PERMISSIBLE EXPLOSIVES, MINING EQUIPMENT, AND APPARATUS APPROVED PRIOR TO JANUARY 1, 1924

BY

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BUREAU OF MINES PERMISSIBLE LISTS.

As part of its work for the increase of safety in mining, the Bureau of Mines tests mining apparatus and explosives and approves as permissible those that pass the tests. Lists of permissible equipment and supplies have been established for breathing apparatus, coal-cutting machines, electric drills, electric cap lamps, flame safety lamps, shot-firing units, storage-battery locomotives, and explosives.

The various schedules, stating the procedure and requirements under which these devices and supplies are tested and the fees charged, may be obtained by application to the Director, Bureau of Mines, Washington, D. C. A complete list of permissible mining equipment and explosives is published as a Technical Paper once during each calendar year. Additions to the active and inactive lists are published from time to time as Reports of Investigations.

PERMISSIBLE EXPLOSIVES TESTED PRIOR TO JANUARY 1, 1924.

By J. E. Crawshaw.

GENERAL STATEMENT.

In the table following are the brand names of all explosives now considered as permissible explosives that were tested by the Bureau of Mines prior to January 1, 1924.

Further information on permissible explosives may be found in other Bureau of Mines publications. The precautions to be observed in the handling, storage, and use of permissible explosives are found in Miners' Circular 6. The conditions to be fulfilled by applicants desiring explosives tested to determine their permissibility for use in coal mines are stated in Schedule 17. A description of the tests made, the apparatus used for such tests, and detailed results of tests

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1 See list of publications, p. 28.
of 100 permissible explosives are given in Bulletins 15 and 66. The storage, handling, and use of permissible explosives are discussed in Bulletins 10 and 17 and Miners' Circular 7, and the methods used by the bureau in the analysis of permissible explosives and the tolerances for permissible explosives as promulgated by the Bureau of Mines on July 1, 1915, are detailed in Bulletin 96. On November 15, 1920, and February 26, 1921, and effective from these dates the Director of the Bureau of Mines promulgated certain changes in the rules and regulations governing the testing of permissible explosives, as recommended by the bureau's committee on permissible explosives. The tolerances as now existing are given on pages 11, 12, and 13. These rules also provide for the transferring of permissible explosives from the active (published) list to the inactive (not published) list. Explosives will be placed on the inactive list at the request of the manufacturer or if they have not been manufactured during any calendar year.

A complete list of permissible explosives with pertinent data and full descriptive text will be published once during each calendar year. Additions to the active and inactive lists of permissible explosives will be published from time to time as Reports of Investigations.

There were 154 explosives on the permissible list on December 31, 1923. During the succeeding 12 months 13 explosives were added to the list and 10 explosives were dropped from the active permissible list and placed on the inactive list of permissible explosives. The present list takes the place of all preceding lists and includes a total of 157 explosives.

DEFINITION OF A PERMISSIBLE EXPLOSIVE.

A permissible explosive is an explosive which is similar in all respects to the sample which has passed certain tests prescribed by the Bureau of Mines to determine its safety for use in gaseous and dusty coal mines, and is permissible when used in accordance with the conditions prescribed by the bureau.

While permissible explosives are designed especially for use in gaseous and dusty coal mines, they are suitable for use in other coal mines and for many other blasting operations.

PRESCRIBED CONDITIONS FOR USE OF PERMISSIBLE EXPLOSIVES.

1. That the explosive is in all respects similar to the sample submitted by the manufacturer for test.
2. That detonators—preferably electric detonators—are used of not less efficiency than those prescribed, namely, those consisting by

weight of 90 parts of mercury fulminate and 10 parts of potassium chlorate (or their equivalents).

3. That the explosive, if frozen, shall be thoroughly thawed in a safe and suitable manner before use.

4. That the quantity used for a shot does not exceed 1 1/4 pounds (680 grams), and that it is properly tamped with clay or other non-combustible stemming.

After an explosive has passed the required tests and its brand name has been published in a list of permissible explosives, it is not a permissible explosive if one or more of any of the following conditions prevail:

1. If kept in a moist place until it undergoes a change in character.
2. If used in a frozen or partly frozen condition.
3. If used in excess of 1 1/4 pounds (680 grams) per shot.
4. If the diameter of the cartridge is less than that designated in the column “smallest permissible diameter.”

5. If fired with a detonator or electric detonator of less efficiency than that prescribed.
6. If fired without stemming.
7. If fired with combustible stemming.
8. If fired in the presence of a dangerous percentage of fire damp.

Moreover, even when all of the prescribed conditions have been met, no explosive on the permissible list should necessarily be considered as being permanently a permissible explosive, for the bureau reserves the right, on fuller information concerning the conditions that lead to safety, to revise this list; but any permissible explosive when used under the prescribed conditions may properly continue to be considered a permissible explosive until notice of its withdrawal or removal from the list has been officially published, or until its name is omitted from a later list published by the Bureau of Mines.

After further experiments and conferences the Bureau of Mines may find it advisable to adopt additional and more severe tests to which all permissible explosives may be subjected, in the hope that through the use of such explosives only as pass the more severe tests the lives of miners may be better safeguarded.

LIST OF PERMISSIBLE EXPLOSIVES.

Subject to the conditions and provisions stated herein, the following explosives are classed as permissible explosives:
<table>
<thead>
<tr>
<th>Brand</th>
<th>Volume of poisonous gases</th>
<th>Characteristic ingredient</th>
<th>When used with detonators, preferably electric detonators, of not less efficiency than</th>
<th>Weight of 11 by 8 inch cartridge</th>
<th>Smallest permissible diameter</th>
<th>Unit defecive charge</th>
<th>Rate of detonation in 11-inch diameter cartridges</th>
<th>Manufacturer</th>
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<td></td>
<td></td>
<td></td>
<td>Grams</td>
<td>Inches</td>
<td>Grams</td>
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* Same as Union F, L. F.
Permissible explosives tested prior to January 1, 1924.

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<th>When used with detonators, preferably electric detonators, of not less efficiency than</th>
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<th>Smallest permissible diameter</th>
<th>Unit deflective charge</th>
<th>Rate of detonation in $\frac{1}{16}$ inch diameter cartridges</th>
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* 1½ by 8 inch cartridge.

* 1 inch diameter cartridge.
PERMISSIBLE MINING EQUIPMENT.

CLASSES OF PERMISSIBLE EXPLOSIVES.

In order that the user of explosives may be assisted in selecting an explosive to meet a specific requirement, the Bureau of Mines now classifies permissible explosives in two ways, as follows: (1) On the basis of the volume of poisonous gases produced by 1\frac{1}{2} pounds (680 grams) of the explosive, and (2) on the basis of the characteristic ingredient of each explosive.

VOLUME OF POISONOUS GASES.

Most of the permissible explosives, even when properly and completely detonated in a drill hole in a coal mine, produce poisonous gases, but they produce at the same time a much larger volume of nonpoisonous gases. In order that the poisonous gases may not under normal conditions become a menace to the lives or health of miners, no explosive is now or can become permissible if it evolves upon detonation more than 158 liters (5 cubic feet) of permanent poisonous gases, as determined by tests in the Bichel pressure gage. Field tests of an explosive made under extreme conditions for the production of the greatest percentage of poisonous gases in the air show that in a narrow entry, with no ventilation at or near the face, a 1\frac{1}{2}-pound charge of an explosive, which gave 158 liters of poisonous gas in gage tests, produced 0.18 per cent of carbon monoxide (the only poisonous gas present) in the air when the sample was taken two minutes after the shot. Another sample of the air taken two minutes later contained 0.08 per cent of carbon monoxide. It is therefore evident that where ventilation is not active, as in a closed heading, miners or shot firers should not return to the face until at least five minutes after a shot. At all working faces that are difficult to ventilate, explosives of class A or class B should be used, preferably those of class A.

The classification on the basis of the volume of poisonous gases produced by 1\frac{1}{2} pounds (680 grams) of the explosive is as follows:

Class A, those explosives from which the volume of poisonous gases produced is not more than 53 liters.

Class B, those explosives from which the volume of poisonous gases is more than 53 liters but less than 106 liters, inclusive.

Class C, those explosives in which the volume of poisonous gases is more than 106 liters but less than 158 liters, inclusive.

CHARACTERISTIC INGREDIENTS.

Explosives are classified in accordance with their characteristic ingredients as follows:

Class 1, ammonium nitrate explosives.—To class 1 belong all the explosives in which the characteristic ingredient is ammonium nitrate. This class is divided into two subclasses. Subclass a includes every
ammonium nitrate explosive that contains a sensitizer that is in itself an explosive. Subclass $b$ includes every ammonium nitrate explosive that contains a sensitizer that is not in itself an explosive. The ammonium nitrate explosives of subclass $a$ consist principally of ammonium nitrate with small percentages of nitroglycerin, nitrocellulose, or nitro-substitution compounds which are used as sensitizers. The ammonium nitrate explosives of subclass $b$ consist principally of ammonium nitrate with small percentages of resinous matter or other nonexplosive substances used as sensitizers.

Ammonium nitrate explosives when fresh and properly detonated are well adapted for use in mines that are not unusually wet. They are not suitable for use in wet mines, for if the contents of a cartridge of ammonium nitrate explosive is exposed for only a few hours to the damp atmosphere the explosive may so deteriorate as to fail to detonate completely, because ammonium nitrate takes up moisture readily. The redipping of cartridges of ammonium nitrate explosives aids in protecting the contents against moisture, or moist air, and the cartridges should be so stored and handled as to preserve the efficacy of the paraffinlike coating. The explosives should be obtained in a fresh condition and purchased in such quantities as will permit their prompt use. Experience at the Pittsburgh experiment station of the Bureau of Mines shows that ammonium nitrate explosives will usually detonate completely after storage for six months in a well-ventilated magazine.

Class 2, hydrated explosives.—To class 2 belong all explosives in which salts containing water of crystallization are the characteristic ingredients. The explosives of this class are somewhat similar in composition to the ordinary low-grade dynamites, except that one or more salts containing water of crystallization are added to reduce the flame temperature. They are easily detonated, and most of them can be used successfully in damp working places.

Class 3, organic nitrate explosives.—To class 3 belong all the explosives in which the characteristic ingredient is an organic nitrate other than nitroglycerin. The permissible explosives now listed under class 3 are nitrostarch explosives.

Class 4, nitroglycerin explosives.—To class 4 belong all the explosives in which the characteristic ingredient is nitroglycerin. These explosives contain free water or an excess of carbon, which is added to reduce the flame temperature. A few explosives of this class contain salts, or an unusually low percentage of nitroglycerin, that reduce the strength and shattering effect of the explosives on detonation. The nitroglycerin explosives have the advantages of detonating easily and of not being readily affected by moisture.

Class 5, ammonium perchlorate explosives.—To class 5 belong all explosives in which the characteristic ingredient is ammonium perchlorate.
PERMISSIBLE MINING EQUIPMENT.

WEIGHT OF 1\(\frac{1}{2}\) BY 8 INCH CARTRIDGE.

The size in which cartridges of permissible explosives are usually sold is 1\(\frac{1}{2}\) by 8 inches, and from the weight of a cartridge of this size as given in the table the number of cartridges required to make the 680 grams (1\(\frac{1}{2}\) pounds) maximum permissible quantity of explosive in a shot may be readily determined. To illustrate, the first explosive on the accompanying list (Apache coal powder A), like all the other explosives on the list, is permissible only when fired in charges not exceeding 680 grams (1\(\frac{1}{2}\) pounds). The maximum permissible weight shot (680 grams) divided by the weight of one 1\(\frac{1}{2}\) by 8 inch cartridge (137 grams of Apache coal powder A), gives the maximum permissible number of cartridges of this size that may be used—5 cartridges approximately.

SMALLEST PERMISSIBLE DIAMETER.

In order that the user may know readily the smallest diameter in which a given explosive is permissible, this information is given in the table. Should a manufacturer desire that an explosive be approved as permissible in a smaller diameter than that in which it is now permissible, he should make application for the necessary tests.

UNIT DEFLECTIVE CHARGE.

The unit deflective charge is that weight of an explosive in grams which gives the same swing on the ballistic pendulum as 227 grams (1 pound) of Pittsburgh Testing Station Standard 40 per cent straight nitroglycerin dynamite.

The bureau requires that this unit deflective charge shall not exceed 454 grams (1 pound), as tests have shown that explosives whose unit deflective charge exceeds 454 grams (1 pound) require more than 680 grams (1\(\frac{1}{2}\) pounds) in a single charge to satisfactorily blast down coal and when so used are not permissible.

Many observers have expressed the opinion that the "coal-getting" strength of permissible explosives is represented better by the results of this test than by the results of any other single test yet devised. The reader should note that the results do not take into consideration whether the coal when shot down is fine or coarse.

In comparing the unit deflective charge of one explosive with that of another explosive a fine distinction should not be drawn, for it must be remembered that tolerance limits have been established for the results with the ballistic pendulum, as given on page 13, and these limits are designed to cover all reasonable variations of manufacture, sampling, and chemical and physical determinations made. This principle applies to all the items of the chemical analysis as well as to the items of the physical tests.
PERMISSIBLE EXPLOSIVES TESTED PRIOR TO JANUARY 1, 1924. 11

RATE OF DETONATION.

The table shows in feet per second and meters per second the relative velocity of detonation of each explosive. The adaptability of a permissible explosive to a particular coal-mining condition depends greatly on its rate of detonation. For certain work in which a shattering effect is desired, as in driving through or "bushing" rock, or in producing coal for coke making, the explosive reaction should be rapid, and for such work permissible explosives having a high rate of detonation should be selected. Similarly, for shooting down a soft, friable coal to produce lump or steam coal, a permissible explosive should be selected that detonates slowly and hence gives a more prolonged pressure. For medium hard coal an explosive having an intermediate rate of detonation may be expected to be most suitable.

Although these relations usually hold, they do not always, because coals differ in hardness and coal beds differ in the number and position of the joints, partings, and shale bands. Such facts have to be considered in selecting an explosive for mining coal.

An explosive having a very low rate of detonation is not always the best for mining a friable coal much fractured, because some of its energy may be lost by its gases escaping through the fractures. Under such conditions an explosive having an intermediate rate produces the most economical results.

TOLERANCES FOR PERMISSIBLE EXPLOSIVES.

The tolerances promulgated by the Bureau of Mines provide for reasonable limits of variation in the results of analyses and tests of field samples of permissible explosives. The tolerances as now existing and as stated below are quoted, except as amended November 15, 1920, and February 26, 1921, from Bulletin 96, in which they were first published after having been established and made effective July 1, 1915.

In order to define more exactly what is meant by the phrase "similar in all respects" in the definition of a permissible explosive, namely, "A permissible explosive is an explosive which is similar in all respects to the sample which has passed certain tests prescribed by the Bureau of Mines to determine its safety for use in gaseous and dusty coal mines, and when used in accordance with the conditions prescribed by the bureau," the following tolerances are established for field samples or manufacturers' samples of explosives, beyond which such lot of explosives can not vary and still be considered permissible for use in coal mines.

Chemical analysis.—Moisture, to be fixed by a sliding scale from $1\frac{1}{4}$ per cent at zero to 4 per cent at 10 per cent of moisture in original
sample, this tolerance being on total percentage of moisture in the explosive.

Other ingredients (or their equivalents) in quantities not exceeding 60 per cent, according to curve shown in Figure 1, except that the chemical tolerance for carbonaceous combustible material is changed to plus or minus 3 per cent regardless of the amount of carbonaceous combustible material reported as present. For ingredients in quantities of 60 per cent or more, the tolerance shall be plus or minus 3 per cent: Provided, That the ingredients of a permissible explosive shall be considered to be those substances reported as found by the Bureau of Mines in the original sample of that explosive submitted for test as to its permissibility: And further provided, That an equivalent shall be considered to be a substance which would not materially alter the properties of the explosive and which would produce the same result as the original substance.

For the purpose of applying the chemical tolerance for explosives containing ammonium nitrate, the commercial ammonium nitrate will be reported as the sum of the ammonium nitrate, the ammonium chloride and ammonium sulphate reported as present, and the tolerance applied to this figure. The sum of the ammonium chloride and the ammonium sulphate will be reported separately in a note and the tolerance applied to their sum will be 4 per cent of the commercial ammonium nitrate reported as present in the basic sample, except in those cases where the tolerance thus applied would be less than for a separate ingredient, when the tolerances for “other ingredients” would apply.
PERMISSIBLE EXPLOSIVES TESTED PRIOR TO JANUARY 1, 1924.

Products of combustion (determined by Bichel gage tests).—The volume of poisonous gases from 680 grams of the explosive, including its wrapper, must be less than 158 liters, except that in case the first test yields 158 liters or more poisonous gases per 680 grams of the explosive, including its wrapper, the average result of three tests agreeing within 5 per cent of each other shall be taken, and no explosive shall remain permissible when this average for poisonous gases exceeds the above standard limits.

Physical tests.2—In making rate of detonation and unit deflective charge tests by the ballistic pendulum, the tests stop after obtaining three results within 5 per cent, or a total of six results. All the results within 10 per cent will be averaged. If there are two or more groups in which the results are within 10 per cent of each other, then all the results which are within any group will be averaged.

The tolerances applied, using the above rules, are:

Rate of detonation (the average of 3 to 6 trials within 10 per cent with Mettegang Recorder) plus or minus 15 per cent.

Unit deflective charge determined by the ballistic pendulum as compared with the Pittsburgh Testing Station standard 40 per cent straight nitroglycerin dynamite (the average of 3 to 6 trials within 10 per cent with the ballistic pendulum), plus or minus 10 per cent.

Grams of wrapper per 100 grams of explosive, plus or minus 2.0 grams (average of four determinations): Provided, That the manufacturers shall submit samples of all different sizes of cartridges, to be considered as part of the original sample, the amount of wrapper to be determined for each size of sample: And provided further, That the tolerances as suggested shall be determined in comparison with the various diameters of samples as submitted with the original sample.

Apparent specific gravity of cartridge, by sand, plus or minus 7.5 per cent (average of four determinations): Provided, That actual density shall be determined on cartridges of the same diameter as the standard: And provided further, That manufacturers shall be required to submit samples of all sizes.

Gas and dust gallery No. 1.—No ignition must be obtained in each of one or more trials. Note: In the retesting of permissible explosives by tests 1 and 4, the charges of the explosives fired will be reduced 10 per cent in weight from the weights originally used in order to eliminate any likelihood of a failure being due to the natural variations in the gallery conditions.

Pendulum friction test.—Each explosive must pass a test of 10 trials under the same conditions as originally tested, except that the height of fall of the woodfiber shoe will be reduced by 10 per cent in order to eliminate any likelihood of a failure being due to the natural variations in test conditions.

FIELD SAMPLES OF PERMISSIBLE EXPLOSIVES.

The bureau will from time to time reexamine permissible explosives found in commercial shipments and in the field to determine how closely they conform to the samples upon which the permissibility tests were originally made, and the manufacturer will be notified of the results of tests on all field samples. In order that this

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PERMISSIBLE MINING EQUIPMENT.

examination can be properly made, the tolerances as given above are applied in the manner stated below, according to the rules and regulations promulgated November 15, 1920, and February 26, 1921. These methods of applying the tolerances supersede all previous methods.

In the event that a field sample of a permissible explosive exceeds the tolerance for one or more items, the bureau will take the following action:

(a) If the explosive exceeds the tolerance for any items of the chemical analysis, for grams of wrapper per 100 grams of explosive, for apparent specific gravity, for rate of detonation, or for unit deflective charge, the manufacturer only will be advised of the results, except that, should these results in the opinion of the explosives engineer indicate that the explosive is unsafe for use, then the operator or owner will be immediately warned, and further tests promptly inaugurated.

(b) If the explosive exceeds the tolerance for gallery tests, pendulum friction test, or poisonous gases, the bureau will declare that particular lot of explosives not permissible, and a copy of the notification to the consumer or owner will be furnished the manufacturer, the notification to state that the explosive did not meet the requirement for gallery tests, pendulum friction test, or poisonous gases, as the case may be.

The term "Lot of permissible explosives" as used in the tolerances promulgated by the director is defined as "all of that explosive in the magazine from which the sample is procured bearing identical case markings."

When a given lot of explosive is declared not permissible and the owner and the manufacturer notified, the bureau does not attempt to fix responsibilities between owner and manufacturer.

The usual causes of an explosive exceeding the tolerances for chemical analysis or physical tests are two: (1) It may not have been properly manufactured; (2) it may not have been properly stored. The manufacturer is responsible for (1) because the consumer has no control over the method of manufacture of the explosive, but the consumer or owner is responsible for (2) because the manufacturer has no control over the conditions of storage when the explosive has once passed from his ownership.

The manufacturer should exercise due care that the quality of the raw materials, and the weighing and incorporating of them, is similar in all respects to that for the original sample of explosives submitted for tests, and that the explosive is fresh and in first-class condition when sold. The user should store explosives in well-ventilated magazines, at temperatures not exceeding 90° F. The boxes should be placed so that the cartridges lie horizontally, though the tops of the boxes may be up or down. The explosives purchased first should be used first, and hence older explosives should not be stored under or behind a fresh consignment. It is well to purchase explosives in such quantities that they can be used promptly.
PERMISSIBLE MINING EQUIPMENT APPROVED PRIOR TO JANUARY 1, 1924.

By L. C. ILSLEY.

GENERAL STATEMENT.

The Bureau of Mines, for the information of manufacturers or others submitting equipment or apparatus to be tested for features relating to safety, issues permissibility schedules. In general, a Bureau of Mines permissibility schedule establishes certain minimum standards for safety, gives details of test methods adopted to determine whether these standards have been met, and contains a list of charges made for such tests.

Any manufacturer has the right to submit his product for test in accordance with the conditions outlined in these schedules. Such action is entirely voluntary on his part. When the product of a manufacturer has met the requirements of the schedule he is free to advertise it as being approved by the Bureau of Mines, and the bureau in various ways calls the attention of the public to equipment that has met the requirements for permissibility.

The schedules for mining equipment that are in force at present are as follows:

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<th>No.</th>
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<tr>
<td>2B</td>
<td>Permissible motors</td>
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<tr>
<td>4A</td>
<td>Permissible electric switches</td>
<td>May 9, 1922</td>
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<td>6A</td>
<td>Permissible portable electric lamps</td>
<td>Feb. 3, 1915</td>
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<td>7B</td>
<td>Permissible flame safety lamps</td>
<td>Sept. 19, 1922</td>
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<tr>
<td>8A</td>
<td>Permissible methane indicators</td>
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<td>9A</td>
<td>Permissible telephones</td>
<td>Dec. 5, 1922</td>
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<td>10A</td>
<td>Miscellaneous electric lamps</td>
<td>Feb. 2, 1922</td>
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<td>11</td>
<td>Permissible flash lamps</td>
<td>Dec. 9, 1916</td>
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<tr>
<td>12</td>
<td>Permissible single-shot blasting units</td>
<td>Apr. 11, 1919</td>
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<tr>
<td>15</td>
<td>Permissible locomotives</td>
<td>Aug. 16, 1919</td>
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Permissibility schedules have become essential in guiding the activities of the bureau along safety lines, in giving the manufacturer of safety equipment a definite goal, and in placing the approval work on a firm foundation.

SCHEDULES FOR MINING EQUIPMENT.

The schedules named in the preceding list are summarized below:

Schedule 2B, "Procedure for establishing a list of permissible electric motors," covers the permissibility requirements for various types of electric motors and accessories such as rheostats, controllers, switches, fuses, and wiring. Under this schedule mine equipment such as coal-cutting outfits, drills, coal-loading machines, hoists, pumps, air compressors, and equipment for miscellaneous services can be investigated.
Schedule 4A, "Procedure for establishing a list of permissible electric switches and junction boxes for use at the outer end of trailing cables," covers the permissibility requirements for isolated switches and junction boxes. Equipment of this kind is not designed to operate in explosive mixtures of gas or coal dust but should such accumulations exist no hazard should result.

Schedule 6A, "Procedure for establishing a list of permissible portable electric mine lamps," covers the permissibility requirements for miners' electric cap lamps. Electric cap lamps are intended for use in both metal and coal mines. They offer protection where gas and coal dust may accumulate in dangerous quantities.

Schedule 7B, "Procedure for establishing lists of permissible flame safety lamps and methane detectors of the flame type," covers the permissibility requirements for flame safety lamps and also for apparatus primarily designed for gas detecting and built on the principle of the flame safety lamp.


Schedule 10A, "Procedure for establishing a list of permissible electric hand lamps, trip lamps, animal lamps, and rescue lamps for use in gaseous mines," covers the permissibility requirements for various types of lamps used in underground work except miners' cap lamps and electric flash lamps.

Schedule 11, "Procedure for establishing a list of permissible flash lamps that are safe for use in explosive mixtures of methane and air," covers the permissibility requirements for flash lamps such as might be used for emergency or mine rescue work.

Schedule 12, "Procedure for establishing a list of permissible single-shot blasting units," covers the permissibility requirements for apparatus designed to fire single shots, such as would be used where the shot firing is done inside the mine by a shot firer or by the miner.

Schedule 15, "Procedure for establishing a list of permissible storage-battery locomotives for use in gaseous mines," covers the permissibility requirements for storage-battery locomotives. Permissible storage-battery locomotives are used in mines and sections of mines where it is not considered safe to operate other types of electric locomotives.

GENERAL CONDITIONS GOVERNING TESTS.

The general policy under schedule procedure is to have one or more complete equipments forwarded to the bureau for inspection and investigation. No classes of equipments are approved by inspection only but rather as a result of a detailed inspection followed by numerous tests devised to try out the various safety features and to determine the suitability of construction.

In general, the tests are made in explosive atmospheres, the gas being Pittsburgh natural gas, so proportioned with air as to give a very explosive mixture within and around the compartment under investigation. In a certain percentage of the tests coal dust is introduced into the compartment in order that the effect of dust in the explosive atmosphere may also be noted. Those equipments that meet the schedule requirements are approved officially. Drawings showing the exact construction of all equipment that has been approved are kept on file by the bureau.
The manufacturer is given an approval number and outline of a design for an approval plate for each approval granted. He assumes the responsibility of making apparatus like the one tested and approved and for which drawings have already been furnished the bureau. Having constructed such an apparatus, the manufacturer can attach an approval plate and claim the bureau's approval. If he changes the construction of approved equipment without having the approval extended to cover such change, he should no longer claim the bureau's approval, since the bureau can not be held responsible for unapproved designs. Also, if he fails to attach the approval plate to an approved design the bureau does not consider the outfit as approved.

SPECIFIC REQUIREMENTS.

Certain specific requirements are peculiar to several schedules. For example, Schedules 2B, 4A, 9A, and 15 are designed to safeguard equipment which by its nature is likely to create sparks or electric flashes during normal operation. The compartments containing or housing such spark-producing parts must be safeguarded. All joints of the casings must be metal-to-metal and have an effective length of at least 1 inch. No unprotected openings into the compartments are permitted. The casings themselves must be strong enough to withstand an explosion within them and must retain all flames resulting from such an explosion, in order that there shall be no likelihood of igniting an explosive mixture without the casing. The wiring between compartments must be run in rigid or flexible metallic conduit.

Schedules 6A, 10A, and 11 are designed to safeguard portable electric lamps, which have their chief danger from the incandescent filament, although lamps that have excessive battery short-circuit current values may have a double hazard. All lamps are required to have a device to interrupt the circuit in case the bulb is broken. Cap lamps, in addition, must meet certain requirements for efficiency and reliability.

Schedule 7B has two sets of requirements, one for flame safety lamps when designed for illumination, and one for apparatus designed only for gas-detecting purposes. Both classes of devices must be safe in still atmospheres and in moving gaseous atmospheres up to 2,500 feet per minute, and must be adequate in the field for which they are intended.

Schedule 8A covers specific requirements as to safety, reliability, and adequacy for gas-detecting equipments other than the safety lamp. Electrical parts, if used, are subject to the same requirements as to safety as are given for electric lamps.

Schedule 12 covers safety requirements for single-shot blasting equipment. The requirements differ according to whether the device is of the battery or magneto type. Both types are investigated as to the likelihood of their igniting gas, and both are tested for reliability and endurance.
Permissible "explosion-proof" equipment approved under Schedules 2, 2A, and 2B, prior to January 1, 1924.

<table>
<thead>
<tr>
<th>Approval No.</th>
<th>Machine designation</th>
<th>Application</th>
<th>Rated motor horsepower</th>
<th>Voltage and current</th>
<th>Manufacturer</th>
<th>Approved cable reel</th>
<th>Cables tentatively approved(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>CE-7 Iron clad (\text{Short-wall mining.})</td>
<td>do</td>
<td>30</td>
<td>250 D.C.</td>
<td>Sullivan Machining Co.</td>
<td>Yes (\text{No. 3 or No. 4.})</td>
<td>Concentric (\text{Rubber clad.}) Super Service. Rome Wire Co.</td>
</tr>
<tr>
<td>100A</td>
<td>do</td>
<td>do</td>
<td>30</td>
<td>500 D.C.</td>
<td>do</td>
<td>Yes</td>
<td>Simplex Wire &amp; Cable Co.</td>
</tr>
<tr>
<td>101</td>
<td>May 20, 1916 12-CC</td>
<td>do</td>
<td>35</td>
<td>210 D.C.</td>
<td>Goodman Mfg. Co.</td>
<td>Yes (\text{No. 3 or No. 4.})</td>
<td>Duplex and concentric (\text{Super Service.}) Rome Wire Co.</td>
</tr>
<tr>
<td>101A</td>
<td>do</td>
<td>do</td>
<td>35</td>
<td>500 D.C.</td>
<td>do</td>
<td>Yes</td>
<td>Simplex Wire &amp; Cable Co.</td>
</tr>
<tr>
<td>103</td>
<td>Type 35-B</td>
<td>do</td>
<td>35</td>
<td>250 D.C.</td>
<td>do</td>
<td>Yes (\text{No. 3 or No. 6.})</td>
<td>Triplex (\text{Rubber clad.}) Super Service. Rome Wire Co.</td>
</tr>
<tr>
<td>103A</td>
<td>do</td>
<td>do</td>
<td>35</td>
<td>500 D.C.</td>
<td>do</td>
<td>Yes</td>
<td>Simplex Wire &amp; Cable Co.</td>
</tr>
<tr>
<td>104</td>
<td>Jan. 16, 1919 CE-7 Iron clad</td>
<td>do</td>
<td>30</td>
<td>220 A.C.</td>
<td>Sullivan Machining Co.</td>
<td>Yes (\text{No. 4.})</td>
<td>Duplex (\text{Simplex Wire &amp; Cable Co.})</td>
</tr>
<tr>
<td>104A</td>
<td>do</td>
<td>do</td>
<td>30</td>
<td>440 A.C.</td>
<td>do</td>
<td>Yes</td>
<td>Rome Wire Co.</td>
</tr>
<tr>
<td>105A</td>
<td>do</td>
<td>do</td>
<td>50</td>
<td>500 D.C.</td>
<td>do</td>
<td>Yes</td>
<td>Rome Wire Co.</td>
</tr>
<tr>
<td>106</td>
<td>Feb. 9, 1922 112-CC</td>
<td>do</td>
<td>50</td>
<td>210 D.C.</td>
<td>do</td>
<td>Yes</td>
<td>Rome Wire Co.</td>
</tr>
<tr>
<td>106A</td>
<td>do</td>
<td>do</td>
<td>50</td>
<td>500 D.C.</td>
<td>do</td>
<td>Yes</td>
<td>Rome Wire Co.</td>
</tr>
<tr>
<td>107</td>
<td>12-CC</td>
<td>do</td>
<td>35</td>
<td>210 D.C.</td>
<td>do</td>
<td>Yes</td>
<td>Rome Wire Co.</td>
</tr>
<tr>
<td>107A</td>
<td>do</td>
<td>do</td>
<td>35</td>
<td>500 D.C.</td>
<td>do</td>
<td>Yes</td>
<td>Rome Wire Co.</td>
</tr>
<tr>
<td>108</td>
<td>112-CJ</td>
<td>do</td>
<td>35</td>
<td>210 D.C.</td>
<td>do</td>
<td>Yes</td>
<td>Rome Wire Co.</td>
</tr>
<tr>
<td>108A</td>
<td>do</td>
<td>do</td>
<td>35</td>
<td>500 D.C.</td>
<td>do</td>
<td>Yes</td>
<td>Rome Wire Co.</td>
</tr>
<tr>
<td>109</td>
<td>Sept. 19, 1922 No. 2-BF</td>
<td>Coal drilling</td>
<td>1</td>
<td>80-110 D.C.</td>
<td>(\text{Chicago Pneumatic Tool Co.})</td>
<td>N ot used (\text{No. 14.})</td>
<td>Duplex (\text{Tubular Woven Fabric Co.}) Romeo Wire Co.</td>
</tr>
<tr>
<td>109A</td>
<td>do</td>
<td>do</td>
<td>1</td>
<td>250 D.C.</td>
<td>do</td>
<td>Yes</td>
<td>Rome Wire &amp; Cable Co.</td>
</tr>
<tr>
<td>110</td>
<td>Sept. 16, 1922 Type CD</td>
<td>do</td>
<td>110 D.C.</td>
<td>(\text{Martin Hardsoeg Co.})</td>
<td>do</td>
<td>Yes</td>
<td>Rome Wire &amp; Cable Co.</td>
</tr>
<tr>
<td>110A</td>
<td>do</td>
<td>do</td>
<td>110 D.C.</td>
<td>(\text{Martin Hardsoeg Co.})</td>
<td>do</td>
<td>Yes</td>
<td>Rome Wire &amp; Cable Co.</td>
</tr>
<tr>
<td>111</td>
<td>Oct. 16, 1922 (\text{Type M. M. 35-35-BB. Short-wall mining.})</td>
<td>do</td>
<td>50</td>
<td>250 D.C.</td>
<td>Jeffrey Mfg. Co.</td>
<td>Yes (\text{No. 3 or No. 6.})</td>
<td>Concentric (\text{Tirex.}) Simplex Wire &amp; Cable Co.</td>
</tr>
<tr>
<td>111A</td>
<td>do</td>
<td>do</td>
<td>50</td>
<td>500 D.C.</td>
<td>do</td>
<td>Yes</td>
<td>Simplex Wire &amp; Cable Co.</td>
</tr>
</tbody>
</table>

\(^a\) Cables tentatively approved on recommendation of manufacturers of machines.
**Permissible electric lamps approved under Schedules 6A and 10A prior to January 1, 1924.**

<table>
<thead>
<tr>
<th>Name of manufacturer</th>
<th>Designation of lamp</th>
<th>Type of lamp</th>
<th>Bureau of Mines' approval No.</th>
<th>Date of approval</th>
<th>Weight of complete lamp, pounds</th>
<th>Number of cells in battery</th>
<th>Kind of plate</th>
<th>Kind of electrolyte</th>
<th>Kind of battery casing</th>
<th>Kind of battery jar</th>
<th>Mean candlepower of light stream</th>
<th>Symbol for cords</th>
<th>Kind of reflector</th>
<th>Manufacturers of approved bulbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Witherbee Igniter Co.</td>
<td>Wheat</td>
<td>Cap</td>
<td>14</td>
<td>June 10, 1916</td>
<td>4.2</td>
<td>1</td>
<td>Lead</td>
<td>Acid</td>
<td>Cast aluminum</td>
<td>Armco metal</td>
<td>Snap (key-opened)</td>
<td>0.81</td>
<td>Aluminum</td>
<td>National Lamp Works and Edison Lamp Works of General Electric Co.</td>
</tr>
<tr>
<td>Concordia Electric Co.</td>
<td>RM-6</td>
<td>Hand and trip</td>
<td>10</td>
<td>Aug. 2, 1923</td>
<td>6.8</td>
<td>1</td>
<td>Lead</td>
<td>Solidified acid</td>
<td>Steel</td>
<td>Aluminium</td>
<td>Snap (magnet-opened)</td>
<td>0.8</td>
<td>Aluminum finish; porcelain finish</td>
<td>National Lamp Works and Edison Lamp Works of General Electric Co.</td>
</tr>
<tr>
<td>Concordia Electric Co.</td>
<td>RM-6</td>
<td>Hand and trip</td>
<td>1</td>
<td>May 25, 1922</td>
<td>6.8</td>
<td>1</td>
<td>Lead</td>
<td>Solidified acid</td>
<td>Steel</td>
<td>Aluminium</td>
<td>Snap (magnet-opened)</td>
<td>0.8</td>
<td>Aluminum finish; porcelain finish</td>
<td>National Lamp Works and Edison Lamp Works of General Electric Co.</td>
</tr>
</tbody>
</table>

*This table includes only those approved lamps that are being actively marketed or are readily obtainable.*

*In addition to Armco metal, the approval also permits the use of Toncan metal, Monel metal, or nickel.*

*No separate casing used, the jar being extra thick to give the necessary strength.*

*Spherical candlepower.*
**PERMISSIBLE MINING EQUIPMENT.**

*Permissible flame safety-lamps approved under Schedule 7A, prior to January 1, 1924.*

[DETAILED INFORMATION ON LAMP CHARACTERISTICS.]

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bureau of Mines, approval No.</td>
<td>201A</td>
<td>201A</td>
<td>203A</td>
<td>203A</td>
<td>204</td>
</tr>
<tr>
<td>Date of approval.</td>
<td>Aug. 21, 1915</td>
<td>July 29, 1918</td>
<td>Feb. 7, 1919</td>
<td>Feb. 7, 1919</td>
<td>July 18, 1921</td>
</tr>
<tr>
<td>Material of lamp.</td>
<td>Steel</td>
<td>Steel</td>
<td>Aluminum</td>
<td>Aluminum</td>
<td>Chieflly brass</td>
</tr>
<tr>
<td>Fuel used.</td>
<td>Gasoline</td>
<td>Gasoline</td>
<td>Gasoline</td>
<td>Gasoline</td>
<td>Gasoline</td>
</tr>
<tr>
<td>Shape of wick.</td>
<td>Flat</td>
<td>Round</td>
<td>Flat</td>
<td>Round</td>
<td>Round</td>
</tr>
<tr>
<td>Weight of lamp, empty (lb.).</td>
<td>3.33</td>
<td>3.34</td>
<td>2.40</td>
<td>2.38</td>
<td>3.34</td>
</tr>
<tr>
<td>Number of gauzes.</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Kind of gauzes.</td>
<td>Steel</td>
<td>Steel</td>
<td>Steel</td>
<td>Steel</td>
<td>Steel</td>
</tr>
<tr>
<td>Gauze mesh.</td>
<td>28</td>
<td>28</td>
<td>28</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>Mean zonal candlepower.</td>
<td>0.429</td>
<td>0.351</td>
<td>0.429</td>
<td>0.351</td>
<td>0.334</td>
</tr>
<tr>
<td>Kind of igniter.</td>
<td>Koehler &quot;pyro&quot; internal igniter.</td>
<td>Koehler &quot;pyro&quot; internal igniter.</td>
<td>Koehler &quot;pyro&quot; internal igniter.</td>
<td>Koehler &quot;pyro&quot; internal igniter.</td>
<td>Wolf internal igniter.</td>
</tr>
<tr>
<td>Kind of glass (symbol).</td>
<td>Macbeth No. 2100 High-Speed and Smoking Chimney.</td>
<td>Macbeth No. 2100 High-Speed and Smoking Chimney.</td>
<td>Macbeth No. 2100 High-Speed and Smoking Chimney.</td>
<td>Macbeth No. 2100 High-Speed and Smoking Chimney.</td>
<td>Macbeth No. 2100 High-Speed and Smoking Chimney.</td>
</tr>
</tbody>
</table>

*Table includes only those approved lamps that are being actively marketed.

**PERMISSIBLE METHANE INDICATORS.**

Approval No. 800, covering the Burrell methane indicator, manufactured by the Mine Safety Appliances Co., Pittsburgh, Pa., was issued under Schedule 8A on March 10, 1922.

**PERMISSIBLE SINGLE-SHOT BLASTING UNITS.**

The single-shot blasting units named below have been approved by the Bureau of Mines in accordance with Schedule 12.

Approval No. 1200, covering a single-shot storage-battery unit manufactured by the Mine Safety Appliances Co., Pittsburgh, Pa., was issued under date of May 24, 1920.

Approval No. 1201, covering a single-shot magneto unit manufactured by the Davis Instrument Mfg. Co. (Inc.), Baltimore, Md., was issued under date of March 15, 1921.
**Permissible storage-battery locomotives approved under Schedule 15 prior to January 1, 1924.**

<table>
<thead>
<tr>
<th>Name of manufacturer</th>
<th>Approval No.</th>
<th>Date of approval.</th>
<th>Designation of locomotive.</th>
<th>Approximate weight of locomotive.</th>
<th>Drive.</th>
<th>Battery equipment.</th>
<th>No. of cells</th>
<th>Extension of original approval to cover additional batteries.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mancha Storage Battery</td>
<td>1502</td>
<td>Nov. 13, 1922</td>
<td>Flame-proof &quot;Hercules.&quot;</td>
<td>6-7</td>
<td>Single motor</td>
<td>Ironclad Exide. M. V., 21 plates.</td>
<td>48</td>
<td>Sept. 8, 1923</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Philadelphia. W. M. L., 33 plates.</td>
<td>49</td>
<td></td>
</tr>
</tbody>
</table>
APPROVED MINE-RESCUE BREATHING APPARATUS.

By D. J. Parker.

The mine-rescue breathing apparatus named below were approved under Schedule 13.

The Gibbs mine-rescue breathing apparatus, manufactured by the Mine Safety Appliances Co., 909 Chamber of Commerce Building, Pittsburgh, Pa., was approved January 15, 1920, as permissible for use in irrespirable and poisonous gases. Approval number 1300 was assigned to this apparatus.

The Paul mine-rescue breathing apparatus, manufactured by the American Atmos Corporation, Wilkinsburg Station, Pittsburgh, Pa., was approved January 15, 1920, as permissible in irrespirable and poisonous gases. Approval number 1301 was assigned to this apparatus.

The Fleuss-Davis Proto mine-rescue breathing apparatus, manufactured by Siebe, Gorman & Co., Ltd., 187 Westminster Bridge Road, London, S. E. 1, was approved February 7, 1924, as permissible for use in irrespirable and poisonous gases. Approval number 1302 was assigned to this apparatus.

Approval numbers 1300 and 1301 were made contingent upon certain modifications which had been incorporated in the apparatus as tested at the Bureau.

GIBBS APPARATUS.

Approval No. 1300. The Gibbs apparatus modifications are as follows:

1. Regenerator.—Baffle plate is placed in regenerator so as to form a partial partition, as shown in drawing D 254 of December 4, 1919.

2. Reducing valve.—Lug is attached on valve-arm steel to prevent knife edges from going over dead center, as shown in drawing B 541 of November 5, 1919.

3. Reducing valve.—A square head and square socket lock is made on screw connected to bellows, as per drawing D 541 of November 5, 1919.

4. Reducing valve.—A lock is placed on adjusting screw, as per drawing B 541 of November 5, 1919.

5. Pressure-gage closing valve.—This valve is made a needle-point closing valve, as shown on drawing B 541 of November 5, 1919.
PERMISSIBLE MINING EQUIPMENT.

PAUL APPARATUS.

Approval No. 1301. The Paul apparatus modifications are as follows:

1. Closing valve lock.—A chain fastened to the metal frame of the apparatus connects to an eyelet on the wheel of the closing-valve stem only when the valve is open.

2. Safety valve in saliva trap.—A supplemental mica-disk valve is placed in the saliva trap in such manner that it is open at all times during exhalation and closes during inhalation. This valve is to prevent air from the outside atmosphere being drawn in.

3. Pressure gage.—The dial of the pressure gage is graduated in divisions of 25 atmospheres, with figures and markings that are clearly legible.

4. Pressure gage valve.—The pressure-gage valve is placed near the closing valve in such manner that it can be readily manipulated by the wearer.

5. Regenerator.—Air courses through the regenerating material are enlarged and the metal partition in the back of the canister is eliminated.

6. Breathing bag.—Closing of the automatic valve in the breathing bag is so adjusted that undue resistance from excess pressure in the bag, upon exhalation, is eliminated.

FLEUSS-DAVIS PROTO APPARATUS.

Approval number 1302 is effective when the apparatus is charged and manipulated as follows:

1. Oxygen supply.—(a) The oxygen cylinder shall be charged to 135 atmospheres.

   (b) The reducing valve shall feed 2 liters per minute by standard Bureau of Mines liter-bag test.

2. Regeneration.—(a) The regenerating charge shall be 4½ pounds of coke impregnated and coated with caustic soda. Such regenerating material shall be considered satisfactory when the coke carries its own weight of caustic soda.

   (b) The regenerating charge is to be thoroughly broken up every 10 minutes by the wearer.

3. Cooling.—(a) The cooling chemical shall be 15 ounces of sodium phosphate, to be placed in the cooling chamber in liquid form and allowed to crystallize.

   (b) The cooler is to be worn only when the chemical is in crystalline state. When the apparatus has been worn in a hot place, the phosphate will probably have liquified. Cold water passed through the cooler for 10 or 15 minutes will cool and recrystallize the chemical
when it may be used for further wearing. Should cold water not be available, a spare cooler should be substituted.

4. Relief valve.— (a) The relief valve may be operated automatically or by hand.
   
   (b) Tolerance of automatic relief pressure is to be 4 to 5 inches, water gage.

5. Wearing.—(a) The apparatus is approved for two hours of continuous wearing.
   
   (b) At the start of the wearing period the breathing bag shall be evacuated as completely as possible by the lungs of the wearer, the oxygen turned on and allowed to flow until the wearer has sufficient supply for breathing; then the nose clip is to be put in place.

RECOMMENDATIONS.

For the Gibbs and the Paul apparatus, formal recommendations is made that the by-pass valve and connection, as placed on the apparatus tested by the bureau, be made a part of all these apparatus manufactured in the future. It is believed that at this time practically all Gibbs and Paul apparatus have such a by-pass. All apparatus owned by the Bureau of Mines have been so equipped.

For the Fleuss-Davis Proto apparatus formal recommendation was made that some suitable heat-insulating material be made a part of the canvas bag on the side between the wearer and the regenerating charge; also that some method be devised to maintain an equal and even distribution of the regenerating charge in the two compartments of the rubber breathing bag.

All approvals cover only apparatus identical in construction and material with the full-sized working models of each retained at the Pittsburgh station for reference.

REGENERATORS.

The M. S. A. refillable regenerator for use with the Gibbs self-contained mine-rescue breathing apparatus has been approved as permissible for use in irrespirable and poisonous gases in accordance with Schedule 13, subject to the following provisions:

1. The regenerator shall be considered to have the bureau’s approval only when identical in all respects with the full-size working model retained at the Bureau of Mines experiment station, Pittsburgh, Pa. and only when used with that particular type of Gibbs self-contained mine-rescue breathing apparatus approved by the bureau. The regenerator shall correspond in all respects to drawing M. S. A. No. 1, dated January 10, 1920.

2. Regenerating material or “cardoxide,” used in this refillable regenerator shall be identical in all respects with the regenerating material furnished by the Mine Safety Appliances Co., Pittsburgh, Pa., and used in the series of tests to which the regenerator was subjected.
3. Four pounds of this regenerating material shall be used in a regenerator, and shall be divided so that approximately 2 pounds are placed in each of the two compartments of the regenerator.

The M. S. A. refillable regenerator for use with the Paul self-contained mine-rescue breathing apparatus has been approved as permissible for use in irrespirable and poisonous gases in accordance with Schedule 13, subject to the following provisions:

1. The regenerator shall be considered to have the bureau's approval only when identical in all respects with the full-size working model retained at the United States Bureau of Mines experiment station, Pittsburgh, Pa., and only when used with that particular type of Paul self-contained mine-rescue breathing apparatus approved by the Bureau of Mines. Regenerators shall correspond in all respects to drawing M. S. A. No. 65-C, dated May 27, 1921.

2. Regenerating material or "cardoxide" used in this refillable regenerator shall be identical in all respects to the regenerating material furnished by the Mine Safety Appliances Co., Pittsburgh, Pa., and used in the series of tests to which the regenerator was subjected.

3. Four pounds of this regenerating material shall be used in a regenerator.

Each refillable regenerator shall bear a Bureau of Mines approval plate of size approximately 4 1/2 by 1 1/4 inches.
PERMISSIBLE GAS MASK APPROVED PRIOR TO JANUARY 1, 1924.

By. A. C. Fieldner.

Schedule 14 was rewritten as Schedule 14 A and extended to include carbon-monoxide gas masks as well as gas masks for all other poisonous gases, vapors, and smokes. The arrangements whereby the Underwriters' Laboratories, Chicago, Ill., had undertaken to approve gas masks in accordance with Schedule 14, has been discontinued and hereafter the approval will be conducted entirely by the Bureau of Mines.

Only one approval has been granted prior to March 15, 1923, that to the Mine Safety Appliances Co., Chamber of Commerce Building, Pittsburgh, Pa., to cover the Burrell ammonia mask. This mask passed all tests required in Schedule 14 A.

The approved masks are identified by a plate on the haversack or mask case bearing the seal of the Bureau of Mines, a statement of the approval, and the approval number, 1401. The separate approved canisters are identified by a paper label bearing the seal and statement similar to the foregoing, and the statement that the separate canisters are approved for use only with the B. M. 1401 gas masks. Approved face pieces are of the Tissot type that allow breathing through the nose; they are identified by a stenciled or embossed mark, B. M. 1401.

See list of publications, p. 30.
PUBLICATIONS RELATING TO PERMISSIBLE EXPLOSIVES
AND MINE EQUIPMENT.

A limited supply of the following publications of the Bureau of
Mines has been printed and is available for free distribution until the
edition is exhausted. Requests for all publications can not be
granted, and to insure equitable distribution, applicants are re-
quested to limit their selection to publications that may be of es-
pecial interest to them. Requests for publications should be ad-
dressed to the Director, Bureau of Mines.

The Bureau of Mines issues a list showing all its publications avail-
able for free distribution as well as those obtainable only from the
Superintendent of Documents, Government Printing Office, on pay-
ment of the price of printing. Interested persons should apply to
the Director, Bureau of Mines, for a copy of the latest list.

PERMISSIBLE EXPLOSIVES.

PUBLICATIONS AVAILABLE FOR FREE DISTRIBUTION.

BULLETIN 17. A primer on explosives for coal miners, by C. E. Munroe and
Clarence Hall. 1911. 69 pp., 10 pls., 12 figs.

BULLETIN 96. The analysis of permissible explosives, by C. G. Storm. 1916.
88 pp., 3 pls., 7 figs.

TECHNICAL PAPER 186. Methods for routine work in the explosives physical
63 pp.

TECHNICAL PAPER 333. Permissible explosives, mining equipment, and ap-
paratus approved prior to January 1, 1923, by S. P. Howell, L. C. Ilsley, D. J.
Parker, and A. C. Fieldner. 1923. 22 pp., 1 fig.

MINERS' CIRCULAR 7. Use and misuse of explosives in coal mining, by J. J.
Rutledge, with a preface by J. A. Holmes. 1913. 52 pp., 8 figs.

SCHEDULE 17. Procedure for testing explosives for permissibility for use in
gaseous and dusty coal mines, with test requirements, tolerance limits, and
schedule of fees. Apr. 8, 1921. 12 pp.

PUBLICATIONS OBTAINABLE ONLY THROUGH THE SUPERINTENDENT OF
DOCUMENTS.

BULLETIN 10. The use of permissible explosives, by J. J. Rutledge and
Clarence Hall. 1912. 34 pp., 5 pls. 10 cents.

BULLETIN 15. Investigations of explosives used in coal mines, by Clarence
Hall, W. O. Snelling, and S. P. Howell, with a chapter on the natural gas used
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