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UNITED STATES
DEPARTMENT OF THE INTERIOR
J. A. KRUG, SECRETARY

BUREAU OF MINES
R. R. SAYERS, DIRECTOR

REPORT OF INVESTIGATIONS

ACTIVE LIST OF PERMISSIBLE EXPLOSIVES AND BLASTING DEVICES

APPROVED PREVIOUS TO DECEMBER 31, 1945



PREPARED BY

J. E. TIFFANY AND Z. C. GAUGLER

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ACTIVE LIST OF PERMISSIBLE EXPLOSIVES AND BLASTING DEVICES APPROVED PREVIOUS TO DECEMBER 31, 1945^{1/}

Prepared by J. E. Tiffany and Z. C. Gaugler^{2/}

PERMISSIBLE EXPLOSIVES TESTED UNDER SCHEDULE 1F

An active list of permissible explosives was published in December 1943 as part of the Bureau of Mines Report of Investigations 3736 under the title "Active List of Permissible Explosives and Blasting Devices Approved Previous to June 30, 1943." This list included 180 brand names.

Changes in the list that have been authorized to December 31, 1945, placed 10 additional brands of permissible explosives on the active permissible list as a result of tests and changes in brand names. Twelve permissible explosives were transferred from the active to the inactive list. The present list contains 178 brand names. The brand names of the permissible explosives placed on the active list are as follows:

American 3-A	By test.
Apocl No. 1-B	Do.
Black Diamond No. 11-B	Do.
Black Diamond No. 55	Do.
Coalite G-1	Do.
Coalite K-1	Do.
Coalite L-1	Do.
Coalite LS-1	Do.
Columbia B-2	By change in name.
Monobel AA	By test.

The permissible explosives transferred from the active to the inactive list are as follows:

Anthracite B, L. F.	Independent No. 5, L. F.
Big Red No. 8	Independent No. 9, L. F.
Independent No. 1, L. F.	Independent No. 9-C, L. F.
Independent No. 2, L. F.	Independent No. 10, L. F.
Independent No. 3, L. F.	Independent No. 11, L. F.
Independent No. 4, L. F.	King No. 9

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Report of Investigations 3910."

2/ Explosives Division, Central Experiment Station, Bureau of Mines, Pittsburgh, Pa.

Permissible explosives as of December 31, 1945 (Cont'd.)

NONGELATINOUS PERMISSIBLE EXPLOSIVES

Brand	Class designation basis, volume of poisonous gases ^{1/}	Weight of 1-1/4- by 8-inch cartridge	Number of 1-1/4- by 8-inch cartridges in 50-lb. case	Small-est permissible diameter ^{2/}	Rate of detonation in 1-1/4-inch diameter cartridge				Manufacturer
					Feet per second		Meters per second		
					Average	Allowable variation	Average	Allowable variation	
1	2	3	4	5	6				7
		Grams		Inches		±		±	
Black Diamond No. 11..	B	123	185	c/7/8	8,900	1,300	2,700	400	Illinois
Black Diamond No. 11-A	B	111	205	c/7/8	10,200	1,600	3,100	500	Do.
Black Diamond No. 11-B	A	115	197	b/7/8	7,200	1,000	2,200	300	Do.
Black Diamond No. 12-B	B	105	216	1/1-1/8	7,900	1,300	2,400	400	Do.
Black Diamond No. 15..	A	160	142	b/7/8	6,600	1,000	2,000	300	Do.
Black Diamond No. 55..	A	208	109	b/7/8	11,200	1,600	3,400	500	Do.
Black Diamond A.....	A	194	117	w/1	8,500	1,300	2,600	400	Do.
Black Diamond G.....	B	90	252	m/1-1/8	8,500	1,300	2,600	400	Do.
Black Diamond.									
Special A.....	A	169	134	d/1-1/4	4,900	700	1,500	200	Do.
Black Diamond									
Special C.....	A	138	164	i/1-1/4	5,900	1,000	1,800	300	Do.
Burton A.....	B	201	113	f/1	7,200	1,000	2,200	300	American
Coalite B.....	B	133	164	a/7/8	11,500	1,600	3,500	500	Atlas
Coalite C.....	A	168	135	a/7/8	12,100	2,000	3,700	600	Do.
Coalite E.....	A	168	135	a/7/8	6,200	1,000	1,900	300	Do.
Coalite G.....	A	152	149	a/7/8	7,900	1,300	2,400	400	Do.
Coalite G-1.....	A	153	148	j/1-1/8	7,200	1,000	2,200	300	Do.
Coalite K.....	B	101	225	a/7/8	9,500	1,300	2,900	400	Do.
Coalite K-1.....	B	101	225	j/1-1/8	9,200	1,300	2,800	400	Do.

^{1/} Classification upon basis of volume of poisonous gases produced given on p. 2.^{2/} See p. 13 for all other permissible diameters.

Permissible explosives as of December 31, 1945 (Cont'd.)

NONGELATINOUS PERMISSIBLE EXPLOSIVES

Brand	Class designation basis, volume of poisonous gases ^{1/}	Weight of 1-1/4- by 8-inch cartridge	Number of 1-1/4- by 8-inch cartridges in 50-lb. case	Small-est permissible diameter ^{2/}	Rate of detonation in 1-1/4-inch diameter cartridge				Manufacturer
					Feet per second		Meters per second		
					Average	Allowable variation	Average	Allowable variation	
1	2	3	4	5	6		7		8
		Grams		Inches		±		±	
Coalite L.....	A	111	205	$\frac{2}{7/8}$	8,900	1,300	2,700	400	Atlas.
Coalite L-1.....	A	111	205	$\frac{1}{1-1/8}$	8,900	1,300	2,700	400	Do.
Coalite IS.....	B	105	220	$\frac{2}{7/8}$	6,200	1,000	1,900	300	Do.
Coalite IS-1.....	B	105	220	$\frac{1}{1-1/8}$	6,600	1,000	2,000	300	Do.
Coalite M.....	B	124	185	$\frac{2}{7/8}$	9,500	1,300	2,900	400	Do.
Coalite M-1.....	A	125	185	$\frac{1}{1-1/4}$	9,500	1,300	2,900	400	Do.
Coalite MS.....	B	119	191	$\frac{1}{1-1/8}$	6,200	1,000	1,900	300	Do.
Coalite MS-1.....	A	119	191	$\frac{1}{1-1/8}$	6,600	1,000	2,000	300	Do.
Coalite O.....	B	92	247	$\frac{2}{7/8}$	7,500	1,000	2,300	300	Do.
Coalite S.....	B	138	164	$\frac{2}{1}$	7,900	1,300	2,400	400	Do.
Coalite S-1.....	A	138	164	$\frac{1}{1-1/4}$	7,900	1,300	2,400	400	Do.
Coalite T.....	A	139	163	$\frac{2}{7/8}$	5,900	1,000	1,800	300	Do.
Coalite T-1.....	A	134	169	$\frac{1}{1-1/4}$	5,900	1,000	1,800	300	Do.
Collier C.....	A	141	161	$\frac{2}{7/8}$	11,800	1,600	3,600	500	Hercules
Columbia A.....	A	162	140	$\frac{2}{1-1/4}$	5,900	1,000	1,800	300	Columbia
Columbia B.....	A	177	128	$\frac{2}{1}$	7,900	1,300	2,400	400	Do.
Columbia B-2 ^{3/}	A	160	142	$\frac{2}{7/8}$	9,200	1,300	2,800	400	Do.
Columbia C.....	A	150	151	$\frac{2}{1}$	8,200	1,300	2,500	400	Do.
Columbia C-1.....	A	151	150	$\frac{2}{7/8}$	8,500	1,300	2,600	400	Do.

^{1/} Classification upon basis of volume of poisonous gases produced given on p. 2.^{2/} See p. 13 for all other permissible diameters.^{3/} Same as Big Red No. 7-C.

Permissible explosives as of December 31, 1945 (Cont'd.)

NONGELATINOUS PERMISSIBLE EXPLOSIVES

Brand	Class designation basis, volume of poisonous gases ^{1/}	Weight of 1-1/4- by 8-inch cartridge	Number of 1-1/4- by 8-inch cartridges in 50-lb. case	Small-est permissible diameter ^{2/}	Rate of detonation in 1-1/4-inch diameter cartridge				Manufacturer
					Feet per second		Meters per second		
					Allowable		Allowable		
					Average	variation	Average	variation	
1	2	3	4	5	6		7		8
		Grams		Inches		±		±	
Columbia D.....	A	142	160	c/7/8	7,500	1,000	2,300	300	Columbia
Columbia E.....	A	129	176	f/ 1	7,500	1,000	2,300	300	Do.
Columbia F.....	A	116	196	d/ 1	8,900	1,300	2,700	400	Do.
Columbia G.....	A	114	199	e/7/8	5,600	1,000	1,700	300	Do.
Columbia 2.....	C	106	214	d/ 1	8,900	1,300	2,700	400	Do.
Columbia 3.....	A	134	169	d/ 1	11,200	1,600	3,400	500	Do.
Columbia 4.....	A	186	122	s/7/8	9,800	1,300	3,000	400	Do.
Duobel A.....	A	168	135	ab/7/8	10,500	1,600	3,200	500	du Pont
Duobel B.....	A	150	151	b/7/8	9,800	1,300	3,000	400	Do.
Duobel C.....	A	143	159	a/7/8	9,800	1,300	3,000	400	Do.
Duobel D.....	A	124	183	b/7/8	10,200	1,600	3,100	500	Do.
Duobel E.....	A	112	203	b/7/8	10,800	1,600	3,300	500	Do.
Duobel F.....	B	99	229	a/7/8	9,200	1,300	2,800	400	Do.
Duobel G.....	B	91	249	c/7/8	8,500	1,300	2,600	400	Do.
Genite A.....	A	163	139	ad/7/8	11,200	1,600	3,400	500	American
Hercoal C-1.....	A	117	194	e/ 1	9,200	1,300	2,800	400	Hercules
Hercoal D.....	B	96	232	e/ 1	8,900	1,300	2,700	400	Do.
Hercoal F-1.....	B	88	258	a/7/8	8,500	1,300	2,600	400	Do.
Hercules Coal Powder 2.	A	168	135	ae/1-1/8	9,200	1,300	2,800	400	Do.
Independent A.....	A	143	159	1-1/4	7,900	1,300	2,400	400	Independent
Independent B.....	B	98	232	1-1/4	6,600	1,000	2,000	300	Do.

^{1/} Classification upon basis of poisonous gases produced given on p. 2.

^{2/} See p. 15 for all other permissible diameters.

Permissible explosives as of December 31, 1945 (Cont'd.)

NONGELATINOUS PERMISSIBLE EXPLOSIVES

Brand	Class designation basis, volume of poisonous gases ^{1/}	Weight of 1-1/4-inch cartridge	Number of 1-1/4-inch cartridges in 50-lb. case	Small-est. permissible diameter ^{2/}	Rate of detonation in 1-1/4-inch diameter cartridge				Manufacturer
					Feet per second		Meters per second		
					Average	Allowable variation	Average	Allowable variation	
1	2	3	4	5	6		7		8
		<u>Grams</u>		<u>Inches</u>		<u>±</u>		<u>±</u>	
Independent C.....	A	112	203	1-1/4	6,600	1,000	2,000	300	Independent
Independent D.....	A	127	179	1-1/4	6,600	1,000	2,000	300	Do.
Independent E.....	A	179	127	1-1/4	7,500	1,000	2,300	300	Do.
Independent F.....	A	156	167	1-1/4	8,900	1,300	2,700	400	Do.
Independent G.....	B	100	227	1-1/4	7,900	1,300	2,400	400	Do.
Independent H.....	A	120	189	1-1/4	8,500	1,300	2,600	400	Do.
King No. 7-A.....	B	155	146	c/7/8	11,500	1,600	3,500	500	King
King No. 15.....	A	160	142	b/7/8	6,600	1,000	2,000	300	Do.
Liberty No. 1.....	C	106	214	d/1	8,900	1,300	2,700	400	Liberty
Liberty No. 2.....	A	154	169	d/1	11,200	1,600	3,400	500	Do.
Liberty No. 2-A.....	A	142	160	c/7/8	7,500	1,000	2,300	300	Do.
Liberty No. 3.....	A	150	151	d/1	8,200	1,300	2,500	400	Do.
Liberty No. 3-A.....	A	151	150	e/7/8	8,500	1,300	2,600	400	Do.
Liberty No. 5.....	A	125	123	s/7/8	9,800	1,300	3,000	400	Do.
Liberty No. 6.....	A	129	176	f/1	7,500	1,000	2,300	300	Do.
Liberty No. 9.....	A	114	199	b/7/8	5,600	1,000	1,700	300	Do.
Liberty No. 11.....	B	86	264	k/1	7,200	1,000	2,200	300	Do.
Lump Coal C.....	A	157	166	af/1-1/4	5,900	1,000	1,800	300	du Pont
Lump Coal CC.....	A	156	167	l/1-1/8	6,900	1,000	2,100	300	Do.

^{1/} Classification upon basis of poisonous gases produced given on p. 2.^{2/} See p. 13 for all other permissible diameters.

Permissible explosives as of December 31, 1945 (Cont'd.)

NONGELATINOUS PERMISSIBLE EXPLOSIVES

Brand	Class designation basis, volume of poisonous gases ^{1/}	Weight of 1-1/4- by 8-inch cartridge	Number of 1-1/4- by 8-inch cartridges in 50-lb. case	Small-est permissible diameter ^{2/}	Rate of detonation in 1-1/4-inch diameter cartridge				Manufacturer
					Feet per second		Meters per second		
					Average	Allowable variation	Average	Allowable variation	
1	2	3	4	5	6				7
		Grams		Inches		+		+	
Miners' Friend No. 2...	B	166	137	<u>5</u> / <u>7</u> / <u>8</u>	10,500	1,600	3,200	500	Atlas
Monobel No. 9, L. F....	A	134	169	<u>5</u> / <u>7</u> / <u>8</u>	6,200	1,000	1,900	300	du Pont
Monobel AA.....	A	190	119	<u>1</u> / <u>2</u>	7,900	1,300	2,400	400	Do.
Monobel A.....	A	169	134	<u>5</u> / <u>7</u> / <u>8</u>	8,200	1,300	2,500	400	Do.
Monobel B.....	A	150	151	<u>5</u> / <u>7</u> / <u>8</u>	8,500	1,300	2,600	400	Do.
Monobel C.....	A	137	166	<u>5</u> / <u>7</u> / <u>8</u>	8,200	1,300	2,500	400	Do.
Monobel D.....	B	123	185	<u>5</u> / <u>7</u> / <u>8</u>	8,200	1,300	2,500	400	Do.
Monobel E.....	B	111	205	<u>5</u> / <u>7</u> / <u>8</u>	8,200	1,300	2,500	400	Do.
National A.....	A	160	142	<u>1</u> / <u>2</u>	8,500	1,300	2,600	400	National
National B.....	A	147	155	<u>1</u> / <u>2</u>	10,500	1,600	3,200	500	Do.
National C.....	B	100	227	<u>1</u> / <u>2</u>	8,900	1,300	2,700	400	Do.
National D.....	A	162	140	<u>1</u> / <u>2</u>	6,900	1,000	2,100	300	Do.
National E.....	A	143	159	1-1/4	7,900	1,300	2,400	400	Do.
National F.....	B	98	232	1-1/4	6,600	1,000	2,000	300	Do.
National F-1.....	B	90	252	<u>9</u> / <u>16</u>	8,500	1,300	2,600	400	Do.
National G.....	A	112	203	1-1/4	6,600	1,000	2,000	300	Do.
National H.....	A	127	179	<u>1</u> / <u>2</u>	6,600	1,000	2,000	300	Do.
Red Crown D-2.....	A	123	177	<u>9</u> / <u>16</u>	6,200	1,000	1,900	300	King
Red H8.....	A	155	146	<u>22</u> / <u>78</u>	12,100	2,000	3,700	600	Hercules
Red HC.....	A	163	135	<u>22</u> / <u>78</u>	5,900	1,000	1,800	300	Do.

^{1/} Classification upon basis of volume of poisonous gases given on p. 2.^{2/} See p. 13 for all other permissible diameters.

Permissible explosives as of December 31, 1945 (Cont'd.)

NONGELATINOUS PERMISSIBLE EXPLOSIVES

Brand	Class designation basis, volume of poisonous gases ^{1/}	Weight of 1-1/4- by 8-inch cartridge	Number of 1-1/4- by 8-inch cartridges in 50-lb. case	Small-est permissible diameter ^{2/}	Rate of detonation in 1-1/4-inch diameter cartridge				Manufacturer
					Feet per second		Meters per second		
					Average	Allowable variation	Average	Allowable variation	
1	2	3	4	5	6				7
		Grams		Inches		±		±	
Red HD	A	150	151	a/7/8	7,900	1,300	2,400	400	Hercules
Red HF	A	150	175	e/ 1	7,500	1,000	2,300	300	Do.
Red H No. 4	B	164	138	ai/7/8	8,900	1,300	2,700	400	Do.
Red H No. 5	B	170	134	g/ 1	6,900	1,000	2,100	300	Do.
Trojan Coal Powder M-2	A	178	128	h/ 1	10,500	1,600	3,200	500	Trojan
Trojan Coal Powder M-3	A	184	123	h/ 1	12,100	2,000	3,700	600	Do.
Trojan Coal Powder M-5	A	188	121	h/ 1	12,800	2,000	3,900	600	Do.
Trojan Coal Powder M-6	A	190	119	h/ 1	11,800	1,600	3,600	500	Do.
Trojan Coal Powder P-1	B	154	147	p/1-1/4	9,500	1,300	2,900	400	Do.
Trojan Coal Powder P-2	B	174	130	h/ 1	12,800	2,000	3,900	600	Do.
Trojan Coal Powder P-3	B	176	129	h/ 1	13,100	2,000	4,000	600	Do.
U. S. No. 15	A	160	142	b/7/8	6,600	1,000	2,000	300	United
U. S. G.	B	90	252	m/1-1/8	8,500	1,300	2,600	400	Do.
U. S. Special C	A	138	164	i/1-1/4	5,900	1,000	1,800	300	Do.
Wesco Coal Powder No.1	A	175	130	1-1/4	9,200	1,300	2,800	400	West

^{1/} Classification upon basis of volume of poisonous gases produced given on p. 2.^{2/} See p. 13 for all other permissible diameters.

Permissible explosives as of December 31, 1945 (Cont'd.)

GELATINOUS PERMISSIBLE EXPLOSIVES

Brand	Class designation basis, volume of poisonous gases ^{1/}	Weight of 1-1/4- by 8-inch cartridge	Number of 1-1/4- by 8-inch cartridges in 50-lb. case	Small-est permissible diameter ^{2/}	Rate of detonation in 1-1/4-inch diameter cartridge				Manufacturer
					Feet per second		Meters per second		
					Average	Allowable variation	Average ^{3/}	Allowable variation	
1	2	3	4	5	6		7		8
		Grams		Inches		±		±	
Alton-Gel B	A	227	100	b/7/8	14,800	2,300	4,500	700	Equitable
Alton-Gel C	A	171	133	b/7/8	10,200	1,600	3,100	500	Do.
Austin Red-D-Gel	A	244	93	f/1	14,800	2,300	4,500	700	Austin
Black Diamond Nu-Gel No. 4	A	193	118	c/7/8	13,400	2,000	4,100	600	Illinois
Columbia-Gel 1	A	226	100	d/1	13,800	2,000	4,200	600	Columbia
Columbia-Gel 2	A	171	133	b/7/8	10,200	1,600	3,100	500	Do.
Columbia-Gel 3	A	227	100	b/7/8	14,800	2,300	4,500	700	Do.
Gel-Coalite W	A	189	120	a/7/8	12,500	2,000	3,800	600	Atlas
Gel-Coalite X	A	239	95	a/7/8	9,500	1,300	2,900	400	Do.
Gel-Coalite Z	A	226	100	a/7/8	16,700	2,600	5,100	800	Do.
Gelobel A	A	220	103	b/7/8	15,700	2,300	4,800	700	du Pont
Gelobel B	A	202	112	k/1	8,900	1,300	2,700	400	Do.
Gelobel C	A	190	119	a/7/8	13,400	2,000	4,100	600	Do.
Hercogel 2	A	186	122	a/7/8	11,800	1,600	3,600	500	Hercules
Hercogel A	A	220	103	a/7/8	14,800	2,300	4,500	700	Do.
Independent Gel-A	A	244	93	f/1	14,800	2,300	4,500	700	Independent
Liberty-Gel, L.F.	A	226	100	d/1	13,800	2,000	4,200	600	Liberty
Liberty-Gel A	A	227	100	b/7/8	14,800	2,300	4,500	700	Do.
Liberty-Gel B	A	171	133	b/7/8	10,200	1,600	3,100	500	Do.
Napcogel No. 1	A	216	105	ph/1-1/8	14,800	2,300	4,500	700	National

1/ Classification upon basis of volume of poisonous gases produced given on p. 2.

2/ See p. 13 for all other permissible diameters.

3/ Rates of detonation of gelatinous permissible explosives may be low (approximately 2,000 m./sec.), high (approximately 5,000 m./sec.), or intermediate. However, it is believed that in a borehole all of these explosives will develop rates close to the high rate.

Permissible explosives as of December 31, 1945 (Cont'd.)

GELATINOUS PERMISSIBLE EXPLOSIVES

Brand	Class designation basis, volume of poisonous gases ^{1/}	Weight of 1-1/4- by 8-inch cartridge	Number of 1-1/4- by 8-inch cartridges in 50-lb. case	Small-est permissible diameter ^{2/}	Rate of detonation in 1-1/4-inch diameter cartridge				Manufacturer
					Feet per second		Meters per second		
					Average	Allowable variation	Average	Allowable variation	
1	2	3	4	5	6		7		
		<u>Grams</u>		<u>Inches</u>		<u>±</u>		<u>±</u>	
Permigel 1.....	A	236	95	1/1	13,800	2,000	4,200	600	American
Permigel 2-A.....	A	217	105	1/1	9,800	1,300	3,000	400	Do.
Permigel 3.....	A	183	124	1/1	12,500	2,000	3,800	600	Do.

1/ Classification upon basis of volume of poisonous gases produced given on p. 2.

2/ Permissible diameters of cartridges other than the smallest diameter:

a/ 1", 1-1/8", 1-1/4", 1-3/8", 1-1/2", 1-3/4", 2".

s/ 1-1/4", 1-1/2", 1-3/4", 2".

b/ 1", 1-1/8", 1-1/4", 1-1/2", 1-3/4", 2".

t/ 1-1/2".

c/ 1", 1-1/8", 1-1/4", 1-1/2", 1-3/4".

u/ 1-1/8", 1-1/4", 1-3/8", 1-1/2", 1-3/4", 2".

d/ 1-1/8", 1-1/4", 1-1/2".

v/ 1-1/8", 1-1/4".

e/ 1-1/8", 1-1/4", 1-3/8", 1-1/2", 1-3/4", 2", 3".

w/ 1-1/2", 1-3/4", 2".

f/ 1-1/8", 1-1/4", 1-1/2", 1-3/4".

x/ 1", 1-1/8", 1-1/4", 1-3/8", 1-1/2", 1-3/4", 2".

g/ 1-1/8", 1-1/4", 1-3/8", 1-1/2", 1-3/4", 2".

y/ 1-3/8", 1-1/2", 1-3/4", 2".

h/ 1-1/4", 1-1/2", 1-3/4".

z/ 1", 1-1/8", 1-1/4", 1-1/2", 1-3/4", 2-1/2".

i/ 1-3/8", 1-1/2", 1-3/4", 2".

aa/ 1", 1-1/8", 1-1/4", 1-3/8", 1-1/2", 1-3/4", 2", 3".

j/ 1-1/4", 1-3/8", 1-1/2", 1-3/4", 2".

ab/ 1", 1-1/8", 1-1/4", 1-3/8", 1-1/2", 1-3/4".

k/ 1-1/8", 1-1/4", 1-1/2", 1-3/4", 2".

ac/ 1", 1-1/8", 1-1/4", 1-3/8", 1-1/2", 1-7/8", 2".

l/ 1-1/4", 1-1/2", 1-3/4", 2".

ad/ 1-1/4".

m/ 1-1/4", 1-1/2", 1-3/4".

ae/ 1-1/4", 1-3/8", 1-3/4", 2".

n/ 1-7/16", 1-1/2".

af/ 1-1/2", 1-3/4", 2", 2-1/2".

o/ 1-1/4", 1-1/2".

ag/ 1", 1-1/8", 1-1/4", 1-3/8", 1-1/2", 1-3/4", 2".

p/ 1-1/2", 1-3/4".

2-1/2", 3", 3-1/2", 4".

q/ 1-3/8", 1-1/2", 1-3/4".

ah/ 1-1/4".

r/ 1-1/2", 1-3/4", 2".

ai/ 1-1/4", 1-1/2".

3/ See page 12, footnote 5.

It is provided further:

That, in accordance with the provisions and conditions, explosives enumerated on the permissible lists of the Bureau of Mines are permissible in use only when they satisfy the following requirements:

1. That the explosive be in all respects similar to the sample submitted by the manufacturer for test, and that the diameters of the cartridges used must be those that have been approved.

2. That electric detonators (not fuse and detonators) be used of not less efficiency than No. 6, the detonating charge of which shall consist of a 1-gram mixture of 80 parts of mercury fulminate and 20 parts of potassium chlorate (or their equivalents), and that the required electric firing must be done by means of a permissible-type blasting unit.

3. That the explosive be stored in surface magazines under proper conditions, so that it will not undergo change in character, and that after taking underground it be used in less than 36 hours.

4. That the coal to be blasted be undercut or equivalently relieved; that, to prevent blow-throughs, all portions of the borehole must be at least 18 inches from relief in any direction; that, to prevent blow-outs, the charge be properly confined with not less than 2 feet of clay³/ or other incombustible stemming and not be on the solid; that, to prevent the hole being on the solid, it shall be at least 6 inches shorter than the depth of the undercut or equivalent relief, and, when placed adjacent to the roof, ribs, or floor, all but 12 inches at the rear of the hole must be at least 6 inches from the adjacent surface as projected into the coal to be blasted, and all parts of the hole shall be free from the adjacent surface as projected into the coal to be blasted; that the shot be not a dependent shot; and that the shot hole be cleaned before charging.

5. That the quantity used for a shot (1) be not in excess of 680 grams (1-1/2 pounds) when fired in accordance with these requirements and (2) when used under certain additional requirements or restrictions be not in excess of 1,361 grams (3 pounds).⁴/

3/ If the length of the hole will not permit the charge desired and 2 feet of stemming, at least half the length of the hole shall be filled with stemming.

4/ The use of charges over 1-1/2 pounds and not exceeding 3 pounds is approved tentatively pending further investigation. The approval, which may be withdrawn at any time, expires June 30, 1946, unless renewed. For charges over 1-1/2 pounds, the following additional requirements must be observed:

(a) Shot holes must be 6 feet or more in length.

(b) Explosive must be charged in a continuous train, with no cartridges deliberately deformed or crushed, with all cartridges in contact with each other, and with the end cartridges touching the rear of the hole and the stemming, respectively.

(c) Examinations for gas must be made in the blasting area before and after a shot is fired.

(d) The permissible explosive must be one showing toxic gas emission that will place it in either class A or class B.

6. That the region in which the blasting is done be kept well-protected by rock dust or otherwise in accordance with Bureau of Mines inspection standards.

7. That the shot be not fired in the presence of a dangerous percentage of firedamp. Examination for firedamp to be made at the blasting area before and after shooting in a gassy mine.

The complete name and address of each manufacturer indicated in the table are as follows:

American:	American Cyanamid & Chemical Corp., New York, N. Y.
Apache:	Apache Powder Co., Benson, Ariz.
Atlas:	Atlas Powder Co., Wilmington, Del.
Austin:	Austin Powder Co., Cleveland, Ohio.
Columbia:	Columbia Powder Co., Tacoma, Wash.
du Pont:	E. I. du Pont de Nemours & Co., Wilmington, Del.
Equitable:	Equitable Powder Manufacturing Co. and Egyptain Powder Co., East Alton, Ill.
Hercules:	Hercules Powder Co., Wilmington, Del.
Illinois:	Illinois Powder Manufacturing Co., St. Louis, Mo.
Independent:	Independent Explosives Co. of Pennsylvania, Scranton, Pa.
King:	King Powder Co., Inc., Cincinnati, Ohio.
Liberty:	Liberty Powder Co., Division of Olin Corp., Pittsburgh, Pa.
National:	National Powder Co., Eldred, Pa.
Trojan:	Trojan Powder Co., Allentown, Pa.
United:	United States Powder Co., Terre Haute, Ind.
West:	West Coast Powder Co., Everett, Wash.

PERMISSIBLE BLASTING DEVICES TESTED UNDER SCHEDULE 1F

An active list of permissible blasting devices was published in December, 1943 as part of Bureau of Mines Report of Investigations 3736, issued under the title "Active List of Permissible Explosives and Blasting Devices Approved Previous to June 30, 1943."

The permissible blasting devices Cardox models B-20, B-37, B-44, D-100, 2-50, 2-80, 2-100, 231-130, and 3-200 utilize as a blasting agent liquid carbon dioxide, which is confined in a stout steel cylinder with a heater element, which, by its combustion, supplies enough energy to gasify the carbon dioxide. One end of the steel cylinder is closed hermetically by a replaceable steel disk, which is sheared by the pressure of the carbon dioxide when sufficiently gasified, and the latter is thus enabled to escape from the cylinder. In blasting with Cardox the heater is fired by means of a permissible blasting unit. The permissibility of the Cardox devices was established by gallery tests similar to those used in testing explosives. In these tests the shell was discharged into gas and air, or gas, coal-dust, and air mixtures without igniting them. The conditions of charging the shell, such as the weight of the carbon dioxide charge and of the ingredients of the heater element and the thickness of the disk, were varied according to the conditions under which these devices would be likely to be used in blasting coal.

R.I. 3910

The complete active list of permissible blasting devices approved previous to December 31, 1945, is shown in the following table, which includes the permissible conditions of charging each shell for a given thickness of disk as to maximum weight of heater ingredient.

R.I. 3910

Permissible Cardox models. as of December 31, 1945. manufactured by Cardox Corp.. Chicago. Ill.

Number of		Dimension of shell				Authorized combinations			
						Shear opening in discharge cap. diameter	Heater, maximum weight of ingredient (potassium perchlo- rate-coal mixture	Disk (sheet metal).	
								Minimum	Minimum shear- ing pressure, thousands of pounds $\frac{1}{2}$
Approval	Extension	Cm.	In.	Cm.	In.	In.	Grams	Minimum gage	

CARDOX MODEL B-20

Usual charge of carbon dioxide 255 grams $\frac{2}{2}$

7 and 18	1 and 2	60.7	23-7/8	4.4	1-3/4	7/8	35	12	18
						7/8	45	10	23

CARDOX MODEL B-37

Usual charge of carbon dioxide 450 grams $\frac{2}{2}$

6 and 18	2 and 3	103.2	40-5/8	4.4	1-3/4	7/8	80	12	18
						7/8	100	10	23

CARDOX MODEL B-44

Usual charge of carbon dioxide 570 grams $\frac{2}{2}$

8 and 18	2 and 3	118.4	46-5/8	4.4	1-3/4	7/8	80	12	18
						7/8	100	10	23

CARDOX MODEL D-100

Usual charge of carbon dioxide 1425 grams $\frac{2}{2}$

5 and 18	3 and 4	118.1	46-1/2	6.4	2-1/2	1-7/16	180	3/10	17
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See footnotes on p. 19.

Permissible Cardox Models, as of December 31, 1945, manufactured by Cardox Corp., Chicago, Ill. (Cont'd.)

Number of		Authorized combinations							
		Dimension of shell				Shear opening in discharge cap. diameter	Heater, maximum weight of ingredient (potassium perchlo- rate-coal mixture	Disk (sheet metal)	
								Minimum	Minimum shear- ing pressure, thousands of pounds <u>1</u> / ₂
Approval	Extension	Length	Diameter						
		Cm.	In.	Cm.	In.	In.	Grams	Minimum gage	

CARDOX MODEL 2-50

Usual charge of carbon dioxide 675 grams $\frac{2}{2}$

18		88	34-5/8	5.1	2	1-1/16	80	12	13
						1-1/16	100	10	17

CARDOX MODEL 2-80

Usual charge of carbon dioxide 1,075 grams $\frac{2}{2}$

18		118.4	46-5/8	5.1	2	1-1/16	100	12	13
						1-1/16	110	10	17

CARDOX MODEL 2-100

Usual charge of carbon dioxide, 1,425 grams $\frac{2}{2}$

18		148.9	58-5/8	5.1	2	1-1/16	110	12	13
						1-1/16	110	10	17

CARDOX MODEL 231-130

Usual charge of carbon dioxide 1,800 grams $\frac{2}{2}$

18		151.4	59-5/8	5.9	2-5/16	1-3/8	130	3/12	12
						1-3/8	160	3/10	16

See footnotes on p. 19.

Permissible Cardox Models, as of December 31, 1945, manufactured by Cardox Corp., Chicago, Ill. (Cont'd.)

Number of		Dimension of shell				Authorized combinations					
						Shear opening in discharge cap. diameter		Heater, maximum weight of ingredient (potassium perchlo- rate-coal mixture		Disk (sheet metal)	
										Minimum	Minimum shear- ing pressure, thousands of
Approval	Extension	Cm.	In.	Cm.	In.	In.	Grams	gage	pounds ^{1/}		

CARDOX MODEL 3-200

Usual charge of carbon dioxide 2,800 grams^{2/}

18		134.0	52-3/4	7.6	3	1-3/4 1-3/4	200 200	3/12 3/10	10 13
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- 1/ Minimum shearing pressures allow a reasonable tolerance from those actually determined by tests.
- 2/ Maximum weight of heater and minimum disk gage are combinations for the usual charge of carbon dioxide as stated for each model. Combinations studied and tested at the gallery were with low charges of carbon dioxide. Therefore, a charge of carbon dioxide less than that usually used does not affect the permissible use of the device.
- 3/ Strip-steel disks instead of sheet metal.

GENERAL REQUIREMENTS

It is provided further:

That, in accordance with the provisions and conditions, the devices enumerated on the permissible list of the Bureau of Mines are permissible in use only when they satisfy the following requirements:

1. That the device be in all respects similar to the sample submitted for tests.
2. That the permissible conditions of charging, as to thickness of disk, weights of heater ingredient, and weight of carbon dioxide charge, be met.
3. That the wires of the firing line shall be connected to either type of shell top (end or side connection) only after the shell has been placed in the borehole; and, further, that the terminal plug, when the end connection shell top is used, shall not be inserted into the shell until these connections are being made.
4. That the device shall not be fired in the presence of a dangerous percentage of firedamp. This firing must be done only by means of a permissible-type blasting unit.
5. That the device shall not be fired until everyone is 100 feet or more from the shot and protected by adequate cover, having one or, if possible, two right angles between them and the blast.
6. That the device shall not be charged with the heater ingredient and carbon dioxide in the mine.
7. That the coal to be blasted be undercut or equivalently relieved; that the length of the shot hole be at least 6 inches less than the depth of the undercut or equivalent relief; and that the shot hole shall be at least 6 inches away from the side of the undercut or equivalent relief.

R. R. SAYERS
Director

U.S. DEPARTMENT OF LABOR MSHA



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