

MSHA'S NEW REGULATIONS FOR EXPLOSIVES USED IN COAL MINES

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ABSTRACT

The Mine Safety and Health Administration (MSHA) has made an extensive revision of its existing blasting regulations and approval standards for explosives used in underground coal mines. A proposed set of revised regulations were developed and provided to mine operators, union, trade associations, manufacturers and other interested parties for comment. Final rules were subsequently prepared and published in the U.S. FEDERAL REGISTER on November 18, 1988. A summary of the final rules is presented and discussed. The requirements for "qualified shotfirer" are specified. Requirements on the use of explosives and blasting equipment, means of transporting explosives and blasting procedures are addressed. New rules that apply to approval of explosives and sheathed explosive units are also discussed. In addition, data on accidents involving explosives are summarized.

INTRODUCTION

The Mine Safety and Health Administration (MSHA) has revised its existing safety standards for blasting and approval of explosives used in underground coal mines. The revisions update existing requirements consistent with current technology. Unnecessary and duplicative standards are eliminated and alternative methods of compliance are provided where possible. The final rule on Safety Standards for Explosives and Blasting, Part 75, and Requirements for Approval of Explosives and Sheathed Explosive Units, Part 15, were published in the Federal Register on November 18, 1988. The effective date of these final rules was January 17, 1989.

The use of explosives in underground coal mines presents a potential risk for serious injuries and death to miners. A major hazard associated with the use of explosives is the accidental ignition of methane and coal dust. In the United States, from 1982 through 1987, there were 10 fatalities and 126 injuries as a result of blasting accidents in underground coal mines (Coal Accident and Injury Abstracts). Table 1 shows the accident data for each of these

years. The major causes of these accidents include premature blasts, blast area security, blasting fumes, and misfires.

Table 1: Underground coal mine explosive accidents, 1982-1987

<u>Year</u>	<u>Fatalities</u>	<u>Nonfatalities</u>
1982	3	19
1983	0	18
1984	1	16
1985	6	32
1986	0	18
1987	0	23

The new regulations provide increased safety protection for miners by including requirements to address identified hazards, by including more performance oriented requirements, and by reflecting advances in technology and modern blasting practices. The final rule, Part 15, for approval of explosives updates the existing regulations to reflect advances in technology that have led to the development of new types of explosives. The new regulations continue to require the use of explosives approved as permissible. Permissible explosives reduce the potential for igniting methane gas or coal dust that may be present where

blasting is performed.

BLASTING REQUIREMENTS, PART 75

The new regulations address the need for knowledgeable and experienced personnel to perform blasting functions. Only qualified persons or persons working in the presence of and under the direction of a qualified person may use explosives in underground coal mines. The final rule provides two alternatives for achieving qualification. A person certified to use explosives by the State in which the mine is located may be considered a "qualified person" if the State requires a demonstration of ability to safely use permissible explosives with respect to the new regulations. For States that do not certify persons to use explosives, a person may be considered a "qualified person" if he or she has at least one year of experience working underground on a coal-producing section of a mine where explosives are used. The person must demonstrate to an MSHA authorized representative the ability to use explosives safely.

The new regulations permit only permissible explosives, approved sheathed explosive units and permissible blasting units to be taken or used in underground coal mines. Black blasting powder, aluminum-cased detonators and detonators with aluminum leg wires and safety fuses are prohibited. Explosives, sheathed explosive units, and blasting units must meet certain design and performance requirements to be approved for use in underground coal mines.

The rules for transporting explosives and detonators underground require separate, substantially constructed containers made of nonconductive material. Transporting explosives and detonators in separate containers provides protection against accidental detonation of the explosives by the detonators. Nonconductive containers protect explosives and detonators from stray electric current during transportation.

The rules require that each container of explosives and detonators be marked with warnings to identify its

contents. Trips using trolley locomotives to transport explosives and detonators must be separated from all other mantrips by at least a five-minute interval. The cars containing explosives or detonators on these trips must be separated from the locomotive by at least one empty car or car containing noncombustible materials.

Explosives must be separated from detonators by at least 50 feet when transported on conveyor belts. Conveyor belts must be stopped before explosives or detonators are loaded or unloaded.

Underground Magazines

The quantity of explosives kept underground must not be more than needed for 48 hours of use. Explosives and detonators taken underground shall be kept in separate closed magazines at least five feet apart or separated by a hardwood or laminated partition. The magazines must be at least 25 feet from roadways and any source of electric current. Magazine locations must be posted with warnings to indicate the presence of explosives.

Explosive Materials Outside of Magazines

The amount of explosives taken outside of a magazine for use in blasting must not exceed 100 pounds or must not exceed the amount needed to blast one round when more than 100 pounds is required.

Sheathed Explosive Units

The revised blasting regulations for underground coal mines permit the use of approved sheathed explosive units. The sheathed explosive unit, which was developed by the Bureau of Mines, U.S. Department of the Interior, can be fired outside of a borehole without the hazard of igniting gas or dust that can be in the mine atmosphere. Historically, the firing of unconfined shots has been prohibited in underground coal mines. However, there are situations where a safety advantage can be gained by using the sheathed explosive unit. Some situations are dislodging loose roof slabs or rock overhangs, boulder breaking and leveling of roof falls.

The sheathed explosive unit is designed to form a flame-prohibiting cloud when the unit is fired. This cloud will prevent flame caused by firing the sheathed explosive from igniting explosive gas or dust mixtures.

No more than three sheathed explosive units are permitted to be fired at one time. A separate instantaneous detonator must be used to fire each sheathed explosive unit. It is not permissible to fire sheathed explosive units in contact with each other. The sheathed explosive unit must be approved by MSHA under the new approval requirements included in Part 15. The major aspects of these approval requirements are discussed in a following section.

Boreholes for Explosives

With the exception of sheathed explosive units and shots fired in anthracite mines for battery starting or for blasting coal overhangs, all explosives fired underground must be confined in boreholes. Each borehole in coal for explosives must be at least 24 inches from any other borehole and from any free face, unless the thickness of the coal seam prohibits such spacing. Each borehole in rock must be at least 18 inches from any other borehole in rock at least 24 inches from any other borehole in coal and at least 18 inches from any free face.

Blasting Preparation

Each borehole must be cleared and its depth and direction determined before loading with explosives. When priming explosives, a nonsparking punch must be used. Detonators must be inserted completely in and parallel to the length of the explosive cartridge; the leg wires must be secured around the explosive. The cartridge containing the detonator must be the first cartridge loaded in the borehole. Explosives of different brands and cartridges of different diameters are not permitted to be loaded in the same borehole. Tamping poles used for loading and tamping boreholes must be nonconductive and nonsparking.

Except when blasting solid rock in its natural deposit, not more than three pounds of explosive are

permitted in any borehole in bituminous and lignite mines. Only noncombustible material is permitted for stemming boreholes. Only pliable clay dummies are permitted as stemming when blasting off the solid in bituminous and lignite mines. Water stemming bags can be used for boreholes in cut coal. However, water stemming bags must be constructed of tear-resistant and flame-resistant material.

Multiple-Shot Blasting

Not more than 20 boreholes are permitted to be fired in a round unless permission has been obtained from MSHA. Instantaneous detonators in combination with delay detonators are not permitted in the same blasting circuit. Only detonators with delay periods of 1,000 milliseconds (ms) or less are permitted in bituminous and lignite mines.

When blasting cut coal in bituminous and lignite mines, the first shot or shots fired in a round must be initiated in the row nearest the kerf, or the row or rows nearest the shear. After the first shot or shots, the interval between the delay periods of successive shots must be at least 50 ms but not more than 100 ms.

When blasting coal off the solid in bituminous and lignite mines, each shot in the round must be initiated in sequence from the opener hole or holes. After the first shot or shots, the interval between the delay periods of successive shots must be at least 50 ms, but not more than 100 ms.

Blasting Circuits

Blasting circuits must be protected from sources of stray electric current. Detonator leg wires must be shunted until connection is made into the blasting circuit. Blasting cables must be well-insulated, copper wire of a diameter not smaller than 14-gauge. Wire used between the blasting cable and detonator circuitry must be well insulated with a resistance no greater than 20-gauge copper wire and not exceed 30 feet in length. When 20 or fewer boreholes are fired in a round, the blasting circuit must be wired in a single

series. Blasting cables must be hunted until immediately before firing, except when testing for circuit continuity. Immediately prior to firing, all blasting circuits must be tested for continuity and resistance using a blasting galvanometer or other instrument designed for testing blasting circuits.

Determination for Methane

No shot is permitted to be fired in an area that contains 1.0 volume percent or more of methane. Immediately before shots are fired, the methane concentration must be determined by a person qualified to test for methane.

Examination After Blasting

After blasting, the blasting area must be examined for misfires, methane and other hazardous conditions. If a round has partially detonated, the qualified person must immediately leave the area and no person may reenter that area for at least five minutes. When misfires occur, only work by a qualified person shall be performed in the affected area. Misfires that are not found and disposed of properly can be accidentally detonated during loading or other operations. Because of varying characteristics of explosives, a particular procedure for handling misfires is not specified in the regulations. However, the regulations permit a qualified person and mine management to address these situations on a case-by-case basis and limit the exposure of persons to the hazard of accidental detonation.

APPROVAL OF EXPLOSIVES, PART 15

The final rule updates the existing approval regulations to reflect state-of-the-art technology and deletes obsolete provisions. The final rule contains general approval procedures, technical requirements for the testing and evaluations of explosives, and new requirements for the approval of sheathed explosive units.

The revised regulations for Part 15 were effective January 17, 1989. Explosives issued an approval under regulations in place prior to

January 17, 1989, and in compliance with those regulations, can continue to be manufactured and marked as approved as long as no change is made to the explosive.

One revision in the approval requirements for explosives used in underground coal mines is the introduction of a modified gallery test. In this test, coal dust is predispersed prior to firing of an explosive charge into the gallery. This test provides for evaluation of explosives under conditions that are more representative of actual conditions in underground mines. Another change revises the existing requirements for toxic gases that are produced by detonation of explosives and a new method for calculating the equivalent volume of various gases relative to carbon monoxide is established. This method is based on threshold limit values published by the American Conference of Governmental Hygienists.

The test for air-gap sensitivity has been changed from a half-cartridge to a 7-inch cartridge method. modification includes marking the wrapper of each cartridge and each case of approved explosives with the test detonator strength and the minimum product firing temperature. A "test detonator" is an instantaneous detonator having a strength equivalent to a detonator with a base charge of 0.40-0.45 grams PETN. A test detonator is used to test explosives submitted for approval under the new requirements of Part 15. In addition, the lowest product temperature at which an explosive is approved for use under the newly revised Part 15 is defined as the "minimum product firing temperature."

Test Requirements for Explosives

Test requirements for approval of explosives consist of a rate-of-detonation test, an air-gap sensitivity test, a gallery test using methane! a gallery test using methane and bituminous coal dust, a pendulum-friction test, and a test for toxic gases.

The rate-of-detonation test is conducted on an unconfined 50-inch column of explosive. The test is intended to determine whether an

explosive has a tendency to misfire or partially detonate.

The air-gap sensitivity test is modified from a half-cartridge method to a 1/2-inch cartridge method. In this method, two 8-inch cartridges are used. One inch is cut off the end of each cartridge. The cartridges are placed in a paper tube with the cut ends facing each other with an air gap between them. The explosive must propagate across a 3-inch air gap when the test is conducted at a temperature between 68 and 86 degrees Fahrenheit. The explosive must also propagate across a 2-inch gap when the test is conducted at the minimum product firing temperature specified or 41 degrees Fahrenheit, whichever is lower.

Two gallery tests are conducted on an explosive to determine the incendivity when fired into a flammable atmosphere. One test is conducted by firing explosives from a steel cannon into a long gallery containing approximately 8 percent of natural gas. Another gallery test is conducted by firing explosives into a mixture of bituminous coal dust which is predispersed into a 4 percent natural gas atmosphere.

The pendulum friction test is conducted on a small sample of explosive. The explosive is placed on an anvil and the pendulum is adjusted and released from a height of 59 inches. The test demonstrates whether the explosive is unduly sensitive to impact and friction.

The test for toxic gases is made by firing a 1-pound explosive charge from a steel cannon into a large chamber. The gaseous products resulting from detonation of the explosive are collected and analyzed for toxic gases. The equivalent volume of each toxic gas produced, relative to carbon monoxide, is determined by multiplying the measured volume of the gas by a conversion factor. The conversion factor is equal to the threshold limit value, time weighted average in parts-per-million for carbon monoxide divided by the threshold limit value, time weighted average for the toxic gas. The total volume equivalent to carbon monoxide of the toxic gases produced by detonation of the

explosive is the sum of the equivalent volumes of the individual toxic gases.

TEST REQUIREMENTS FOR SHEATHED EXPLOSIVE UNITS

The test requirements for the approval of sheathed explosive units are new. Each sheathed explosive unit must not contain more than 1-1/2 pounds of an approved or permissible explosive. This quantity of explosive is the maximum amount used in the prototype units designed and tested by the Bureau of Mines and found to be adequate for all situations where sheathed explosives are likely to be used. A drop test is conducted on sheathed explosive units to determine whether the contents of the units are susceptible to shifting or damage under conditions comparable to those likely to be encountered in underground mines.

Four gallery tests are conducted on sheathed explosive units to determine their incendivity in mixtures in methane and coal dust. In one gallery test, three units are placed two feet apart on a concrete slab in an explosive methane-air atmosphere. In this test, an evaluation under conditions simulating the blasting of fallen rock in an underground mine is made. A second gallery test using the same arrangement of sheathed explosive units is conducted in an explosive methane-air atmosphere in which bituminous coal dust has been predispersed. A third gallery test is conducted with three sheathed explosive units arranged in a triangular pattern in a simulated crevice formed by two concrete slabs. This test is made in an explosive methane-air atmosphere to simulate conditions of blasting an overhanging roof slab. A fourth gallery test is conducted with three sheathed explosive units arranged in a triangular pattern in a corner formed by three steel plates. This test is made in an explosive methane-air atmosphere to simulate conditions of blasting along a rib where compression and reflection of the explosive shock wave are produced. A detonation test is also made on sheathed explosive units when fired at the minimum product firing temperature established for the explosive used in the unit, or at

41 degrees Fahrenheit for units with previously approved explosives. The test evaluates the effect of temperature on the sensitivity of the explosive and the performance of the flame-inhibiting material in the unit.

SUMMARY

In the final rules, MSHA has reorganized, updated, and clarified existing regulatory provisions for the use and approval of explosives. MSHA believes that the clarification of these rules will facilitate better understanding and improve application of safe blasting practices in underground coal mines.

REFERENCES

Safety Standards for Explosives and Blasting; Final Rule, 30 CFR Part 75, U.S. Department of Labor, Mine Safety and Health Administration, Federal Register, Vol. 53, No. 233, November 18, 1988, pp. 46768-46789.

Requirements for Approval of Explosives and Sheathed Explosive Units; Final Rule, 30 CFR Part 15, U.S. Department of Labor, Mine Safety and Health Administration, Federal Register, Vol. 53, No. 223, November 18, 1988, pp. 46748-46765.

Coal Accident and Injury Abstracts, U.S. Department of Labor, Mine Safety and Health Administration, 1982-1987.