

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, DIRECTOR

BULLETIN 369

THE PREVENTION OF MINE EXPLOSIONS
REPORT AND RECOMMENDATIONS

BY

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WITH LETTER OF TRANSMITTAL BY

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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
Washington, October 20, 1908.

SIR: I send you herewith the report of Messrs. Watteyne, Meissner, and Desborough, the three foreign mining experts who, at my request, and in accordance with the appropriation made by Congress for the investigation of mine explosions, have made a very thorough examination and study of the mine conditions in our country. They have visited the principal coal-mining districts of the country, making personal examination of the representative mines. Their report is of great interest and will be of the highest importance in aiding Congress and the different state governments in providing legislation which will insure more efficient and careful operation of coal mines, by the adoption of mining methods and safety appliances which will materially aid in preventing the terrible losses of life that have occurred through mine explosions in recent years.

Each of these gentlemen has had the widest experience in his own country, and it is fortunate that we have been able to obtain their services in making this examination and report.

The report is preliminary to the more extensive investigations now being conducted by the technologic branch of the Geological Survey, and shows the vital importance of studying in a thoroughly scientific and at the same time practical way the conditions under which the more than half a million coal miners are daily risking their lives.

Very respectfully,

JAMES RUDOLPH GARFIELD,
Secretary.

THE PRESIDENT.



THE PREVENTION OF MINE EXPLOSIONS.

REPORT.

TO THE HONORABLE

THE SECRETARY OF THE INTERIOR.

SIR: In response to your request that we cooperate with the United States Geological Survey in the inauguration of its investigations looking to the prevention of mine explosions, and that we submit for the consideration of those connected with the coal-mining industry in the United States such recommendations as experience in our own countries and observation among American coal mines indicates may be useful in providing for greater safety, we beg to submit the recommendations given below.

Since coming to the United States, we have given careful attention to and approve the investigations in relation to this subject begun by the Geological Survey. We have visited typical mines in the more important coal fields of the United States, and have discussed the mining problems with many coal operators, miners, and state inspectors.

To be effective, investigations for the benefit of mining must be continuous. The opening up of new mines, the deepening of old mines, the meeting with new conditions, the changing of explosives, and the inauguration of new processes and methods will call for continuous investigations, to be followed by continuous educational work.

Our investigations and recommendations relate primarily to questions of safety in mining; but in this connection we have been greatly impressed with another closely associated phase of the industry, viz, the large and permanent loss of coal in mining operations in many portions of the United States. This is a serious, permanent, and national loss. It seems to be a natural outcome of the ease with which coal has been mined in the United States and the enormously rapid growth of the industry.

The active competition among the operators and the constant resulting effort to produce cheaper coal has often naturally led to the mining of only that part of the coal which could be brought to the surface most easily and cheaply, leaving underground, in such condition as to

be permanently lost, a considerable percentage of the total possible product. Certainly much of this loss can be prevented through the introduction of more efficient mining methods, such as the long-wall system, more or less modified, the flushing method. (See "H," 7, p. 10.)

In the preparation of these recommendations we have recognized fully the great differences between the mining conditions in Europe and those in America, where the industry has developed so rapidly that thorough organization has not yet been possible; where a large percentage of the men entering the mine are unfamiliar either with mining methods or the English language; and where the price of coal at the mine is less than half that in Europe. Nevertheless, we believe that these recommendations will be found useful in the further development of the American coal-mining industry for safety and efficiency. The cordial reception everywhere accorded us leads us to believe that these recommendations will be received by the operators and miners in the same spirit of good will as that in which they have been prepared. But the success of this movement for greater safety and efficiency will depend upon the hearty and patient cooperation of the operators and the miners, working together for the accomplishment of this purpose.

RECOMMENDATIONS.

A. SELECTING THE EXPLOSIVES TO BE USED.

(1) We recommend that the Government of the United States examine the explosives now and hereafter used in mining, with a view to eliminating the more dangerous explosives and to improving and standardizing such explosives as may be considered most suitable for such use, these to be designated by the Government "permissible explosives."

The term "permissible explosives" is suggested for the reason that no explosives are entirely safe, and all of them develop flame when ignited; and we advise therefore against the use in the United States of the terms "safety explosives" or "flameless explosives," as these terms may be misunderstood and this misunderstanding may endanger life.

(2) We recommend that the operators and miners of coal use only such explosives as are included in a list of "permissible explosives," when the same has been published by the Government, in all mines where there is risk of igniting either dust or gas, selecting that one which their own experience indicates can be used to the best advantage under local conditions.

(3) We also recommend that investigations be conducted to determine the amount of charge of such "permissible explosives" which may be used to the best advantage under different conditions with a view to reducing danger to the minimum.

B. CARRYING THE EXPLOSIVES INTO THE MINES.

(1) All explosives should be made into cartridges and placed in closed receptacles before being carried into the mine, and the quantity carried into the mine during one day by any miner should be limited as nearly as practicable to the quantity needed by him for use during that day. Handling loose explosives and making them into cartridges by an open light in the mine should be prevented.

(2) Detonators or caps should be handled with great care, and should be carried only by a limited number of responsible persons.

C. USE OF EXPLOSIVES IN THE MINE.

- (1) Shooting in or off the solid should not be practiced.
- (2) The depth of the shot hole should be less by at least 6 inches than the depth of the cutting or mining. The use of very deep shot holes should be avoided as unnecessarily dangerous.
- (3) The overcharging of shots (the use of a larger charge than is required to do the work satisfactorily) should also be avoided as unnecessary and dangerous. The proper standardization of explosives used in coal mining will greatly facilitate the carrying out of this recommendation. (See also "A," 1, p. 7.)
- (4) Shots should never be tamped with fine coal or material containing coal. Clay or other suitable material should be supplied and used for this purpose.
- (5) The firing of two or more shots in one working place, except simultaneously by electricity, should not be allowed until a sufficient interval has elapsed between the firings to permit an examination of the working place in order to see whether any cause of danger has arisen.
- (6) Before a shot is fired the fine coal should be removed from the working place, as far as practicable, and the coal dust on the floor, sides, and roof, for a distance of at least 20 yards from the place where the shot is to be fired, should be thoroughly wet, unless it has been demonstrated that the dust in the mine is not inflammable. (See also "E," 1, p. 9.)
- (7) If gas is known to occur in the mine, no shot should be fired until, in addition to the watering, an examination made immediately preceding the time for firing, by a competent person, using a lamp which will easily detect 2 per cent of gas, has shown the absence of that amount of gas from all spaces within 20 yards of the point where the shot is to be fired.
- (8) Believing that such will be one of the greatest advances which can be made in safeguarding the lives of the miners, we recommend the adoption of a system of electric shot firing, in all mines where practicable, by which all shots in the mine, or in each ventilation district of the mine, may be fired simultaneously, at a time when all miners and other employees are out of the mine.

D. KEEPING THE MINE ROADWAYS CLEAN.

- (1) The roadways of the mines should be kept as free as possible from loose coal which may be ground into dust and of rubbish in which such dust may accumulate, in order to facilitate the removal and wetting of the dust.

E. WETTING THE COAL DUST.

(1) In all coal mines where explosives are used it is desirable, and in all mines containing gas it is highly important, that the dust on the walls, timbers, and floors of the working places and roadways should be kept continually wet prior to and during the work in the mine. If, however, conditions of roof or lack of water render this general watering impracticable, at least the dust within 20 yards of each shot should be wet before each firing, and other precautions against explosions should be practiced with unusual care.

It is our opinion that a system of watering which occasionally sprinkles the floor only and leaves dry the dust on the walls and timbers of the roadways is useless and is also dangerous in that it may generate an unwarranted feeling of security against an explosion.

F. SPECIAL PRECAUTIONS FOR MINES CONTAINING GAS.

(1) In any mine where as much as 2 per cent of gas can be detected by suitable method only locked safety lamps of an approved type should be used so long as such condition exists or is likely to recur.

All safety lamps should be maintained in good condition, cleaned, filled, kept in a special room at the surface, and carefully examined both when delivered to the miner and when returned by him at the close of each day's work. A defective safety lamp is especially dangerous because of the false feeling of security it engenders.

In the filling of lamps with benzine or other low-flash oils, which should always be done at the surface, special precautions against fire or explosions should be taken.

G. USE OF ELECTRICITY.

(1) Electricity in mining operations offers so many advantages, and has been so generally adopted, that no reasonable objection can be made to its use under proper restrictions. The electrical equipment, however, should be installed, maintained, and operated with great care, and so safeguarded as to minimize danger from fire or shock. The fact that the effectiveness of some insulating materials is soon destroyed in most mines should not be lost sight of.

We recommend the following precautions: For distribution underground the voltage should not exceed 650 direct current or 500 alternating current, these voltages being intended for transmission to machinery operating at 500 volts direct current and 440 volts alternating current, respectively. Even lower voltages are preferable. The trolley wires should be installed in such manner as to render shocks least likely; that is, placed either high enough to be beyond easy reach or to one side of the track and properly protected.

Where current at a potential of more than 650 volts is employed for transmission underground, it should be transmitted by means of a completely insulated cable; and where a lead or armored covering is used, such covering should be grounded.

In all mines having electric installation special precautions should be taken against the setting on fire of coal or timber. Inclosed fuses or cut-outs are recommended, and each branch heading should be so arranged that the current may be cut off when necessary.

No live electric wire should be permitted in that part of any mine in which gas is found to the amount of 2 per cent.

In all mines producing gas in dangerous quantities, as indicated by a safety lamp which will detect 2 per cent of gas, the working places should be examined for gas by a qualified man, using such a lamp, immediately before any electric machine is taken or operated there.

H. PRECAUTIONS AGAINST MISCELLANEOUS ACCIDENTS.

(1) In all new construction, shaft lining and superstructures about the entrance of the shaft (or slopes or drifts) should be built as far as practicable of noncombustible materials.

About the entrances to mines, every possible precaution should be taken to prevent fires or the injury of the equipment for ventilation and haulage. Ventilating fans should be placed to one side of the mine opening, and hinged doors or light timbering should render easy the escape of the explosive force in direct line of the shaft or slope.

Proper precautions should be taken for immediately preventing the entrance into the mine of heat and gases and for facilitating the escape of the men in case of surface or shaft fires.

(2) The surface equipment for handling the coal should be so arranged as to prevent coal dust entering into the mine shaft.

(3) In all new mines, and in all old mines as far as practicable, suitable man roads should be provided for the men separate from the main haulage roads.

(4) In connection with the system of ventilation it is recommended that in the more frequented roads connecting the intake with the return air courses, two doors be provided, these doors to be placed at such a distance apart that while one is open the other is closed.

(5) In view of the large number of accidents from falls of coal or roof, under the existing practice with single props, more attention should be given to the introduction in mines where the roof is bad of better systems of timbering, such as have been long in use with economy and safety in many well managed mines.

(6) In undercutting coal by hand, the premature fall of the coal should be prevented by sprags or other suitable supports.

(7) We believe that the difficulties and dangers encountered in the working of coal seams which are thick and steeply pitching, or of

which the coal is highly inflammable in character or subject to firing from spontaneous combustion, and in mines where the subsidence of the surface must be avoided, may be successfully and economically overcome in many cases through the adoption of the flushing system of mining—that is, the filling with sand or other similar materials of the space from which the coal is removed. This system originated in the United States and is now successfully practiced in portions of Germany, Austria, Belgium, and France.

I. MINE SUPERVISION AND INSPECTION.

(1) We can not too strongly emphasize the fact that thorough discipline about the mine is absolutely essential to safety, and that thorough discipline can be brought about only through the hearty cooperation of the operators, the miners, and the State.

(2) We are of the opinion that the responsibility for safety in the mine should primarily rest with some person, such as the manager or superintendent, clothed with full authority; and that such person can greatly facilitate the attainment of safety through the employment of a sufficient number of foremen, and also of one or more inspectors whose special duty it shall be to see that the regulations are strictly enforced.

(3) The State can not exercise too much care concerning the experience, technical training, and selection of its inspectors. Their positions should be made independent of all considerations other than that of efficiency; and their continuance in the service should be coexistent with good behavior and proper discharge of official duty.

J. TRAINING FOR MINE FOREMEN, INSPECTORS, ETC.

We are of the opinion that the cause of both safety and efficiency in coal mining in the United States would be greatly aided through the establishment and maintenance in the different coal regions of special schools for the training of fire bosses, mine foremen, superintendents, and inspectors. The instruction in such schools should be practical rather than theoretical.

The work of these schools would supplement most effectively that of the colleges already established in many parts of the country for the more thorough training of mining engineers.

Respectfully submitted.

VICTOR WATTEYNE.

CARL MEISSNER.

ARTHUR DESBOROUGH.