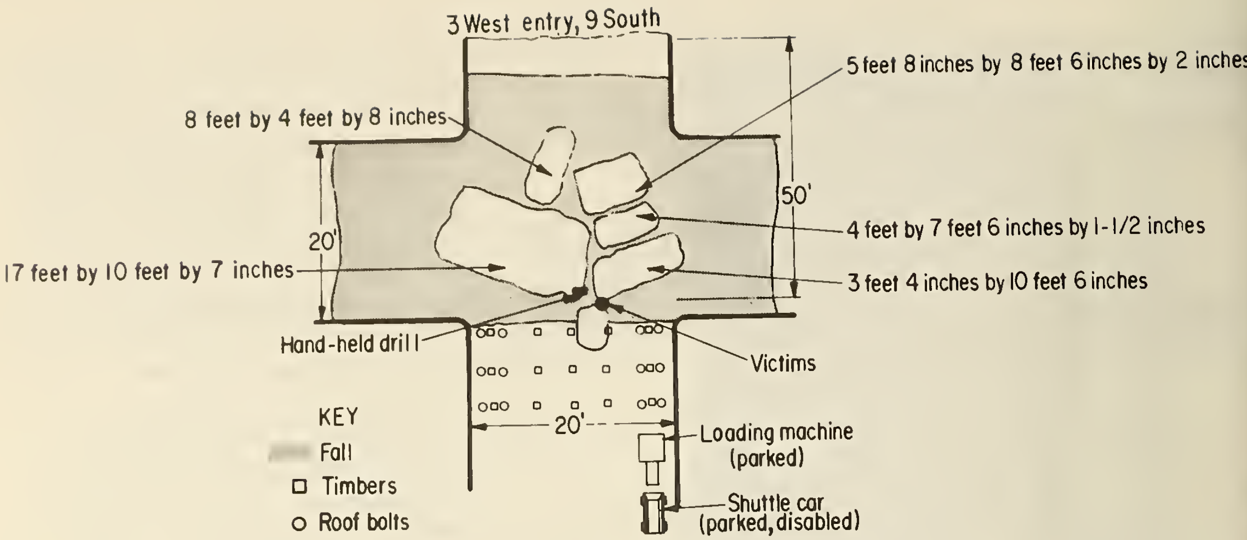

FIGURE A-18. - Accident 19.

Cause

This accident resulted from failure of management and workmen involved to test and properly evaluate the roof condition, to take down any loose material found, and then to set adequate temporary timbers before starting to drill.

Recommendations

1. The roof in all underground working places should be secured adequately.

2. Persons exposed to danger from roof falls should examine and test the roof before starting work and frequently thereafter. When dangerous conditions are found, they should be corrected immediately before work is continued, or any other work is done.

3. Closer supervision should be exercised by management, even when experienced workmen are involved. The degree of supervision should be in accordance with the extent of hazard involved in the work.

4. An intensive training program should be initiated with emphasis on the importance of careful judgment and cautious attitude toward roof control.

Accident 19--Washington County, Pa., September 10, 1969

Two men, superintendent and master mechanic, were killed by a fall of rib rock. The superintendent was 35 years old and had 13 years of mining experience, 2-1/2 years as superintendent. The mechanic was 46 years old and had 20 years of mining experience, 9 years as master mechanic. The mine was located in the Pittsburgh seam that averages 60 inches thick. Two hundred and eight underground employees produced 5,000 tons per day of coal.

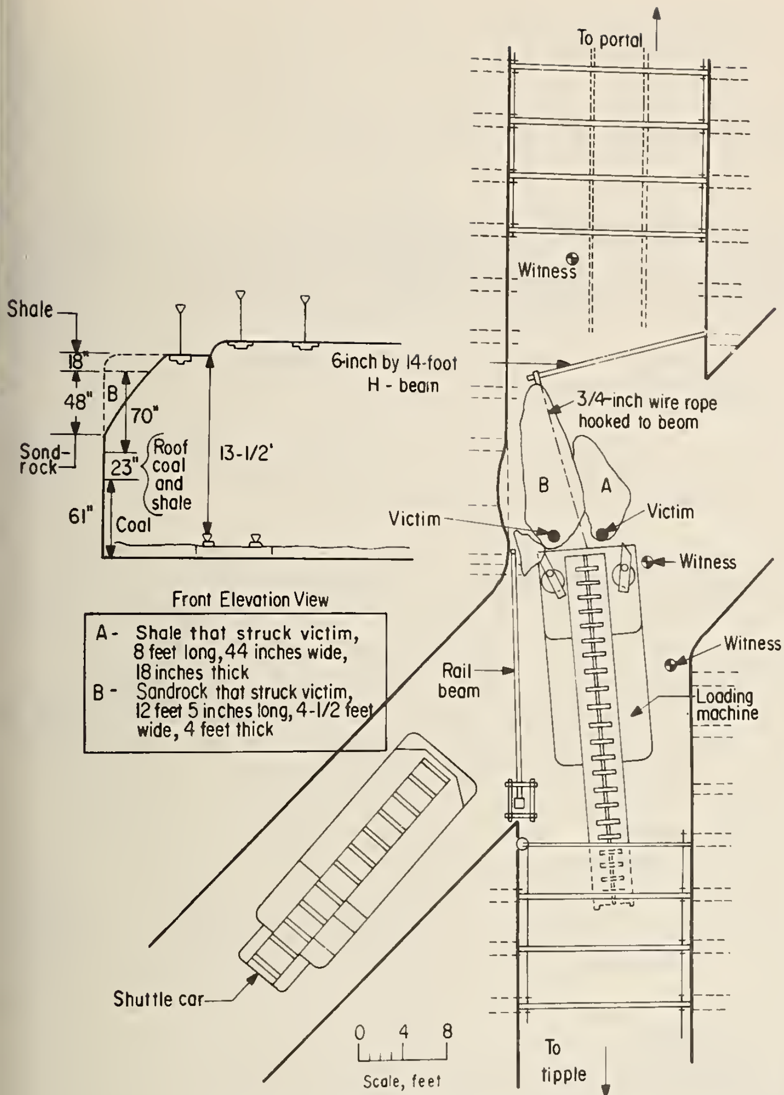

FIGURE A-19. - Accident 20.

A massive roof fall had occurred along the main track haulage road suspending production (fig. A-19). The material that fell was sandstone, laminated coal, and shale and was about 50 feet long, 8 to 10 feet wide, and 7 feet thick. The roof that fell had been supported by 6-inch by 14-foot steel H-beams set on 4-foot centers. The roof above the fall was bolted before loading operations began. Loading was difficult due to the H-beams and wooden planks lying on the floor. Consequently, the top part of the fall was loaded out in the first pass, leaving the bottom 15 inches of rock containing this debris. The loading machine then began loading out the bottom 15 inches of the fall. Upon exposure, the H-beams were pulled out of the fall by the loading machine using a 3/4-inch steel rope. The two victims were fastening the steel rope to the loading machine when the rib above the coal, along the left side, suddenly toppled over on them. The piece of rock that struck the superintendent was 12-1/2 feet long, 4-1/2 feet wide, and 48 inches thick. The piece of rock that struck the mechanic was 8 feet long, 3-1/2 feet wide, and 18 inches thick.

The officials and workmen stated that frequent tests and examinations of roof and rib conditions had been made and no unsafe conditions had been detected. The roof in the fall areas was well supported with roof bolts.

Cause

Failure of management to abstain from working in an area of a dangerous unsupported rib was the cause of this accident. Contributing factors could have been inadequate tests and examinations and/or improper evaluation of conditions revealed by such tests and examinations.

Recommendations

1. Doubtful or dangerous rib conditions should be made safe either by taking down or adequately supporting such ribs before other work is done in the area.

2. In areas where roof falls have occurred, more careful and thorough tests and examination of the ribs should be made frequently, and proper evaluations should be made of the results of these tests and examinations.

3. Stricter attention by the officials and workmen should be given to rib-support practices and rib condition in the areas where falls have occurred.

Accident 21--Pike County, Ky., November 12, 1969

One man, aged 39, was killed while operating a scoop. He had 20 years of mining experience, the last 6 months at this mine, 5 months as a scoop operator. The mine was operated on an intermittent basis. Three underground employees produced 150 tons per day of coal. The mine was located in the Clintwood seam that averages 61 inches thick. Active mining consisted of driving rooms through large barrier pillars that had been left when the area was initially mined years ago. The immediate roof, of undetermined thickness, was mixed shale and sandstone; the main roof was sandstone.

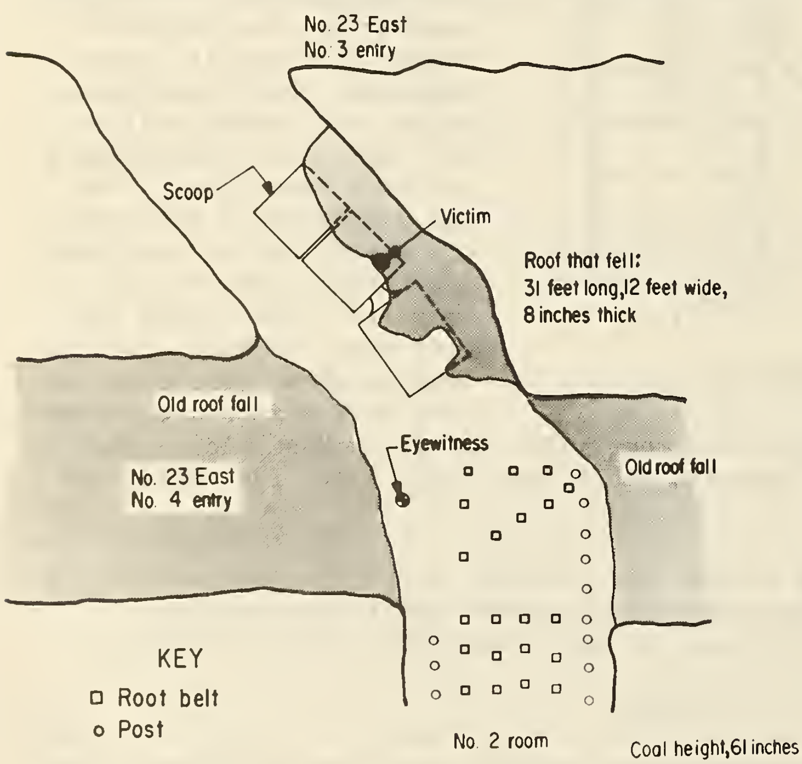

FIGURE A-20. - Accident 21.

A crosscut was being cleaned up to make a roadway to the next barrier pillar (fig. A-20). The victim and another miner were cleaning up fallen rock and installing roof bolts and timbers. The roof had been examined by the foreman and found to be drummy. The victim made a run at the small amount of rock that was left in the crosscut and, in so doing, knocked out some old timbers that had been set when the area was developed. The roof gave a ripping sound along the right side of the crosscut. The victim reversed the scoop, but before he could get in the clear, the roof fell, crushing his head and chest against the frame of the scoop. The fall was 31 feet long, 12 feet wide, and averaged 8 inches thick. The victim was 24 feet beyond the last roof supports (bolts) installed during the cleanup operation.

Cause

This accident was caused by the failure of management to adequately support or to take down roof that was known to sound drummy and to be inadequately supported. Failure by management and employees to comply with the adopted roof support plan contributed to the accident.

Recommendations

1. Where dangerous roof conditions are found, management should have such conditions corrected or withdraw promptly all workmen from the affected area.

2. Workmen should be thoroughly instructed in the roof support plan, and they should comply with the plan at all times.

3. Workmen should not dislodge roof supports unless additional and ample support has been provided in the area.

Accident 22--Pike County, Ky., December 9, 1969

A cutting machine operator was killed instantly by a roof fall while working as a member of a crew cleaning up the fall. He was 32 years old and had 5 years of mining experience, the last 2 years at this mine as a cutting machine operator. The mine was located in the Pond Creek seam that averages 54 inches thick. One hundred and forty-seven underground employees produced 5,200 tons per day of coal.

The accident occurred in the track entry, which was 23 to 26 feet wide and 7 feet 10 inches high. The immediate roof consisted of 18 inches of fragile shale; the main roof was sandstone of undetermined thickness. Treated 3-inch by 8-inch by 16-foot crossbars were bolted to the mine roof on 28-inch centers. These crossbars were supported with three or four 5/8-inch roof bolts 3 to 5 feet long.

A roof fall occurred in the track entry. The fall was 36 feet long, 15 feet wide, and ranged from 3 feet 4 inches to 8 feet thick (fig. A-21). The cleanup crew tested and examined the roof and set six safety posts around the edge of the fall. The victim was fastening a chain onto a crossbar, in preparation for pulling the crossbar from under the fall with a locomotive, when a section of roof fell on him. The second fall was a triangular section of roof adjacent to the original fall. It was 3 feet 4 inches long, 7 feet 3 inches wide, and 3 feet 4 inches thick. Two 36-inch-long roof bolts had been installed in this section of roof.

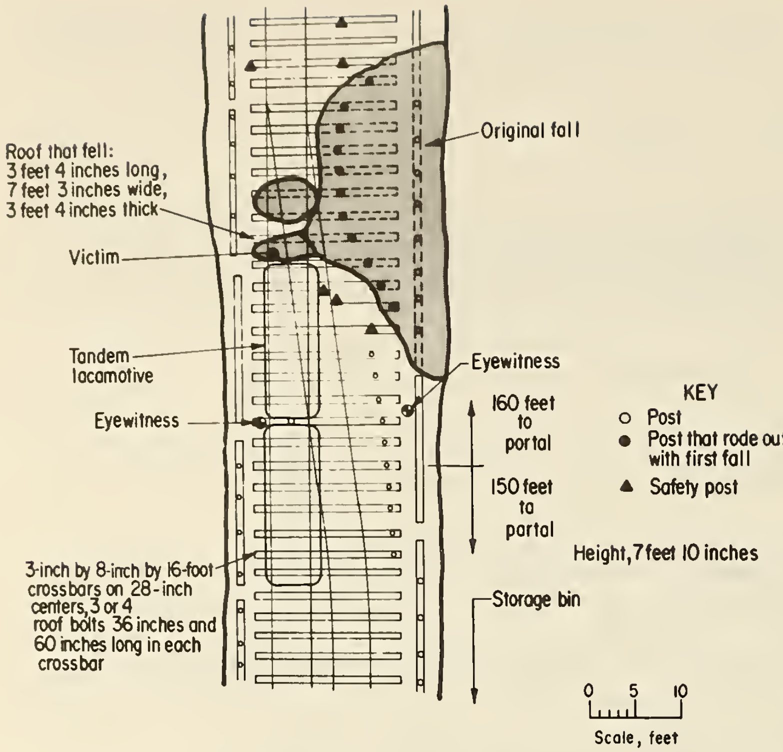

FIGURE A-21. - Accident 22.

Cause

This accident was caused by failure of mine management to have sufficient temporary roof supports installed in the area surrounding a recent large roof fall while work was being done in the area. A contributing factor was the failure of management and workmen to properly evaluate a potentially hazardous roof condition.

Recommendations

1. When work is being done in an area where a roof fall has occurred, management should cause sufficient temporary supports to be installed to adequately support the roof in the work area.

2. Thorough examinations of the roof in all work areas should be made by officials and workmen to properly evaluate the potential hazard.

Accident 23--Cambria County, Pa., April 15, 1970

A mechanic helper was killed. He was 43 years old and had more than 10 years of mining experience, 6 months as a mechanic helper. The mine was located in the Lower Kittanning seam that averages 60 inches thick. Four hundred and six underground employees produced 4,500 tons per day of coal. The immediate roof was laminated shale more than 27 feet thick; a clay vein was present in the roof across the intersection where the accident occurred. Openings were driven 16 feet wide. The liberal removal of two corners from the intersection that fell made the area of exposed roof bigger than average. One of the diagonal measurements across this intersection was 34 feet.

The original fall covered the intersection and measured 28 feet long, 33 feet wide, and 60 inches thick. The trailing cable of the continuous miner was caught under the fall (fig. A-22). More than half of the fall had been cleaned up on the two preceding shifts. Four temporary posts had been set along the right edge of the cleaned area adjacent to the remaining fallen rock. Two other posts had been set atop the fall, and a seventh post had been set on the left side near the mouth of the No. 8 entry.

The continuous miner was used to load two shuttle cars of rock and then to knock out the four posts adjacent to the fall in order to reposition the posts along the left side of the cleaned area. This would permit machine

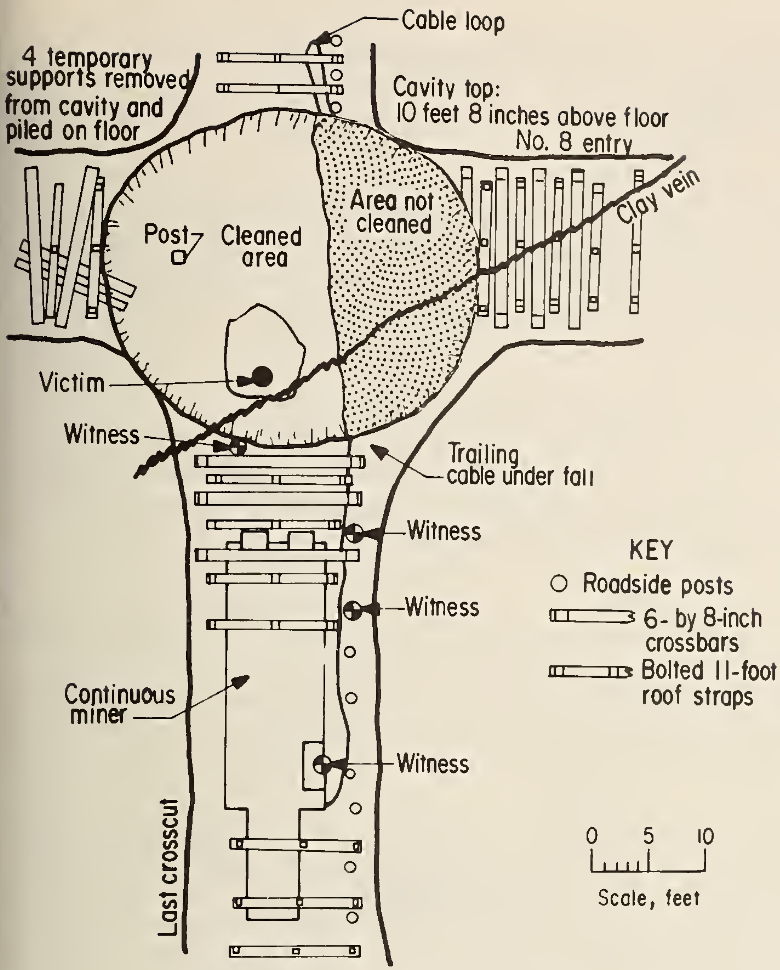

FIGURE A-22. - Accident 23.

approach to the remainder of the fall. The crew was using a wire rope, attached to the continuous miner and fastened to roof bolts protruding from the rock, to drag out rock in the way of proposed crossbar legs. The rope broke and was being repaired when the second fall occurred with little warning. The victim was caught under the fall. He had previously serviced the continuous miner and was not supposed to be in the danger area.

A second crewman, who was near the victim, heard the roof break and ran out of the danger area. The second fall measured 7 feet long, 6 feet wide, and 3 inches thick.

Cause

The two primary causes of this accident were the action of the victim in proceeding beyond permanent roof supports for purposes other than setting temporary support, and the failure of the employees to first set additional temporary roof supports before removing temporary supports. Preconditions of the accident were failure of management to prevent the original roof fall by providing adequate support for the oversize intersection after disclosure of such need, and failure to choose a safer method for support of the cavity and removal of the fall. The lack of effectiveness in educating the employee to properly respect roof fall hazards and the temporary absence of supervision were contributing factors.

Recommendations

1. Only persons engaged in setting temporary roof support should proceed beyond permanent supports as needed supports are set.

2. Before removing temporary roof supports for machine access to an area, the employees should set additional supports nearby to compensate as much as possible for such removal.

3. Where unusual conditions such as large exposed areas and/or clay veins are present, management should provide adequate additional roof support over and above the customary support installed before any travel or other work is permitted in the area.

4. Management should analyze the problem of loading roof falls and prepare a suitable plan for safely supporting the cavities and removing the fallen material. Such a plan should provide adequate temporary roof support and safe step-by-step advance in the installation of permanent supports, such as crown bolting or using crossbars and lagging.

Accident 24--Greene County, Pa., May 27, 1970

A timberman was killed. He was 58 years old and had 30 years of mining experience. The mine was located in the Pittsburgh seam that averages 84 inches thick. One hundred and ninety-nine underground employees produced 3,500 tons per day of coal.

The west auxiliary entries had intersected the first of five 13-foot-wide entries that were driven about 30 years ago. The roof strata in these old entries had fallen to various heights. The roof in the accident area had caved to about 10 feet above the coalbed. The fallen material was loaded outby the continuous miner, creating a passageway across the old entry.

The following timbering plan was used for crossing caved entries. Four-and-one-half-inch-diameter holes were drilled into the rib at each corner of the intersection. A short section of steel track rail (pin) was inserted into each hole with a portion of the rail protruding a short distance out of the hole. One 6-inch H-beam was placed on each pair of rails on opposite sides of the intersection at right angles to the new entry. Five- by seven-inch crossbars were installed, parallel to the new entry, their ends resting on the H-beams. The crossbars were then covered with 3- by 8-inch by 16-foot planks laid skin to skin.

Three general crewmen with previous experience in this type of work were assigned to timber the caved areas (fig. A-23). Holes were drilled in the compacted material on both sides of the cavity and blasted to taper the material to a suitable angle. After blasting, the crewmen observed the roof cavity and did not detect any loose overhangs. Two rib pin holes had been drilled, and the victim was picking a spot for the third hole when he was caught by a fall from the roof of the cavity. The piece of rock that fell was 10 feet wide, 5 feet high, and 24 inches thick.

Cause

The accident occurred because management failed to provide adequate roof controls inasmuch as employees were permitted to work for an extended period of time without benefit of roof supports.

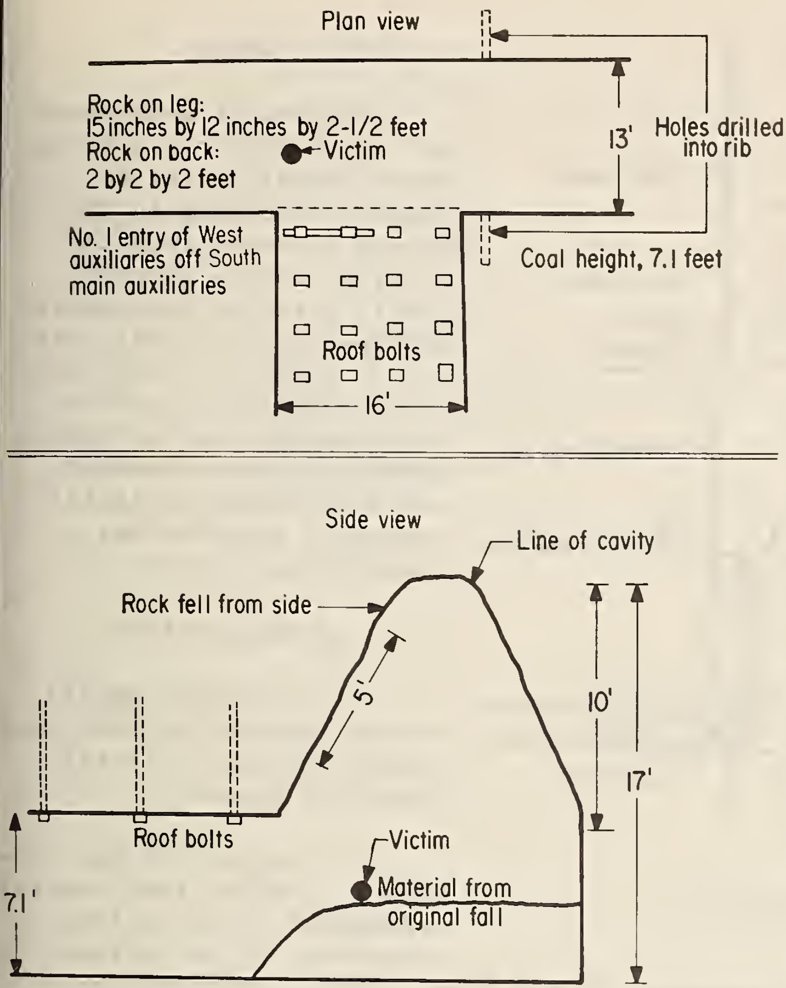

FIGURE A-23. - Accident 24.

Recommendations

1. Management should put into effect and insist on compliance with a roof-control plan to minimize the amount of time that workmen are exposed to unsupported roof.

2. Workmen should not proceed beyond the last permanent roof supports unless adequate temporary support is provided.

Accident 25--Hopkins County, Ky., July 18, 1970

One man was killed. The victim (aged 37) was assistant mine foreman and was supervising a timbering crew at the time of the accident. The mine was located in the Kentucky No. 9 seam that averages 60 inches thick. Two hundred and ninety-eight underground employees produced 7,800 tons per day of coal, all loaded mechanically with conventional equipment. Roof bolts used to support the roof were at intervals not to exceed 5 feet, supplemented with crossbars and timbers where needed.

A 10-foot-thick roof fall had previously occurred at the juncture of the Nos. 7 East and 4 Main South entries. The fall encompassed an entire intersection, which was 22 feet square, and extended both east and west in the No. 7 Main East entry (fig. A-24). The rock had been loaded out, and one set of posts and crossbars had been installed by the previous shift. Cribs had not yet been installed on top of the crossbars. Upon arriving at the fall area, the victim visually examined the area. He detected loose roof at the inby end and instructed the men to install supports at this location. The victim then turned and walked about 15 feet outby, where he was struck by a piece of falling rock. The second fall was 5-3/4 feet long, 3-1/2 feet wide, and ranged from 1 to 5 inches thick. Temporary supports had not been installed either while loading the rock or timbering the area. The roof cavity had only been examined visually. The supply of timbering materials was on the outby end of the fall and timbering had been started on the inby end, thus requiring the men to walk back and forth under unsupported roof.

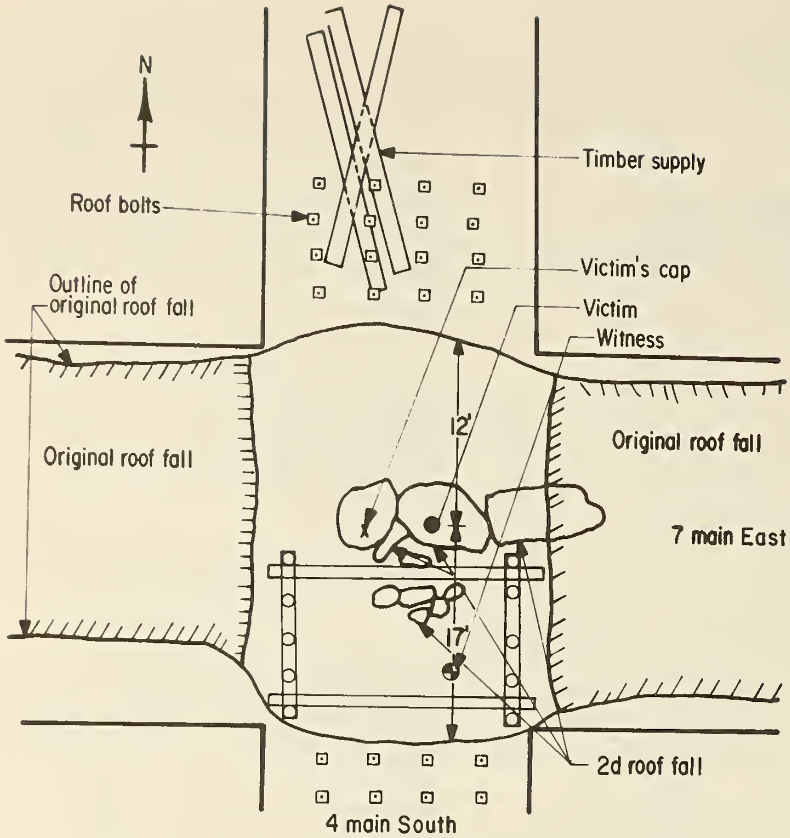

FIGURE A-24. - Accident 25.

Cause

Failure of management to have temporary roof supports installed and to require timbering in the proper sequence from the supply location progressively into the roof cavity was the cause of this accident. Failure of the supervisor (victim) to observe the standard that no person advance beyond permanent supports except to install temporary supports was a contributing factor.

Recommendations

1. No person should advance beyond the last roof support except to install temporary support.

2. As part of the program to improve roof control, management should establish procedures to be followed in special circumstances. Such procedures should require that temporary support be set, followed by permanent timbering, step-by-step, working from solid roof into the area of irregular roof.

3. Where miners are exposed to danger from falls of roof, face, and ribs, the operator should examine and test the roof, face, and ribs before any other work is started.

Accident 26--McCreary County, Ky., August 12, 1970

A section foreman was killed while operating a loading machine. He was 49 years old, and had 31 years of mining experience, 6 years as section foreman. The mine was located in the No. 2 seam that averages 36 inches thick. Eighty-one underground employees produced 700 tons per day of coal. Entries and crosscuts were driven 20 to 25 feet wide. Twenty-four inches of roof rock was removed to provide vertical clearance. The immediate roof consisted of laminated sandy shale of undetermined thickness, but known to exceed 14 feet.

The second shift crew was completing the cleanup of material from a roof fall that had occurred about 2 p.m. the previous day (fig. A-25). The original fall was 40 feet long, 22 feet wide, and 108 inches thick. An initial examination by the foreman revealed no dangerous conditions and rock was

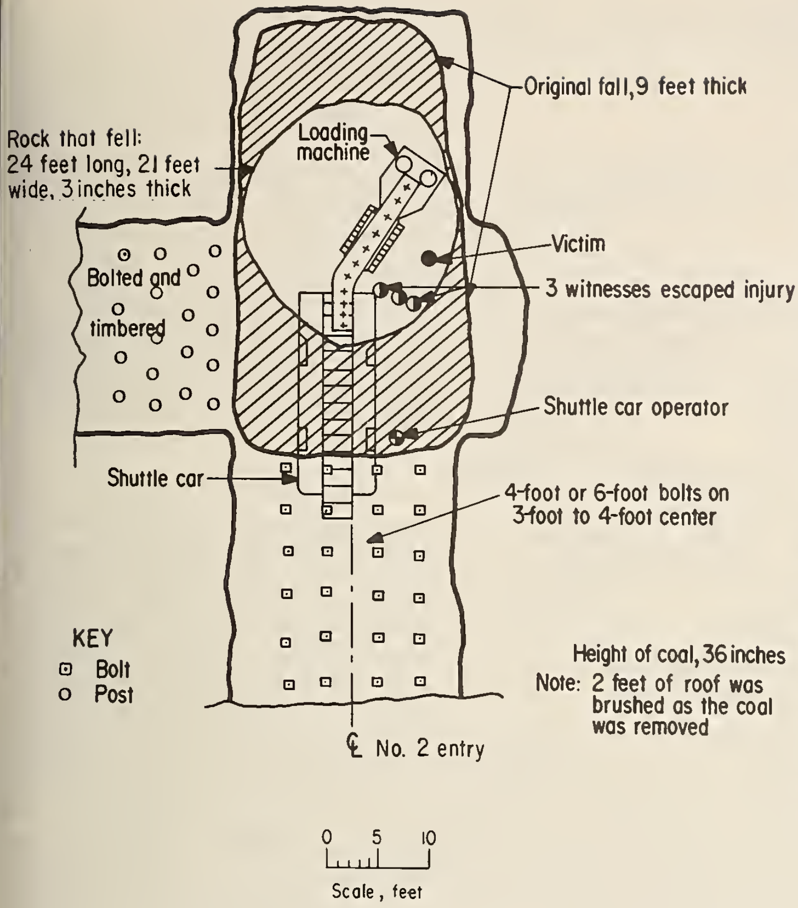

FIGURE A-25. - Accident 26.

loaded for 4 hours. At this time, the general foreman visited the area and, after examining the roof and ribs, directed the blasting of some unsafe rock on the right rib. After blasting, the material in the face "worked" a little but had been quiet for about 30 minutes when loading resumed. The roof was tested and found to be drummy; however, no cracks or other indications of danger were detected. The victim had begun operating the loading machine when the roof fell. The second fall was 24 feet long, 21 feet wide, and 3 inches thick. The victim was 20 feet beyond the last permanent support and no temporary supports had been set in the area.

Cause

Failure of management to have the roof supported in the accident area was the direct cause of the accident. Failure of management to ascertain or evaluate the true condition of the roof was a contributing factor.

Recommendations

1. The roof should be supported adequately to prevent falls of roof.

2. The roof should be tested and examined to ascertain and properly evaluate the true conditions.

3. Persons should not be allowed to advance inby permanent roof supports except to install additional roof supports.

Accident 27--Union County, Ky., September 3, 1970

Two men were killed and a third sustained slight injuries. The first victim, aged 25, was employed as a shift leader; the second victim, aged 39, was employed as a miner. The mine was being opened by a shaft and slope into the Kentucky No. 9 seam. Eighteen men were employed in the slope-sinking operation. The immediate roof consisted of sandstone for a distance of

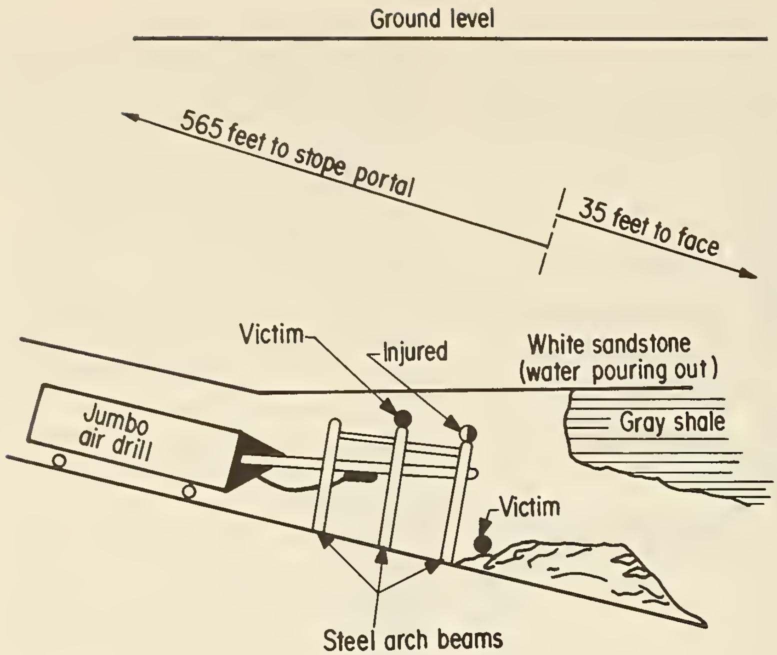

FIGURE A-26. - Accident 27.

approximately 550 feet from the surface, then changed to laminated shale as the face of the slope advanced; the roof in the area where the accident occurred was laminated shale overlain with sandstone. The roof was supported with 4- and 5-foot roof bolts, with steel arches spaced intermittently. The accident occurred approximately 565 feet inby the portal.

A roof fall had occurred 2 days previously where the underlying shale roof material tapered out against the overlying sandstone (fig. A-26). Water was pouring from the sandstone. The roof had been bolted, but no additional support had been installed where the shale tapered out. Roof bolts had been broken off, and temporary roof supports had not been installed after the first fall. Fifteen cars of rock had been loaded and two arches had been installed since the fall first occurred. The two arches that had been installed did not bear against the roof. Maximum height of the cavity was 17 feet. One victim was astride one of the installed arches and the injured miner was on the third arch, which was being held in position with a jumbo air drill boom. The miners were in the process of bolting the two arches together when the shale roof fell, breaking into several pieces. The victim was pinned between fallen shale and an arch and apparently died instantly. The injured miner fell from his position on the arch to the floor and sustained slight injuries. The second victim, who was standing below, was struck by the falling material and died later that day. The piece of shale that pinned the first victim measured 6 feet long, 6 feet wide, and 7 inches thick. The piece that fell on the second victim measured 6 feet long, 5 feet wide, and from 1 to 13 inches thick.

Cause

This accident resulted from failure of management and workmen involved to properly evaluate the roof condition, to take down any loose material found, and to set temporary support before starting to install permanent supports.

Recommendations

1. The roof in all underground areas of a mine should be secured adequately. Where a weak stratum or area is encountered, the steel arches should be installed promptly.

2. Where miners are exposed to danger from falls of roof, the operator should cause the roof to be examined and tested before any work is started. When dangerous conditions are found, they should be corrected immediately before any other work is done.

3. Adequate temporary supports should be used to protect workmen when permanent roof supports are being installed.

4. If the same conditions arise at a future date, management should consider, as one means of correction, the installation of temporary supports on top of the fallen material and roof bolting any potentially dangerous roof, which is not feasible to take down, before clearing the fallen material and installing permanent supports.

Accident 28--Muhlenberg County, Ky., September 5, 1970

One man was killed and two men were injured. The victim of the fatality was 57 years old and was the second-shift mine foreman. The mine was located in the Kentucky No. 11 seam that averages 60 inches thick. One hundred and seventy-one underground employees produced 3,500 tons per day of coal. The immediate roof consisted of shale, locally called "gob." At the accident area, unconformities, slips, rolls, and a coal seam were present in the roof. The roof was supported by roof bolts on 5-foot centers plus additional support where conditions indicated the need.

The original fall measured 75 feet long and up to 15 feet high at the outby end. The rock had been loaded out and the first tier of timbering--consisting of legs, crossbars, and flooring--had been installed (fig. A-27). The height of the roof above the flooring ranged from 3 to 10 feet. The previous shift had begun cribbing on top of the flooring, beginning at the inby end of the fall. The inby end of the fall was located about 72 feet outby the face of the No. 5 entry. The victim, who was second-shift mine foreman, and two workmen were up on the flooring, where the victim was instructing the workmen in the timbering procedure, when the roof fell without warning. The rock fell in two pieces: one measured 4 feet long, 2 feet wide, and ranged from 6 to 12 inches thick, and the other was 3 feet long, 18 inches wide, and 10 inches thick. One safety post had been set between the roof and flooring. The victim was beyond the safety post.

Cause

Failure of management and workmen to thoroughly test and properly evaluate the roof condition caused this accident.

Recommendations

1. Management should conduct a program to impress on all employees that roof testing should be done with thoroughness, and that any loose material should be scaled down before any other work is done.

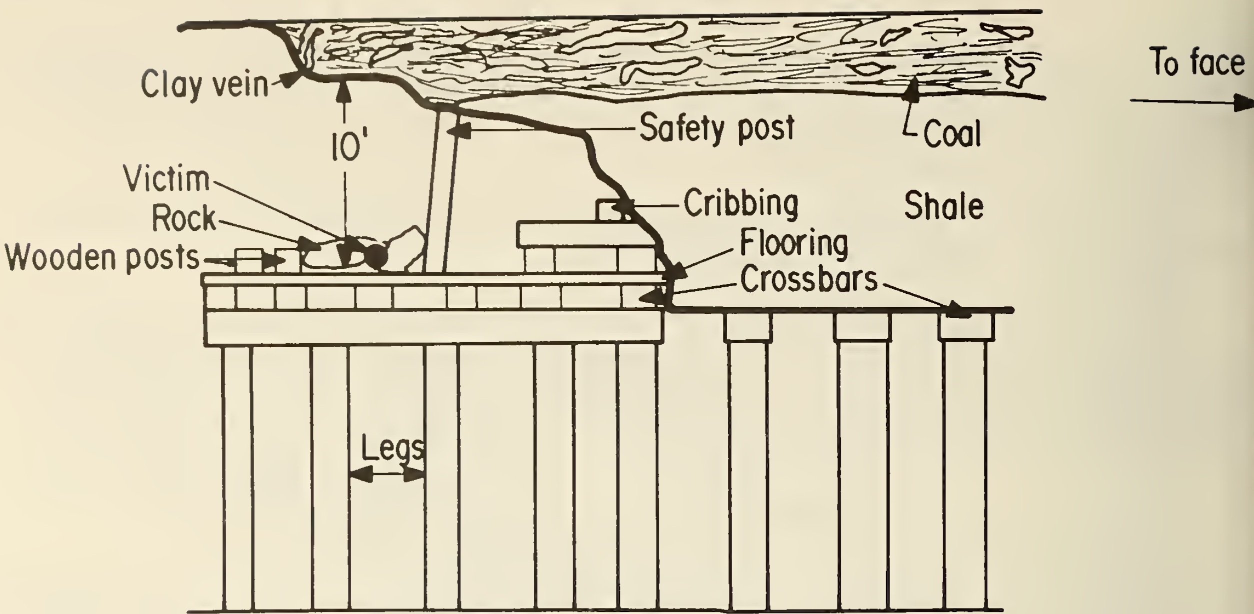

FIGURE A-27. - Accident 28.

2. Management should impress on all employees that no person should be, or work, beyond roof support.

Accident No. 29--Monongalia County, W. Va., September 9, 1970

One man was killed. He was 51 years old with 26 years of mining experience. He had been employed as a general laborer; this was his fourth shift as a continuous-mining machine helper. The mine was located in the Pittsburgh seam that averages 78 inches thick. Three hundred and three underground employees produced 8,000 tons per day of coal. Entries were driven 12-1/2 feet wide and 6-1/2 feet high. The immediate roof was 8 to 10 inches of top coal left to help support the overlying draw rock and wild coal; the main roof was sandstone or hard shale and lies 12 to 15 feet above the coalbed. A borer-type continuous miner was being used on the section. The roof was supported by two rows of 6-foot-long roof bolts installed through 2-inch by 8-inch by 6-foot planks on 4-1/2-foot centers.

A roof fall occurred in the unbolted face area between the day and afternoon shifts (fig. A-28). It measured 30 feet long, 10 feet wide, and 20 inches thick. The continuous miner was used to load the fallen material. The victim, who was performing the duties of continuous-miner operator helper, was standing 3 feet outby the left rear of the machine under an unsupported overhanging arched section of top coal and draw rock. The overhanging material fell on him. The second fall was triangular in cross section, 15 feet long, and ranged from zero to 24 inches thick. The victim was standing 8 feet inby the last permanent support when he was caught by the fall. No temporary supports were set.

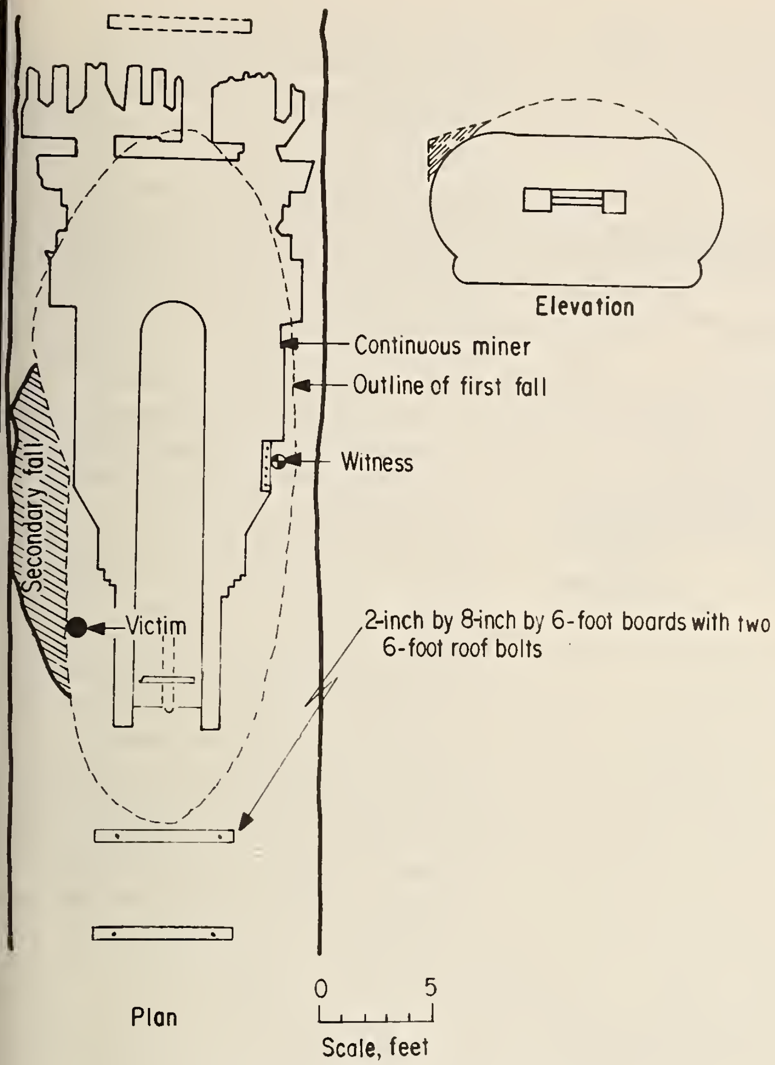

FIGURE A-28. - Accident 29.

Cause

The cause of the accident was failure of management to enforce the adopted roof support plan and to make proper examinations of the roof and ribs in a fall area, and management's approval of men working under hazardous unsupported roof.

Recommendations

1. Management should enforce the adopted roof support plan, and officials and workmen should comply with the provisions of such plan.

2. Management should make thorough and frequent examinations of the roof and ribs in fall areas before and during cleanup operations. If dangerous conditions are found, they should be corrected immediately before any other work is done or the area should be dangered off.

3. Management should not permit employees to operate equipment or make repairs to equipment, and employees should not perform such work inby roof supports in a fall area.

4. Management should establish work plans to be followed that will provide the maximum roof support protection for the workmen when cleaning up roof falls.

Accident 30--Washington County, Pa., September 21, 1970

An apprentice miner was killed and a general laborer was injured. The victim of the fatality was 22 years old and had less than 1 day of mining experience. The mine was located in the Pittsburgh seam that averages 60 inches thick. Three hundred and twenty-nine underground employees produced 9,300 tons per day of coal. Entries were driven not more than 18 feet wide.

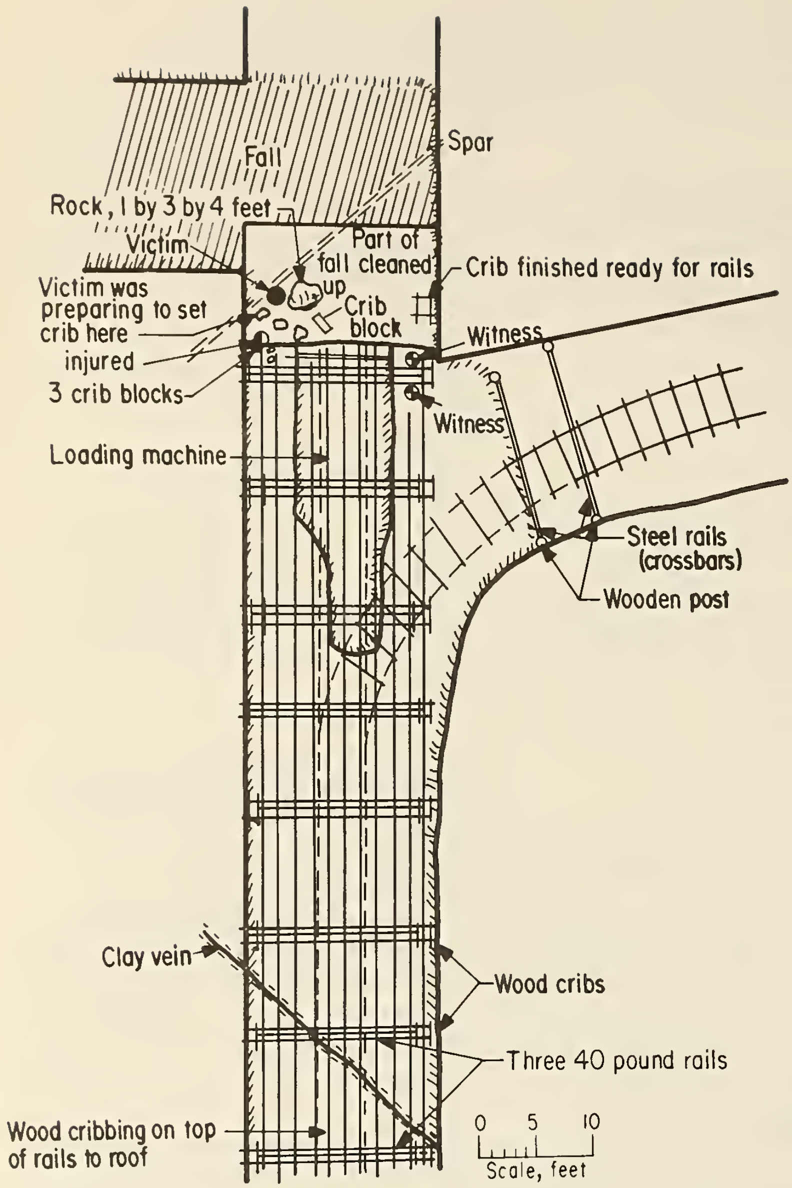

FIGURE A-29. - Accident 30.

The No. 3 Butt Left section had been idle for about 9 months. Rehabilitation work, which included cleaning up a fall of roof, was in progress in the No. 4 entry, a haulage road (fig. A-29). The fall was about 90 feet long and 30 feet high. About 70 feet of the fall had been cleaned up. The victim and the general laborer were cleaning up material along the left rib in preparation for building a crib when the fall occurred. The largest piece of rock that fell was 4 feet long, 3 feet wide, and 12 inches thick. Several smaller pieces of rock also fell, but it could not be determined which pieces struck the workmen. It was obvious that prior to and at the time of the accident, workmen had been and were working under unsupported loose roof and ribs.

Cause

Failure of management to (1) have a safe plan and/or procedure for cleaning up falls, (2) make proper examination of roof and ribs in such areas and take necessary precautions, and (3) properly instruct workers in safe practices led to the accident, which was caused by working under loose unsupported roof and ribs. It is obvious that the work of building cribs had been and was being done under unsupported roof and ribs. The man fatally injured had 6 hours of experience in the mine.

Recommendations

1. Management should establish and follow a suitable procedure for installing roof-and-rib support in fall areas that will provide the maximum roof support protection for the workmen.

2. When miners are exposed to danger from falls of roof and ribs, the operator should examine and test the roof and ribs before any work or machine is started and as frequently thereafter as is necessary to insure safety. Dangerous conditions should be corrected immediately or the area dangered off.

3. No person should proceed beyond the last permanent support except to install temporary support, and new or inexperienced miners should be more closely supervised and instructed in safe working practices.

Accident 31--Indiana County, Pa., October 15, 1970

One man was injured so severely that he died about 5 months later. He was 19 years old and had 1-1/2 years of mining experience, primarily as helper on a continuous-mining machine. The mine was located in the Lower Kittanning seam that averages 53 inches thick. Ninety-two underground employees produced 1,200 tons per day of coal. Entries and crosscuts were driven 18 to 20 feet wide. The immediate roof was laminated shale with streaks of coal and was generally firm.

A previous fall measuring 40 feet long, 10 to 20 feet wide, and 7 inches thick had occurred at the face of the No. 2 entry and extended to the crosscut (fig. A-30). The roof in the fall area had not been supported due to an inoperative roof-bolting machine. Plans were made to mine the remaining coal and complete the crosscut from the No. 3 to the No. 2 entry. This work was scheduled to start between the first and second shift. The regular bolting-machine operator on the first shift declined when offered the between shift bolting assignment. The continuous-miner operator and his helper, both of whom had worked the first shift, agreed to stay and do this work. The helper (victim) had operated a bolting machine only one or two times previously. The two men mined the remaining coal, completing the crosscut from the No. 3 to the No. 2 entry. Some top fell as they mined the coal. They trammed the bolting machine into the crosscut, examined the roof, and set four or five safety posts because the roof was drummy. The victim drilled one bolt hole but could not tension the bolt because it extended about 4 inches below the roof (hole too short). He moved the machine about 2 feet to the right, and was starting the second hole when the roof fell on him. The rock slab striking the victim was 4 to 6 inches thick.

Cause

The accident occurred because management permitted an employee to perform dangerous work for which he had not been properly trained. A contributing factor was the drilling of known loose roof while in an unprotected area. Vibrations from drilling possibly loosened the roof further.

Recommendations

1. Management should permit only experienced roof bolters to do roof-bolting work and train other employees in the safe operation of all equipment and machinery before assigning them to such work.

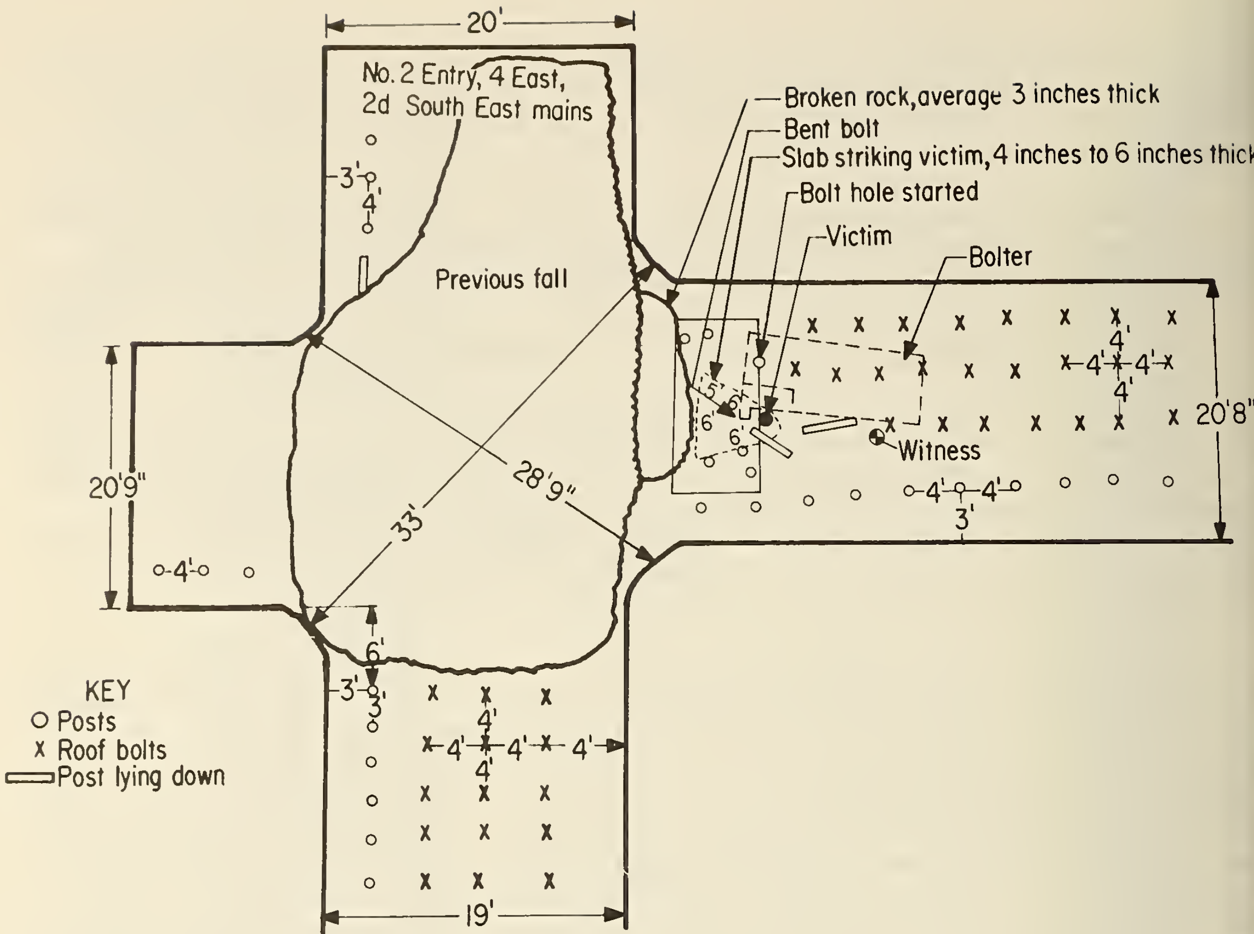

FIGURE A-30. - Accident 31.

2. Broken roof should be taken down or supported adequately to protect persons from falls before bolt holes are drilled.

3. Consideration should be given to the construction of cabs or shields on mining equipment to protect operators from the danger of falling material.

Accident 32--Williamson County, Ill., April 5, 1971

One man was killed. He was 43 years old and had 24 years of mining experience, the last 14 years as a motorman. The mine was located in the Illinois No. 5 seam that averages 52 inches thick. Nineteen underground employees produced 900 tons per day of coal. The immediate roof consisted of 10 feet of hard shale; the main roof consisted of 10 feet of limestone.

A rock fall in the 14-foot-wide No. 4 Main West entry was being cleaned up to reroute the air (fig. A-31). This entry had been driven about 30 years earlier, and it is not known when the fall occurred. The shale roof had fallen exposing the limestone, which was self-supporting. The shale rib, exposed by the fall, had deteriorated considerably owing to years of exposure.

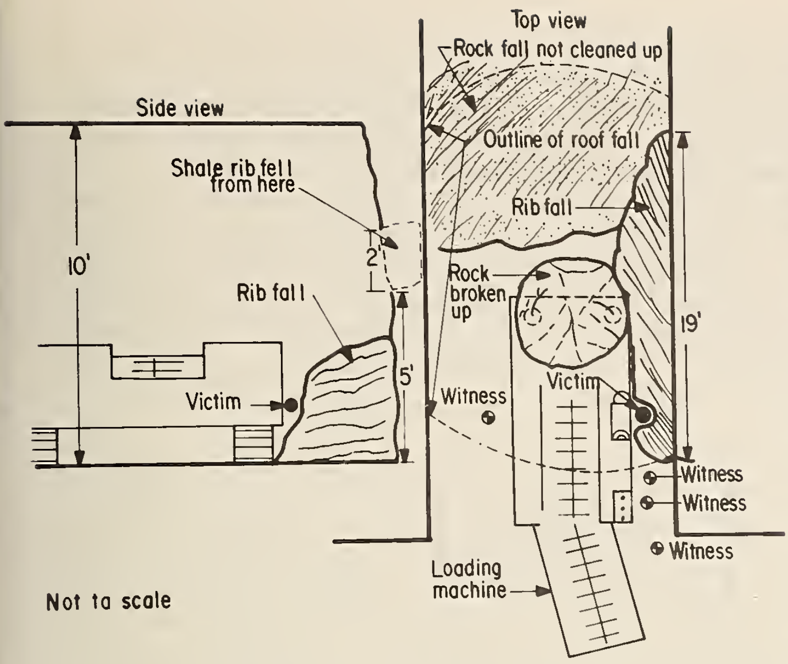

FIGURE A-31. - Accident 32.

The rock was being loaded into a shuttle car and then into steel coal cars.

Loading progressed normally until a large rock was encountered on the head of the loading machine. The victim left the motor and assisted in breaking the rock. After the rock was broken, the victim was returning to his respective work position when a section of the rib fell and crushed him against the loading machine. He was approaching the brow of the cavity and was caught by the extreme outby edge of the falling rib material. The fallen rib measured 19 feet long, 2 feet wide, and from 10 to 16 inches thick. The rib was almost perpendicular and had been tested and scaled about 20 minutes prior to the accident, and judged to be safe. Subsequent examination showed horizontal separation, indicating a previous opening in the rib that was not detected when the rib was examined prior to the fall.

Cause

Failure of management and workmen involved to properly evaluate the rib condition was the cause of the accident. Failure to withdraw the loading machine, with the rock on the head, to a safe location under supported roof before attempting to break the rock was a contributing factor.

Recommendations

1. A more thorough and frequent examination of ribs should be made.

2. Where there is a possibility of falling ribs, they should be taken down, supported, or, as in this case, the work located away from any questionable rib.

Accident 33--Gallatin County, Ill., May 15, 1971

A loading-machine helper was killed. He was 24 years old and had 3 years 10 months of mining experience, 1 year as a loading-machine helper. The mine was located in the Illinois No. 5 coalbed that averages 58 inches thick. Two hundred and sixty-five underground employees produced 4,250 tons per day of coal. The immediate roof was gray shale, about 5 feet thick, and was overlain by about 10 feet of limestone.

A section of roof had been previously blasted for an overcast (fig. A-32). Loading operations were started to clean up the blasted roof rock. The roof was examined periodically by the section foreman and the victim, and loose material was scaled down. The roof was drummy but could not be pulled down. This exposed, unsupported roof was 42 feet long and 24 feet wide. After about 53 shuttle cars of rock had been loaded, the loading-machine operator turned the loader into the No. 6 entry to load some of the remaining rock on the outby side of the blasted area. The victim entered the area, under the loose unsupported roof, to move the loading-machine trailing cable and was hit by a falling rock slab. The victim was struck by the inby edge of the rock that measured 21 feet long, 9 feet wide, and ranged from 4 inches thick to a featheredge.

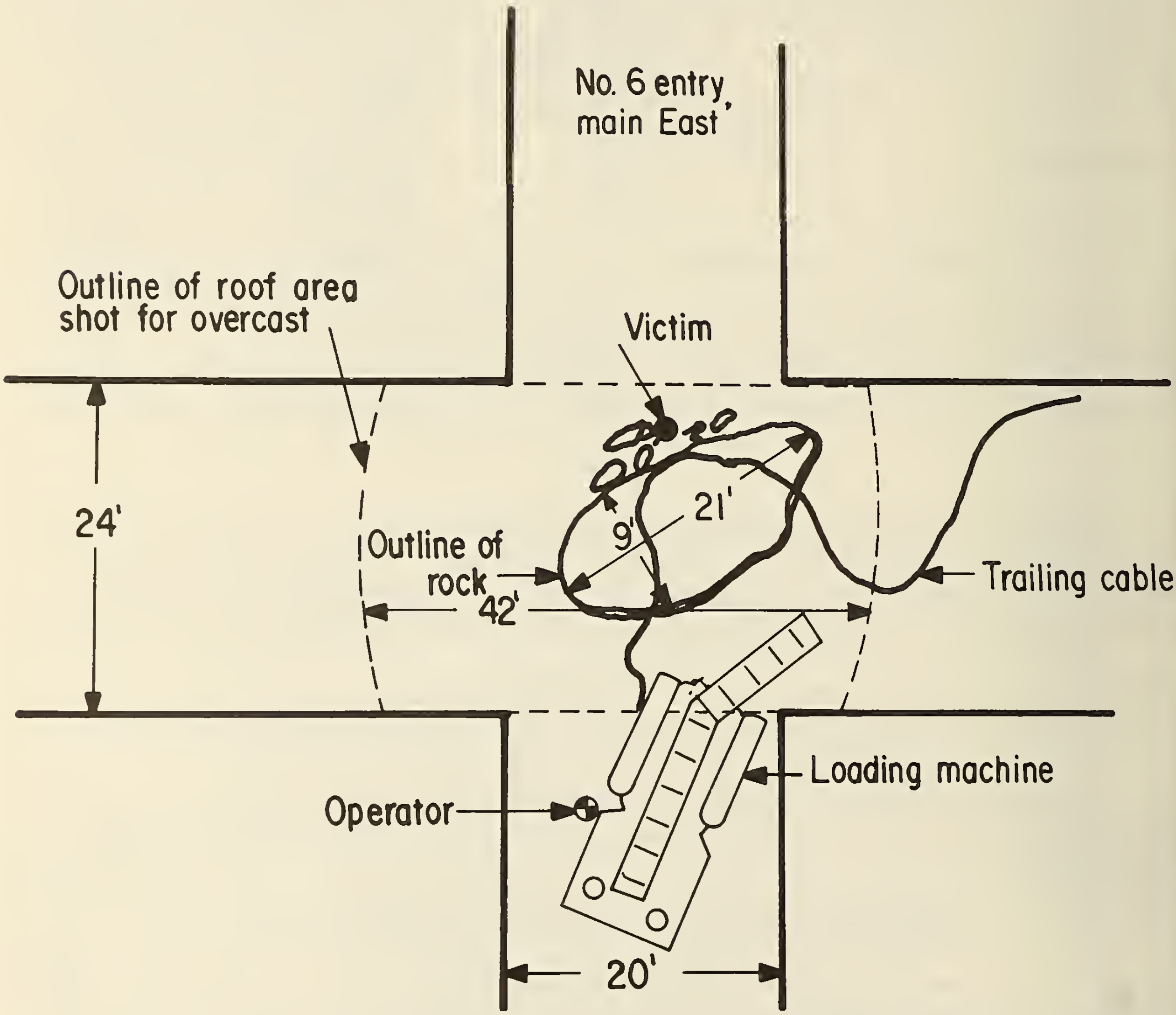

FIGURE A-32. - Accident 33.

Cause

Failure of management to comply with the requirements of the approved roof-support plan by allowing persons to work under known loose roof and inby the last permanent roof supports without temporary supports being provided was the cause of this accident.

Recommendations

None.

Accident 34--Union County, Ky., May 26, 1971

One man, a 23 year old roof bolter, was so severely injured that he died 7 days later. He had 15 months of mining experience, all as a roof bolter trainee and operator. The mine was located in the Kentucky No. 9 seam that averages 60 inches thick. Production was 8,300 tons per day. The immediate roof was hard gray shale; the main roof consisted of a series of shales. Maximum entry width was 20 feet. Roof support was by bolts installed on not more than 5-foot centers. The bolting plan specified that bolts be installed from left to right. Additional height for installation of belt drives was made by blasting holes in the roof. It was company policy to load rock and install the roof bolts in steps so that the operator did not proceed inby roof supports.

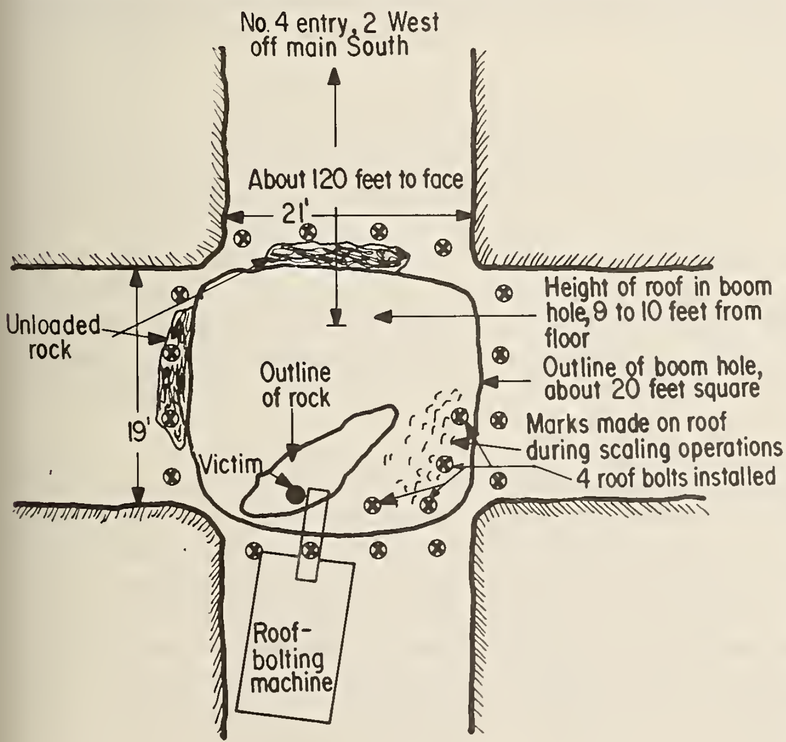

FIGURE A-33. - Accident 34.

The cavity for the belt drive boom hole in the roof had been blasted the previous day. The cavity measured about 20 feet square and about 4 or 5 feet above normal roof plane (fig. A-33). All rock, except for small amounts located at inby and left side of cavity, were loaded out. The victim then tested and scaled the roof and started bolting. No temporary supports were set. Four bolts had been installed on a right-to-left pattern when the victim was instructed by foremen to change to a left-to-right bolting procedure. The victim insisted upon finishing the fifth hole before changing the pattern, and was caught under a fall while finishing the hole. The fall measured 16 feet long, 4 feet wide, and from 4 inches to featheredge thick. It was noted that the loader operator had evidently advanced beyond the permanent roof supports while loading the fall. The bolting machine controls were set on high pressure.

Cause

The cause of the accident was the failure of the operator to have temporary supports installed under the roof, which was disturbed by blasting before roof-bolting operations were started, and to have the roof bolts installed from left to right as the approved roof control plan requires. Drilling the roof disturbed by blasting with the rotation set on high pressure may have been a contributing factor.

Recommendations

1. Roof bolts should be installed from left to right so that the bolting-machine operator can maintain a position under previously installed bolts.

2. Safety jacks or other reliable temporary supports should be used when drilling roof that has been disturbed by blasting or is otherwise deemed unsafe to drill.

3. The pressure and rotation of drill heads should be decreased when drilling is being done in disturbed roof or at extreme heights where long sections of drill steel are exposed.

Accident 35--Marion County, Tenn., September 9, 1971

One man, operator and mine foreman, was killed while cleaning up a rock fall. The victim was 49 years old and had 25 years of mining experience. The mine was located in the Sewanee seam that averages 42 inches thick. The mine, which had three underground employees, was worked at intermittent intervals. Entries were driven 14 feet wide. The immediate roof was massive sandstone containing numerous fractures. In several locations the sandstone was separated from the main firm shale strata by layers of mud and sand. Conventional timbering was the sole means of roof support.

The victim examined the mine, assigned the workmen their duties, and then went to the face area of the No. 1 Left entry, and prepared to start removing a rock fall (fig. A-34). The fall had dislodged the only two safety posts that had been installed in the face area. He examined the roof, decided it was safe, and started to work. The mine car was partly loaded when he stopped and remarked to a coworker that he heard a noise like an automobile on the surface. About this time the rock fell on him. The fall was 3 feet long, 20 inches wide, and tapered from 11 to 2 inches in thickness.

Cause

The cause of the accident was advancing beyond the protection of artificial roof supports, and the failure to reinstall dislodged safety posts. A

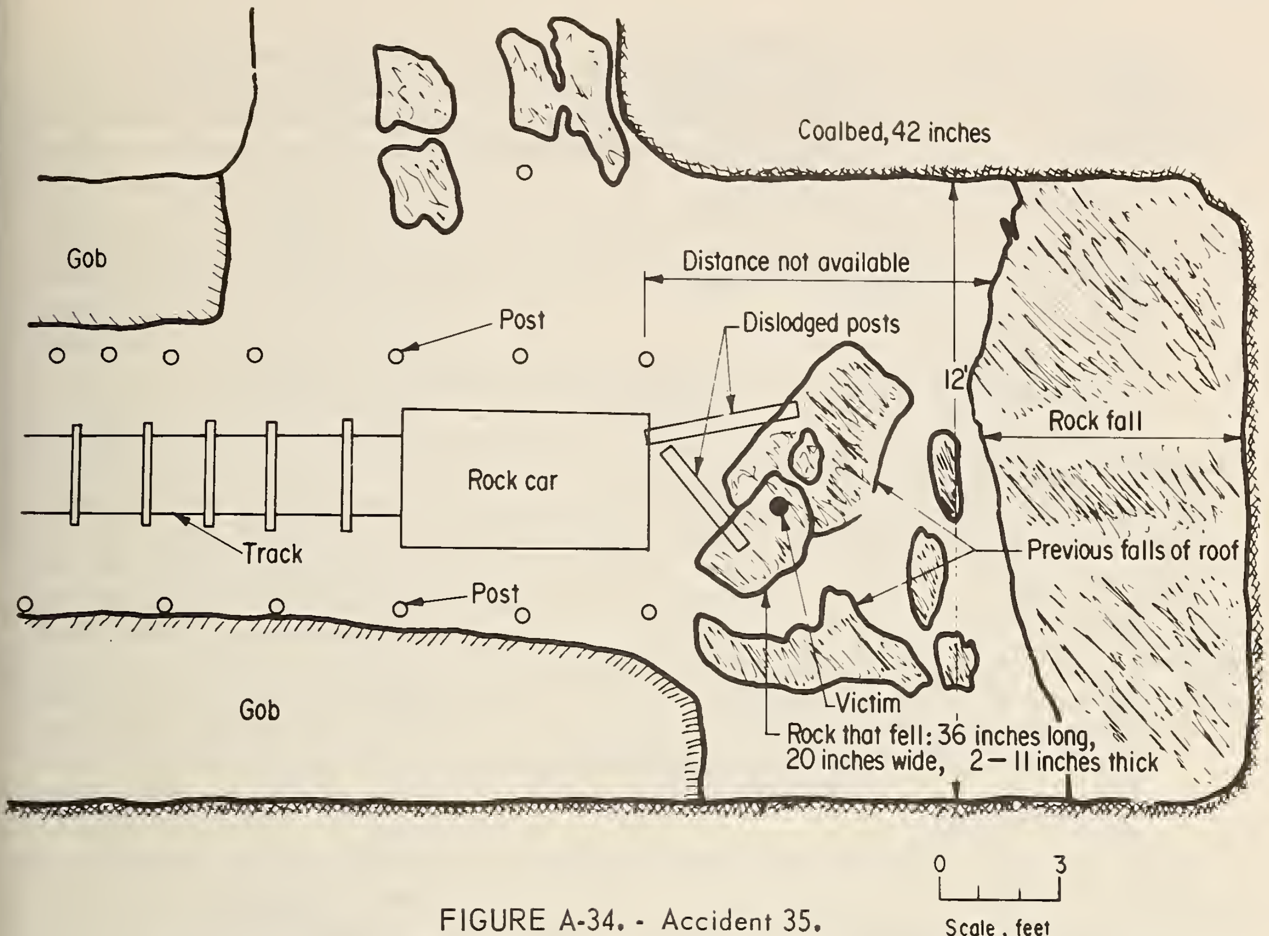

FIGURE A-34. - Accident 35.

contributing factor was the failure of management to recognize dangerous roof conditions.

Recommendations

No personnel should advance inby the protection of the last artificial roof support. Roof supports accidentally dislodged should be immediately reinstalled.

Accident 36--Buchanan County, Va., November 25, 1971

Four men were injured. The first was 62 years old with 35 years mining experience, 6 months as a roof bolter helper. The second was employed as the mine foreman and was 27 years old with 9 years of mining experience, including 18 months as a supervisor. The third was 60 years old with 38 years of mining experience, 1 year as a loader operator. The fourth was 24 years old with 2 years of mining experience including 9 months as a roof bolter operator. The mine was located in the Eagle coalbed that averages 45 inches thick. Ten underground employees produced 180 tons per day of coal. The entry and crosscut had been driven a maximum of 19 feet in width. The immediate roof was fragile shale, 66 inches thick, containing coal streaks and other defects, and required prompt support; the main roof was laminated shale approximately 8 inches thick overlain by Clintwood coalbed.

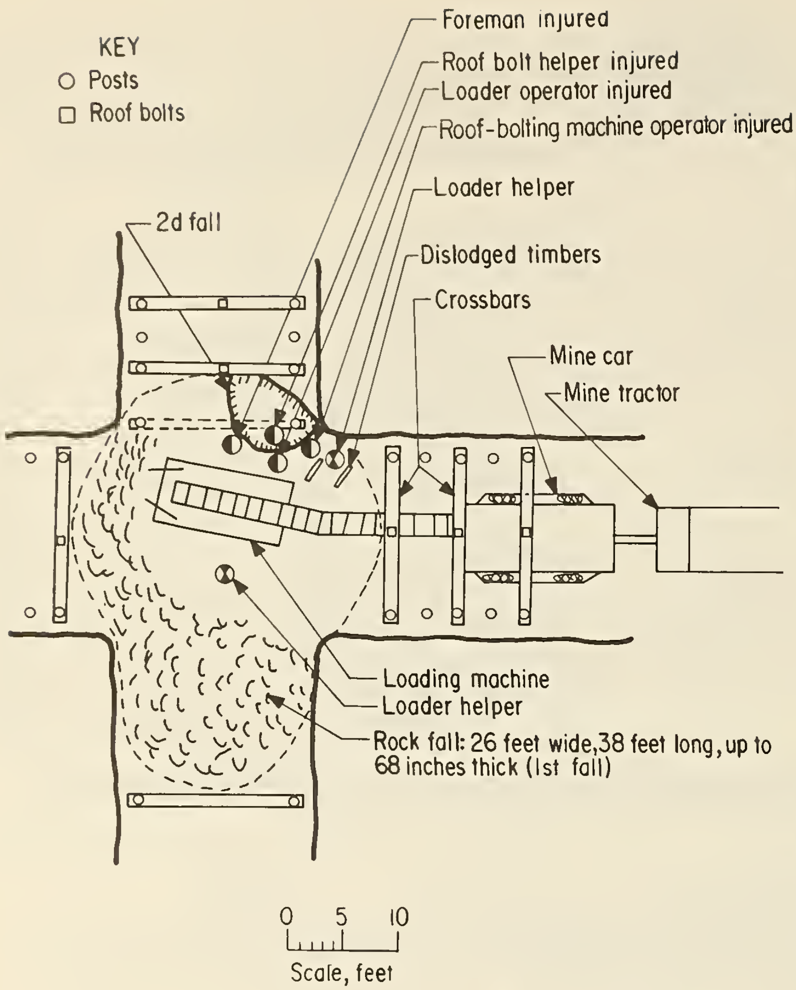

FIGURE A-35. - Accident 36.

The crew was loading out a fall that had occurred in an intersection on the previous day. The fall measured 38 feet long, 26 feet wide, and up to 6 inches thick (fig. A-35). The section foreman and three miners were standing together within a 10-foot circle beneath the edge of a protruding roof brow. The brow was partially supported with half of a crossbar that had a bolt in the center and a post on one end. No temporary supports had been set in the area. The loading machine had just finished loading the 16th car of rock when the roof brow suddenly broke and fell without warning. The second fall measured 6 feet long, 5 feet wide, and 0 to 6 inches thick. The foreman stated that he had tested the roof 15 minutes before the accident by the sound-and-vibration method and had detected no dangerous conditions.

Cause

The accident was caused by failure of management to recognize that the occurrence of an unintentional fall of mine roof should be considered as ample evidence that additional roof supports in excess of the minimum requirements of the adopted roof control plan are necessary before any other work is done in the area.

Recommendations

1. The roof where falls have occurred should be considered unsupported, and if persons are required to enter such areas, either to travel over the falls or clean them up, the roof should be adequately supported.

2. Where falls are to be cleaned up, management should devise and have in writing at the scene of each fall a plan for installing supports in such areas, and all such work should be done under the direct and constant supervision of a person appointed by mine management.

3. The installation of permanent supports in areas where falls have occurred should be done only where a minimum of four temporary supports are installed, and such temporary supports should be located so as to provide the maximum protection for persons working in the area.

4. Thorough and frequent examinations of the roof should be made by employees and officials so that a true evaluation of roof conditions can be made, and when dangerous conditions are found, they should be corrected immediately.

<u>Accident 37--Marshall County, W. Va., September 28, 1972</u>

A section foreman was seriously injured. He was 26 years old with 8 years of mining experience, about 1-1/2 years as a section foreman at this mine. The mine was located in the Pittsburgh No. 8 seam that averages 62 inches thick. Total employment was 748 men; 654 worked underground. The average daily production was 10,000 tons of coal. Six to eighteen inches of draw rock lying immediately above the coalbed was removed for additional height and better roof control. The immediate roof consisted of 6 to 24 inches of roof coal left to help support laminated shale of varying thickness. Slips and clay veins were occasionally encountered. Wooden planks were used with the roof bolts. In the accident area, bolts were installed with units mounted in the sides of the continuous miners. Maximum entry width was 16-1/2 feet.

The crew was uncovering a continuous-mining machine from under a roof fall that had occurred in the No. 1 entry on the preceding day (fig. A-36). Work progressed without incident for about 3 hours. Six posts had been installed along the left side of the continuous miner, and 14 roof bolts had been installed in the fall area. To facilitate rock loading, three posts along the left rib were dislodged by the loading machine. When the loading machine reached the end of the conveyor boom of the continuous miner, loading of rock ceased. The victim and the loading-machine operator placed a lifting jack under the boom of the continuous miner. The assistant mine foreman was on top of the fall breaking rock with a hammer, and the shuttle car

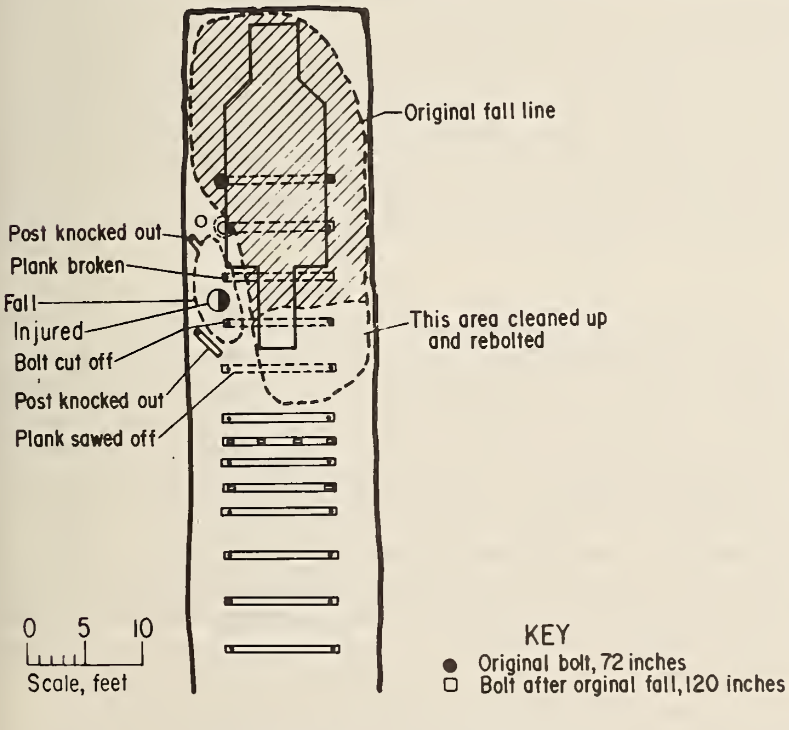

FIGURE A-36. - Accident 37.

operator was sawing a plank that was partially under the roof fall and connected to an installed roof bolt. Shortly after the plank was sawed off, the roof fell on the victim. The victim was removed from under the fallen material and transported to a hospital, where examination revealed fractures of two vertebrae. The fall was 9 feet long, 42 inches wide, and ranged from 2 to 18 inches thick.

Cause

Employees were working in an area from which temporary supports had been removed; failure of the supervisor to see that the adopted roof-support plan was followed was the direct cause of this accident.

Recommendations

1. No person should enter or work in any area where there is unsafe and inadequately supported roof.

2. The adopted roof-support plan should be complied with by supervisors and employees.

Accident 38--Wyoming County, W. Va., June 1, 1973

A roof-bolting-machine operator was killed. He was 36 years old with 18 months of mining experience, including 12 months as a roof bolter in rehabilitation work. The mine was located in the Pocahontas No. 3 seam that averages 43 inches thick. Total employment was 225 men; 223 worked underground. The average daily production was 3,000 tons of coal. An old mains area of the mine had been idle approximately 10 years. Rehabilitation work in the area had been in progress for about 1 year. An old roof fall was being removed to improve ventilation and permit the extension of the mainline haulage track system. The original size of the fall was 240 feet long, 14 feet high, and 19 feet wide. About 190 linear feet of the fall had been removed at the time of the accident. The roof in the area consisted of laminated shale and sandstone.

The construction crew included a crew loader, the victim, and a second roof bolter. Their duties, as the evening shift crew, were to perform blasting and roof support operations to prepare the fall material for loading on the day shift. Normal operations were started upon arrival in the fall area (fig. A-37). Two blastholes were drilled in the fallen rock material, charged, and fired. After a short wait for smoke clearance, the crew leader returned and examined the work area. He discovered a layer of sandstone rock (the piece that later fell on the victim), and made several unsuccessful attempts to bar it down. He then informed the two bolters that the section of rock would have to be supported and bolted, gave them instructions regarding the work to be performed atop the fall, and left the area to perform other duties. The victim and the second bolter moved the stoper to the bench area and began removing the broken rock to install metal jacks as temporary roof supports. The victim also attempted to bar down the rock slab but was unsuccessful. Thereafter, as the two miners were manually removing the broken rock, the roof fell, without warning, striking the victim.

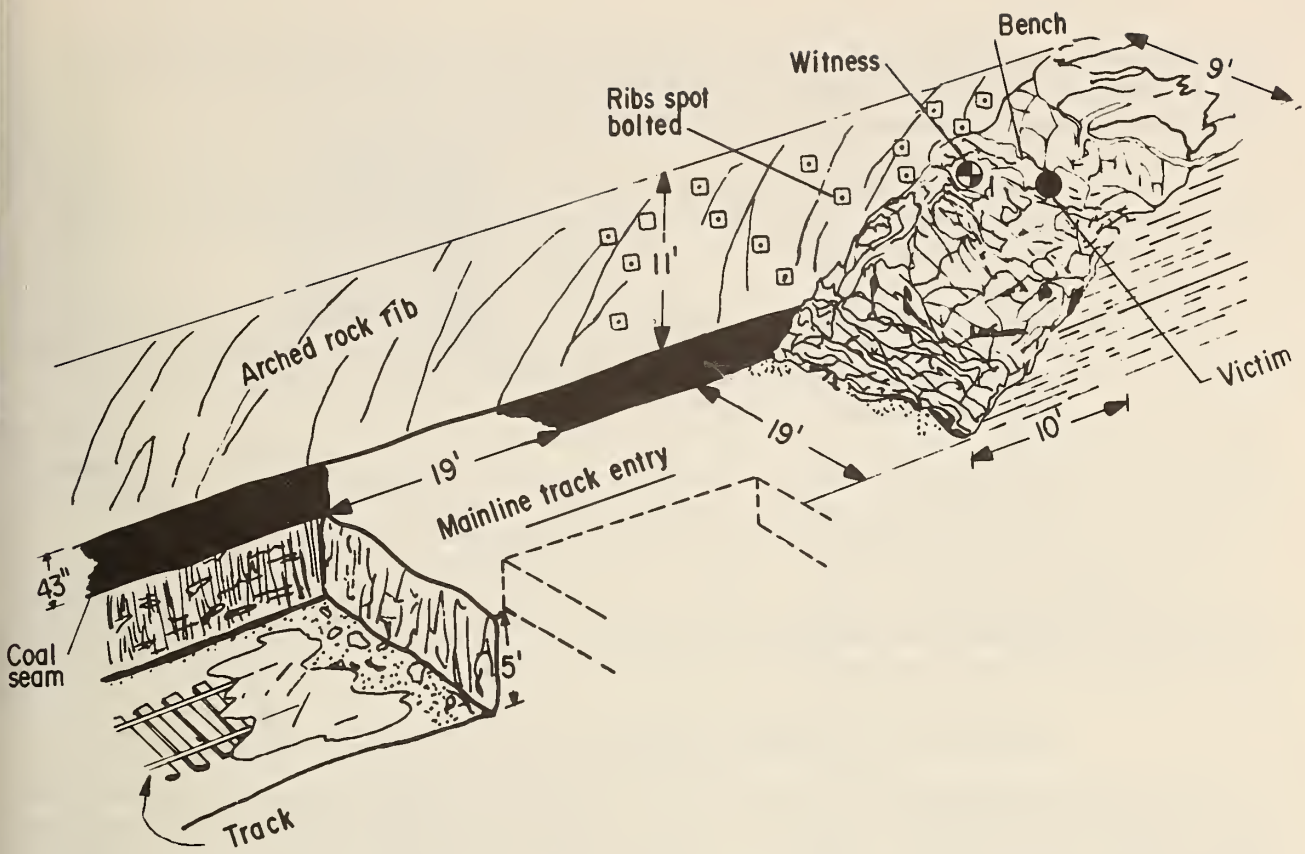

FIGURE A-37. - Accident 38.

The victim was inby the last row of permanent supports (roof bolts) when the accident occurred. Apparently he was removing broken rock to install a temporary support (jack), but no temporary supports had been installed. The bench on which the men were working was about 9 feet wide and 2-3/4 feet deep. The working height from the bench to the roof ranged from 42 to 0 inches, as the rock-fall material sloped toward the roof line.

Cause

1. The physical limitations of the working area apparently hampered the efforts to take down the hazardous section of roof rock.

2. The victim, while performing tasks inby permanent roof supports, unnecessarily exposed himself to a known hazardous roof condition.

3. Management failed to maintain a safe working environment, in that employees were permitted to work in restricted areas without suitably designed tools and equipment.

Recommendations

1. Management should formulate suitable work procedures and methods to insure that rehabilitation work, such as roof-fall removal operations, is

performed in a safe manner. Such plans should be provided for an operation-by-operation basis and posted at work sites. Plans formulated for similar roof-fall removals should include the following:

a. Hazardous roof should be removed or supported by suitable temporary supports that do not expose employees unnecessarily, prior to the installation of permanent supports.

b. When roof falls are worked by the "bench" method, such benches should be of sufficient size to permit employees to perform their duties without working inby permanent roof support, except to install temporary supports.

c. Equipment, such as temporary jacks, pneumatic drills, and other roof-scaling tools, should be of such design so as to permit use without exposing employees to unnecessary hazards.

2. Mine personnel should insist on safe job procedures, and such personnel should refrain from exposing themselves to unnecessary hazards during the performance of assigned duties.

Accident 39--McDowell County, W. Va., July 14, 1973

A roof-bolting-machine operator and certified shot firer was killed. He was 49 years old with 25 years of mining experience, all at this mine performing construction duties. The mine was located in the Pocahontas Nos. 3 and 5 seams that average 72 and 48 inches thick, respectively. Total employment was 645 men; 566 worked underground. Average daily production was 6,000 tons of coal. Preparatory work for starting a panel section was underway in the accident area. This work included the construction of several overcasts and roof-blasting to obtain vertical clearance for the belt-conveyor system. A three-man unit used a battery-powered scoop and a roof-bolting machine to perform roof-blasting, roof-support, and roof-material removal operations. Other members of the construction crew installed overcasts and performed miscellaneous duties.

The construction work was being performed in an area where a roof fall had occurred 2 years previous (fig. A-38). The working height ranged from 7 to 12 feet for a linear distance of 125 feet. The work procedure used in this area consisted of blasting roof material to permit overcasting the belt-conveyor system. The victim (who was acting as crew leader), a scoop operator, and a beltman were moving roof material that had been blasted the previous day, using the scoop loader. After two scoops of material were transported from the site, the victim obtained a slate bar and began scaling the roof. He was standing on fallen roof material, scaling down small pieces of roof, when a large section of the roof fell on him. The fall dimensions were 13 feet long, 6-1/2 feet wide, and to 16 inches thick.

Examination of the accident area indicated that the victim was inby permanent roof supports when the accident occurred, and that temporary supports had not been installed. An area about 25 feet long and 15 feet wide had been

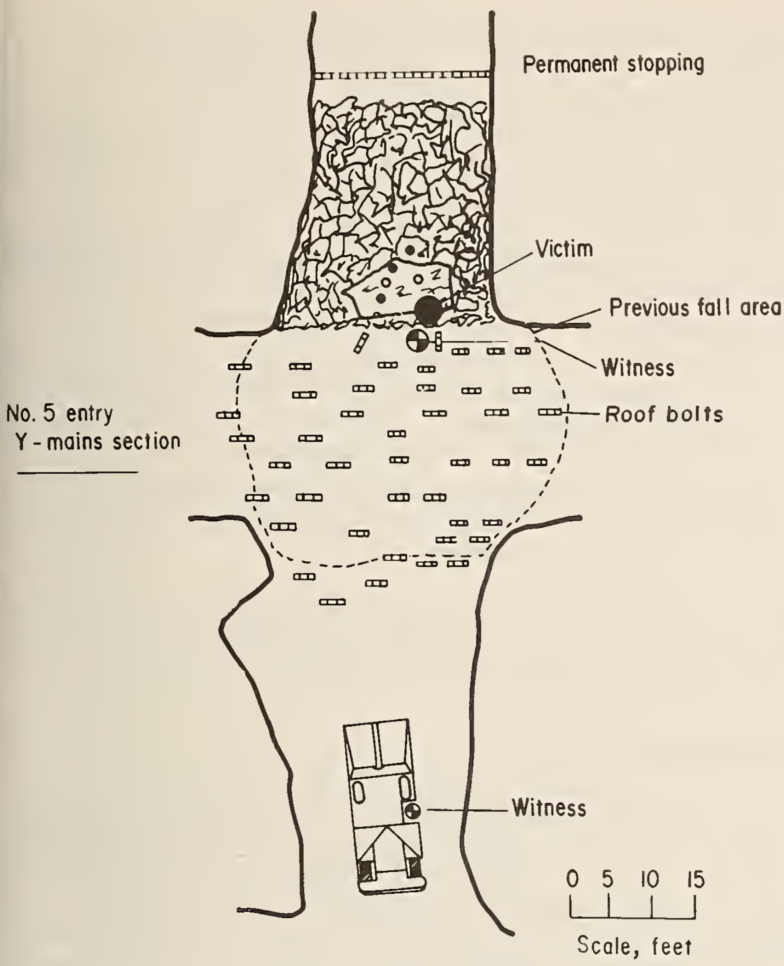

FIGURE A-38. - Accident 39.

blasted. The victim was permitted to climb upon blasted roof material to reach, with a slate bar, a height of about 11 feet in an attempt to scale the roof. The location of his body while scaling the roof was governed by the tool (regular design slate bar) provided for him to use. The broken rock that was left on the floor to facilitate roof scaling prevented the normal installation of safety posts. Scaffolds or special tools permitting the workmen to remain under supported roof while scaling the roof were not provided.

Cause

The fatality occurred when the victim was performing roof-scaling operations inby permanent roof supports in an unsafe manner.

The factors that constituted the unsafe work procedures were as follows:

1. Management did not provide specially designed tools to perform the roof-scaling operation in a safe manner.

2. Management did not require, or provide, the necessary materials for the workmen to build a scaffold installation to permit the safe roof-scaling operations.

3. Management did not provide the necessary supervision of the victim to insure that work procedures followed were compatible with the environment of the construction site.

Recommendations

1. Management should require that suitable preshift and on-shift examinations be conducted in construction work areas.

2. Management should comply with the approved roof-control plan in regard to the supporting and/or removing hazardous mine roof and brows in construction work areas.

3. Management should formulate suitable work procedures and methods for construction work operations that should include the following:

a. A means to insure that roof-scaling operations are performed from areas of supported roof with equipment to provide suitable working heights when necessary.

b. A posted plan at each construction site, where roof-fall removal or roof-blasting operations are conducted, which includes specific instructions as to the type of roof supports, the blasting procedures, and roof-scaling methods. A provision should be included that stipulates that only top mine management can approve changes in the planned operation.

c. Roof-scaling tools and roof-support materials should be provided on a job-by-job basis compatible with the conditions in which roof-scaling operations are required.

Accident 40--Boone County, W. Va., July 30, 1973

A timberman was killed. He was 53 years old with 29 years of mining experience, including 3 years at this mine. The mine was located in the No. 5 Block seam that averages 72 inches thick. Total employment was 63 men; 54 worked underground. The average daily production was 1,200 tons of coal. The construction work being performed in the area consisted of blasting mine roof to create vertical clearance for ventilation overcasts. The blastholes were drilled with a roof-bolting machine. The roof in the accident area consisted of shale, ranging to 8 feet in thickness, overlain with sandstone. The roof had been supported with 48-inch roof bolts. The victim was a certified miner and shot firer, and he was familiar with construction work involving roof blasting.

The victim and a second miner were instructed to complete the blasting operations for the overcast (fig. A-39). They charged and fired an undetermined number of holes (about 25). After waiting for the smoke to clear, they examined the area and installed two safety posts. The victim examined the roof and decided that additional supports were not needed. The two miners then charged 27 more shotholes and were in the process of charging the 28th hole when the roof fell on the victim, narrowly missing the second miner. The fall was about 6 feet long and 4 feet wide. During the investigation, loose and unsupported sections of mine roof were observed adjacent to the blasting operations.

Cause

This fatal accident was the result of employees performing work tasks in an area of the mine containing unsupported roof.

Factors contributing to the employees working in such areas were:

1. Management did not require, as standard procedure, the installation of roof supports in all areas adjácent to roof-blasting operations where previously installed roof supports were destroyed by blasting operations.

2. Employees (including the victim) were not aware of or disregarded the need for additional roof supports in areas adjacent to roof-blasting operations to safely control the roof to permit work in such areas.

3. Management did not provide necessary direct supervision of the construction site to determine that employees were suitably controlling the mine roof while performing tasks in such areas.

Recommendations

1. Management should formulate approved job procedures for construction work on a project-by-project basis and such procedures should include the following:

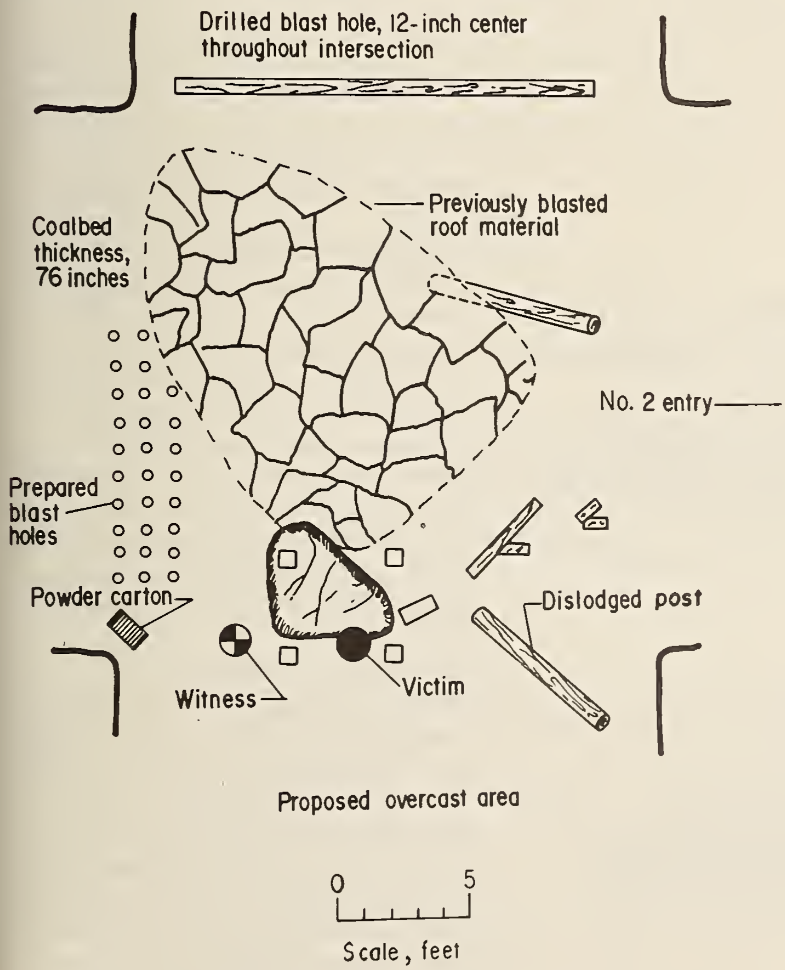

FIGURE A-39. - Accident 40.

a. Provisions to provide adequate roof supports in all areas adjacent to blasting and/or cleanup operations.

b. A posted plan at each work site that includes specific instructions regarding the type of roof supports, blasting materials, and the location of such supplies.

c. All construction operations should be provided with scheduled on-shift examinations to insure that employees are performing required tasks in a safe manner.

d. All employees required to perform construction work should be trained in safe work procedures, including the provisions of the posted work plan, relative to their job assignments.

2. All mine employees required to perform blasting operations should be trained in the permissible use of explosives.

3. Blasting operations should be conducted in accordance with the permits in effect at the mine.

Accident 41--Marion County, W. Va., August 7, 1973

A general laborer was killed. He was 30 years old and had 15 months of mining experience, 1-1/2 months at this mine. The mine was located in the Pittsburgh seam that averages 84 inches thick. Total employment was 287 men; 246 worked underground. The average daily production was 3,823 tons of coal. The immediate roof was 6 to 12 inches of top coal left to help support the overlying unconsolidated soft shale and wild coal; the main roof, 12 to 20 feet above the coalbed, was sandstone.

A wooden canopy had been erected along the main haulageway for protection of personnel (fig. A-40). The canopy was located in the area of an old roof fall that had been removed before installation of the canopy. Settlement of the support posts, due to the weight of spalling roof material that had accumulated on the canopy, made it necessary to raise the canopy and reset the support posts. The victim and another miner were on top of the canopy removing rock. The foreman had examined the roof area over the canopy and had scaled loose material that he was able to reach with a short bar. Owing to the height of the cavity, most of the area was only examined visually. The victim was pushing loose material through an opening in the top of the canopy into a mine car below when a rock dislodged from the brow and struck him on the head. The rock was approximately 36 inches long, 24 inches wide, and 12 inches thick.

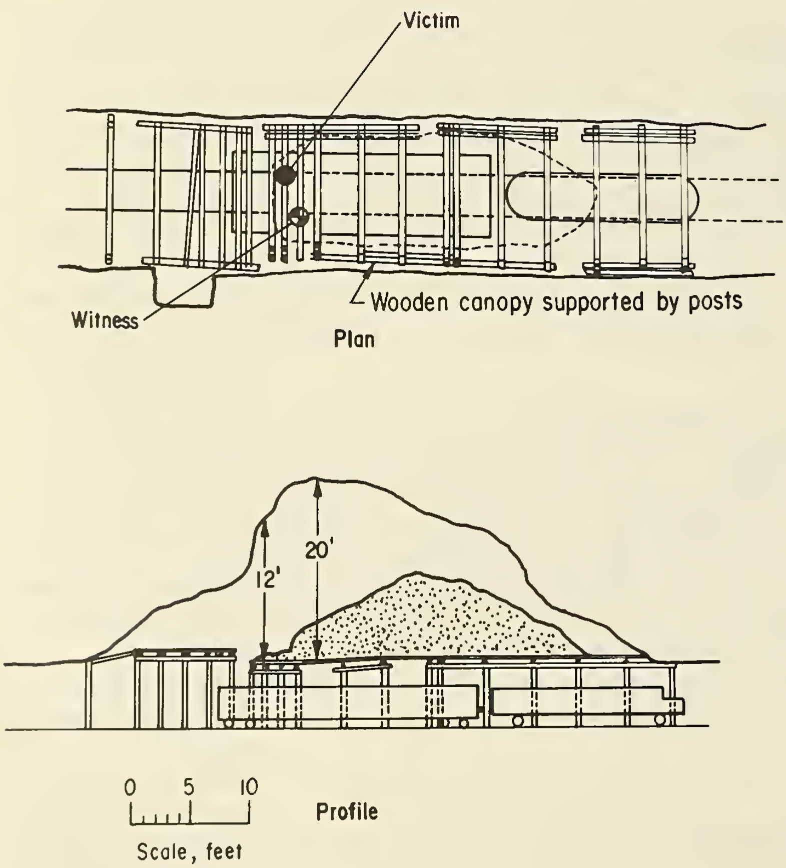

FIGURE A-40. - Accident 41.

It was believed that the rock fell from a position about 15 feet above the canopy.

An investigation revealed that the men were working on top of the canopy without temporary roof supports. However, they were preparing to install a temporary support between the top of the canopy and the roof, which was about 20 feet above the canopy.

Cause

Failure of management to devise an appropriate plan that would provide adequate protection for workmen exposed to the unsupported roof or roof-fall cavities and to properly scale the roof and brows during rehabilitation of previously mined haulage entries was the cause of the accident.

Recommendations

1. Management should formulate a revised plan for rehabilitating fall areas where the fallen material has been removed. The plan should include means and measures necessary to provide persons with maximum protection from falls of roof and brows.

2. The management personnel and employees should make a careful and thorough examination and evaluation of the area where persons are to work.

3. Bars of sufficient length should be used to scale the roof and brows in areas where men are required to work.

Accident 42--Preston County, W. Va., August 25, 1973

A mine tractor operator was killed. The victim was also a certified preshift examiner. He was 30 years old with 12 years of mining experience. The mine was located in the Freeport seam that averages 50 inches thick. Total employment was nine men; seven worked underground. The average daily production was 160 tons of coal. The immediate roof was 18 to 24 inches of carbonaceous shale or bone coal overlain by a firm sandy shale of variable thickness; the main roof was sandstone.

Some bone coal had fallen along a haulage entry approximately 500 feet outby the working face. A four-man crew, consisting of the general manager, the victim, and two general laborers, was in the process of removing it (fig. A-41). Two posts were set across the entry just outby the area, and the remaining loose bone coal was barred down. Reportedly, the overlying shale was examined by the sound-and-vibration method and visual observation. Although the shale was broken, it was not considered unsafe. The men then decided to gob the fallen material behind the line posts along the haulageway. The rockfall occurred while the men were preparing to set a crossbar. Apparently, there was some roof action indicating an impending fall because the victim shouted a warning to the other men. Another miner, who was near the victim, was struck by falling rock but managed to escape serious injury. The

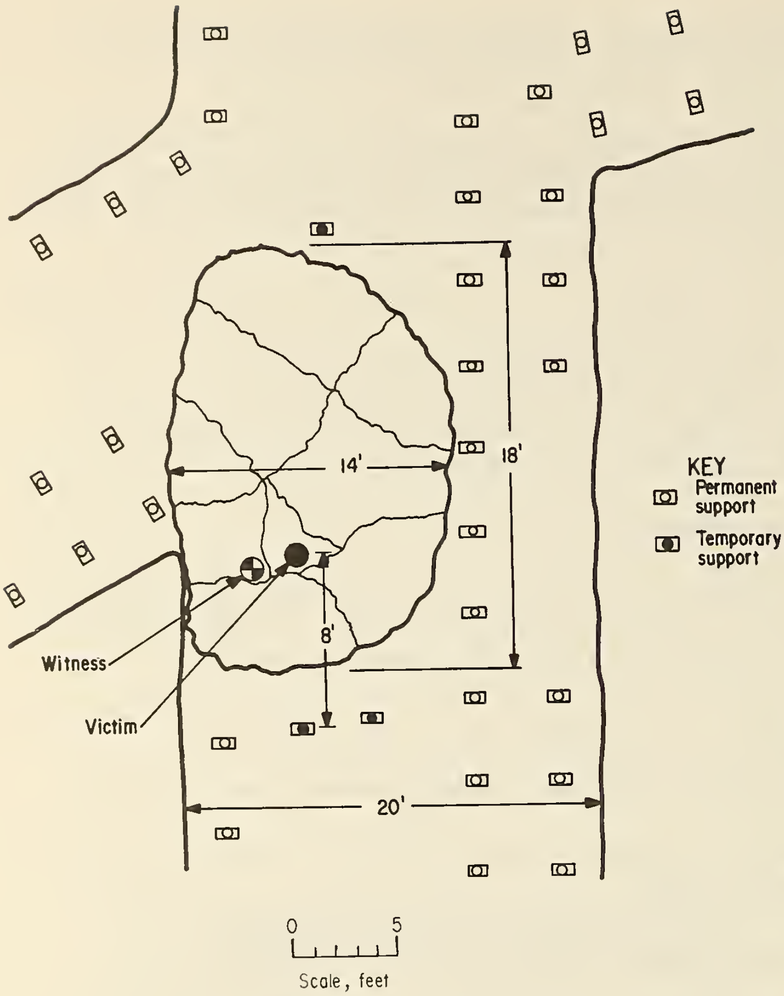

FIGURE A-41. - Accident 42.

other two men were inby the fall area. The rockfall was about 20 feet long, 14 feet wide, and 10 inches thick; it broke into several pieces.

An investigation revealed that the rock overlying the loose bone coal was broken and loose. The men were working as much as 8 feet inby the nearest support. The approved roof-support plan was not being followed in the accident area.

Cause

The cause of the accident was the failure of management to have temporary roof supports installed as required by the approved roof-support plan, and allowing men to work inby supported roof.

Recommendations

1. Management should enforce and all persons should comply with the approved roof-support plan.

2. Management should not permit employees to work under unsupported roof, and employees should not advance beyond permanent supports unless sufficient temporary supports are installed.

Accident 43--Logan County, W. Va., September 1, 1973

A mine foreman was killed. He was 46 years old with 29 years of mining experience, including 2 years as mine foreman. The mine was located in the Cedar Grove seam that averages 60 inches thick. Total employment was 155 men; 140 worked underground. Average daily production was 1,200 tons of coal.

The victim and a three-man crew were cleaning up a roof fall on the haulage sidetrack (fig. A-42). The fall had occurred the previous day, shutting down the sidetrack. A loading machine was used to fill a mine car with the fallen roof material. Two of the miners were assigned to transport this material to the surface. The victim and the third miner prepared four shots, all

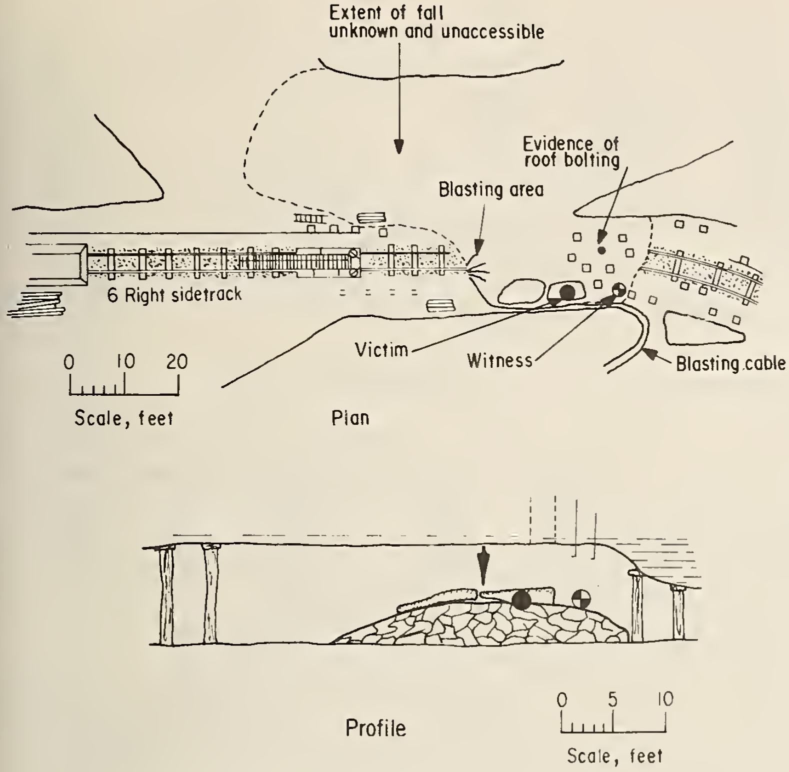

FIGURE A-42. - Accident 43.

unconfined, walked over the fall area to the outby edge, and fired the shots. The victim then climbed upon the fallen material to evaluate the results of the blasting operations when additional roof material fell on him. The fall dimensions were 30 feet long, 8 feet wide, and from a featheredge to 18 inches thick.

An investigation revealed that the victim had traveled over the fall area to perform blasting operations and that this area was unsupported since there was no evidence of temporary supports having been used. Also, there was no evidence that the roof had been examined except visually at any time prior to the accident because tools of proper length were not provided.

Cause

This fatality was the result of the victim (mine management) unnecessarily exposing himself to an unsupported mine roof during a roof-fall cleanup operation.

Contributing factors that resulted in the victim working under unsupported mine roof were as follows:

1. The operator of the mine did not furnish to the victim specific guidelines to follow in regard to construction work projects.

2. The operator of the mine did not provide a safety program, including scheduled inspections of the accident area, that would have detected the unsafe work procedures.

3. The disregard of safety standards by mine management and the labor force at this mine was reflected in the risk-taking actions by the victim, resulting in the subsequent fatality.

Recommendations

1. Management should formulate approved plans to adequately support the mine roof during roof-fall cleanup projects.

2. Management should reinstruct all employees in the provisions of the approved roof-control plan and the permissible use of explosives.

3. Management should notify MESA of unintentional roof falls that are defined in Part 80.11(i) of the Code of Federal Regulations.

Accident 44--Kanawha County, W. Va., September 8, 1973

A general laborer was killed. He was 20 years old with 4 months of mining experience, of which 8 days were at this mine. The mine was located in the No. 2 Eagle seam that ranges from 42 to 54 inches thick. Total employment was 168 men; 150 worked underground. The average daily production was 1,200 tons of coal. The roof consisted of about 30 inches of shale overlain with a weaker shale ranging up to 10 feet. This is overlain with a 9-inch-thick rider coalbed. The roof material often falls to the rider coalbed.

The victim and a second miner, under the supervision of a section foreman, were leveling a massive roof fall (fig. A-43). The fall had obstructed a main return airway and crushed an overcast over an intake airway. A prior fall, adjacent to this one, had been resupported the previous year. The work procedure was to blast the material, manually load it into a wheelbarrow, and move it about 25 feet to level the top of the fall.

The foreman examined the area and determined that a crib-roof support installed in the area was ineffective due to shifting of the fallen material from blasting and removal. He instructed the two miners to tear down the crib and rebuild it. One safety post (crib block) was installed adjacent to the area and the crib was taken down. After a suitable area was cleaned on the fallen roof material, the men began rebuilding the crib. The crib blocks were placed about three layers (18 inches) high when, without warning, the roof fell, striking the victim in the head and the second miner on the arm. The fall was about 5 feet long, 5 feet wide, and averaged 4 inches thick. The width of the exposed roof was about 11 feet, and only one temporary support was installed instead of four, as required by the posted procedures.

Cause

This fatality resulted when loose mine roof over a working area was not adequately supported with temporary supports.

Contributing factors to the occurrence were as follows:

1. Management did not incorporate a method of leveling the roof fall that would insure that employees were not exposed to adverse roof conditions.

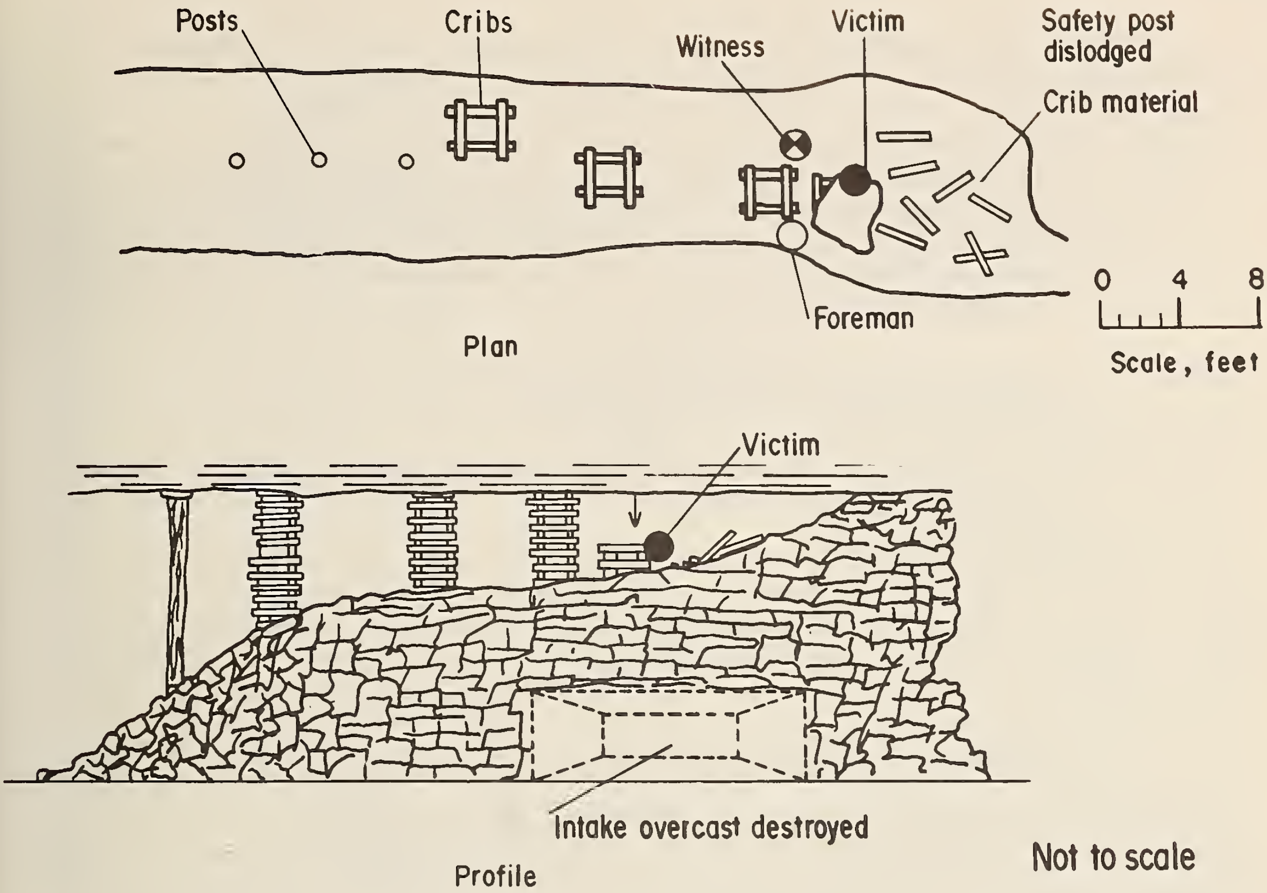

FIGURE A-43. - Accident 44.

2. Management did not formulate a suitable plan that would control the mine roof and instruct the employees in specific requirements of the roof-support program to insure that sufficient temporary supports were installed.

3. Management did not incorporate a roof-control plan that included sufficient additional supports installed in entries used as airways, after active mining was completed, to prevent unintentional roof falls.

Recommendations

1. Management should require that preshift examinations be conducted in construction work areas.

2. Management should comply with the approved roof-control plan in regard to supporting and/or removing hazardous mine roof in rehabilitation work areas.

3. Management should formulate suitable work procedures and methods for construction operations that should include the following:

a. A posted plan at each construction site where roof-fall removal or roof-bolting operations are conducted, which includes specific instructions as to the type of roof supports, the blasting procedures, and roof-scaling methods. A provision shall be included that stipulates that only top mine management can approve changes in the planned operation.

b. Roof-supporting materials and roof-scaling tools on a job-by-job basis compatible with the conditions.

c. A provision to report required unintentional roof falls to MESA for investigating purposes.

4. Management should, on a continual basis, upgrade the approved roof-control plan to include the installation of cribs, or the equivalent, in all entries used as airways in an attempt to prevent unintentional roof falls. These additional support installations should be incorporated on the working cycle of the active sections, where roof conditions require such supports.

Accident 45--Buchanan County, Va., December 19, 1973

A section foreman was seriously injured. He was 42 years old with 19 years of mining experience; 10 years as a section forman (3-1/2 years at this mine). The mine was located in the Pocahontas No. 3 seam that ranges from 48 to 60 inches thick. Total employment was 497 men; 440 worked underground. The average daily production was 4,500 tons of coal. The immediate roof in the accident area consisted of fragile shale and laminated sandstone from 6 to 36 inches thick; the main roof was laminated sandstone.

The right side of a roof fall in the face of the No. 4 entry was removed with a continuous-mining machine (fig. A-44). The rock on the left side was not loaded because it was sandstone and emitted sparks when struck by the machine bits. Three safety posts that had been dislodged by the miner were reset as the crews left, for a total of five safety posts installed in the place. The two men of the roof-bolting crew observed the roof cavity left by the fallen rock and assumed that the roof was bad. They only examined the roof visually. The victim entered the place as the bolters were starting to set safety posts, commented on the bad roof condition, instructed them to be careful, helped them install six more safety posts, and then left the area. Sometime later, the victim returned to the place as one of the bolters was attempting to free a stuck drill steel. The victim walked around in front of the bolter and asked if the drill steel had been freed. As the bolter answered in the affirmative, the victim turned to walk away when the roof fell on him without any warning. The bolter was knocked down by the fall, which dislodged two safety posts, but was not injured. The victim's injuries included a broken left leg, several broken ribs, and a fractured vertebra. One of the bolters stated that they had not detected the bad roof.

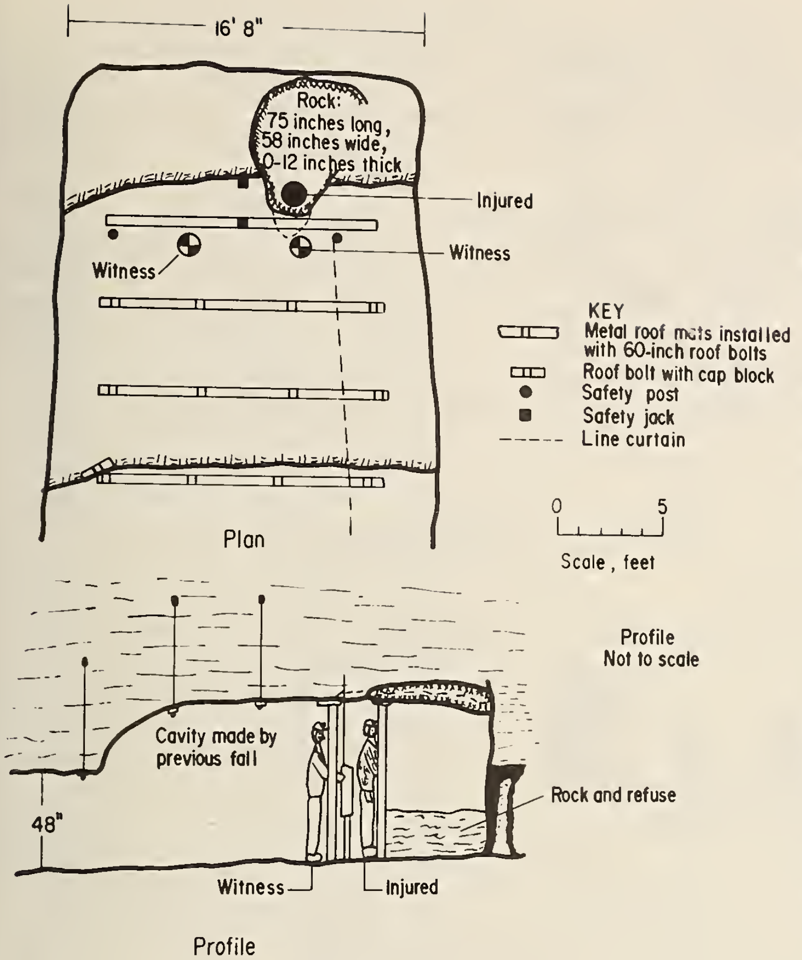

FIGURE A-44. - Accident 45.

Cause

1. Failure of management to adequately support or otherwise control the roof where abnormal roof conditions were being encountered was the cause of this accident.

2. Failure of management and employees to make proper roof examinations and accurate evaluation of the true roof conditions was a contributing factor to the accident.

Recommendations

1. Management should support or otherwise adequately control the roof and ribs in all active underground roadways, travelways, and working places to protect persons from falls of roof or ribs.

2. Where miners are exposed to danger from falls of roof, face, or ribs, the operator should examine and test the roof, face, or ribs before any work or machine is started, and as frequently thereafter as may be necessary to insure safety. Where dangerous conditions are found, they should be corrected immediately.

Accident 46--Monongalia County, W. Va., January 8, 1974

An assistant mine foreman was killed. He was 41 years old with 26 years of mining experience; 14 months as an assistant mine foreman. The mine was located in the Pittsburgh seam that averages 84 inches thick. Total employment was 507 men; 430 worked underground. The average daily production was 12,000 tons of coal.

A roof fall had occurred at an intersection along the main haulageway (fig. A-45). This area had been mined about 15 years previously. The roof was approximately 13 feet high before the fall occurred. Temporary supports were installed, the roof of the cavity was supported with roof bolts, and the fallen material was removed. After removal of the fall, the roof height in the cavity was about 20 feet above the mine floor, and the cavity measured

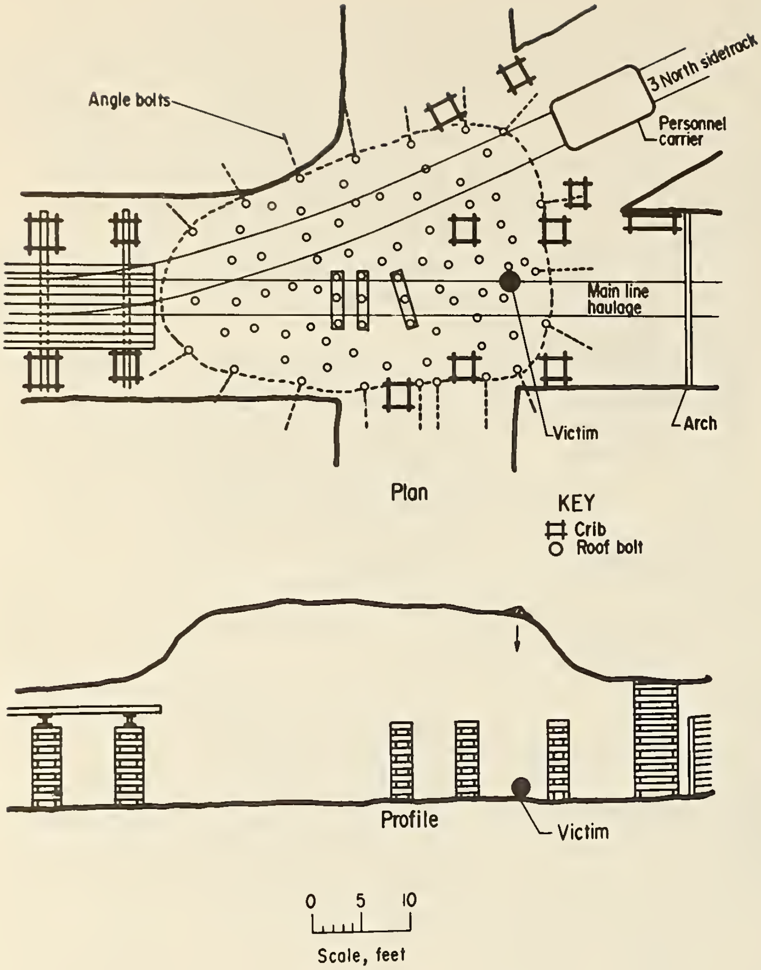

FIGURE A-45. - Accident 46.

about 50 feet long by 50 feet wide at the center of the intersection. The exposed roof in the cavity was unconsolidated shale of unknown thickness.

The victim took a crew to the fall area to install trolley wire hangers. Upon arrival, a visual examination was made of the roof. The crew then started erecting cribs to serve as supports for a scaffold on which the crew would drill the trolley wire hanger holes. After the four cribs were built, the dispatcher instructed the workmen to clear the main-line haulage entry to permit passage of a trip of empty mine cars and a trip of loaded mine cars. The crew moved into the sidetrack entry to wait for the trips to pass. The trip of empty cars passed, but the trip of loaded cars did not appear. The victim left the sidetrack entry to determine the status of the loaded trip. He walked about 30 feet and, as he reached the main-line track entry, a piece of rock fell from a height of about 30 feet and struck him on the head.

Cause

This accident was caused by failure of management to properly determine the roof conditions in the cavity while roof bolts were being installed and to devise a roof-support plan to adequately support the roof to prevent spalling of small pieces of rock before loading of the fallen material was started. Contributing thereto was the inability of officials and employees to make a thorough examination of the roof in the cavity before the scaffolding work was started.

Recommendations

1. Management should see that the roof and ribs in a fall area are adequately supported during cleanup operations.

2. Management should submit for approval a roof-support plan for areas in which unintentional roof falls have occurred and under which workmen will be required to work or travel. This should include one of the following: bolting of wire screening against the roof or installation of overhead canopy above the haulageway.

3. Management should require that a thorough and suitable roof examination be made by employees and officials of all areas in which employees are required to perform work. When conditions are such that the roof cannot be examined adequately, temporary supports or overhead protection should be provided for workmen.

Accident 47--Armstrong County, Pa., April 11, 1974

An assistant mine foreman was killed and three men were injured. The victim of the fatality was 60 years old with 36 years of mining experience, 9-1/2 years as assistant mine foreman at this mine. The injured men were 22, 49, and 56 years old with 1/2, 23, and 40 years, respectively, of mining experience. The mine was located in the Upper Freeport seam that averages 48 inches thick. Total employment was 123 men; 120 worked underground. The average daily production was 2,500 tons of coal. The immediate roof was firm shale.

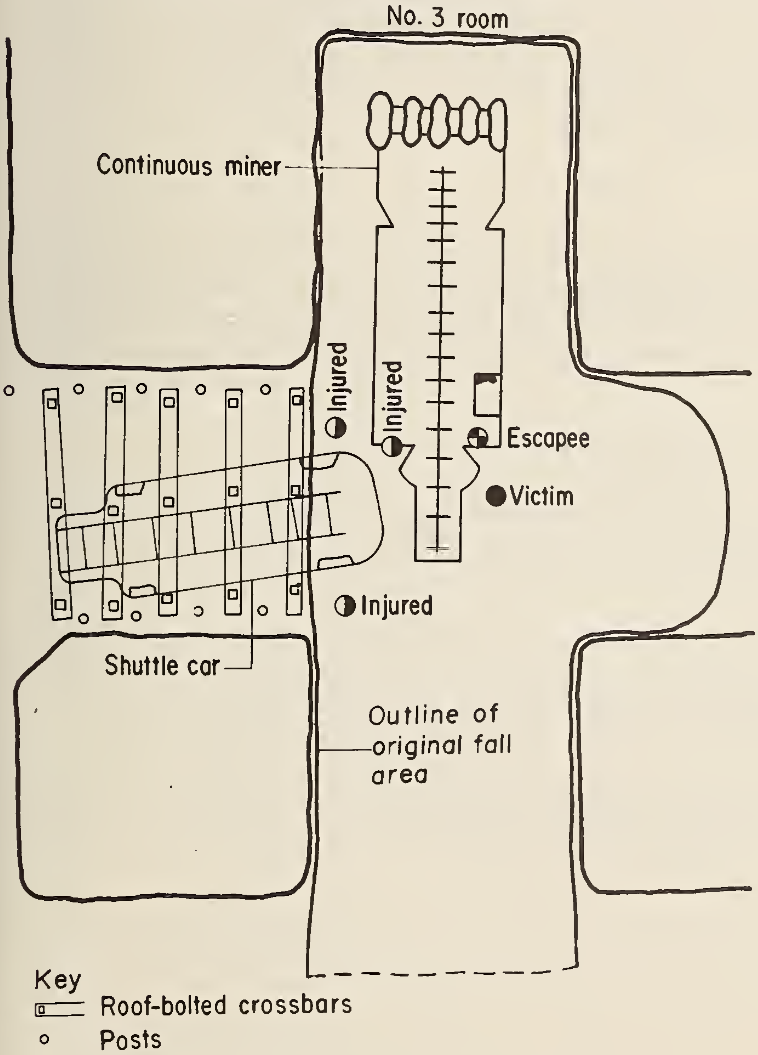

FIGURE A-46. - Accident 47.

A continuous-mining machine, parked in a face area of an advancing entry, had been covered by a massive roof fall during a change of shift (fig. A-46). Reportedly, the initial fall was 80 feet long, 18 feet wide, and 5 feet high. Management decided to recover the machine through the crosscut; the work had been progressing for two shifts. The recovery work was done by the production crews, by loading rock by hand into a shuttle car. Upon arrival of the next workshift in the fall area, the roof was examined by the victim, and it appeared to be solid. The crew proceeded with recovery operations.

Sometime later, after three shuttle cars of rock were loaded, the roof above the mining machine started working and the men withdrew from the area. A second fall then occurred, covering the head of the machine and extending to the face of the entry. The roof stopped working in about 30 minutes, whereupon the victim reexamined the roof and said that it "sounded good." The workmen then proceeded with rock removal. The victim kept testing the roof periodically. No temporary posts were set in the fall area owing to the arched, slickensided formation of the roof. The workmen depended on visual and sound-and-vibration tests to determine the roof condition. About 2 hours later, the miners were on top of the fallen material removing rock when the third fall occurred. Four men were caught by the falling rock; the fifth managed to escape. The man that escaped injury had felt rock chips strike his shoulder and had moved toward the right side of the entry while shouting a warning. The mine foreman was killed by the fall, one man sustained extensive lacerations and a compound fracture of the upper leg, and two men suffered minor injuries. The piece of rock that struck the victim was estimated to be 10 feet long, 5 feet wide, and 36 inches thick.

Cause

The roof fall was a result of failure to support the roof while cleaning a roof fall, as required by the approved roof-support plan. The assistant foreman's and workmen's failure to properly evaluate loose unsupported roof, and working inby permanant roof supports contributed to the seriousness of the accident.

Recommendations

1. The roof of all active underground roadways, travelways, and working places should be adequately supported to protect persons from falls of the roof.

2. The approved roof-control plan should be complied with at all times.

3. Except to install temporary supports, as stipulated in the roof-control plan, no person should proceed inby permanently supported roof.

4. If the roof of any work area cannot be adequately supported and made safe for the workmen, the area should be abandoned.

☆U.S. GOVERNMENT PRINTING OFFICE: 1976-703-001/3
INT.-BU.OF MINES,PGH.,PA. 21645