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Mine Inspection Records Study

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MINE INSPECTION RECORDS STUDY

by

George J. Conroy,¹ Glenn Harrison,²
and Jack Simmons³

ABSTRACT

This Bureau of Mines report summarizes the results of a study of mine inspection records covering 2,200 mining installations over a 3-year period ending December 1974. Tables show the relative frequency of violations of certain provisions of the Coal Mine Health and Safety Act of 1969 in particular areas of concern, such as circuit breakers, grounding, and permissibility. Examples of past use of the data and analyses are presented.

INTRODUCTION

The following is a summary of results of a study of mine-inspection records covering 2,200 coal mining installations including underground mines and their surface facilities, surface mines, maintenance shops, and preparation plants. The purpose of the study was to obtain indications that could lead in new directions of research contributing to electrical safety. Since the study was started, the Health and Safety Analysis Center of the Mining Enforcement and Safety Administration (MESA) in Denver is reportedly pursuing studies toward this purpose; however, they were not so engaged at the time of this study. Further, it is doubtful that a purely statistical analysis of data, although valuable, would be as beneficial as an engineering-based review in indicating equipment and component areas in which to concentrate technical research.

The reports were routinely forwarded by MESA as they were initiated. Those studied covered the period from January 1972 through December 1974. However, because receipt of the reports at the Bureau of Mines is sporadic and not ordered with respect to time, it is probable that not all reports issued in the stated period are covered by the study.

In this summary, some values were rounded to the nearest decade. There were, for example, 2,198 installations, reported as 2,200, of which 1,698 were underground mines, reported as 1,700. Where this general order of accuracy is not maintained, appropriate qualifying terms are used ("approximately," etc.).

¹Electrical engineer.

²Mathematics aid.

³Engineering aid.

TYPES OF RECORDS

The inspection record forms are shown in figures 1 through 3. All of the blanks were not always completed, so some lapses of information do occur. The total number of Coal Mine Inspection Reports (form 2000-34) processed was much greater than 2,200, as each inspection trip to an installation resulted in a new record being generated. New data from these records replaced the old in the data base when received; only the latest were retained. Although the information from form 2000-3, Notice of Violation, was also updated from form 6-1383, Notice of Abatement Action, the original information was retained in the data base.

DATA SUMMARY

There were 7,500 citation notices issued against the 2,200 installations; however, only 5,940 of these were for electrical violations, which are the only type of violations considered. These concern title 30 of the Coal Mine Health and Safety Act of 1969, part 75 (underground mines), subparts F through K, and part 77 (surface mines), subparts F through I. Of the total 2,200 mines, 1,700, or 77 percent, were underground mines, and 4,640 of the 5,940 electrical violation citations, or 78 percent, applied to underground mines. A single citation often applied to more than one machine. In fact, there was a total of 8,950 machines or components involved; 7,000 of these (again, 78 percent) were in underground mines. Considering that about the same percentage value applies to number of underground mines and number of violations in underground mines, the evident conclusion is that the incidence of violations per unit is not greater in underground mines than it is in surface facilities, whether based on notices or on number of machines involved.

First, considering violations in underground mines (part 75) separately, the 11 most commonly violated paragraphs by machine or component count, together comprising 70 percent of the total violations are shown in table 1.

TABLE 1. - Top 11 violations of part 75

Rank	Description	Para- graph	Viola- tion, percent
1.....	Short circuit protection of trailing cables.....	601	11
2.....	Maintain permissibility of face equipment.....	503	10
3.....	Overload and ac protection for equipment and circuits	518	9
4.....	Grounding of frames.....	701	8
5.....	Examination, test, and maintenance of equipment.....	512	7
6.....	Ground check circuits (medium and low voltage).....	902	7
7.....	Supporting power wires on well-insulated hangers....	516	5
8.....	Use of insulating bushings where cables enter metal.	515	4
9.....	Suitability of splices and connections.....	514	4
10.....	Effective grounding of dc machines.....	703	4
11.....	Circuit breakers (medium and low voltage), three- phase circuits.....	900	4
Total	-	-	73

**UNITED STATES
DEPARTMENT OF THE INTERIOR
MINING ENFORCEMENT AND SAFETY ADMINISTRATION**

Form 2000-34
(Dec. 1970)
Room 635
4015 Wilson Blvd.
Arlington, Va. 22203

Mine ID No. _____

Coal Mine Health and Safety District _____

COAL MINE _____ INSPECTION REPORT

This report is based on a survey made pursuant to the Federal
Coal Mine Health and Safety Act of 1969 (85 Stat. 742).

Originating Office:

This Inspection:

Mine: _____

Company: _____

Location: _____

Symbol _____

Daily Production _____

Surface Employment _____

Underground Employment _____

No. of Active Section(s) _____

No. of Days for Inspection _____

Date(s) of Inspection: _____

Previous Inspection:

Mine: _____

Company: _____

Date(s): _____

Type and Number of Openings:

Drifts Slopes Shafts

Type of Mine:

Underground Strip Auger Other _____

Name of Coalbed _____

Thickness of Coalbed _____

No. of Production Shifts _____

No. of Maintenance Shifts _____

Date Final Report Transmitted _____

	Notice(s)	Order(s)
No. Issued _____		
No. Terminated _____		
No. Pending _____		

Frequency Rate	
Fatal	Nonfatal
19____	
Industry _____	_____
This Operation _____	_____

Name	Address
President _____	_____
Superintendent _____	_____
Safety Director _____	_____
Principal Officer—Health and Safety _____	_____
_____	_____
Labor Organization _____	District No. _____ Local Union No. _____
Recording Secretary (Name and Address) _____	_____
Union affiliation previous inspection _____	Is a mine safety committee maintained? <input type="checkbox"/> Yes <input type="checkbox"/> No

Coal Mine Inspector

FIGURE 1. - Coal mine inspection report (form 2000-34).

△

2000-3
(July 1973)

Symbol.....

UNITED STATES
DEPARTMENT OF THE INTERIOR
MINING ENFORCEMENT AND SAFETY
ADMINISTRATION
Coal Mine Health and Safety Subdistrict Office
4099 William Penn Highway
Monroeville, Pennsylvania 15146

TO THE OPERATOR, OR HIS AGENT, OF THE
.....MINE
Company.....
Location.....
I.D. No.....

ORDER NOTICE No.....

Time:..... A.M. P.M. Date:..... 19.....
(Person Served)

Pursuant to the Federal Coal Mine Health and Safety Act of 1969 (83 Stat. 742; 30 USC 801; PL 91-173) the undersigned 'duly authorized representative of the Secretary of the Interior, upon making an inspection of the above named mine on this date finds that the following described condition or practice exists in the mine:

Condition or Practice

[Cont'd Sheet No.]

The undersigned finds that:

- Men had been withdrawn prior to issuance of this order
- An **IMMINENT DANGER EXISTS** in that the condition or practice described could reasonably be expected to cause death or serious physical harm before such condition or practice can be abated.
- There has been a violation of §..... of Part....., Title 30, Code of Federal Regulations, a mandatory health or safety standard, but the violation has not created an imminent danger.
- The undersigned further finds:
 - the violation is of such nature as could significantly and substantially contribute to the cause and effect of a mine safety or health hazard, and is caused by an unwarrantable failure to comply with such standard.
 - The violation was found during the same inspection in which during a subsequent inspection made within 90 days after

Notice No..... was issued on, 19.....
and is also caused by an unwarrantable failure to comply with such standard.

- the violation is similar to the violation of the mandatory health or safety standard which resulted in the issuance of Withdrawal Order No..... on....., 19....., and no inspection of the mine has been made since such date which disclosed no similar violation.

ACTION REQUIRED

- NOTICE** The violation of the mandatory health or safety standard described above shall be totally abated by o'clock on, 19.....
- ORDER** You are hereby **ORDERED** to cause immediately all persons, except those referred to in subsection (d) of section 104 of the Act, to be withdrawn from, and to be prohibited from entering, the area of the mine described below until an authorized representative of the Secretary of the Interior determines that the imminent danger no longer exists or the violation of the mandatory health or safety standard has been abated.

Area of Mine

Cont'd Sheet No.....

Orders 104 (a) 104 (c) (1) 104 (c) (2)
Notices 104 (b) 104 (c) (1)

Signed.....
Authorized Representative

Form 1

FIGURE 2. - Notice of violation (form 2000-3)

6-1383
(July 1973)

Symbol

**UNITED STATES
DEPARTMENT OF THE INTERIOR
MINING ENFORCEMENT AND SAFETY
ADMINISTRATION**

TO THE OPERATOR, OR HIS AGENT, OF THE
..... MINE

Company

Location

I.D. No.

Coal Mine Health and Safety Subdistrict Office
4099 William Penn Highway
Monroeville, Pennsylvania 15146

ORDER NOTICE No.

Time: A.M.
 P.M. Date: 19.....
(Person Served)

Pursuant to the Federal Coal Mine Health and Safety Act of 1969 (83 Stat. 742; 30 USC 801; PL 91-173) the undersigned duly authorized representative of the Secretary of the Interior upon making an inspection of the above named mine on this date and upon the expiration of a period of time as originally fixed upon the expiration of a period of time as extended upon the request of the operator Finds that the condition or practice set forth in.

ORDER(S) NO.(S) dated 19.....

NOTICE(S) NO.(S) dated 19.....

has been totally abated been partially abated not been abated

Action Taken to Abate

and the undersigned further finds that the period of time fixed in said Notice(s) should

be extended to the time fixed below not be extended.

Reason for Extension

Said ORDER(S) NOTICE(S) No.(s)

is or are hereby terminated vacated

shall remain in full force and effect as issued

is or are hereby modified as follows, and except as modified shall remain in full force and effect:

ACTION REQUIRED

NOTICE The condition or practice shall be totally abated by o'clock
on 19.....

ORDER You are hereby ORDERED to cause immediately all persons, except those referred to in subsection (d) of section 104 of the Act, to be withdrawn from, and to be prohibited from entering, the area of the mine described below until an authorized representative of the Secretary of the Interior determines that the condition or practice no longer exists and has been totally abated:

Area of Mine

Order 104(b)

Signed
Authorized Representative

FIGURE 3. - Notice of abatement action (form 6-1383).

If the various paragraphs of part 75 are grouped in accordance with their similarity of content or the subjects addressed, the most significant percentages are shown in table 2.

TABLE 2. - Paragraphs in part 75, grouped by subject

General concern	Paragraphs	Violations, percent
Circuit breaker.....	001, 518, 601, 800, 809....	25
Grounding.....	700-701, 703-704, 801, 803, 811, 902.	21
Use of permissible equipment and maintaining permissibility.	500-506, 512, 522.....	17
Splices and connections.....	507, 514, 602-604, 804, 810	9
Cable insulation, physical protection, and bushings.	516-517, 600, 605-606.....	8
Total.....	-	180

¹Violations remaining are in miscellaneous categories.

Table 3 shows the number of violations by equipment type for each of the foregoing regulation groupings. The data utilized has been retained on magnetic tape; however, since the date of the study, the information retrieval system utilized is no longer available. Therefore, extending the list to other equipment types would require Fortran programming to retrieve the taped data.

TABLE 3. - Violations by category, part 75 regulations group

Equipment	Circuit breakers	Grounding	Permissibility maintenance	Splices and connections	Cable insulation and protection	Total
Mining machines (continuous miners, cutting machines, loaders, etc.).	140	43	166	54	46	449
Roof machines (drills, bolters).....	136	40	63	70	28	337
Face haulage vehicles (shuttle cars, etc.)	12	39	43	15	0	109
Battery vehicles and charging stations.....	89	87	45	19	18	258
Total.....	377	209	317	158	92	1,153

In the table, permissibility maintenance and circuit-breaker violations are prominent among mining and roof machines. Circuit breaker and grounding

violations are significant among battery equipment. An unexpected item is the low incidence of cable-related violations among shuttle cars. This could be because the cable reels provide a more beneficial environment than is possible with a drag cable; however, it may also be that defects are noticed and corrected more quickly on these vehicles because they can strongly affect production as well as safety.

Considering violations of part 77 (surface mines) separately, the 11 most commonly violated paragraphs by machine or component count, together comprising 83 percent of the total violations, are shown in table 4. Regulations in part 77 may be combined into four groups of related paragraphs which together cover almost all (96 percent) of the violations contained in the data base. These groups are presented in table 5.

TABLE 4. - Top 11 violations of part 77

Rank	Description	Paragraph	Violations, percent
1.....	Grounding of frames.....	701	21
2.....	Cable fittings and bushings.....	505	16
3.....	Overload and short circuit protection.....	506	13
4.....	Lightning arresters.....	508	7
5.....	Examination, test, and maintenance of equipment.	502	6
6.....	Fail-safe ground check, high voltage.....	803	6
7.....	Cover plates in place.....	512	5
8.....	Splices and connections.....	504	3
9.....	Ground check, low and medium voltage.....	504	3
10.....	Transformer installation and grounding.....	509	2
11.....	Conductor capacity and insulation.....	503	2
Total	-	-	¹ 83

¹Apparent 1 percent difference in total is due to rounding individual values.

TABLE 5. - Paragraphs in part 77, grouped by subject

General concern	Paragraphs	Violations, percent
Grounding and ground check.....	700-703, 705, 801-803, 807, 810, 901-902.	40
Circuit breakers, switches, and disconnects.	506-507, 600, 808-809, 900, 903-904.	22
Cable protection, bushings, etc.....	505, 603-604, 805.....	20
Installation and maintenance.....	500-502, 509, 511-515, 605-606, 704, 806, 811.	14
Total.....	-	¹ 96

¹Violations remaining are in miscellaneous categories.

Analyzing violations of part 77, which would give information similar to that shown in table 3, was not performed at this time. Such inquiries are best tailored to particular problems as, for example, the question of how various components are involved when paragraph 75.516, which requires that equipment conform to the National Electric Code, is invoked. Such an inquiry was

conducted in relation to a request for proposal (RFP) being prepared for a study of coal preparation plant safety. Of the items of this nature covered in the data base, five violations involved ac power lines, four were for lighting units, three for conveyor belts, two for fans, and one each for a battery charger and a pump. The remaining citations did not specify the equipment or components involved. Since part of the rationale for issuance of the RFP was that preparation plants were possibly being unduly subjected to regulatory action because of 75.516, it was of interest that the total of 20 violations cited is 1.2 percent of the part 77 portion of the data base, ranking 17th in order of frequency (see table 4 for top 11).

Various arrangements of the data can be made to show production and employment-related statistics for individual mines, companies, and districts. An example is shown in table 6. No information is available regarding the original accuracy of the production figures used in developing the table. They were presumably furnished by mine officials and were not checked for accuracy.

TABLE 6. - Production by inspection district¹

Inspection district	Mine type	Production, tons per day	Number of mines	Number of shifts	Number of men	Average daily production, tons		
						Per mine	Per shift	Per man
1.....	Underground	1,627	49	45	329	332	36.2	5.0
	Surface....	26,501	69	118	894	384.1	224.6	29.6
2.....	Underground	205,817	122	272	18,640	1,687	756.7	11.0
	Surface....	13,815	22	30	525	628.0	460.5	26.31
3.....	Underground	152,804	68	116	10,725	2,247.1	1,317.3	14.3
	Surface....	600	2	3	54	300.0	200.0	9.4
4.....	Underground	252,563	260	495	20,992	971.4	510.2	12.0
	Surface....	8,950	5	6	95	1,790.0	1,491.7	94.2
5.....	Underground	113,372	294	384	10,508	385.6	295.2	10.8
	Surface....	300	1	1	8	300.0	300.0	37.5
6.....	Underground	93,662	336	425	6,538	278.8	220.4	14.3
	Surface....	12,500	3	4	50	4,166.7	3,125.0	250.0
7.....	Underground	225,978	283	405	15,327	798.5	558.0	14.7
	Surface....	188,985	88	105	4,514	2,147.6	1,800.0	41.9
8.....	Underground	242,188	63	144	14,421	3,844.3	1,681.9	16.8
	Surface....	325,108	77	109	7,554	4,222.2	2,982.6	43.1
9.....	Underground	48,707	38	68	3,317	1,281.8	716.3	14.7
	Surface....	225,890	46	55	3,475	4,910.7	4,107.1	65.0
Total underground.	-	1,336,718	1,513	2,345	100,797	883.5	570.0	13.0
Total surface.	-	802,649	313	431	17,179	2,564.4	1,872.3	46.7
Grand total.	-	2,139,367	1,826	2,776	117,976	1,171.6	770.7	18.1

¹83 percent of installations in data base.

CONCLUSION

This summary of results is intended to provide basic data for possible decisionmaking, rather than to present specific conclusions. In general, the data as assembled has already proven useful for this purpose. As examples, they influenced RFPs and existing investigations on circuit-breaker test apparatus, flameproof enclosures, splice connectors, and splice insulation. As discussed, the data arrangements utilized are not the only ones possible, and future consideration should be given to utilizing this data base with special inquiries when relevant problems are encountered.

APPENDIX.--VIOLATIONS RELATED TO FATAL AND NONFATAL ACCIDENTS

As a separate data base, records were available on 73 serious electrical accidents, 65 of which resulted in fatalities. Accident dates range from January 21, 1969, to April 18, 1976. Although the file is obviously incomplete, it is representative of important types of accidents that occur. Analyses of the data are summarized in tables A-1 and A-2, arranged for easy comparison with tables 2 and 5, respectively. In those cases where specifically applicable regulation paragraphs were not cited by the originators of the accident reports, the numbers were assigned by Conroy after a careful reading of the accident descriptions.

TABLE A-1. - Violations of part 75 directly contributing to accidents, grouped by subject

General concern	Paragraphs	Violations, percent
Circuit breakers and switches.....	518, 520, 523, 900, 1001..	8.5
Grounding and ground check.....	700, 701, 703, 803-804(a), 901.	21.0
Test and maintenance.....	512, 1725(a).....	11.2
Splices and connections.....	514, 603-604, 804(b), 805.	13.0
Cable insulation, physical protection, and bushings.	516-517, 606, 802(b).....	11.2
Repair procedures (deenergization, tools, qualified personnel, etc.).	509-511, 705.....	21.0
Installation, guards, and clearances.....	807, 1003.....	7.0
Unsafe practices.....	-	7.0
Total.....	-	199.9

¹Does not add to 100 because of independent rounding.

TABLE A-2. - Violations of part 77 directly contributing to accidents, grouped by subject

General concern	Paragraphs	Violations, percent
Grounding and ground check.....	700, 900.....	4.3
Circuit breakers and switches.....	507.....	2.2
Cable insulation, physical protection, and bushings.	505, 805.....	4.3
Installation, guards, and clearances ¹	509, 513, 807.....	26.1
Test and maintenance ¹	502.....	10.9
Repair procedures.....	500-501, 704.....	26.1
Safety instruction program.....	1708.....	2.2
Drill rig mast positioning.....	1008(a).....	2.2
Unsafe practices.....	-	21.7
Total.....	-	100.0

¹So combined for comparison with table A-1.

The last item in each of the two tables is termed "unsafe practices." For these cases, no regulation paragraph was directly applicable; however, in all cases, the accident could have been avoided with reasonable attention to practical safety rules. Several of the accidents in this class involved contact with overhead transmission or distribution lines or with uninsulated portions of switchgear, pointing to a possible need for more stringent regulations in these areas.

Table A-3 gives the equipment category involved in the accidents. This table is arranged to permit comparison of the first several items with those of table 3. Both surface and underground items are included.

TABLE A-3. - Violations directly contributing to accidents, by equipment category

Equipment	Circuit breakers	Ground- ing	Test and main- te- nance	Splices and connec- tions	Cable insula- tion and protec- tion	Repair proce- dures	Instal- lation, guards, and clear- ances	Other	Total
Mining machines	4	8	2	2	3	4	1	1	25
Roof drill.....	-	1	-	-	-	-	-	-	1
Face haulage...	1	-	2	1	1	-	-	-	5
Battery vehicles and chargers.....	-	2	4	-	-	4	2	-	12
Pumps.....	1	3	2	2	2	4	2	-	16
Trolley and locomotives...	-	-	1	-	-	1	3	2	7
Conveyors.....	-	-	1	1	1	-	1	-	4
Power centers, substations, switchgear....	1	3	1	2	2	11	3	2	25
High voltage cables and overhead transmission..	-	-	-	1	1	2	3	5	12
Other (welders, heater, drill jigs).....	-	-	-	-	-	1	2	5	8
Total.....	7	17	13	9	10	27	17	15	145