	tier 1 225≤kW<450 (300≤hp<600).....	(0.60 g/bhp-hr).
	tier 1 450≤kW<560 (600≤hp<750).....	0.80 g/kW-hr (0.60 g/bhp-hr).
	tier 1 kW≥560 (hp≥750).....	0.40 g/kW-hr (0.30 g/bhp-hr).
		0.30 g/kW-hr (0.22 g/bhp-hr).
		0.54 g/kW-hr (0.40 g/bhp-hr).
		0.54 g/kW-hr (0.40 g/bhp-hr).
		0.54 g/kW-hr (0.40 g/bhp-hr).
		0.54 g/kW-hr (0.40 g/bhp-hr).

Notes:
"g" means grams.
"hp" means horsepower.
"g/bhp-hr" means grams/brake horsepower-hour.
"kW" means kilowatt.
"g/kW-hr" means grams/kilowatt-hour.

(b) For purposes of paragraph (a):
(1) The term "introduced" means any engine added to the underground inventory of engines of the mine in question, including: (i) An engine in newly purchased equipment;
(ii) An engine in used equipment brought into the mine; and
(iii) A replacement engine that has a different serial number than the engine it is replacing; but
(2) The term "introduced" does not include engines that were previously part of the mine inventory and rebuilt.
(3) The term *introduced* does not include the transfer of engines or equipment from the inventory of one underground mine to another underground mine operated by the same mine operator.

30 CFR § 57.5070 Miner training.

(a) Mine operators must provide annual training to all miners at a mine covered by this part who can reasonably be expected to be exposed to diesel emissions on that property. The training must include--
(1) The health risks associated with exposure to diesel particulate matter;
(2) The methods used in the mine to control diesel particulate matter concentrations;
(3) Identification of the personnel responsible for maintaining those controls; and
(4) Actions miners must take to ensure the controls operate as intended.
(b) An operator must retain a record at the mine site of the training required by this section for one year after completion of the training.

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Editorial Note: Based on *FedReg. Doc. 05-10681*, this section has been changed.
The new version is in **BOLD**. The old section will remain, pending the next publication of the 30 CFR.
The effective date for this is July 6, 2005.

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30 CFR § 57.5071 Environmental monitoring.

(a) Mine operators must monitor as often as necessary to effectively determine, under conditions that can be reasonably anticipated in the mine--

(1) Whether the concentration of diesel particulate matter in any area of the mine where miners normally work or travel exceeds the applicable limit specified in § 57.5060; and

(2) The average full shift airborne concentration of diesel particulate matter at any position or on any person designated by the Secretary.

(b) The mine operator must provide affected miners and their representatives with an opportunity to observe exposure monitoring required by this section. Mine operators must give prior notice to affected miners and their representatives of the date and time of intended monitoring.

(c) If any monitoring performed under this section indicates that the applicable concentration limit established by § 57.5060 has been exceeded, an operator must promptly post notice of the corrective action being taken, initiate corrective action by the next work shift, and promptly complete such corrective action.

(d)(1) The results of monitoring for diesel particulate matter, including any results received by a mine operator from sampling performed by the Secretary, must be posted on the mine bulletin board within 15 days of receipt and must remain posted for 30 days. The operator must provide a copy of the results to the authorized representative of miners.

(2) The mine operator must retain for five years (from the date of sampling), the results of any samples the operator collected as a result of monitoring under this section, and information about the sampling method used for obtaining the samples.

§ 57.5071 Exposure monitoring.

(a) Mine operators must monitor as often as necessary to effectively determine, under conditions that can be reasonably anticipated in the mine, whether the average personal full-shift airborne exposure to DPM exceeds the DPM limit specified in § 57.5060.

(b) The mine operator must provide affected miners and their representatives

with an opportunity to observe exposure monitoring required by this section. Mine operators must give prior notice to affected miners and their representatives of the date and time of intended monitoring.

(c) If any monitoring performed under this section indicates that a miner's exposure to diesel particulate matter exceeds the DPM limit specified in § 57.5060, the operator must promptly post notice of the corrective action being taken on the mine bulletin board, initiate corrective action by the next work shift, and promptly complete such corrective action.

(d)(1) The results of monitoring for diesel particulate matter, including any results received by a mine operator from sampling performed by the Secretary, must be posted on the mine bulletin board within 15 days of receipt and must remain posted for 30 days. The operator must provide a copy of the results to the authorized representative of miners.

(2) The mine operator must retain for five years (from the date of sampling), the results of any samples the operator collected as a result of monitoring under this section, and information about the sampling method used for obtaining the samples.

****

Editorial Note: Based on ***FedReg. Doc. 05-10681***, this section has been changed.
The new version is in **BOLD**. The old section will remain, pending the next publication of the 30 CFR.
The effective date for this is July 6, 2005.

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30 CFR § 57.5075 Diesel particulate records.

(a) The table entitled "Diesel Particulate Recordkeeping Requirements" lists the records the operator must retain pursuant to Secs. 57.5060 through 57.5071, and the duration for which particular records need to be retained. The table follows:

Table 57.5075(a). - Diesel Particulate Recordkeeping Requirements

Record	Section reference	Retention time
1. Approved application for extension of time to comply with final concentration limit.	§ 57.5060(c)	1 year beyond duration of extension.
2. Approved plan for miners to perform inspection, maintenance or repair actions in areas exceeding the concentration limit.	§ 57.5060(d)	For duration of plan.
3. Control plan.....	§ 57.5062(b)	1 year beyond duration of plan.
4. Compliance plan verification	§ 57.5062(c)	5 years from sample date.
5. Purchase records noting sulfur content of diesel fuel.	§ 57.5065(a)	1 year beyond date of purchase.
6. Maintenance log.....	§ 57.5066(b)	1 year after date any equipment is tagged.
7. Evidence of competence to perform maintenance.	§ 57.5066(c)	1 year after date maintenance performed.
8. Annual training provided to potentially exposed miners.	§ 57.5070(b)	1 year beyond date training completed.
9. Sampling method used to effectively evaluate mine particulate concentration, and sample results.	§ 57.5071(d)	5 years from sample date.

(b)(1) Any record listed in this section which is required to be retained at the mine site may, notwithstanding such requirement, be retained elsewhere if the

mine operator can immediately access the record from the mine site by electronic transmission.

(2) Upon request from an authorized representative of the Secretary of Labor, the Secretary of Health and Human Services, or from the authorized representative of miners, mine operators must promptly provide access to any record listed in the table in this section.

(3) An operator must provide access to a miner, former miner, or, with the miner's or former miner's written consent, a personal representative of a miner, to any record required to be maintained pursuant to § 57.5071 to the extent the information pertains to the miner or former miner. The operator must provide the first copy of a requested record at no cost, and any additional copies at reasonable cost.

(4) Whenever an operator ceases to do business, that operator must transfer all records required to be maintained by this part, or a copy thereof, to any successor operator who must maintain them for the required period.

§ 57.5075(a) Diesel particulate records.

(a) Table 57.5075(a), ``Diesel Particulate Recordkeeping Requirements,'' lists the records the operator must retain pursuant to § § 57.5060 through 57.5071, and the duration for which particular records must be retained.

Table 57.5075(a).--Diesel Particulate Recordkeeping Requirements

Record	Section reference	Retention time
1. Approved application for extension of time to comply with exposure limits.	§ 57.5060(c).....	Duration of extension.
2. Purchase records noting sulfur content of diesel fuel.	§ 57.5065(a).....	1 year beyond date of purchase.
3. Maintenance log.....	§ 57.5066(b).....	1 year after date any equipment is tagged.
4. Evidence of competence to perform maintenance.	§ 57.5066(c).....	1 year after date maintenance performed.
5. Annual training provided to potentially exposed miners.	§ 57.5070(b).....	1 year beyond date training completed.
6. Record of corrective action	§ 57.5071(c).....	Until the corrective action is completed.
7. Sampling method used to effectively evaluate a miner's personal exposure, and sample results.	§ 57.5071(d).....	5 years from sample date.

(b)(1) Any record listed in this section which is required to be retained at the mine site may, notwithstanding such requirement, be retained elsewhere if the mine operator can immediately access the record from the mine site by electronic transmission.

(2) Upon request from an authorized representative of the Secretary of Labor, the Secretary of Health and Human Services, or from the authorized representative of miners, mine operators must promptly provide access to any record listed in the table in this section.

(3) An operator must provide access to a miner, former miner, or, with the miner's or former miner's written consent, a personal representative of a miner, to any record required to be maintained pursuant to § 57.5071 to the extent the information pertains to the miner or former miner. The operator must provide the first copy of a requested record at no cost, and any additional copies at reasonable cost.

(4) Whenever an operator ceases to do business, that operator must transfer all records required to be maintained by this part, or a copy thereof, to any

successor operator who must maintain them for the required period.

Subpart E—Explosives

30 CFR § 57.6000

Definitions.

The following definitions apply in this subpart.

Blasting agent. Any substance classified as a blasting agent by the Department of Transportation in 49 CFR 173.114a(a). This document is available at any MSHA Metal and Nonmetal Safety and Health district office.

*Detonating cord.*A flexible cord containing a center core of high explosives which may be used to initiate other explosives.

Detonator. Any device containing a detonating charge used to initiate an explosive. These devices include electric or nonelectric instantaneous or delay blasting caps and delay connectors. The term ``detonator'' does not include detonating cord. Detonators may be either ``Class A'' detonators or ``Class C'' detonators, as classified by the Department of Transportation in 49 CFR 173.53, and 173.100. This document is available at any MSHA Metal and Nonmetal Safety and Health district office.

Explosive. Any substance classified as an explosive by the Department of Transportation in 49 CFR 173.53, 173.88, and 173.100. This document is available at any MSHA Metal and Nonmetal Safety and Health district office.

Explosive material. Explosives, blasting agents, and detonators.

Flash point. The minimum temperature at which sufficient vapor is released by a liquid to form a flammable vapor-air mixture near the surface of the liquid.

Igniter cord. A fuse that burns progressively along its length with an external flame at the zone of burning, used for lighting a series of safety fuses in a desired sequence.

Magazine. A bullet-resistant, theft-resistant, fire-resistant, weather-resistant, ventilated facility for the storage of explosives and detonators (BATF Type 1 or Type 2 facility).

Misfire. The complete or partial failure of explosive material to detonate as planned. The term also is used to describe the explosive material itself that has failed to detonate.

Primer. A unit, package, or cartridge of explosives which contains a detonator and is used to initiate other explosives or blasting agents.

Safety switch. A switch that provides shunt protection in blasting circuits between the blast site and the switch used to connect a power source to the blasting circuit.

Slurry. An explosive material containing substantial portions of a liquid, oxidizers, and fuel, plus a thickener.

Water gel. An explosive material containing substantial portions of water, oxidizers, and fuel, plus a cross-linking agent.

STORAGE--SURFACE AND UNDERGROUND

30 CFR § 57.6100

Separation of stored explosive material.

STORAGE--SURFACE AND UNDERGROUND
(a) Detonators shall not be stored in the same magazine with other explosive material.

(b) When stored in the same magazine, blasting agents shall be separated from explosives, safety fuse, and detonating cord to prevent contamination.

30 CFR § 57.6101

Areas around explosive material storage facilities.

(a) Areas surrounding storage facilities for explosive material shall be clear of rubbish, brush, dry grass, and trees for 25 feet in all directions, except that live trees 10 feet or taller need not be removed.

(b) Other combustibles shall not be stored or allowed to accumulate within 50 feet of explosive material. Combustible liquids shall be stored in a manner that ensures drainage will occur away from the explosive material storage facility in case of tank rupture.

30 CFR § 57.6102

Explosive material storage practices.

(a) Explosive material shall be--

(1) Stored in a manner to facilitate use of oldest stocks first;

(2) Stored according to brand and grade in such a manner as to facilitate identification; and

(3) Stacked in a stable manner but not more than 8 feet high.

(b) Explosives and detonators shall be stored in closed nonconductive containers except that nonelectric detonating devices may be stored on nonconductive racks provided the case-insert instructions and the date-plant-shift code are maintained with the product.

STORAGE--SURFACE ONLY

30 CFR § 57.6130

Explosive material storage facilities.

STORAGE--SURFACE ONLY

(a) Detonators and explosives shall be stored in magazines.

(b) Packaged blasting agents shall be stored in a magazine or other facility which is ventilated to prevent dampness and excessive heating, weather-resistant, and locked or attended. Drop trailers that are currently licensed by the Federal, State, or local authorities for over-the-road use do not have to be ventilated. Facilities other than magazines used to store blasting agents shall contain only blasting agents.

(c) Bulk blasting agents shall be stored in weather-resistant bins or tanks which are locked, attended, or otherwise inaccessible to unauthorized entry.

(d) Facilities, bins or tanks shall be posted with the appropriate United States Department of Transportation placards or other appropriate warning signs that indicate the contents and are visible from each approach.

30 CFR § 57.6131

Location of explosive material storage facilities.

(a) Storage facilities for any explosive material shall be--

(1) Located so that the forces generated by a storage facility explosion will not create a hazard to occupants in mine buildings and will not damage dams or electric substations; and

(2) Detached structures located outside the blast area and a sufficient distance from powerlines so that the powerlines, if damaged, would not contact the magazines.

(b) Operators should also be aware of regulations affecting storage facilities in 27 CFR part 55, in particular, §§ 55.218 and 55.220. This document is available at any MSHA Metal and Nonmetal Safety and Health district office.

[56 FR 46508, Sept. 12, 1991; 56 FR 52193, Oct. 18, 1991; 58 FR 31908, June 7, 1993; 58 FR 69596, Dec. 30, 1993]

NOTE: At 58 FR 69596, December 30, 1993, the effective date of §57.6131(a)(1) is stayed until January 31, 1994.

30 CFR § 57.6132

Magazine requirements.

(a) Magazines shall be--

(1) Structurally sound;

(2) Noncombustible or the exterior covered with fire-resistant material;

(3) Bullet resistant;

(4) Made of nonsparking material on the inside;

(5) Ventilated to control dampness and excessive heating within the magazine;

(6) Posted with the appropriate United States Department of Transportation placards or other appropriate warning signs that indicate the contents and are

visible from each approach, so located that a bullet passing through any of the signs will not strike the magazine;

(7) Kept clean and dry inside;

(8) Unlighted or lighted by devices that are specifically designed for use in magazines and which do not create a fire or explosion hazard;

(9) Unheated or heated only with devices that do not create a fire or explosion hazard;

(10) Locked when unattended; and

(11) Used exclusively for the storage of explosive material except for essential nonsparking equipment used for the operation of the magazine.

(b) Metal magazines shall be equipped with electrical bonding connections between all conductive portions so the entire structure is at the same electrical potential. Suitable electrical bonding methods include welding, riveting, or the use of securely tightened bolts where individual metal portions are joined. Conductive portions of nonmetal magazines shall be grounded.

(c) Electrical switches and outlets shall be located on the outside of the magazine.

30 CFR § 57.6133

Powder chests.

(a) Powder chests (day boxes) shall be--

(1) Structurally sound, weather-resistant, equipped with a lid or cover, and with only nonsparking material on the inside;

(2) Posted with the appropriate United States Department of Transportation placards or other appropriate warning signs that indicate the contents and are visible from each approach;

(3) Located out of the blast area once loading has been completed;

(4) Locked or attended when containing explosive material; and

(5) Emptied at the end of each shift with the contents returned to a magazine or other storage facility, or attended.

(b) Detonators shall be kept in chests separate from explosives or blasting agents, unless separated by 4-inches of hardwood or equivalent, or a laminated partition. When a laminated partition is used, operators must follow the provisions of the Institute of Makers of Explosives (IME) Safety Library Publication No. 22, ``Recommendations for the Safe Transportation of Detonators in a Vehicle with other Explosive Materials," (May 1993), and the ``Generic Loading Guide for the IME-22 Container," (October 1993). This incorporation by reference has been approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies are available at MSHA, 1100 Wilson Boulevard Room 2436, Arlington, Virginia 22209-3939, and at all Metal and Nonmetal Mine Safety and Health district offices, or available for inspection at the Office of the Federal Register, 800 North Capitol Street, NW., 7th Floor, suite 700, Washington, DC.

30 CFR § 57.6140

Magazine location.

Magazines shall be located in accordance with the current American Table of Distances for storage of explosives.

[58 FR 31908, June 7, 1993; 58 FR 69596, Dec. 30, 1993]

NOTE: At 58 FR 69596, December 30, 1993, §57.6140 is effective until January 31, 1994, unless terminated earlier by FEDERAL REGISTER notice.

For more information: See MSHA'S Program Policy Manual

STORAGE--UNDERGROUND ONLY

30 CFR § 57.6160

Main facilities.

STORAGE--UNDERGROUND ONLY

(a) Main facilities used to store explosive material underground shall be located--

(1) In stable or supported ground;

(2) So that a fire or explosion in the storage facilities will not prevent escape from the mine, or cause detonation of the contents of another storage facility;

(3) Out of the line of blasts, and protected from vehicular traffic, except that accessing the facility;

(4) At least 200 feet from work places or shafts;

(5) At least 50 feet from electric substations;

(6) A safe distance from trolley wires; and

(7) At least 25 feet from detonator storage facilities.

(b) Main facilities used to store explosive material underground shall be--

(1) Posted with warning signs that indicate the contents and are visible from any approach;

(2) Used exclusively for the storage of explosive material and necessary equipment associated with explosive material storage and delivery;

(b)(2)(i) Portions of the facility used for the storage of explosives shall only contain nonsparking material or equipment.

(b)(2)(ii) The blasting agent portion of the facility may be used for the storage of other necessary equipment.

(3) Kept clean, suitably dry, and orderly;

(4) Provided with unobstructed ventilation openings;

(5) Kept securely locked unless all access to the mine is either locked or attended; and

(6) Unlighted or lighted only with devices that do not create a fire or explosion hazard and which are specifically designed for use in magazines.

(c) Electrical switches and outlets shall be located outside the facility.

30 CFR § 57.6161

Auxiliary facilities.

(a) Auxiliary facilities used to store explosive material near work places shall be wooden, box-type containers equipped with covers or doors, or facilities constructed or mined-out to provide equivalent impact resistance and confinement.

(b) The auxiliary facilities shall be--

(1) Constructed of nonsparking material on the inside when used for the storage of explosives;

(2) Kept clean, suitably dry, and orderly;

(3) Kept in repair;

(4) Located out of the line of blasts so they will not be subjected to damaging shock or flyrock;

(5) Identified with warning signs or coded to indicate the contents with markings visible from any approach;

(6) Located at least 15 feet from all haulageways and electrical equipment, or placed entirely within a mined-out recess in the rib used exclusively for explosive material;

(7) Filled with no more than a one-week supply of explosive material;

(8) Separated by at least 25 feet from other facilities used to store detonators; and

(9) Kept securely locked unless all access to the mine is either locked or attended.

TRANSPORTATION--SURFACE AND UNDERGROUND

30 CFR § 57.6200

Delivery to storage or blast site areas.

TRANSPORTATION--SURFACE AND UNDERGROUND

Explosive material shall be transported without undue delay to the storage area or blast site.

30 CFR § 57.6201

Separation of transported explosive material.

Detonators shall not be transported on the same vehicle or conveyance with other explosives except as follows:

(a) Detonators in quantities of more than 1000 may be transported in a vehicle or conveyance with explosives or blasting agents provided the detonators are--

(1) Maintained in the original packaging as shipped from the manufacturer; and

2) Separated from explosives or blasting agents by 4-inches of hardwood or equivalent, or a laminated partition. The hardwood or equivalent shall be fastened to the vehicle or conveyance. When a laminated partition is used, operators must follow the provisions of the Institute of Makers of Explosives (IME) Safety Library Publication No.22, ``Recommendations for the Safe Transportation of Detonators in a Vehicle with other Explosive Materials," (May 1993), and the ``Generic Loading Guide for the IME-22 Container," (October 1993). This incorporation by reference has been approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies are available at MSHA, 1100 Wilson Boulevard Room 2436, Arlington, Virginia 22209-3939, and at all Metal and Nonmetal Mine Safety and Health district offices, or available for inspection at the Office of the Federal Register, 800 North Capitol Street, NW., 7th Floor, suite 700, Washington, DC.

(b) Detonators in quantities of 1000 or fewer may be transported with explosives or blasting agents provided the detonators are--

(1) Kept in closed containers; and

(2) Separated from explosives or blasting agents by 4-inches of hardwood or equivalent, or a laminated partition. The hardwood or equivalent shall be fastened to the vehicle or conveyance. When a laminated partition is used, operators must follow the provisions of IME Safety Library Publication No. 22, ``Recommendations for the Safe Transportation of Detonators in a Vehicle with other Explosive Materials," (May 1993), and the ``Generic Loading Guide for the IME-22 Container," (October 1993). This incorporation by reference has been approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies are available at MSHA, 4015 Wilson Boulevard, Room 728, Arlington, VA 22209-3939 , and at all Metal and Nonmetal Mine Safety and Health district offices, or available for inspection at

the Office of the Federal Register, 800 North Capitol Street, NW., 7th Floor, suite 700, Washington, DC.

30 CFR § 57.6202

Vehicles.

(a) Vehicles containing explosive material shall be--

(1) Maintained in good condition and shall comply with the requirements of subpart M of this part;

(2) Equipped with sides and enclosures higher than the explosive material being transported or have the explosive material secured to a nonconductive pallet;

(3) Equipped with a cargo space that shall contain the explosive material (passenger areas shall not be considered cargo space);

(4) Equipped with at least two multipurpose dry-chemical fire extinguishers or one such extinguisher and an automatic fire suppression system;

(5) Posted with warning signs that indicate the contents and are visible from each approach;

(6) Occupied only by persons necessary for handling the explosive material; (7) Attended or the cargo compartment locked, except when parked at the blast site and loading is in progress; and

(8) Secured while parked by having--

(i) The brakes set;

(ii) The wheels chocked if movement could occur; and

(iii) The engine shut off unless powering a device being used in the loading operation.

(b) Vehicles containing explosives shall have--

(1) No sparking material exposed in the cargo space; and

(2) Only properly secured nonsparking equipment in the cargo space with the explosives.

(c) Vehicles used for dispensing bulk explosive material shall--

(1) Have no zinc or copper exposed in the cargo space; and

(2) Provide any enclosed screw-type conveyors with protection against internal pressure and frictional heat.

30 CFR § 57.6203

Locomotives.

Explosive material shall not be transported on a locomotive. When explosive material is hauled by trolley locomotive, covered, electrically insulated cars shall be used.

30 CFR § 57.6204

Hoists.

(a) Before explosive material is transported in hoist conveyances--

(1) The hoist operator shall be notified; and

(2) Hoisting in adjacent shaft compartments, except for empty conveyances or counterweights, shall be stopped until transportation of the explosive material is completed.

(b) Explosive material transported in hoist conveyances shall be placed within a container which prevents shifting of the cargo that could cause detonation of the container by impact or by sparks. The manufacturer's container may be used if secured to a nonconductive pallet. When explosives are transported, they shall be secured so as not to contact any sparking material.

(c) No explosive material shall be transported during a mantrip.

30 CFR § 57.6205

Conveying explosives by hand.

Closed, nonconductive containers shall be used to carry explosives and detonators to and from blast sites. Separate containers shall be used for explosives and detonators.

30 CFR § 57.6220

Maintenance and operation of transport vehicles.

Vehicles containing explosives or detonators shall be maintained in good condition and shall be operated at a safe speed and in accordance with all safe operating practices.

[58 FR 31908, June 7, 1993; 58 FR 69596, Dec. 30, 1993]

NOTE: At 58 FR 69596, December 30, 1993, §57.6220 is effective until January 31, 1994, unless terminated earlier by FEDERAL REGISTER notice.

USE--SURFACE AND UNDERGROUND

30 CFR § 57.6300

Control of blasting operations.

USE--SURFACE AND UNDERGROUND

(a) Only persons trained and experienced in the handling and use of explosive material shall direct blasting operations and related activities.

(b) Trainees and inexperienced persons shall work only in the immediate presence of persons trained and experienced in the handling and use of explosive material.

30 CFR § 57.6301

Blasthole obstruction check.

Before loading, blastholes shall be checked and, wherever possible, cleared of obstructions.

30 CFR § 57.6302

Separation of explosive material.

Explosives and blasting agents shall be kept separated from detonators until loading begins.

30 CFR § 57.6303

Initiation preparation.

(a) Primers shall be made up only at the time of use and as close to the blast site as conditions allow.

(b) Primers shall be prepared with the detonator contained securely and completely within the explosive or contained securely and appropriately for its design in the tunnel or cap well.

(c) When using detonating cord to initiate another explosive, a connection shall be prepared with the detonating cord threaded through, attached securely to, or otherwise in contact with the explosive.

30 CFR § 57.6304

Primer protection.

(a) Tamping shall not be done directly on a primer.

(b) Rigid cartridges of explosives or blasting agents that are 4 inches (100 millimeters) in diameter or larger shall not be dropped on the primer except where the blasthole contains sufficient depth of water to protect the primer from impact. Slit packages of prill, water gel, or emulsions are not considered rigid cartridges and may be drop loaded.

[56 FR 46508, Sept. 12, 1991; 56 FR 52193, Oct. 18, 1991; 58 FR 31908, June 7, 1993; 58 FR 69596, Dec. 30, 1993]

NOTE: At 58 FR 69596, December 30, 1993, the effective date of §57.6304(b) is stayed until January 31, 1994.

30 CFR § 57.6305

Unused explosive material.

Unused explosive material shall be moved to a protected location as soon as practical after loading operations are completed.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6306

Loading, blasting, and security.

(a) When explosive materials or initiating systems are brought to the blast site, the blast site shall be attended; barricaded and posted with warning signs, such as ``Danger,'' ``Explosives,'' or ``Keep Out;'' or flagged against unauthorized entry.

(b) Vehicles and equipment shall not be driven over explosive material or initiating systems in a manner which could contact the material or systems, or create other hazards.

(c) Once loading begins, the only activities permitted within the blast site shall be those activities directly related to the blasting operation and the activities of surveying, stemming, sampling of geology, and reopening of holes, provided that reasonable care is exercised. Haulage activity is permitted near the base of a highwall being loaded or awaiting firing, provided no other haulage access exists.

(d) Loading and blasting shall be conducted in a manner designed to facilitate a continuous process, with the blast fired as soon as possible following the completion of loading. If blasting a loaded round may be delayed for more than 72 hours, the operator shall notify the appropriate MSHA district office.

(e) In electric blasting prior to connecting to the power source, and in nonelectric blasting prior to attaching an initiating device, all persons shall leave the blast area except persons in a blasting shelter or other location that protects them from concussion (shock wave), flying material, and gases.

(f) Before firing a blast--

(1) Ample warning shall be given to allow all persons to be evacuated;

(2) Clear exit routes shall be provided for persons firing the round; and

(3) All access routes to the blast area shall be guarded or barricaded to prevent the passage of persons or vehicles.

(g) Work shall not resume in the blast area until a post-blast examination addressing potential blast-related hazards has been conducted by a person with the ability and experience to perform the examination.

30 CFR § 57.6307

Drill stem loading.

Explosive material shall not be loaded into blastholes with drill stem equipment or other devices that could be extracted while containing explosive material. The use of loading hose, collar sleeves, or collar pipes is permitted.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6308

Initiation systems.

Initiation systems shall be used in accordance with the manufacturer's instructions.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6309

Fuel oil requirement for ANFO.

(a) Liquid hydrocarbon fuels with flash points lower than that of No. 2 diesel oil (125 °F) shall not be used to prepare ammonium nitrate-fuel oil, except that diesel fuels with flash points no lower than 100 °F may be used at ambient air temperatures below 45 °F.

(b) Waste oil, including crankcase oil, shall not be used to prepare ammonium nitrate-fuel oil.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6310

Misfire waiting period.

When a misfire is suspected, persons shall not enter the blast area--

(a) For 30 minutes if safety fuse and blasting caps are used; or

(b) For 15 minutes if any other type detonators are used.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6311

Handling of misfires.

(a) Faces and muck piles shall be examined for misfires after each blasting operation.

(b) Only work necessary to remove a misfire and protect the safety of miners engaged in the removal shall be permitted in the affected area until the misfire is disposed of in a safe manner.

(c) When a misfire cannot be disposed of safely, each approach to the area affected by the misfire shall be posted with a warning sign at a conspicuous location to prohibit entry, and the condition shall be reported immediately to mine management.

(d) Misfires occurring during the shift shall be reported to mine management not later than the end of the shift.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6312

Secondary blasting.

Secondary blasts fired at the same time in the same work area shall be initiated from one source.

[58 FR 69596, Dec. 30, 1993]

ELECTRIC BLASTING--SURFACE AND UNDERGROUND

30 CFR § 57.6400

Compatibility of electric detonators.

ELECTRIC BLASTING--SURFACE AND UNDERGROUND

All electric detonators to be fired in a round shall be from the same manufacturer and shall have similar electrical firing characteristics.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6401

Shunting.

Except during testing--

(a) Electric detonators shall be kept shunted until connected to the blasting line or wired into a blasting round;

(b) Wired rounds shall be kept shunted until connected to the blasting line; and

(c) Blasting lines shall be kept shunted until immediately before blasting.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6402

Deenergized circuits near detonators.

Electrical distribution circuits within 50 feet of electric detonators at the blast site shall be deenergized. Such circuits need not be deenergized between 25 to 50 feet of the electric detonators if stray current tests, conducted as frequently as necessary, indicate a maximum stray current of less than 0.05 amperes through a 1-ohm resistor as measured at the blast site.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6403

Branch circuits.

(a) If electric blasting includes the use of branch circuits, each branch shall be equipped with a safety switch or equivalent method to isolate the circuits to be used.

(b) At least one safety switch or equivalent method of protection shall be located outside the blast area and shall be in the open position until persons are withdrawn.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6404

Separation of blasting circuits from power source.

(a) Switches used to connect the power source to a blasting circuit shall be locked in the open position except when closed to fire the blast.

(b) Lead wires shall not be connected to the blasting switch until the shot is ready to be fired.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6405

Firing devices.

(a) Power sources shall be capable of delivering sufficient current to energize all electric detonators to be fired with the type of circuits used. Storage or dry cell batteries are not permitted as power sources.

(b) Blasting machines shall be tested, repaired, and maintained in accordance with manufacturer's instructions.

(c) Only the blaster shall have the key or other control to an electrical firing device.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6406

Duration of current flow.

If any part of a blast is connected in parallel and is to be initiated from powerlines or lighting circuits, the time of current flow shall be limited to a maximum of 25 milliseconds. This can be accomplished by incorporating an arcing control device in the blasting circuit or by interrupting the circuit with an explosive device attached to one or both lead lines and initiated by a 25-millisecond delay electric detonator.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6407

Circuit testing.

A blasting galvanometer or other instrument designed for testing blasting circuits shall be used to test the following:

(a) In surface operations--

(1) Continuity of each electric detonator in the blasthole prior to stemming and connection to the blasting line;

(2) Resistance of individual series or the resistance of multiple balanced series to be connected in parallel prior to their connection to the blasting line;

(3) Continuity of blasting lines prior to the connection of electric detonator series; and

(4) Total blasting circuit resistance prior to connection to the power source.

(b) In underground operations--

(1) Continuity of each electric detonator series; and

(2) Continuity of blasting lines prior to the connection of electric detonators.

[58 FR 69596, Dec. 30, 1993]

NONELECTRIC BLASTING--SURFACE AND UNDERGROUND

30 CFR § 57.6500

Damaged initiating material.

NONELECTRIC BLASTING--SURFACE AND UNDERGROUND

A visual check of the completed circuit shall be made to ensure that the components are properly aligned and connected. Safety fuse, igniter cord, detonating cord, shock or gas tubing, and similar material which is kinked, bent sharply, or damaged shall not be used.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6501

Nonelectric initiation systems.

(a) When the nonelectric initiation system uses shock tube--

(1) Connections with other initiation devices shall be secured in a manner which provides for uninterrupted propagation;

(2) Factory-made units shall be used as assembled and shall not be cut except that a single splice is permitted on the lead-in trunkline during dry conditions; and

(3) Connections between blastholes shall not be made until immediately prior to clearing the blast site when surface delay detonators are used.

(b) When the nonelectric initiation system uses detonating cord--

(1) The line of detonating cord extending out of a blasthole shall be cut from the supply spool immediately after the attached explosive is correctly positioned in the hole;

(2) In multiple row blasts, the trunkline layout shall be designed so that the detonation can reach each blasthole from at least two directions;

(3) Connections shall be tight and kept at right angles to the trunkline;

(4) Detonators shall be attached securely to the side of the detonating cord and pointed in the direction in which detonation is to proceed;

(5) Connections between blastholes shall not be made until immediately prior to clearing the blast site when surface delay detonators are used; and

(6) Lead-in lines shall be manually unreeled if connected to the trunklines at the blast site.

(c) When nonelectric initiation systems use gas tube, continuity of the circuit shall be tested prior to blasting.

[56 FR 46509, Sept. 12, 1991; 56 FR 52193, Oct. 18, 1991; 58 FR 31908, June 7, 1993; 58 FR 69596, Dec. 30, 1993]

NOTE: At 58 FR 69596, December 30, 1993, the effective date of §57.6501(a) is stayed until January 31, 1994.

30 CFR § 57.6502

Safety fuse.

(a) The burning rate of each spool of safety fuse to be used shall be measured, posted in locations which will be conspicuous to safety fuse users, and brought to the attention of all persons involved with the blasting operation.

(b) When firing with safety fuse ignited individually using handheld lighters, the safety fuse shall be of lengths which provide at least the minimum burning time for a particular size round, as specified in the following table.

TABLE E-1--SAFETY FUSE--MINIMUM BURNING TIME

Number of holes in a round	Minimum burning time
1	1 2 minutes.
2-5	2 minutes 40 seconds.
6-10	3 minutes 20 seconds.
11-15	5 minutes.

1 For example, at least a 36-inch length of 40-second-per-foot safety fuse or at least a 48-inch length of 30-second-per-foot safety fuse would have to be used to allow sufficient time to evacuate the area.

(c) Where flyrock might damage exposed safety fuse, the blast shall be timed so that all safety fuses are burning within the blastholes before any blasthole detonates.

(d) Fuse shall be cut and capped in dry locations.

(e) Blasting caps shall be crimped to fuse only with implements designed for that purpose.

(f) Safety fuse shall be ignited only after the primer and the explosive material are securely in place.

(g) Safety fuse shall be ignited only with devices designed for that purpose. Carbide lights, liquefied petroleum gas torches, and cigarette lighters shall not be used to light safety fuse.

(h) At least two persons shall be present when lighting safety fuse, and no one shall light more than 15 individual fuses. If more than 15 holes per person are to be fired, electric initiation systems, igniter cord and connectors, or other nonelectric initiation systems shall be used.

[58 FR 69596, Dec. 30, 1993]

EXTRANEOUS ELECTRICITY--SURFACE AND UNDERGROUND

30 CFR § 57.6600

Loading practices.

EXTRANEOUS ELECTRICITY--SURFACE AND UNDERGROUND

If extraneous electricity is suspected in an area where electric detonators are used, loading shall be suspended until tests determine that stray current does not exceed 0.05 amperes through a 1-ohm resister when measured at the location of the electric detonators. If greater levels of extraneous electricity are found, the source shall be determined and no loading shall take place until the condition is corrected.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6601

Grounding.

Electric blasting circuits, including powerline sources when used, shall not be grounded.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6602

Static electricity dissipation during loading.

When explosive material is loaded pneumatically into a blasthole in a manner that generates a static electricity hazard--

(a) An evaluation of the potential static electricity hazard shall be made and any hazard shall be eliminated before loading begins;

(b) The loading hose shall be of a semiconductive type, have a total of not more than 2 megohms of resistance over its entire length and not less than 1000 ohms of resistance per foot;

(c) Wire-countered hoses shall not be used;

(d) Conductive parts of the loading equipment shall be bonded and grounded and grounds shall not be made to other potential sources of extraneous electricity; and

(e) Plastic tubes shall not be used as hole liners if the hole contains an electric detonator.

30 CFR § 57.6603

Air gap.

At least a 15-foot air gap shall be provided between the blasting circuit and the electric power source.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6604

Precautions during storms.

During the approach and progress of an electrical storm--

(a) Surface blasting operations shall be suspended and persons withdrawn from the blast area or to a safe location.

(b) Underground electrical blasting operations that are capable of being initiated by lightning shall be suspended and all persons withdrawn from the blast area or to a safe location.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6605

Isolation of blasting circuits.

Lead wires and blasting lines shall be isolated and insulated from power conductors, pipelines, and railroad tracks, and shall be protected from sources of stray or static electricity. Blasting circuits shall be protected from any contact between firing lines and overhead powerlines which could result from the force of a blast.

[58 FR 69596, Dec. 30, 1993]

EQUIPMENT/TOOLS--SURFACE AND UNDERGROUND

30 CFR § 57.6700

Nonsparking tools.

EQUIPMENT/TOOLS--SURFACE AND UNDERGROUND

Only nonsparking tools shall be used to open containers of explosive material or to punch holes in explosive cartridges.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6701

Tamping and loading pole requirements.

Tamping and loading poles shall be of wood or other nonconductive, nonsparking material. Couplings for poles shall be nonsparking.

[58 FR 69596, Dec. 30, 1993]

MAINTENANCE--SURFACE AND UNDERGROUND

30 CFR § 57.6800

Storage facilities.

MAINTENANCE--SURFACE AND UNDERGROUND

When repair work which could produce a spark or flame is to be performed on a storage facility--

(a) The explosive material shall be moved to another facility, or moved at least 50 feet from the repair activity and monitored; and

(b) The facility shall be cleaned to prevent accidental detonation.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6801

Vehicle repair.

Vehicles containing explosive material and oxidizers shall not be taken into a repair garage or shop.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6802

Bulk delivery vehicles.

No welding or cutting shall be performed on a bulk delivery vehicle until the vehicle has been washed down and all explosive material has been removed.

Before welding or cutting on a hollow shaft, the shaft shall be thoroughly cleaned inside and out and vented with a minimum 1/2-inch diameter opening to allow for sufficient ventilation.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6803

Blasting lines.

Permanent blasting lines shall be properly supported. All blasting lines shall be insulated and kept in good repair.

[58 FR 69596, Dec. 30, 1993]

GENERAL REQUIREMENTS--SURFACE AND UNDERGROUND

30 CFR § 57.6900

Damaged or deteriorated explosive material.

GENERAL REQUIREMENTS--SURFACE AND UNDERGROUND

Damaged or deteriorated explosive material shall be disposed of in a safe manner in accordance with the instructions of the manufacturer.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6901

Black powder.

(a) Black powder shall be used for blasting only when a desired result cannot be obtained with another type of explosive, such as in quarrying certain types of dimension stone.

(b) Containers of black powder shall be--

(1) Nonsparking;

(2) Kept in a totally enclosed cargo space while being transported by a vehicle;

(3) Securely closed at all times when--

(b)(3)(i) Within 50 feet of any magazine or open flame,

(b)(3)(ii) Within any building in which a fuel-fired or exposed-element electric heater is operating, or

(b)(3)(iii) In an area where electrical or incandescent-particle sparks could result in powder ignition; and

(4) Open only when the powder is being transferred to a blasthole or another container and only in locations not listed in paragraph (b)(3) of this section.

(c) Black powder shall be transferred from containers only by pouring.

(d) Spills shall be cleaned up promptly with nonsparking equipment. Contaminated powder shall be put into a container of water and shall be disposed of promptly after the granules have disintegrated, or the spill area shall be flushed promptly with water until the granules have disintegrated completely.

(e) Misfires shall be disposed of by washing the stemming and powder charge from the blasthole, and removing and disposing of the initiator in accordance with the requirement for damaged explosives.

(f) Holes shall not be reloaded for at least 12 hours when the blastholes have failed to break as planned.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6902

Excessive temperatures.

(a) Where heat could cause premature detonation, explosive material shall not be loaded into hot areas, such as kilns or sprung holes.

(b) When blasting sulfide ores where hot holes occur that may react with explosive material in blastholes, operators shall--

(1) Measure an appropriate number of blasthole temperatures in order to assess the specific mine conditions prior to the introduction of explosive material;

(2) Limit the time between the completion of loading and the initiation of the blast to no more than 12 hours; and

(3) Take other special precautions to address the specific conditions at the mine to prevent premature detonation.

[58 FR 31908, June 7, 1993; 58 FR 69596, Dec. 30, 1993]

NOTE: At 58 FR 69596, December 30, 1993, the effective date of §57.6902(b) is stayed until January 31, 1994.

30 CFR § 57.6903

Burning explosive material.

If explosive material is suspected of burning at the blast site, persons shall be evacuated from the endangered area and shall not return for at least one hour after the burning or suspected burning has stopped.

[58 FR 31908, June 7, 1993; 58 FR 69596, Dec. 30, 1993]

NOTE: At 58 FR 69596, December 30, 1993, the effective date of §57.6903 is stayed until January 31, 1994.

30 CFR § 57.6904

Smoking and open flames.

Smoking and use of open flames shall not be permitted within 50 feet of explosive material except when separated by permanent noncombustible barriers. This standard does not apply to devices designed to ignite safety fuse or to heating devices which do not create a fire or explosion hazard.

[58 FR 69596, Dec. 30, 1993]

30 CFR § 57.6905

Protection of explosive material.

(a) Explosive material shall be protected from temperatures in excess of 150 degrees Fahrenheit.

(b) Explosive material shall be protected from impact, except for tamping and dropping during loading.

GENERAL REQUIREMENTS--UNDERGROUND ONLY

30 CFR § 57.6960

Mixing of explosive material.

GENERAL REQUIREMENTS--UNDERGROUND ONLY

(a) The mixing of ingredients to produce explosive material shall not be conducted underground unless prior approval of the MSHA district manager is obtained. In granting or withholding approval, the district manager shall consider the potential hazards created by--

(1) The location of the stored material and the storage practices used;

(2) The transportation and use of the explosive material;

(3) The nature of the explosive material, including its sensitivity;

(4) Any other factor deemed relevant to the safety of miners potentially exposed to the hazards associated with the mixing of the bulk explosive material underground.

(b) Storage facilities for the ingredients to be mixed shall provide drainage away from the facilities for leaks and spills.

[58 FR 69596, Dec. 30, 1993]

APPENDIX I to Subpart E--MSHA Tables of Distances

Appendix I to Subpart E--MSHA Tables of Distances

TABLE 1--SURFACE STORAGE OF EXPLOSIVE MATERIAL

Quantity of explosive material (pounds)	Minimum separation distances (feet)			
	From mine buildings, dams and electric substations		Between magazines	
Not over	Barricaded	Unbarricaded	Barricaded	Unbarricaded
5	70	140	6	12
10	90	180	8	16
20	110	220	10	20
30	125	250	11	22
40	140	280	12	24
50	150	300	14	28
75	170	340	15	30
100	190	380	16	32
125	200	400	18	36
150	215	430	19	38
200	235	470	21	42
250	255	510	23	46
300	270	540	24	48
400	295	590	27	54
500	320	640	29	58
600	340	680	31	62
700	355	710	32	64
800	375	750	33	66
900	390	780	35	70
1,000	400	800	36	72
1,200	425	850	39	78
1,400	450	900	41	82
1,600	470	940	43	86
1,800	490	980	44	88
2,000	505	1,010	45	90
2,500	545	1,090	49	98
3,000	580	1,160	52	104
4,000	635	1,270	58	116
5,000	685	1,370	61	122
6,000	730	1,460	65	130
7,000	770	1,540	68	136
8,000	800	1,600	72	144
9,000	835	1,670	75	150
10,000	865	1,730	78	156
12,000	875	1,750	82	164
14,000	885	1,770	87	174
16,000	900	1,800	90	180
18,000	940	1,880	94	188

20,000	975	1,950	98	196
25,000	1,055	2,000	105	210
30,000	1,130	2,000	112	224
35,000	1,205	2,000	119	238
40,000	1,275	2,000	124	248
45,000	1,340	2,000	129	258
50,000	1,400	2,000	135	270
55,000	1,460	2,000	140	280
60,000	1,515	2,000	145	290
65,000	1,565	2,000	150	300
70,000	1,610	2,000	155	310
75,000	1,655	2,000	160	320
80,000	1,695	2,000	165	330
85,000	1,730	2,000	170	340
90,000	1,760	2,000	175	350
95,000	1,790	2,000	180	360
100,000	1,815	2,000	185	370
110,000	1,835	2,000	195	390
120,000	1,855	2,000	205	410
130,000	1,875	2,000	215	430
140,000	1,890	2,000	225	450
150,000	1,900	2,000	235	470
160,000	1,935	2,000	245	490
170,000	1,965	2,000	255	510
180,000	1,990	2,000	265	530
190,000	2,010	2,010	275	550
200,000	2,030	2,030	285	570
210,000	2,055	2,055	295	590
230,000	2,100	2,100	315	630
250,000	2,155	2,155	335	670
275,000	2,215	2,215	360	720
300,000	2,275	2,275	385	770

For purposes of this table, "barricaded" means that the storage facility containing explosive material is screened effectively by a natural barricade or an artificial barricade consisting of a mound or revetted wall of earth with a minimum thickness of three feet.

TABLE 2--MSHA TABLE OF SEPARATION DISTANCES

Quantity of ammonium nitrate of blasting agents (pounds) Not over	Storage facilities--minimum separation distances when barricaded * (feet)		Minimum thickness of artificial barricades** (inches)
	Ammonium nitrate	Blasting agents	
100	3	11	12
300	4	14	12
600	5	18	12

1,000	6	22	12
1,600	7	25	12
2,000	8	29	12
3,000	9	32	15
4,000	10	36	15
6,000	11	40	15
8,000	12	43	20
10,000	13	47	20
12,000	14	50	20
16,000	15	54	25
20,000	16	58	25
25,000	18	65	25
30,000	19	68	30
35,000	20	72	30
40,000	21	76	30
45,000	22	79	35
50,000	23	83	35
55,000	24	86	35
60,000	25	90	35
70,000	26	94	40
80,000	28	101	40
90,000	30	108	40
100,000	32	115	40
120,000	34	122	50
140,000	37	133	50
160,000	40	144	50
180,000	44	158	50
200,000	48	173	50
220,000	52	187	60
250,000	56	202	60
275,000	60	216	60
300,000	64	230	60

* When the ammonium nitrate or blasting agents are not barricaded, the distances shown in the table must be multiplied by six.

** For purposes of this table, "barricaded" means that the storage facility is screened effectually by a natural barricade or an artificial barricade consisting of amount of revetted wall or earth with the prescribed minimum thickness.

Note: At 56 FR 69596, December 30, 1993, appendix I to subpart E of part 57 is stayed until January 31, 1994.

Subpart F--Drilling and Rotary Jet Piercing

DRILLING--SURFACE ONLY

30 CFR § 57.7002

Equipment defects.

Equipment defects affecting safety shall be corrected before the equipment is used.

30 CFR § 57.7003

Drill area inspection.

The drilling area shall be inspected for hazards before starting the drilling operations.

30 CFR § 57.7004

Drill mast.

Persons shall not be on a mast while the drill-bit is in operation unless they are provided with a safe platform from which to work and they are required to use safety belts to avoid falling.

30 CFR § 57.7005

Augers and drill stems.

Drill crews and others shall stay clear of augers or drill stems that are in motion. Persons shall not pass under or step over a moving stem or auger.

30 CFR § 57.7008

Moving the drill.

When a drill is being moved from one drilling area to another, drill steel, tools, and other equipment shall be secured and the mast placed in a safe position.

30 CFR § 57.7009

Drill helpers.

If a drill helper assists the drill operator during movement of a drill to a new location, the helper shall be in sight of, or in communication with, the operator at all times.

30 CFR § 57.7010

Power failures.

In the event of power failure, drill controls shall be placed in the neutral position until power is restored.

30 CFR § 57.7011

Straightening crossed cables.

The drill stem shall be resting on the bottom of the hole or on the platform with the stem secured to the mast before attempts are made to straighten a crossed cable on a reel.

30 CFR § 57.7012

Tending drills in operation.

While in operation, drills shall be attended at all times.

30 CFR § 57.7013

Covering or guarding drill holes.

Drill holes large enough to constitute a hazard shall be covered or guarded.

30 CFR § 57.7018

Hand clearance.

Persons shall not hold the drill steel while collaring holes, or rest their hands on the chuck or centralizer while drilling.

DRILLING--UNDERGROUND ONLY

30 CFR § 57.7028

Hand clearance.

DRILLING--UNDERGROUND ONLY

Persons shall not rest their hands on the chuck or centralizer while drilling.

30 CFR § 57.7032

Anchoring.

Columns and the drills mounted on them shall be anchored firmly before and during drilling.

DRILLING--SURFACE AND UNDERGROUND

30 CFR § 57.7050

Tool and drill steel racks.

DRILLING--SURFACE AND UNDERGROUND

Receptacles or racks shall be provided for drill steel and tools stored or carried on drills.

30 CFR § 57.7051

Loose objects on the mast or drill platform.

To prevent injury to personnel, tools and other objects shall not be left loose on the mast or drill platform.

30 CFR § 57.7052

Drilling positions.

Persons shall not drill from

(a) Positions which hinder their access to the control levers;

(b) Insecure footing or insecure staging; or

(c) Atop equipment not suitable for drilling.

30 CFR § 57.7053

Moving hand-held drills.

Before hand-held drills are moved from one working area to another, air shall be turned off and bled from the hose.

30 CFR § 57.7054

Starting or moving drill equipment.

Drill operators shall not start or move drilling equipment unless all miners are in the clear.

30 CFR § 57.7055

Intersecting holes.

Holes shall not be drilled where there is a danger of intersecting a misfired hole or a hole containing explosives, blasting agents, or detonators.

[56 FR 46517, Sept. 12, 1991; 56 FR 52193, Oct. 18, 1991]

30 CFR § 57.7056

Collaring in bootlegs.

Holes shall not be collared in bootlegs.

[56 FR 46517, Sept. 12, 1991]

ROTARY JET PIERCING--SURFACE ONLY

30 CFR § 57.7801

Jet drills.

ROTARY JET PIERCING--SURFACE ONLY

Jet piercing drills shall be provided with:

(a) A system to pressurize the equipment operator's cab, when a cab is provided; and

(b) A protective cover over the oxygen flow indicator.

30 CFR § 57.7802

Oxygen hose lines.

Safety chains or other suitable locking devices shall be provided across connections to and between high pressure oxygen hose lines of 1-inch inside diameter or larger.

30 CFR § 57.7803

Lighting the burner.

A suitable means of protection shall be provided for the employee when lighting the burner.

30 CFR § 57.7804

Refueling.

When rotary jet piercing equipment requires refueling at locations other than fueling stations, a system for fueling without spillage shall be provided.

30 CFR § 57.7805

Smoking and open flames.

Persons shall not smoke and open flames shall not be used in the vicinity of the oxygen storage and supply lines. Signs warning against smoking and open flames shall be posted in these areas.

30 CFR § 57.7806

Oxygen intake coupling.

The oxygen intake coupling on jet piercing drills shall be constructed so that only the oxygen hose can be coupled to it.

30 CFR § 57.7807

Flushing the combustion chamber.

The combustion chamber of a jet drill stem which has been sitting unoperated in a drill hole shall be flushed with a suitable solvent after the stem is pulled up.

Subpart G—Ventilation

SURFACE AND UNDERGROUND

30 CFR § 57.8518

Main and booster fans.

SURFACE AND UNDERGROUND

(a) All mine main and booster fans installed and used to ventilate the active workings of the mine shall be operated continuously while persons are underground in the active workings. However, this provision is not applicable during scheduled production-cycle shutdowns or planned or scheduled fan maintenance or fan adjustments where air quality is maintained in compliance with the applicable standards of subpart D of this part and all persons underground in the affected areas are advised in advance of such scheduled or planned fan shutdowns, maintenance, or adjustments.

(b) In the event of main or booster fan failure due to a malfunction, accident, power failure, or other such unplanned or unscheduled event:

(1) The air quality in the affected active workings shall be tested at least within 2-hours of the discovery of the fan failure, and at least every 4-hours thereafter by a competent person for compliance with the requirements of the applicable standards of subpart D of this part until normal ventilation is restored, or

(2) All persons, except those working on the fan, shall be withdrawn, the ventilation shall be restored to normal and the air quality in the affected active workings shall be tested by a competent person to assure that the air quality meets the requirements of the standards in subpart D of this part, before any other persons are permitted to enter the affected active workings.

30 CFR § 57.8519

Underground main fan controls.

All underground main fans shall have controls placed at a suitable protected location remote from the fan and preferably on the surface.

UNDERGROUND ONLY

30 CFR § 57.8520

Ventilation plan.

UNDERGROUND ONLY

A plan of the mine ventilation system shall be set out by the operator in written form. Revisions of the system shall be noted and updated at least annually. The ventilation plan or revisions thereto shall be submitted to the District Manager for review and comments upon his written request. The plan shall, where applicable, contain the following:

(a) The mine name.

(b) The current mine map or schematic or series of mine maps or schematics of an appropriate scale, not greater than five hundred feet to the inch, showing:

(1) Direction and quantity of principal air flows;

(2) Locations of seals used to isolate abandoned workings;

(3) Locations of areas withdrawn from the ventilation system;

(4) Locations of all main, booster and auxiliary fans not shown in paragraph (d) of this standard.

(5) Locations of air regulators and stoppings and ventilation doors not shown in paragraph (d) of this standard;

(6) Locations of overcasts, undercasts and other airway crossover devices not shown in paragraph (d) of this standard;

(7) Locations of known oil or gas wells;

(8) Locations of known underground mine openings adjacent to the mine;

(9) Locations of permanent underground shops, diesel fuel storage depots, oil fuel storage depots, hoist rooms, compressors, battery charging stations and explosive storage facilities. Permanent facilities are those intended to exist for one year or more; and

(10) Significant changes in the ventilation system projected for one year.

(c) Mine fan data for all active main and booster fans including manufacturer's name, type, size, fan speed, blade setting, approximate pressure at present operating point, and motor brake horsepower rating.

(d) Diagrams, descriptions or sketches showing how ventilation is accomplished in each typical type of working place including the approximate quantity of air provided, and typical size and type of auxiliary fans used.

(e) The number and type of internal combustion engine units used

underground, including make and model of unit, type of engine, make and model of engine, brake horsepower rating of engine, and approval number.

[60 FR 33719, June 29, 1995]

30 CFR § 57.8525

Main fan maintenance.

Main fans shall be maintained according to either the manufacturer's recommendations or a written periodic schedule adopted by the operator which shall be available at the operation on request of the Secretary or his authorized representative.

[60 FR 33719, June 29, 1995]

30 CFR § 57.8527

Oxygen-deficiency testing.

Flame safety lamps or other suitable devices shall be used to test for acute oxygen deficiency.

30 CFR § 57.8528

Unventilated areas.

Unventilated areas shall be sealed, or barricaded and posted against entry.

30 CFR § 57.8529

Auxiliary fan systems

When auxiliary fan systems are used, such systems shall minimize recirculation and be maintained to provide ventilation air that effectively sweeps the working places.

30 CFR § 57.8531

Construction and maintenance of ventilation doors.

Ventilation doors shall be--

(a) Substantially constructed;

(b) Covered with fire-retardant material, if constructed of wood;

(c) Maintained in good condition;

(d) Self-closing, if manually operated; and

(e) Equipped with audible or visual warning devices, if mechanically operated.

30 CFR § 57.8532

Opening and closing ventilation doors.

When ventilation control doors are opened as a part of the normal mining cycle, they shall be closed as soon as possible to re-establish normal ventilation to working places.

30 CFR § 57.8534

Shutdown or failure of auxiliary fans.

(a) Auxiliary fans installed and used to ventilate the active workings of the mine shall be operated continuously while persons are underground in the active workings, except for scheduled production-cycle shutdowns or planned or scheduled fan maintenance or fan adjustments where air quality is maintained in compliance with the applicable standards of subpart D of this part, and all persons underground in the affected areas are advised in advance of such scheduled or planned fan shutdowns, maintenance, or adjustments.

(b) In the event of auxiliary fan failure due to malfunction, accident, power failure, or other such unplanned or unscheduled event:

(1) The air quality in the affected active workings shall be tested at least within 2 hours of the discovery of the fan failure, and at least every 4 hours thereafter by a competent person for compliance with the requirements of the applicable standards of subpart D of this part until normal ventilation is restored, or

(2) All persons, except those working on the fan, shall be withdrawn, the ventilation shall be restored to normal and the air quality in the affected active workings shall be tested by a competent person to assure that the air quality meets the requirements of the standards in subpart D of this part, before any other persons are permitted to enter the affected active workings.

30 CFR § 57.8535

Seals.

Seals shall be provided with a means for checking the quality of air behind the seal and a means to prevent a water head from developing unless the seal is designed to impound water.

Subpart H--Loading, Hauling, and Dumping

Source: 53 FR 32526, Aug. 25, 1988, unless otherwise noted.

Subpart H--Loading, Hauling, and Dumping

TRAFFIC SAFETY

30 CFR § 57.9100

Traffic control.

TRAFFIC SAFETY

To provide for the safe movement of self-propelled mobile equipment

(a) Rules governing speed, right-of-way, direction of movement, and the use of headlights to assure appropriate visibility, shall be established and followed at each mine; and

(b) Signs or signals that warn of hazardous conditions shall be placed at appropriate locations at each mine.

30 CFR § 57.9101

Operating speeds and control of equipment.

Operators of self-propelled mobile equipment shall maintain control of the equipment while it is in motion. Operating speeds shall be consistent with conditions of roadways, tracks, grades, clearance, visibility, and traffic, and the type of equipment used.

30 CFR § 57.9102

Movement of independently operating rail equipment.

Movement of two or more pieces of rail equipment operating independently on the same track shall be controlled for safe operation.

30 CFR § 57.9103

Clearance on adjacent tracks.

Railcars shall not be left on side tracks unless clearance is provided for traffic on adjacent tracks.

30 CFR § 57.9104

Railroad crossings.

Designated railroad crossings shall be posted with warning signs or signals, or shall be guarded when trains are passing. These crossings shall also be planked or filled between the rails.

TRANSPORTATION OF PERSONS AND MATERIALS

30 CFR § 57.9200

Transporting persons.

TRANSPORTATION OF PERSONS AND MATERIALS

Persons shall not be transported--

(a) In or on dippers, forks, clamshells, or buckets except shaft buckets during shaft-sinking operations or during inspection, maintenance and repair of shafts.

(b) In beds of mobile equipment or railcars, unless--

(1) Provisions are made for secure travel, and

(2) Means are taken to prevent accidental unloading if the equipment is provided with unloading devices;

(c) On top of loads in mobile equipment;

(d) Outside cabs, equipment operators' stations, and beds of mobile equipment, except when necessary for maintenance, testing, or training purposes, and provisions are made for secure travel. This provision does not apply to rail equipment.

(e) Between cars of trains, on the leading end of trains, on the leading end of a single railcar, or in other locations on trains that expose persons to hazards from train movement.

(1) This paragraph does not apply to car droppers if they are secured with safety belts and lines which prevent them from falling off the work platform.

(2) Brakemen and trainmen are prohibited from riding between cars of moving trains but may ride on the leading end of trains or other locations when necessary to perform their duties;

(f) To and from work areas in overcrowded mobile equipment;

(g) In mobile equipment with materials or equipment unless the items are secured or are small and can be carried safely by hand without creating a hazard to persons; or

(h) On conveyors unless the conveyors are designed to provide for their safe transportation.

30 CFR § 57.9201

Loading, hauling, and unloading of equipment or supplies.

Equipment and supplies shall be loaded, transported, and unloaded in a manner which does not create a hazard to persons from falling or shifting equipment or supplies.

30 CFR § 57.9202

Loading and hauling large rocks.

Large rocks shall be broken before loading if they could endanger persons or affect the stability of mobile equipment. Mobile equipment used for haulage of mined material shall be loaded to minimize spillage where a hazard to persons could be created.

30 CFR § 57.9260

Supplies, materials, and tools on mantrips.

Supplies, materials, and tools, other than small items that can be carried by hand, shall not be transported underground with persons in mantrips. Mantrips shall be operated independently of ore or supply trips.

30 CFR § 57.9261

Transporting tools and materials on locomotives.

Tools or materials shall not be carried on top of locomotives underground except for secured rerailing devices located in a manner which does not create a hazard to persons.

SAFETY DEVICES, PROVISIONS, AND PROCEDURES FOR ROADWAYS, RAILROADS, AND LOADING AND DUMPING SITES

30 CFR § 57.9300

Berms or guardrails.

SAFETY DEVICES, PROVISIONS, AND PROCEDURES FOR ROADWAYS, RAILROADS, AND LOADING AND DUMPING SITES

(a) Berms or guardrails shall be provided and maintained on the banks of roadways where a drop-off exists of sufficient grade or depth to cause a vehicle to overturn or endanger persons in equipment.

(b) Berms or guardrails shall be at least mid-axle height of the largest self-propelled mobile equipment which usually travels the roadway.

(c) Berms may have openings to the extent necessary for roadway drainage.

(d) Where elevated roadways are infrequently traveled and used only by service or maintenance vehicles, berms or guardrails are not required when all of the following are met:

(1) Locked gates are installed at the entrance points to the roadway.

(2) Signs are posted warning that the roadway is not bermed.

(3) Delineators are installed along the perimeter of the elevated roadway so that, for both directions of travel, the reflective surfaces of at least three delineators along each elevated shoulder are always visible to the driver and spaced at intervals sufficient to indicate the edges and attitude of the roadway.

(4) A maximum speed limit is posted and observed for the elevated unbermed portions of the roadway. Factors to consider when establishing the maximum speed limit shall include the width, slope and alignment of the road, the type of equipment using the road, the road material, and any hazardous conditions which may exist.

(5) Road surface traction is not impaired by weather conditions, such as sleet and snow, unless corrective measures, such as the use of tire chains, plowing, or sanding, are taken to improve traction.

(e) This standard is not applicable to rail beds.

[53 FR 32526, Aug. 25, 1988, as amended at 55 FR 37218, Sept. 7, 1990]

30 CFR § 57.9301

Dump site restraints.

Berms, bumper blocks, safety hooks, or similar impeding devices shall be provided at dumping locations where there is a hazard of overtravel or overturning.

30 CFR § 57.9302

Protection against moving or runaway railroad equipment.

Stopblocks, derail devices, or other devices that protect against moving or runaway rail equipment shall be installed wherever necessary to protect persons.

30 CFR § 57.9303

Construction of ramps and dumping facilities.

Ramps and dumping facilities shall be designed and constructed of materials capable of supporting the loads to which they will be subjected. The ramps and dumping facilities shall provide width, clearance, and headroom to safely accommodate the mobile equipment using the facilities.

30 CFR § 57.9304

Unstable ground.

(a) Dumping locations shall be visually inspected prior to work commencing and as ground conditions warrant.

(b) Where there is evidence that the ground at a dumping location may fail to support the mobile equipment, loads shall be dumped a safe distance back from the edge of the unstable area of the bank.

30 CFR § 57.9305

Truck spotters.

(a) If truck spotters are used, they shall be in the clear while trucks are backing into dumping position or dumping.

(b) Spotters shall use signal lights to direct trucks where visibility is limited.

(c) When a truck operator cannot clearly recognize the spotter's signals, the truck shall be stopped.

30 CFR § 57.9306

Warning devices for restricted clearances.

Where restricted clearance creates a hazard to persons on mobile equipment, warning devices shall be installed in advance of the restricted area and the restricted area shall be conspicuously marked.

30 CFR § 57.9307

Design, installation, and maintenance of railroads.

Roadbeds and all elements of the railroad tracks shall be designed, installed, and maintained to provide safe operation consistent with the speed and type of haulage used.

30 CFR § 57.9308

Switch throws.

Switch throws shall be installed to provide clearance to protect switchmen from contact with moving trains.

30 CFR § 57.9309

Chute design.

Chute-loading installations shall be designed to provide a safe location for persons pulling chutes.

30 CFR § 57.9310

Chute hazards.

(a) Prior to chute-pulling, persons who could be affected by the draw or otherwise exposed to danger shall be warned and given time to clear the hazardous area.

(b) Persons attempting to free chute hangups shall be experienced and familiar with the task, know the hazards involved, and use the proper tools to free material.

(c) When broken rock or material is dumped into an empty chute, the chute shall be equipped with a guard or all persons shall be isolated from the hazard of flying rock or material.

30 CFR § 57.9311

Anchoring stationary sizing devices.

Grizzlies and other stationary sizing devices shall be securely anchored.

30 CFR § 57.9312

Working around drawholes.

Unless platforms or safety lines are used, persons shall not position themselves over drawholes if there is danger that broken rock or material may be withdrawn or bridged.

30 CFR § 57.9313

Roadway maintenance.

Water, debris, or spilled material on roadways which creates hazards to the operation of mobile equipment shall be removed.

30 CFR § 57.9314

Trimming stockpile and muckpile faces.

Stockpile and muckpile faces shall be trimmed to prevent hazards to persons.

30 CFR § 57.9315

Dust control.

Dust shall be controlled at muck piles, material transfer points, crushers, and on haulage roads where hazards to persons would be created as a result of impaired visibility.

30 CFR § 57.9316

Notifying the equipment operator.

When an operator of self-propelled mobile equipment is present, persons shall notify the equipment operator before getting on or off that equipment.

30 CFR § 57.9317

Suspended loads.

Persons shall not work or pass under the buckets or booms of loaders in operation.

30 CFR § 57.9318

Getting on or off moving equipment.

Persons shall not get on or off moving mobile equipment. This provision does not apply to trainmen, brakemen, and car droppers who are required to get on or off slowly moving trains in the performance of their work duties.

30 CFR § 57.9319

Going over, under, or between railcars.

Persons shall not go over, under, or between railcars unless--

(a) The train is stopped; and

(b) The train operator, when present, is notified and the notice acknowledged.

30 CFR § 57.9330

Clearance for surface equipment.

Continuous clearance of at least 30 inches from the farthest projection of moving railroad equipment shall be provided on at least one side of the tracks at all locations where possible or the area shall be marked conspicuously.

30 CFR § 57.9360

Shelter holes.

(a) Shelter holes shall be

(1) Provided at intervals adequate to assure the safety of persons along underground haulageways where continuous clearance of at least 30 inches cannot be maintained from the farthest projection of moving equipment on at least one side of the haulageway; and

(2) At least four feet wide, marked conspicuously, and provide a minimum 40-inch clearance from the farthest projection of moving equipment.

(b) Shelter holes shall not be used for storage unless a 40-inch clearance is maintained.

30 CFR § 57.9361

Drawholes.

To prevent hazards to persons underground, collars of open drawholes shall be free of muck or materials except during transfer of the muck or material through the drawhole.

30 CFR § 57.9362

Protection of signalmen.

Signalmen used during slushing operations underground shall be located away from possible contact with cables, sheaves, and slusher buckets.

Subpart J--Travelways and Escapeways TRAVELWAYS--SURFACE AND UNDERGROUND

30 CFR § 57.11001

Safe access.

TRAVELWAYS--SURFACE AND UNDERGROUND

Safe means of access shall be provided and maintained to all working places.

30 CFR § 57.11002

Handrails and toeboards.

Crossovers, elevated walkways, elevated ramps, and stairways shall be of substantial construction, provided with handrails, and maintained in good condition. Where necessary, toeboards shall be provided.

30 CFR § 57.11003

Construction and maintenance of ladders.

Ladders shall be of substantial construction and maintained in good condition.

30 CFR § 57.11004

Portable rigid ladders.

Portable rigid ladders shall be provided with suitable bases and placed securely when used.

30 CFR § 57.11005

Fixed ladder anchorage and toe clearance.

Fixed ladders shall be anchored securely and installed to provide at least 3 inches of toe clearance.

30 CFR § 57.11006

Fixed ladder landings.

Fixed ladders shall project at least 3 feet above landings, or substantial handholds shall be provided above the landings.

30 CFR § 57.11007

Wooden components of ladders.

Wooden components of ladders shall not be painted except with a transparent finish.

30 CFR § 57.11008

Restricted clearance.

Where restricted clearance creates a hazard to persons, the restricted clearance shall be conspicuously marked.

[53 FR 32528, Aug. 25, 1988]

30 CFR § 57.11009

Walkways along conveyors.

Walkways with outboard railings shall be provided wherever persons are required to walk alongside elevated conveyor belts. Inclined railed walkways shall be nonskid or provided with cleats.

30 CFR § 57.11010

Stairstep clearance.

Vertical clearance above stair steps shall be a minimum of seven feet, or suitable warning signs or similar devices shall be provided to indicate an impaired clearance.

30 CFR § 57.11011

Use of ladders.

Persons using ladders shall face the ladders and have both hands free for climbing and descending.

30 CFR § 57.11012

Protection for openings around travelways.

Openings above, below, or near travelways through which persons or materials may fall shall be protected by railings, barriers, or covers. Where it is impractical to install such protective devices, adequate warning signals shall be installed.

30 CFR § 57.11013

Conveyor crossovers.

Crossovers shall be provided where it is necessary to cross conveyors.

30 CFR § 57.11014

Crossing moving conveyors.

Moving conveyors shall be crossed only at designated crossover points.

30 CFR § 57.11016

Snow and ice on walkways and travelways.

Regularly used walkways and travelways shall be sanded, salted, or cleared of snow and ice as soon as practicable.

30 CFR § 57.11017

Inclined fixed ladders.

Fixed ladders shall not incline backwards.

TRAVELWAYS--SURFACE ONLY

30 CFR § 57.11025

Railed landings, backguards, and other protection for fixed ladders.

TRAVELWAYS--SURFACE ONLY

Fixed ladders, except on mobile equipment, shall be offset and have substantial railed landings at least every 30 feet unless backguards or equivalent protection such as safety belts and safety lines, are provided.

30 CFR § 57.11026

Protection for inclined fixed ladders.

Fixed ladders 70 degrees to 90 degrees from the horizonal and 30 feet or more in length shall have backguards, cages or equivalent protection, starting at a point not more than seven feet from the bottom of the ladders.

30 CFR § 57.11027

Scaffolds and working platforms.

Scaffolds and working platforms shall be of substantial construction and provided with handrails and maintained in good condition. Floorboards shall be laid properly and the scaffolds and working platform shall not be overloaded. Working platforms shall be provided with toeboards when necessary.

TRAVELWAYS--UNDERGROUND ONLY

30 CFR § 57.11036

Ladderway trap doors and guards.

TRAVELWAYS--UNDERGROUND ONLY

Trap doors or adequate guarding shall be provided in ladderways at each level. Doors shall be kept operable.

30 CFR § 57.11037

Ladderway openings.

Ladderways constructed after November 15, 1979, shall have a minimum unobstructed cross-sectional opening of 24 inches by 24 inches measured from the face of the ladder.

30 CFR § 57.11038

Entering a manway.

Before entering a manway where persons may be working or traveling, a warning shall be given by the person entering the manway and acknowledged by any person present in the manway.

30 CFR § 57.11040

Inclined travelways.

Travelways steeper than 35 degrees from the horizontal shall be provided with ladders or stairways.

30 CFR § 57.11041

Landings for inclined ladderways.

Fixed ladders with an inclination of more than 70 degrees from the horizontal shall be offset with substantial landings at least every 30 feet or have landing gates at least every 30 feet.

ESCAPEWAYS--UNDERGROUND ONLY

30 CFR § 57.11050

Escapeways and refuges.

ESCAPEWAYS--UNDERGROUND ONLY

(a) Every mine shall have two or more separate, properly maintained escapeways to the surface from the lowest levels which are so positioned that damage to one shall not lessen the effectiveness of the others. A method of refuge shall be provided while a second opening to the surface is being developed. A second escapeway is recommended, but not required, during the exploration or development of an ore body.

(b) In addition to separate escapeways, a method of refuge shall be provided for every employee who cannot reach the surface from his working place through at least two separate escapeways within a time limit of one hour when using the normal exit method. These refuges must be positioned so that the employee can reach one of them within 30 minutes from the time he leaves his workplace.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.11051

Escape routes.

Escape routes shall be--

(a) Inspected at regular intervals and maintained in safe, travelable condition; and

(b) Marked with conspicuous and easily read direction signs that clearly indicate the ways of escape.

30 CFR § 57.11052

Refuge areas.

Refuge areas shall be--

(a) Of fire-resistant construction, preferably in untimbered areas of the mine;

(b) Large enough to accommodate readily the normal number of persons in the particular area of the mine;

(c) Constructed so they can be made gastight; and

(d) Provided with compressed air lines, waterlines, suitable handtools, and stopping materials.

30 CFR § 57.11053

Escape and evacuation plans.

A specific escape and evacuation plan and revisions thereof suitable to the conditions and mining system of the mine and showing assigned responsibilities of all key personnel in the event of an emergency shall be developed by the operator and set out in written form. Within 45 calendar days after promulgation of this standard a copy of the plan and revisions thereof shall be available to the Secretary or his authorized representative. Also, copies of the plan and revisions thereof shall be posted at locations convenient to all persons on the surface and underground. Such a plan shall be updated as necessary and shall be reviewed jointly by the operator and the Secretary or his authorized representative at least once every six months from the date of the last review. The plan shall include:

(a) Mine maps or diagrams showing directions of principal air flow, location of escape routes and locations of existing telephones, primary fans, primary fan controls, fire doors, ventilation doors, and refuge chambers. Appropriate portions of such maps or diagrams shall be posted at all shaft stations and in underground shops, lunchrooms, and elsewhere in working areas where persons congregate;

(b) Procedures to show how the miners will be notified of emergency;

(c) An escape plan for each working area in the mine to include instructions showing how each working area should be evacuated. Each such plan shall be posted at appropriate shaft stations and elsewhere in working areas where persons congregate;

(d) A fire fighting plan;

(e) Surface procedure to follow in an emergency, including the notification of proper authorities, preparing rescue equipment, and other equipment which may be used in rescue and recovery operations; and

(f) A statement of the availability of emergency communication and transportation facilities, emergency power and ventilation and location of rescue personnel and equipment.

[60 FR 33719, June 29, 1995]

30 CFR § 57.11054

Communication with refuge chambers.

Telephone or other voice communication shall be provided between the surface and refuge chambers and such systems shall be independent of the mine power supply.

30 CFR § 57.11055

Inclined escapeways.

Any portion of a designated escapeway which is inclined more than 30 degrees from the horizontal and that is more than 300 feet in vertical extent shall be provided with an emergency hoisting facility.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.11056

Emergency hoists.

The procedure for inspection, testing and maintenance required by standard 57.19120 shall be utilized at least every 30 days for hoists designated as emergency hoists in any evacuation plan.

30 CFR § 57.11058

Check-in, check-out system.

Each operator of an underground mine shall establish a check-in and check-out system which shall provide an accurate record of persons in the mine. These records shall be kept on the surface in a place chosen to minimize the danger of destruction by fire or other hazards. Every person underground shall carry a positive means of being identified.

30 CFR § 57.11059

Respirable atmosphere for hoist operators underground.

For the protection of operators of hoists located underground which are part of the mine escape and evacuation plan required under standard 57.11053, the hoist operator shall be provided with a respirable atmosphere completely independent of the mine atmosphere. This independent ventilation system shall convert, without contamination, to an approved and properly maintained 2-hour self-contained breathing apparatus to provide a safe means of escape for the hoist operator after the hoisting duties have been completed as prescribed in the mine escape and evacuation plan for that hoist. The hoist operator's independent ventilation system shall be provided by one of the following methods:

(a) A suitable enclosure equipped with a positive pressure ventilation system which may be operated continuously or be capable of immediate activation from within the enclosure during an emergency evacuation. Air for the enclosure's ventilation system shall be provided in one of the following ways:

(1) Air coursed from the surface through a borehole into the hoist enclosure directly or through a metal pipeline from such borehole; or

(2) Air coursed from the surface through metal duct work into the hoist enclosure, although this duct work shall not be located in timber-supported active workings; or

(3) Air supplied by air compressors located on the surface and coursed through metal pipe into the hoist enclosure.

A back-up system shall be provided for a hoist enclosure ventilation system provided by either of the methods set forth in paragraphs (a)(2) and (3) of this section. This back-up system shall consist of compressed air stored in containers connected to the enclosure. This back-up system shall provide and maintain a respirable atmosphere in the enclosure for a period of time equal to at least twice the time necessary to complete the evacuation of all persons designated to use that hoist as prescribed in the mine escape and evacuation plan required under standard 57.11053; or

(b) An approved and properly maintained self-contained breathing apparatus system which shall consist of a mask connected to compressed air stored in containers adjacent to the hoist controls. The self-contained breathing system shall provide a minimum of 24 hours of respirable atmosphere to the hoist operator. In addition, the self-contained breathing system shall be capable of a quick connect with the approved 2-hour self-contained breathing apparatus above.

Subpart K—Electricity
SURFACE AND UNDERGROUND

30 CFR § 57.12001

Circuit overload protection.

SURFACE AND UNDERGROUND

Circuits shall be protected against excessive overloads by fuses or circuit breakers of the correct type and capacity.

30 CFR § 57.12002

Controls and switches.

Electric equipment and circuits shall be provided with switches or other controls. Such switches or controls shall be of approved design and construction and shall be properly installed.

30 CFR § 57.12003

Trailing cable overload protection.

Individual overload protection or short circuit protection shall be provided for the trailing cables of mobile equipment.

30 CFR § 57.12004

Electrical conductors.

Electrical conductors shall be of a sufficient size and current-carrying capacity to ensure that a rise in temperature resulting from normal operations will not damage the insulating materials. Electrical conductors exposed to mechanical damage shall be protected.

30 CFR § 57.12005

Protection of power conductors from mobile equipment.

Mobile equipment shall not run over power conductors, nor shall loads be dragged over power conductors, unless the conductors are properly bridged or protected.

30 CFR § 57.12006

Distribution boxes.

Distribution boxes shall be provided with a disconnecting device for each branch circuit. Such disconnecting devices shall be equipped or designed in such a manner that it can be determined by visual observation when such a device is open and that the circuit is deenergized, and the distribution box shall be labeled to show which circuit each device controls.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.12007

Junction box connection procedures.

Trailing cable and power-cable connections to junction boxes shall not be made or broken under load.

30 CFR § 57.12008

Insulation and fittings for power wires and cables.

Power wires and cables shall be insulated adequately where they pass into or out of electrical compartments. Cables shall enter metal frames of motors, splice boxes, and electrical compartments only through proper fittings. When

insulated wires, other than cables, pass through metal frames, the holes shall be substantially bushed with insulated bushings.

30 CFR § 57.12010

Isolation or insulation of communication conductors.

Telephone and low-potential signal wire shall be protected, by isolation or suitable insulation, or both, from contacting energized power conductors or any other power source.

30 CFR § 57.12011

High-potential electrical conductors.

High-potential electrical conductors shall be covered, insulated, or placed to prevent contact with low potential conductors.

30 CFR § 57.12012

Bare signal wires.

The potential on bare signal wires accessible to contact by persons shall not exceed 48 volts.

30 CFR § 57.12013

Splices and repairs of power cables.

Permanent splices and repairs made in power cables, including the ground conductor where provided, shall be

(a) Mechanically strong with electrical conductivity as near as possible to that of the original;

(b) Insulated to a degree at least equal to that of the original, and sealed to exclude moisture; and,

(c) Provided with damage protection as near as possible to that of the original, including good bonding to the outer jacket.

30 CFR § 57.12014

Handling energized power cables.

Power cables energized to potentials in excess of 150 volts, phase-to-ground, shall not be moved with equipment unless sleds or slings, insulated from such equipment, are used. When such energized cables are moved manually, insulated hooks, tongs, ropes, or slings shall be used unless suitable protection for persons is provided by other means. This does not prohibit pulling or dragging of cable by the equipment it powers when the cable is physically attached to the equipment by suitable mechanical devices, and the cable is insulated from the equipment in conformance with other standards in this part.

30 CFR § 57.12016

Work on electrically-powered equipment.

Electrically powered equipment shall be deenergized before mechanical work is done on such equipment. Power switches shall be locked out or other measures taken which shall prevent the equipment from being energized without the knowledge of the individuals working on it. Suitable warning notices shall be posted at the power switch and signed by the individuals who are to do the work. Such locks or preventive devices shall be removed only by the persons who installed them or by authorized personnel.

30 CFR § 57.12017

Work on power circuits.

Power circuits shall be deenergized before work is done on such circuits unless hot-line tools are used. Suitable warning signs shall be posted by the individuals who are to do the work. Switches shall be locked out or other measures taken which shall prevent the power circuits from being energized without the knowledge of the individuals working on them. Such locks, signs, or preventive devices shall be removed only by the person who installed them or by authorized personnel.

30 CFR § 57.12018

Identification of power switches.

Principal power switches shall be labeled to show which units they control, unless identification can be made readily by location.

30 CFR § 57.12019

Access to stationary electrical equipment or switchgear.

Where access is necessary, suitable clearance shall be provided at stationary electrical equipment or switchgear.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.12020

Protection of persons at switchgear.

Dry wooden platforms, insulating mats, or other electrically-nonconductive material shall be kept in place at all switchboards and power-control switches where shock hazards exist. However, metal plates on which a person normally would stand and which are kept at the same potential as the grounded, metal, non-current-carrying parts of the power switches to be operated may be used.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.12021

Danger signs.

Suitable danger signs shall be posted at all major electrical installations.

30 CFR § 57.12022

Authorized persons at major electrical installations.

Areas containing major electrical installations shall be entered only by authorized persons.

30 CFR § 57.12023

Guarding electrical connections and resistor grids.

Electrical connections and resistor grids that are difficult or impractical to insulate shall be guarded, unless protection is provided by location.

30 CFR § 57.12025

Grounding circuit enclosures.

All metal enclosing or encasing electrical circuits shall be grounded or provided with equivalent protection. This requirement does not apply to battery-operated equipment.

30 CFR § 57.12026

Grounding transformer and switchgear enclosures.

Metal fencing and metal buildings enclosing transformers and switchgear shall be grounded.

30 CFR § 57.12027

Grounding mobile equipment.

Frame grounding or equivalent protection shall be provided for mobile equipment powered through trailing cables.

30 CFR § 57.12028

Testing grounding systems.

Continuity and resistance of grounding systems shall be tested immediately after installation, repair, and modification; and annually thereafter. A record of the resistance measured during the most recent test shall be made available on a request by the Secretary or his duly authorized representative.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.12030

Correction of dangerous conditions.

When a potentially dangerous condition is found it shall be corrected before equipment or wiring is energized.

30 CFR § 57.12032

Inspection and cover plates.

Inspection and cover plates on electrical equipment and junction boxes shall be kept in place at all times except during testing or repairs.

30 CFR § 57.12033

Hand-held electric tools.

Hand-held electric tools shall not be operated at high potential voltages.

30 CFR § 57.12034

Guarding around lights.

Portable extension lights, and other lights that by their location present a shock or burn hazard, shall be guarded.

30 CFR § 57.12035

Weatherproof lamp sockets.

Lamp sockets shall be of a weatherproof type where they are exposed to weather or wet conditions that may interfere with illumination or create a shock hazard.

30 CFR § 57.12036

Fuse removal or replacement.

Fuses shall not be removed or replaced by hand in an energized circuit, and they shall not otherwise be removed or replaced in an energized circuit unless equipment and techniques especially designed to prevent electrical shock are provided and used for such purpose.

30 CFR § 57.12037

Fuses in high-potential circuits.

Fuse tongs or hotline tools, shall be used when fuses are removed or replaced in high-potential circuits.

30 CFR § 57.12038

Attachment of trailing cables.

Trailing cables shall be attached to machines in a suitable manner to protect the cable from damage and to prevent strain on the electrical connections.

30 CFR § 57.12039

Protection of surplus trailing cables.

Surplus trailing cables to shovels, cranes and similar equipment shall be--

(a) Stored in cable boats;

(b) Stored on reels mounted on the equipment; or

(c) Otherwise protected from mechanical damage.

30 CFR § 57.12040

Installation of operating controls.

Operating controls shall be installed so that they can be operated without danger of contact with energized conductors.

30 CFR § 57.12041

Design of switches and starting boxes.

Switches and starting boxes shall be of safe design and capacity.

30 CFR § 57.12042

Track bonding.

Both rails shall be bonded or welded at every joint and rails shall be crossbonded at least every 200 feet if the track serves as the return trolley circuit. When rails are moved, replaced, or broken bonds are discovered, they shall be rebonded within three working shifts.

30 CFR § 57.12045

Overhead powerlines.

Overhead high-potential powerlines shall be installed as specified by the National Electrical Code.

30 CFR § 57.12047

Guy wires.

Guy wires of poles supporting high-voltage transmission lines shall meet the requirements for grounding or insulator protection of the National Electrical Safety Code, part 2, entitled "Safety Rules for the Installation and Maintenance of Electric Supply and Communication Lines" (also referred to as National Bureau of Standards Handbook 81, Nov. 1, 1961), and Supplement 2 thereof issued March 1968, which are hereby incorporated by reference and made a part hereof. These publications and documents may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington,

D.C. 20402, or may be examined in any Metal and Nonmetal Mine Safety and Health District Office of the Mine Safety and Health Administration.

[60 FR 35692, July 11, 1995]

30 CFR § 57.12048

Communication conductors on power poles.

Telegraph, telephone, or signal wires shall not be installed on the same crossarm with power conductors. When carried on poles supporting powerlines, they shall be installed as specified by the National Electrical Code.

30 CFR § 57.12050

Installation of trolley wires.

Trolley wires shall be installed at least seven feet above rails where height permits, and aligned and supported to suitably control sway and sag.

30 CFR § 57.12053

Circuits powered from trolley wires.

Ground wires for lighting circuits powered from trolley wires shall be connected securely to the ground return circuit.

SURFACE ONLY

30 CFR § 57.12065

Short circuit and lightning protection.

SURFACE ONLY

Powerlines, including trolley wires, and telephone circuits shall be protected against short circuits and lightning.

30 CFR § 57.12066

Guarding trolley wires and bare powerlines.

Where metallic tools or equipment can come in contact with trolley wires or bare powerlines, the lines shall be guarded or deenergized.

30 CFR § 57.12067

Installation of transformers.

Transformers shall be totally enclosed, or shall be placed at least 8 feet above the ground, or installed in a transformer house, or surrounded by a substantial fence at least 6 feet high and at least 3 feet from any energized parts, casings, or wiring.

30 CFR § 57.12068

Locking transformer enclosures.

Transformer enclosures shall be kept locked against unauthorized entry.

30 CFR § 57.12069

Lightning protection for telephone wires and ungrounded conductors.

Each ungrounded conductor or telephone wire that leads underground and is directly exposed to lightning shall be equipped with suitable lightning arrestors of approved type within 100 feet of the point where the circuit enters the mine. Lightning arrestors shall be connected to a low resistance grounding medium on the surface and shall be separated from neutral grounds by a distance of not less than 25 feet.

30 CFR § 57.12071

Movement or operation of equipment near high-voltage powerlines.

When equipment must be moved or operated near energized high-voltage powerlines (other than trolley lines) and the clearance is less than 10 feet, the lines shall be deenergized or other precautionary measures shall be taken.

UNDERGROUND ONLY

30 CFR § 57.12080

Bare conductor guards.

UNDERGROUND ONLY

Trolley wires and bare power conductors shall be guarded at mantrip loading and unloading points, and at shaft stations. Where such trolley wires and bare power conductors are less than 7 feet above the rail, they shall be guarded at all points where persons work or pass regularly beneath.

30 CFR § 57.12081

Bonding metal pipelines to ground return circuits.

All metal pipelines, 1,000 feet or more in length running parallel to trolley tracks, that are used as a ground return circuit shall be bonded to the return circuit rail at the ends of the pipeline and at intervals not to exceed 500 feet.

30 CFR § 57.12082

Isolation of powerlines.

Powerlines shall be well separated or insulated from waterlines, telephone lines and air lines.

30 CFR § 57.12083

Support of power cables in shafts and boreholes.

Power cables in shafts and boreholes shall be fastened securely in such a manner as to prevent undue strain on the sheath, insulation, or conductors.

30 CFR § 57.12084

Branch circuit disconnecting devices.

Disconnecting switches that can be opened safely under load shall be provided underground at all branch circuits extending from primary power circuits near shafts, adits, levels and boreholes.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.12085

Transformer stations.

Transformer stations shall be enclosed to prevent persons from unintentionally or inadvertently contacting energized parts.

30 CFR § 57.12086

Location of trolley wire.

Trolley and trolley feeder wire shall be installed opposite the clearance side of haulageways. However, this standard does not apply where physical limitations would prevent the safe installation or use of such trolley and trolley feeder wire.

30 CFR § 57.12088

Splicing trailing cables.

No splice, except a vulcanized splice or its equivalent, shall be made in a trailing cable within 25 feet of the machine unless the machine is equipped with a cable reel or other power feed cable payout-retrieval system. However, a temporary splice may be made to move the equipment for repair.

Subpart L--Compressed Air and Boilers

30 CFR § 57.13001

General requirements for boilers and pressure vessels.

All boilers and pressure vessels shall be constructed, installed, and maintained in accordance with the standards and specifications of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code.

30 CFR § 57.13010

Reciprocating-type air compressors.

(a) Reciprocating-type air compressors rated over 10 horsepower shall be equipped with automatic temperature-actuated shutoff mechanisms which shall be set or adjusted to the compressor when the normal operating temperature is exceeded by more than 25 percent.

(b) However, this standard does not apply to reciprocating-type air compressors rated over 10 horsepower if equipped with fusible plugs that were installed in the compressor discharge lines before November 15, 1979, and designed to melt at temperatures at least 50 degrees below the flash point of the compressors' lubricating oil.

30 CFR § 57.13011

Air receiver tanks.

Air receiver tanks shall be equipped with one or more automatic pressure-relief valves. The total relieving capacity of the relief valves shall prevent pressure from exceeding the maximum allowable working pressure in a receiver tank by not more than 10 percent. Air receiver tanks also shall be equipped with indicating pressure gages which accurately measure the pressure within the air receiver tanks.

30 CFR § 57.13012

Compressor air intakes.

Compressor air intakes shall be installed to ensure that only clean, uncontaminated air enters the compressors.

30 CFR § 57.13015

Inspection of compressed-air receivers and other unfired pressure vessels.

(a) Compressed-air receivers and other unfired pressure vessels shall be inspected by inspectors holding a valid National Board Commission and in accordance with the applicable chapters of the National Board Inspection Code, a Manual for Boiler and Pressure Vessel Inspectors, 1979. This code is incorporated by reference and made a part of this standard. It may be examined at any Metal and Nonmetal Mine Safety and Health District Office of the Mine Safety and Health Administration, and may be obtained from the publisher, the National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Avenue, Columbus, Ohio 43229.

(b) Records of inspections shall be kept in accordance with requirements of the National Board Inspection Code, and the records shall be made available to the Secretary or his authorized representative.

30 CFR § 57.13017

Compressor discharge pipes.

Compressor discharge pipes where carbon build-up may occur shall be cleaned periodically as recommended by the manufacturer, but no less frequently than once every two years.

30 CFR § 57.13019

Pressure system repairs.

Repairs involving the pressure system of compressors, receivers, or compressed-air-powered equipment shall not be attempted until the pressure has been bled off.

30 CFR § 57.13020

Use of compressed air.

At no time shall compressed air be directed toward a person. When compressed air is used, all necessary precautions shall be taken to protect persons from injury.

30 CFR § 57.13021

High-pressure hose connections.

Except where automatic shutoff valves are used, safety chains or other suitable locking devices shall be used at connections to machines of high-pressure hose lines of 3/4-inch inside diameter or larger, and between high-pressure hose lines of 3/4-inch inside diameter or larger, where a connection failure would create a hazard.

30 CFR § 57.13030

Boilers.

(a) Fired pressure vessels (boilers) shall be equipped with water level gauges, pressure gauges, automatic pressure-relief valves, blowdown piping, and other safety devices approved by the American Society of Mechanical Engineers to protect against hazards from overpressure, flameouts, fuel interruptions and low water level, all as required by the appropriate sections, chapters and appendices listed in paragraphs (b) (1) and (2) of this section.

(b) These gauges, devices and piping shall be designed, installed, operated, maintained, repaired, altered, inspected, and tested by inspectors holding a valid National Board Commission and in accordance with the following listed sections, chapters and appendices:

(1) The ASME Boiler and Pressure Vessel Code, 1977, published by the American Society of Mechanical Engineers. SECTION AND TITLE

I Power Boilers

II Material Specifications--Part A--Ferrous

II Material Specifications--Part B--Non-ferrous

II Material Specifications--Part C--Welding Rods, Electrodes, and Filler Metals

IV Heating Boilers

V Nondestructive Examination

VI Recommended Rules for Care and Operation of Heating Boilers

VII Recommended Rules for Care of Power Boilers

(2) The National Board Inspection Code, a Manual for Boiler and Pressure Vessel Inspectors, 1979, published by the National Board of Boiler and Pressure Vessel Inspectors.

CHAPTER AND TITLE

I Glossary of Terms

II Inspection of Boilers and Pressure Vessels

III Repairs and Alterations to Boiler and Pressure Vessels by Welding

IV Shop Inspection of Boilers and Pressure Vessels

V Inservice Inspection of Pressure Vessels by Authorized Owner-User Inspection Agencies

APPENDIX AND TITLE

A Safety and Safety Relief Valves

B Non-ASME Code Boilers and Pressure Vessels

C Storage of Mild Steel Covered Arc Welding Electrodes

D-R National Board "R" (Repair) Symbol Stamp

D-VR National Board "VR" (Repair of Safety and Safety Relief Valve) Symbol Stamp

D-VR1 Certificate of Authorization for Repair Symbol Stamp for Safety and Safety Relief Valves

D-VR2 Outline of Basic Elements of Written Quality Control System for Repairers of ASME Safety and Safety Relief Valves

D-VR3 Nameplate Stamping for "VR"

E Owner-User Inspection Agencies

F Inspection Forms

(c) Records of inspections and repairs shall be kept in accordance with the requirements of the ASME Boiler and Pressure Vessel Code and the National Board Inspection Code. The records shall be made available to the Secretary or his authorized representative.

For more information: See MSHA'S Program Policy Manual

(d) Sections of the ASME Boiler and Pressure Vessel Code, 1977, listed in paragraph (b)(1) of this section, and chapters and appendices of the National Board Inspection Code, 1979, listed in paragraph (b)(2) of this section, are incorporated by reference and made a part of this standard. These publications may be obtained from the publishers, the American Society of Mechanical Engineers, 345 East Forty-seventh Street, New York, N.Y. 10017, and the National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Avenue, Columbus, Ohio 43229. The publication may be examined at any Metal and Nonmetal Mine Safety and Health District Office of the Mine Safety and Health Administration.

Subpart M--Machinery and Equipment

Source: 53 FR 32528, Aug. 25, 1988, unless otherwise noted.

Subpart M--Machinery and Equipment

30 CFR § 57.14000

Definitions.

The following definitions apply in this subpart.

Travelway. A passage, walk, or way regularly used or designated for persons to go from one place to another.

SAFETY DEVICES AND MAINTENANCE REQUIREMENTS

30 CFR § 57.14100

Safety defects; examination, correction and records.

(a) Self-propelled mobile equipment to be used during a shift shall be inspected by the equipment operator before being placed in operation on that shift.

(b) Defects on any equipment, machinery, and tools that affect safety shall be corrected in a timely manner to prevent the creation of a hazard to persons.

(c) When defects make continued operation hazardous to persons, the defective items including self-propelled mobile equipment shall be taken out of service and placed in a designated area posted for that purpose, or a tag or other effective method of marking the defective items shall be used to prohibit further use until the defects are corrected.

(d) Defects on self-propelled mobile equipment affecting safety, which are not corrected immediately, shall be reported to, and recorded by, the mine operator. The records shall be kept at the mine or nearest mine office from the date the defects are recorded, until the defects are corrected. Such records shall be made available for inspection by an authorized representative of the Secretary.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.14101

Brakes.

(a) *Minimum requirements.* (1) Self-propelled mobile equipment shall be equipped with a service brake system capable of stopping and holding the equipment with its typical load on the maximum grade it travels. This standard does not apply to equipment which is not originally equipped with brakes unless the manner in which the equipment is being operated requires the use of brakes for safe operation. This standard does not apply to rail equipment.

(a)(2) If equipped on self-propelled mobile equipment, parking brakes shall be capable of holding the equipment with its typical load on the maximum grade it travels.

(a)(3) All braking systems installed on the equipment shall be maintained in functional condition.

(b) *Testing.* (1) Service brake tests shall be conducted on surface-operated equipment at underground mines when an MSHA inspector has reasonable cause to believe that the service brake system does not function as required, unless the mine operator removes the equipment from service for the appropriate repair;

(b)(2) The performance of the service brakes shall be evaluated according to Table M-1.

TABLE M-1

Gross vehicle weight lbs.	Equipment Speed, MPH									
	10	11	12	13	14	15	16	17	18	19	20
	Service Brake Maximum Stopping Distance--Feet										
0-36,000.....	34	38	43	48	53	59	64	70	76	83	89
36,000-70,000.	41	46	52	58	62	70	76	83	90	97	104
70,000-14,0000	48	54	61	67	74	81	88	95	103	111	119
140,000-250,000.	56	62	69	77	84	92	100	108	116	125	133
250,000-400,000.	59	66	74	81	89	97	105	114	123	132	141
Over-400,000..	63	71	78	86	94	103	111	120	129	139	148

Stopping distances are computed using a constant deceleration of 9.66 FPS(super)2 and system response times of .5.1, 1.5, 2, 2.25 and 2.5 seconds for each of increasing weight category respectively. Stopping distance values include a one-second operator response time.

TABLE M-2.--THE SPEED OF A VEHICLE CAN BE DETERMINED BY CLOCKING IT THROUGH A 100-FOOT MEASURED COURSE AT CONSTANT VELOCITY USING TABLE M-2. WHEN THE SERVICE BRAKES ARE APPLIED AT THE END OF THE COURSE, STOPPING DISTANCE CAN BE MEASURED AND COMPARED TO TABLE M-1.

Miles per hour	10	11	12	13	14	15	16	17	18	19	20
Seconds required to travel 100 ft	6.8	6.2	5.7	5.2	4.9	4.5	4.3	4.0	3.8	3.6	3.4

(b)(3) Service brake tests shall be conducted under the

direction of the mine operator in cooperation with and according to the instructions provided by the MSHA inspector as follows:

(b)(3)(i) Equipment capable of traveling at least 10 miles per hour shall be tested with a typical load for that particular piece of equipment. Front-end loaders shall be tested with the loader bucket empty. Equipment shall not be tested when carrying hazardous loads, such as explosives.

(b)(3)(ii) The approach shall be of sufficient length to allow the equipment operator to reach and maintain a constant speed between 10 and 20 miles per hour prior to entering the 100 foot measured area. The constant speed shall be maintained up to the point when the equipment operator receives the signal to apply the brakes. The roadway shall be wide enough to accommodate the size of the equipment being tested. The ground shall be generally level, packed, and dry in the braking portion of the test course. Ground moisture may be present to the extent that it does not adversely affect the braking surface.

(b)(3)(iii) Braking is to be performed using only those braking systems, including auxiliary retarders, which are designed to bring the equipment to a stop under normal operating conditions. Parking or emergency (secondary) brakes are not to be actuated during the test.

(b)(3)(iv) The tests shall be conducted with the transmission in the gear appropriate for the speed the equipment is traveling except for equipment which is designed for the power train to be disengaged during braking.

(b)(3)(v) Testing speeds shall be a minimum of 10 miles per hour and a maximum of 20 miles per hour.

(b)(3)(vi) Stopping distances shall be measured from the point at which the equipment operator receives the signal to apply the service brakes to the final stopped position.

(b)(4) Test results shall be evaluated as follows:

(b)(4)(i) If the initial test run is valid and the stopping distance does not exceed the corresponding stopping distance listed in Table 1, the performance of the service brakes shall be considered acceptable. For tests to be considered valid, the equipment shall not slide sideways or exhibit other lateral motion during the braking portion of the test.

(b)(4)(ii) If the equipment exceeds the maximum stopping distance in the initial test run, the mine operator may request from the inspector up to four additional test runs with two runs to be conducted in each direction. The performance of the service brakes shall be considered acceptable if the equipment does not exceed the maximum stopping distance on at least three of the additional tests.

(b)(5) Where there is not an appropriate test site at the mine or the equipment is not capable of traveling at least 10 miles per hour, service brake tests will not be conducted. In such cases, the inspector will rely upon other available evidence to determine whether the service brake system meets the performance requirements of this standard.

[53 FR 32528, Aug. 25, 1988; 53 FR 44588, Nov. 4, 1988]

30 CFR § 57.14102

Brakes for rail equipment.

Braking systems on railroad cars and locomotives shall be maintained in functional condition.

30 CFR § 57.14103

Operators' stations.

(a) If windows are provided on operators' stations of self-propelled mobile equipment, the windows shall be made of safety glass or material with equivalent safety characteristics. The windows shall be maintained to provide visibility for safe operation.

(b) If damaged windows obscure visibility necessary for safe operation, or create a hazard to the equipment operator, the windows shall be replaced or removed. Damaged windows shall be replaced if absence of a window would expose the equipment operator to hazardous environmental conditions which would affect the ability of the equipment operator to safely operate the equipment.

(c) The operators' stations of self-propelled mobile equipment shall

(c)(1) Be free of materials that may create a hazard to persons by impairing the safe operation of the equipment; and

(c)(2) Not be modified, in a manner that obscures visibility necessary for safe operation.

30 CFR § 57.14104

Tire repairs.

(a) Before a tire is removed from a vehicle for tire repair, the valve core shall be partially removed to allow for gradual deflation and then removed. During deflation, to the extent possible, persons shall stand outside of the potential trajectory of the lock ring of a multi-piece wheel rim.

(b) To prevent injury from wheel rims during tire inflation, one of the following shall be used:

(1) A wheel cage or other restraining device that will constrain all wheel rim components during an explosive separation of a multi-piece wheel rim, or during the sudden release of contained air in a single piece rim wheel; or

(2) A stand-off inflation device which permits persons to stand outside of the potential trajectory of wheel components.

30 CFR § 57.14105

Procedures during repairs or maintenance.

Repairs or maintenance on machinery or equipment shall be performed only after the power is off, and the machinery or equipment blocked against hazardous motion. Machinery or equipment motion or activation is permitted to the extent that adjustments or testing cannot be performed without motion or activation, provided that persons are effectively protected from hazardous motion.

30 CFR § 57.14106

Falling object protection.

(a) Fork-lift trucks, front-end loaders, and bulldozers shall be provided with falling object protective structures if used in an area where falling objects could create a hazard to the operator.

(b) The protective structure shall be capable of withstanding the falling object loads to which it could be subjected.

30 CFR § 57.14107

Moving machine parts.

(a) Moving machine parts shall be guarded to protect persons from contacting gears, sprockets, chains, drive, head, tail, and takeup pulleys, flywheels, coupling, shafts, fan blades; and similar moving parts that can cause injury.

(b) Guards shall not be required where the exposed moving parts are at least seven feet away from walking or working surfaces.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.14108

Overhead drive belts.

Overhead drive belts shall be guarded to contain the whipping action of a broken belt if that action could be hazardous to persons.

30 CFR § 57.14109

Unguarded conveyors with adjacent travelways.

Unguarded conveyors next to travelways shall be equipped with

(a) Emergency stop devices which are located so that a person falling on or against the conveyor can readily deactivate the conveyor drive motor; or

(b) Railings which

(1) Are positioned to prevent persons from falling on or against the conveyor;

(2) Will be able to withstand the vibration, shock, and wear to which they will be subjected during normal operation; and

(3) Are constructed and maintained so that they will not create a hazard.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.14110

Flying or falling materials.

In areas where flying or falling materials generated from the operation of screens, crushers, or conveyors present a hazard, guards, shields, or other devices that provide protection against such flying or falling materials shall be provided to protect persons.

30 CFR § 57.14111

Slusher, backlash guards and securing.

(a) When persons are exposed to slushing operations, the slushers shall be equipped with rollers and drum covers and anchored securely before slushing operations are started to protect against hazardous movement before slushing operations are started.

(b) Slushers rated over 10 horsepower shall be equipped with backlash guards, unless the equipment operator is otherwise protected.

(c) This standard does not apply to air tuggers of 10 horsepower or less that have only one cable and one drum.

30 CFR § 57.14112

Construction and maintenance of guards.

(a) Guards shall be constructed and maintained to--

(a)(1) Withstand the vibration, shock, and wear to which they will be subjected during normal operation; and

(a)(2) Not create a hazard by their use.

(b) Guards shall be securely in place while machinery is being operated, except when testing or making adjustments which cannot be performed without removal of the guard.

30 CFR § 57.14113

Inclined conveyors: backstops or brakes.

Backstops or brakes shall be installed on drive units of inclined conveyors to prevent the conveyors from running in reverse, creating a hazard to persons.

30 CFR § 57.14114

Air valves for pneumatic equipment.

A manual master quick-close type air valve shall be installed on all pneumatic-powered equipment if there is a hazard of uncontrolled movement when the air supply is activated. The valve shall be closed except when the equipment is being operated.

[53 FR 32528, Aug. 25, 1988; 53 FR 44588, Nov. 4, 1988]

30 CFR § 57.14115

Stationary grinding machines.

Stationary grinding machines, other than special bit grinders, shall be equipped with--

(a) Peripheral hoods capable of withstanding the force of a bursting wheel and enclosing not less than 270°--of the periphery of the wheel;

(b) Adjustable tool rests set so that the distance between the grinding surface of the wheel and the tool rest is not greater than 1/8 inch; and

(c) A safety washer on each side of the wheel.

[53 FR 32528, Aug. 25, 1988; 53 FR 44588, Nov. 4, 1988]

30 CFR § 57.14116

Hand-held power tools.

(a) Power drills, disc sanders, grinders and circular and chain saws, when used in the hand-held mode shall be operated with controls which require constant hand or finger pressure.

(b) Circular saws and chain saws shall not be equipped with devices which lock-on the operating controls.

30 CFR § 57.14130

Roll-over protective structures (ROPS) and seat belts for surface equipment.

(a) *Equipment included.* Roll-over protective structures (ROPS) and seat belts shall be installed on--

(1) Crawler tractors and crawler loaders;

(2) Graders;

(3) Wheel loaders and wheel tractors;

(4) The tractor portion of semi-mounted scrapers, dumpers, water wagons, bottom-dump wagons, rear-dump wagons, and towed fifth wheel attachments;

(5) Skid-steer loaders; and

(6) Agricultural tractors.

(b) ROPS *construction.* ROPS shall meet the requirements of the following Society of Automotive Engineers (SAE) publications, as applicable, which are incorporated by reference:

(1) SAE J1040, "Performance Criteria for Roll-Over Protective Structures (ROPS) for Construction, Earthmoving, Forestry, and Mining Machines,", 1986; or

(2) SAE J1194, "Roll-Over Protective Structures (ROPS) for Wheeled Agricultural Tractors", 1983.

(c) ROPS *labeling.* ROPS shall have a label permanently affixed to the structure identifying--

(1) The manufacturer's name and address;

(2) The ROPS model number; and

(3) The make and model number of the equipment for which the ROPS is designed.

(d) ROPS *installation.* ROPS shall be installed on the equipment in accordance with the recommendations of the ROPS manufacturer.

(e) *ROPS maintenance.* (1) ROPS shall be maintained in a condition that meets the performance requirements applicable to the equipment. If the ROPS is subjected to a roll-over or abnormal structural loading, the equipment manufacturer or a registered professional engineer with knowledge and experience in ROPS design shall recertify that the ROPS meets the applicable performance requirements before it is returned to service.

(2) Alterations or repairs on ROPS shall be performed only with approval from the ROPS manufacturer or under the instructions of a registered professional engineer with knowledge and experience in ROPS design. The manufacturer or engineer shall certify that the ROPS meets the applicable performance requirements.

(f) *Exemptions.* (1) This standard does not apply to--

(i) Self-propelled mobile equipment manufactured prior to July 1, 1969;

(ii) Over-the-road type tractors that pull trailers or vans on highways;

(iii) Equipment that is only operated by remote control; and

(2) Self-propelled mobile equipment manufactured prior to October 24, 1988, that is equipped with ROPS and seat belts that meet the installation and performance requirements of 30 CFR 57.9088 (1986 edition) shall be considered in compliance with paragraphs (b) and (h) of this section.

(g) *Wearing seat belts.* Seat belts shall be worn by the equipment operator except that when operating graders from a standing position, the grader operator shall wear safety lines and a harness in place of a seat belt.
(h) Seat belts construction. Seat belts required under this section shall meet the requirement of SAE J386, ``Operator Restraint System for Off-Road Work Machines" (1985, 1993, or 1997), or SAE J1194, ``Roll- Over Protective Structures (ROPS) for Wheeled Agricultural Tractors" (1983, 1989, 1994, or 1999), as applicable, which are incorporated by reference.

(i) *Seat belt maintenance.* Seat belts shall be maintained in functional condition, and replaced when necessary to assure proper performance.

(j) Publications. The incorporation by reference of these publications is approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies of these publications may be examined at any Metal and Nonmetal Mine Safety and Health District Office; at MSHA's Office of Standards, Regulations, and Variances, 1100 Wilson Boulevard, Room 2349, Arlington, Virginia 22209- 3939; or at the Office of the Federal Register, 800 North Capitol Street, NW., Suite 700, Washington, DC. Copies may be purchased from the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, Pennsylvania 15096-0001.

[53 FR 32528, Aug. 25, 1988; 53 FR 44588, Nov. 4, 1988; 60 FR 33719, June 29, 1995; 67 FR 38385, June 4, 2002; 68 FR 19347, Apr. 21, 2003]

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.14131

Seat belts for surface haulage trucks.

(a) Seat belts shall be provided and worn in haulage trucks.

(b) Seat belts shall be maintained in functional condition, and replaced when necessary to assure proper performance.

(c) Seat belts required under this section shall meet the requirements of SAE J386, ``Operator Restraint System for Off-Road Work Machines" (1985, 1993, or 1997), which are incorporated by reference.

(d) The incorporation by reference of these publications is approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies of these publications may be examined at any Metal and Nonmetal Mine Safety and Health District Office; at MSHA's Office of Standards, Regulations, and Variances, 1100 Wilson Boulevard, Room 2349, Arlington, Virginia 22209-3939; or at the Office of the Federal Register, 800 North Capitol Street, NW., Suite 700, Washington, DC. Copies may be purchased from the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, Pennsylvania 15096-0001.

30 CFR § 57.14132

Horns and backup alarms for surface equipment.

(a) Manually-operated horns or other audible warning devices provided on self-propelled mobile equipment as a safety device shall be maintained in a functional condition.

(b)(1) When the operator has an obstructed view to the rear, self-propelled mobile equipment shall have--

(b)(1)(i) An automatic reverse-activated signal alarm;

(b)(1)(ii) A wheel-mounted bell alarm which sounds at least once for each three feet of reverse movement;

(b)(1)(iii) A discriminating backup alarm that covers the area of obstructed view; or

(b)(1)(iv) An observer to signal when it is safe to back up.

(b)(2) Alarms shall be audible above the surrounding noise level.

(b)(3) An automatic reverse-activated strobe light may be used at night in lieu of an audible reverse alarm.

(c) This standard does not apply to rail equipment.

30 CFR § 57.14160

Mantrip trolley wire hazards underground.

Mantrips shall be covered if there is danger of persons contacting the trolley wire.

30 CFR § 57.14161

Makeshift couplings.

Couplings used on underground rail equipment shall be designed for that equipment, except that makeshift couplings may be used to move disabled rail equipment for repairs if no hazard to persons is created.

30 CFR § 57.14162

Trip lights.

On underground rail haulage, trip lights shall be used on the rear of pulled trips and on the front of pushed trips.

SAFETY PRACTICES AND OPERATIONAL PROCEDURES

30 CFR § 57.14200

Warnings prior to starting or moving equipment.

SAFETY PRACTICES AND OPERATIONAL PROCEDURES

Before starting crushers or moving self-propelled mobile equipment, equipment operators shall sound a warning that is audible above the surrounding noise level or use other effective means to warn all persons who could be exposed to a hazard from the equipment.

30 CFR § 57.14201

Conveyor start-up warnings.

(a) When the entire length of a conveyor is visible from the starting switch, the conveyor operator shall visually check to make certain that all persons are in the clear before starting the conveyor.

(b) When the entire length of the conveyor is not visible from the starting switch, a system which provides visible or audible warning shall be installed and operated to warn persons that the conveyor will be started. Within 30 seconds after the warning is given, the conveyor shall be started or a second warning shall be given.

30 CFR § 57.14202

Manual cleaning of conveyor pulleys.

Pulleys of conveyors shall not be cleaned manually while the conveyor is in motion.

30 CFR § 57.14203

Application of belt dressing.

Belt dressings shall not be applied manually while belts are in motion unless a pressurized-type applicator is used that allows the dressing to be applied from outside the guards.

30 CFR § 57.14204

Machinery lubrication.

Machinery or equipment shall not be lubricated manually while it is in motion where application of the lubricant may expose persons to injury.

30 CFR § 57.14205

Machinery, equipment, and tools.

Machinery, equipment, and tools shall not be used beyond the design capacity intended by the manufacturer, where such use may create a hazard to persons.

30 CFR § 57.14206

Securing movable parts.

(a) When moving mobile equipment between workplaces, booms, forks, buckets, beds, and similar movable parts of the equipment shall be positioned in the travel mode and, if required for safe travel, mechanically secured.

(b) When mobile equipment is unattended or not in use, dippers, buckets and scraper blades shall be lowered to the ground. Other movable parts, such as booms, shall be mechanically secured or positioned to prevent movement which would create a hazard to persons.

30 CFR § 57.14207

Parking procedures for unattended equipment.

Mobile equipment shall not be left unattended unless the controls are placed in the park position and the parking brake, if provided, is set. When parked on a grade, the wheels or tracks of mobile equipment shall be either chocked or turned into a bank or rib.

30 CFR § 57.14208

Warning devices.

(a) Visible warning devices shall be used when parked mobile equipment creates a hazard to persons in other mobile equipment.

(b) Mobile equipment, other than forklifts, carrying loads that project beyond the sides or more than four feet beyond the rear of the equipment shall have a warning flag at the end of the projection. Under conditions of limited visibility these loads shall have a warning light at the end of the projection. Such flags or lights shall be attached to the end of the projection or be carried by persons walking beside or behind the projection.

30 CFR § 57.14209

Safety procedures for towing.

(a) A properly sized tow bar or other effective means of control shall be used to tow mobile equipment.

(b) Unless steering and braking are under the control of the equipment operator on the towed equipment, a safety chain or wire rope capable of withstanding the loads to which it could be subjected shall be used in conjunction with any primary rigging.

(c) This provision does not apply to rail equipment.

30 CFR § 57.14210

Movement of dippers, buckets, loading booms, or suspended loads.

(a) Dippers, buckets, loading booms, or suspended loads shall not be swung over the operators' stations of self-propelled mobile equipment until the equipment operator is out of the operator's station and in a safe location.

(b) This section does not apply when the equipment is specifically designed to protect the equipment operator from falling objects.

30 CFR § 57.14211

Blocking equipment in a raised position.

(a) Persons shall not work on top of, under, or work from mobile equipment in a raised position until the equipment has been blocked or mechanically secured to prevent it from rolling or falling accidentally.

(b) Persons shall not work on top of, under, or work from a raised component of mobile equipment until the component has been blocked or mechanically secured to prevent accidental lowering. The equipment must also be blocked or secured to prevent rolling.

(c) A raised component must be secured to prevent accidental lowering when persons are working on or around mobile equipment and are exposed to the hazard of accidental lowering of the component.

(d) Under this section, a raised component of mobile equipment is considered to be blocked or mechanically secured if provided with a functional load-locking device or devices which prevent free and uncontrolled descent.

(e) Blocking or mechanical securing of the raised component is required during repair or maintenance of elevated mobile work platforms.

30 CFR § 57.14212

Chains, ropes, and drive belts.

Chains, ropes, and drive belts shall be guided mechanically onto moving pulleys, sprockets, or drums except where equipment is designed specifically for hand feeding.

30 CFR § 57.14213

Ventilation and shielding for welding.

(a) Welding operations shall be shielded when performed at locations where arc flash could be hazardous to persons.

(b) All welding operations shall be well-ventilated.

30 CFR § 57.14214

Train warnings.

A warning that is audible above the surrounding noise level shall be sounded--

(a) Immediately prior to moving trains;

(b) When trains approach persons, crossing, other trains on adjacent tracks; and

(c) Any place where the train operator's vision is obscured.

30 CFR § 57.14215

Coupling or uncoupling cars.

Prior to coupling or uncoupling cars manually, trains shall be brought to a complete stop, and then moved at minimum tram speed until the coupling or uncoupling activity is completed. Coupling or uncoupling shall not be attempted from the inside of curves unless the railroad and cars are designed to eliminate hazards to persons.

30 CFR § 57.14216

Backpoling.

Backpoling of trolleys is prohibited except where there is inadequate clearance to reverse the trolley pole. Where backpoling is required, it shall be done only at the minimum tram speed of the trolley.

30 CFR § 57.14217

Securing parked railcars.

Parked railcars shall be blocked securely unless held effectively by brakes.

30 CFR § 57.14218

Movement of equipment on adjacent tracks.

When a locomotive on one track is used to move rail equipment on adjacent tracks, a chain, cable, or drawbar shall be used which is capable of withstanding the loads to which it could be subjected.

30 CFR § 57.14219

Brakeman signals.

When a train is under the direction of a brakeman and the train operator cannot clearly recognize the brakeman's signals, the train operator shall bring the train to a stop.

Appendix I for Subpart M--National Consensus Standards

Mine operators seeking further information regarding the construction and installation of falling object protective structures (FOPS) may consult the following national consensus standards, as applicable.

MSHA STANDARD 57.14106, FALLING OBJECT PROTECTION

Equipment	National consensus standard
Front-end loaders and bulldozers.	Society of Automotive Engineers (SAE) minimum performance criteria for falling object protective structures (FOPS) SAE J231--January, 1981.
Fork-lift trucks.....	American National Standards Institute (ANSI) safety standard for low lift and high lift trucks, B 56.1, section 7.27--1983; or American National Standards Institute (ANSI) standard, rough terrain fork lift trucks, B 56.6--1987.

Subpart N--Personal Protection
SURFACE AND UNDERGROUND

30 CFR § 57.15001

First aid materials.

SURFACE AND UNDERGROUND

Adequate first-aid materials, including stretchers and blankets shall be provided at places convenient to all working areas. Water or neutralizing agents shall be available where corrosive chemicals or other harmful substances are stored, handled, or used.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.15002

Hard hats.

All persons shall wear suitable hard hats when in or around a mine or plant where falling objects may create a hazard.

30 CFR § 57.15003

Protective footwear.

All persons shall wear suitable protective footwear when in or around an area of a mine or plant where a hazard exists which could cause an injury to the feet.

30 CFR § 57.15004

Eye protection.

All persons shall wear safety glasses, goggles, or face shields or other suitable protective devices when in or around an area of a mine or plant where a hazard exists which could cause injury to unprotected eyes

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.15005

Safety belts and lines.

Safety belts and lines shall be worn when persons work where there is danger of falling; a second person shall tend the lifeline when bins, tanks, or other dangerous areas are entered.

30 CFR § 57.15006

Protective equipment and clothing for hazards and irritants.

Special protective equipment and special protective clothing shall be provided, maintained in a sanitary and reliable condition and used whenever hazards of process or environment, chemical hazards, radiological hazards, or mechancial irritants are encountered in a manner capable of causing injury or impairment.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.15007

Protective equipment or clothing for welding, cutting, or working with molten metal.

Protective clothing or equipment and face shields or goggles shall be worn when welding, cutting, or working with molten metal.

30 CFR § 57.15014

Eye protection when operating grinding wheels.

Face shields or goggles in good condition shall be worn when operating a grinding wheel.

[53 FR 32533, Aug. 25, 1988]

SURFACE ONLY

30 CFR § 57.15020

Life jackets and belts.

SURFACE ONLY

Life jackets or belts shall be worn where there is danger from falling into water.

UNDERGROUND ONLY

30 CFR § 57.15030

Provisions and maintenance of self-rescue devices.

A 1-hour self-rescue device approved by MSHA and NIOSH under 42 CFR part 84 shall be made available by the operator to all personnel underground. Each operator shall maintain self-rescue devices in good condition.

[60 FR 30398, June 8, 1995]

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.15031

Location of self-rescue devices.

(a) Except as provided in paragraph (b) and (c) of this section, self-rescue devices meeting the requirements of standard 57.15030 shall be worn or carried by all persons underground.

(b) Where the wearing or carrying of self-rescue devices meeting the requirements of standard 57.15030 is hazardous to a person, such self-rescue devices shall be located at a distance no greater than 25 feet from such person.

(c) Where a person works on or around mobile equipment, self-rescue devices may be placed in a readily accessible location on such equipment.

Subpart O--Materials Storgage and Handling.

30 CFR § 57.16001

Stacking and storage of materials.

Supplies shall not be stacked or stored in a manner which creates tripping or fall-of-material hazards.

30 CFR § 57.16002

Bins, hoppers, silos, tanks, and surge piles.

(a) Bins, hoppers, silos, tanks, and surge piles, where loose unconsolidated materials are stored, handled or transferred shall be--

(a)(1) Equipped with mechanical devices or other effective means of handling materials so that during normal operations persons are not required to enter or work where they are exposed to entrapment by the caving or sliding of materials; and

(a)(2) Equipped with supply and discharge operating controls. The controls shall be located so that spills or overruns will not endanger persons.

(b) Where persons are required to move around or over any facility listed in this standard, suitable walkways or passageways shall be provided.

(c) Where persons are required to enter any facility listed in this standard for maintenance or inspection purposes, ladders, platforms, or staging shall be provided. No person shall enter the facility until the supply and discharge of materials have ceased and the supply and discharge equipment is locked out. Persons entering the facility shall wear a safety belt or harness equipped with a lifeline suitably fastened. A second person, similarly equipped, shall be stationed near where the lifeline is fastened and shall constantly adjust it or keep it tight as needed, with minimum slack.

30 CFR § 57.16003

Storage of hazardous materials.

Materials that can create hazards if accidentally liberated from their containers shall be stored in a manner that minimizes the dangers.

30 CFR § 57.16004

Containers for hazardous materials.

Containers holding hazardous materials must be of a type approved for such use by recognized agencies.

30 CFR § 57.16005

Securing gas cylinders.

Compressed and liquid gas cylinders shall be secured in a safe manner.

30 CFR § 57.16006

Protection of gas cylinder valves.

Valves on compressed gas cylinders shall be protected by covers when being transported or stored, and by a safe location when the cylinders are in use.

30 CFR § 57.16007

Taglines, hitches, and slings.

(a) Taglines shall be attached to loads that may require steadying or guidance while suspended.

(b) Hitches and slings used to hoist materials shall be suitable for the particular material handled.

30 CFR § 57.16009

Suspended loads.

Persons shall stay clear of suspended loads.

30 CFR § 57.16010

Dropping materials from overhead.

To protect personnel, material shall not be dropped from an overhead elevation until the drop area is first cleared of personnel and the area is then either guarded or a suitable warning is given.

30 CFR § 57.16011

Riding hoisted loads or on the hoist hook.

Persons shall not ride on loads being moved by cranes or derricks, nor shall they ride the hoisting hooks unless such method eliminates a greater hazard.

30 CFR § 57.16012

Storage of incompatible substances.

Chemical substances, including concentrated acids and alkalies, shall be stored to prevent inadvertent contact with each other or with other substances, where such contact could cause a violent reaction or the liberation of harmful fumes or gases.

30 CFR § 57.16013

Working with molten metal.

Suitable warning shall be given before molten metal is poured and before a container of molten metal is moved.

30 CFR § 57.16014

Operator-carrying overhead cranes.
Operator-carrying overhead cranes shall be provided with--

(a) Bumpers at each end of each rail;

(b) Automatic switches to halt uptravel of the blocks before they strike the hoist;

(c) Effective audible warning signals within easy reach of the operator; and

(d) A means to lock out the disconnect switch.

30 CFR § 57.16015

Work or travel on overhead crane bridges.

No person shall work from or travel on the bridge of an overhead crane unless the bridge is provided with substantial footwalks with toeboards and railings the length of the bridge.

30 CFR § 57.16016

Lift trucks.

Fork and other similar types of lift trucks shall be operated with the:

(a) Upright tilted back to steady and secure the load;

(b) Load in the upgrade position when ascending or descending grades in excess of 10 percent;

(c) Load not raised or lowered enroute except for minor adjustments; and

(d) Load-engaging device downgrade when traveling unloaded on all grades.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.16017

Hoisting heavy equipment or material.

Where the stretching or contraction of a hoist rope could create a hazard, chairs or other suitable blocking shall be used to support conveyances at shaft landings before heavy equipment or material is loaded or unloaded.

Subpart P—Illumination

30 CFR § 57.17001

Illumination of surface working areas.

Illumination sufficient to provide safe working conditions shall be provided in and on all surface structures, paths, walkways, stairways, switch panels, loading and dumping sites, and working areas.

30 CFR § 57.17010

Electric lamps.

Individual electric lamps shall be carried for illumination by all persons underground.

Subpart Q--Safety Programs
SURFACE AND UNDERGROUND

30 CFR § 57.18002

Examination of working places.

SURFACE AND UNDERGROUND

(a) A competent person designated by the operator shall examine each working place at least once each shift for conditions which may adversely affect safety or health. The operator shall promptly initiate appropriate action to correct such conditions.

(b) A record that such examinations were conducted shall be kept by the operator for a period of one year, and shall be made available for review by the Secretary or his authorized representative.

(c) In addition, conditions that may present an imminent danger which are noted by the person conducting the examination shall be brought to the immediate attention of the operator who shall withdraw all persons from the area affected (except persons referred to in section 104(c) of the Federal Mine Safety and Health Act of 1977) until the danger is abated.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.18006

New employees.

New employees shall be indoctrinated in safety rules and safe work procedures.

30 CFR § 57.18009

Designation of person in charge.

When persons are working at the mine, a competent person designated by the mine operator shall be in attendance to take charge in case of an emergency.

30 CFR § 57.18010

First Aid

An individual capable of providing first aid shall be available on all shifts. The individual shall be currently trained and have the skills to perform patient assessment and artificial respiration; control bleeding; and treat shock, wounds, burns, and musculoskeletal injuries. First aid training shall be made available to all interested miners.

30 CFR § 57.18012

Emergency telephone numbers.

Emergency telephone numbers shall be posted at appropriate telephones.

30 CFR § 57.18013

Emergency communications system.

A suitable communication system shall be provided at the mine to obtain assistance in the event of an emergency.

30 CFR § 57.18014

Emergency medical assistance and transportation.

Arrangements shall be made in advance for obtaining emergency medical assistance and transportation for injured persons.

SURFACE ONLY

30 CFR § 57.18020

Working alone.

SURFACE ONLY

No employee shall be assigned, or allowed, or be required to perform work alone in any area where hazardous conditions exist that would endanger his safety unless he can communicate with others, can be heard, or can be seen.

UNDERGROUND ONLY

30 CFR § 57.18025

Working alone.

UNDERGROUND ONLY

No employee shall be assigned, or allowed, or be required to perform work alone in any area where hazardous conditions exist that would endanger his safety unless his cries for help can be heard or he can be seen.

30 CFR § 57.18028

Mine emergency and self-rescuer training.

(a) On an annual basis, all persons who are required to go underground shall be instructed in the Mine Safety and Health Administration approved course contained in Bureau of Mines Instruction Guide 19, "Mine Emergency Training" (September 1972). The instruction shall be given by MSHA personnel or by persons who are certified by the District Manager of the area in which the mine is located.

(b) On an annual basis, all persons who go underground shall be instructed in the Mine Safety and Health Administration course contained in Bureau of Mines Instruction Guide 2, "MSA W-65 Self-Rescuer" (March 1972) or Bureau of Mines Instruction Guide 3, "Permissible Drager 810 Respirator for Self-Rescue" (March 1972). The instruction shall be given by MSHA personnel or by persons who are certified by the District Manager of the area in which the mine is located: *Provided, however,* That if a Mine Safety and Health Administration instructor or a certified instructor is not immediately available such instruction of new employees in self-rescuers may be conducted by qualified company personnel who are not certified, but who have obtained provisional approval from the District Manager. Any person who has not had self-rescuer instruction within 12 months immediately preceding going underground shall be instructed in the use of self-rescuers before going underground.

(c) All instructional material, handouts, visual aids, and other such teaching accessories used by the operator in the courses prescribed in paragraphs (a) and (b) of this section shall be available for inspection by the Secretary or his authorized representative.

(d) Records of all instruction shall be kept at the mine site or nearest mine office at least 2 years from the date of instruction. Upon completion of such instruction, copies of the record shall be submitted to the District Manager.

(e) The Bureau of Mines instruction guides to which reference is made in items (a) and (b) of this standard are hereby incorporated by reference and made a part hereof. The incorporated instruction guides are available and shall be provided upon request made to any Metal and Nonmetal Mine Safety and Health Subdistrict Office.

Subpart R--Personnel Hoisting.

30 CFR § 57.19000

Application.

(a) The hoisting standards in this subpart apply to those hoists and appurtenances used for hoisting persons. However, where persons may be endangered by hoists and appurtenances used solely for handling ore, rock, and materials, the appropriate standards should be applied.

(b) Standards 57.19021 through 57.19028 shall apply to wire ropes in service used to hoist--

(1) Persons in shafts and slopes underground;

(2) Persons with an incline hoist on the surface; or

(3) Loads in shaft or slope development when persons work below suspended loads.

(4) These standards do not apply to wire ropes used for elevators.

(c) Emergency hoisting facilities should conform to the extent possible to safety requirements for other hoists, and should be adequate to remove the persons from the mine with a minimum of delay.

HOISTS

30 CFR § 57.19001

Rated capacities.

HOISTS

Hoists shall have rated capacities consistent with the loads handled and the recommended safety factors of the ropes used.

30 CFR § 57.19002

Anchoring.

Hoists shall be anchored securely.

30 CFR § 57.19003

Driving mechanism connections.

Belt, rope, or chains shall not be used to connect driving mechanisms to man hoists.

30 CFR § 57.19004

Brakes.

Any hoist used to hoist persons shall be equipped with a brake or brakes which shall be capable of holding its fully loaded cage, skip, or bucket at any point in the shaft.

30 CFR § 57.19005

Locking mechanism for clutch.

The operating mechanism of the clutch of every man-hoist drum shall be provided with a locking mechanism, or interlocked electrically or mechanically with the brake to prevent accidental withdrawal of the clutch.

30 CFR § 57.19006

Automatic hoist braking devices.

Automatic hoists shall be provided with devices that automatically apply the brakes in the event of power failure.

30 CFR § 57.19007

Overtravel and overspeed devices.

All man hoists shall be provided with devices to prevent overtravel. When utilized in shafts exceeding 100 feet in depth, such hoists shall also be provided with overspeed devices.

30 CFR § 57.19008

Friction hoist synchronizing mechanisms.

Where creep or slip may alter the effective position of safety devices, friction hoists shall be equipped with synchronizing mechanisms that recalibrate the overtravel devices and position indicators.

30 CFR § 57.19008

Friction hoist synchronizing mechanisms.

Where creep or slip may alter the effective position of safety devices, friction hoists shall be equipped with synchronizing mechanisms that recalibrate the overtravel devices and position indicators.

30 CFR § 57.19010

Location of hoist controls.

Hoist controls shall be placed or housed so that the noise from machinery or other sources will not prevent hoistmen from hearing signals.

30 CFR § 57.19011

Drum flanges.

Flanges on drums shall extend radially a minimum of 4 inches or three rope diameters beyond the last wrap, whichever is the lesser.

30 CFR § 57.19012

Grooved drums.

Where grooved drums are used, the grooves shall be of suitable size and pitch for the ropes used.

30 CFR § 57.19013

Diesel- and other fuel-injection-powered hoists.

Where any diesel or similar fuel-injection engine is used to power a hoist, the engine shall be equipped with a damper or other cutoff in its air intake system. The control handle shall be clearly labeled to indicate that its intended function is for emergency stopping only.

30 CFR § 57.19014

Friction hoist overtravel protection.

In a friction hoist installation, tapered guides or other approved devices shall be installed above and below the limits of regular travel of the conveyance and arranged to prevent overtravel in the event of failure of other devices.

30 CFR § 57.19017

Emergency braking for electric hoists.

Each electric hoist shall be equipped with a manually-operable switch that will initiate emergency braking action to bring the conveyance and the counterbalance safely to rest. This switch shall be located within reach of the hoistman in case the manual controls of the hoist fail.

30 CFR § 57.19018

Overtravel by-pass switches.

When an overtravel by-pass switch is installed, the switch shall function so as to allow the conveyance to be moved through the overtravel position when the switch is held in the closed position by the hoistman. The overtravel by-pass switch shall return automatically to the open position when released by the hoistman.

WIRE ROPES

30 CFR § 57.19019

Guide ropes.

WIRE ROPES

AUTHORITY: § 101, Federal Mine Safety and Health Act of 1977, Pub. L. 91-173 as amended by Pub. L. 95-164, 91 Stat. 1291 (30 U.S.C. 811).

If guide ropes are used in shafts for personnel hoisting applications other than shaft development, the nominal strength (manufacturer's published catalog strength) of the guide rope at installation shall meet the minimum value calculated as follows: Minimum value = Static Load x 5.0.

30 CFR § 57.19021

Minimum rope strength.

At installation, the nominal strength (manufacturer's published catalog strength) of wire ropes used for hoisting shall meet the minimum rope strength values obtained by the following formulas in which "L" equals the maximum suspended rope length in feet:

(a) *Winding drum ropes* (all constructions, including rotation resistant).

For rope lengths less than 3,000 feet: Minimum Value=Static Load x (7.0--0.001L)
For rope lengths 3,000 feet or greater: Minimum Value=Static Load x 4.0.

(b) Friction drum ropes.

For rope lengths less than 4,000 feet: Minimum Value=Static Load x (7.0--0.0005L)
For rope lengths 4,000 feet or greater: Minimum Value=Static Load x 5.0.

(c) *Tail ropes* (balance ropes).

Minimum Value=Weight of Rope x 7.0

30 CFR § 57.19022

Initial measurement.

After initial rope stretch but before visible wear occurs, the rope diameter of newly installed wire ropes shall be measured at least once in every third interval of active length and the measurements averaged to establish a baseline for subsequent measurements. A record of the measurements and the date shall be made by the person taking the measurements. This record shall be retained until the rope is retired from service.

[60 FR 33719, June 29, 1995]

30 CFR § 57.19023

Examinations.

(a) At least once every fourteen calendar days, each wire rope in service shall be visually examined along its entire active length for visible structural damage, corrosion, and improper lubrication or dressing. In addition, visual examination for wear and broken wires shall be made at stress points, including the area near attachments, where the rope rests on sheaves, where the rope leaves the drum, at drum crossovers, and at change-of-layer regions. When any visible condition that results in a reduction of rope strength is present, the affected portion of the rope shall be examined on a daily basis.

(b) Before any person is hoisted with a newly installed wire rope or any wire rope that has not been examined in the previous fourteen calendar days, the wire rope shall be examined in accordance with paragraph (a) of this section.

(c) At least once every six months, nondestructive tests shall be conducted of the active length of the rope, or rope diameter measurements shall be made--

(c)(1) Wherever wear is evident;

(c)(2) Where the hoist rope rests on sheaves at regular stopping points;

(c)(3) Where the hoist rope leaves the drum at regular stopping points; and

(c)(4) At drum crossover and change-of-layer regions.

(d) At the completion of each examination required by paragraph (a) of this section, the person making the examination shall certify, by signature and date, that the examination has been made. If any condition listed in paragraph (a) of this section is present, the person conducting the examination shall make a record of the condition and the date. Certifications and records of examinations shall be retained for one year.

(e) The person making the measurements or nondestructive tests as required by paragraph (c) of this section shall record the measurements or test results and the date. This record shall be retained until the rope is retired from service.

[60 FR 33719, June 29, 1995]

30 CFR § 57.19024

Retirement criteria.

Unless damage or deterioration is removed by cutoff, wire ropes shall be removed from service when any of the following conditions occurs:

(a) The number of broken wires within a rope lay length, excluding filler wires, exceeds either--

(a)(1) Five percent of the total number of wires; or

(a)(2) Fifteen percent of the total number of wires within any strand.

(b) On a regular lay rope, more than one broken wire in the valley between strands in one rope lay length.

(c) A loss of more than one-third of the original diameter of the outer wires.

(d) Rope deterioration from corrosion.

(e) Distortion of the rope structure.

(f) Heat damage from any source.

(g) Diameter reduction due to wear that exceeds six percent of the baseline diameter measurement.

(h) Loss of more than ten percent of rope strength as determined by nondestructive testing.

30 CFR § 57.19025

Load end attachments.

(a) Wire rope shall be attached to the load by a method that develops at least 80 percent of the nominal strength of the rope.

(b) Except for terminations where use of other materials is a design feature, zinc (spelter) shall be used for socketing wire ropes. Design feature means either the manufacturer's original design or a design approved by a registered professional engineer

(c) Load end attachment methods using splices are prohibited.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.19026

Drum end attachment.

(a) For drum end attachment, wire rope shall be attached--

(1) Securely by clips after making one full turn around the drum spoke;

(2) Securely by clips after making one full turn around the shaft, if the drum is fixed to the shaft; or

(3) By properly assembled anchor bolts, clamps, or wedges, provided that the attachment is a design feature of the hoist drum. Design feature means either the manufacturer's original design or a design approved by a registered professional engineer.

(b) A minimum of three full turns of wire rope shall be on the drum when the rope is extended to its maximum working length.

30 CFR § 57.19027

End attachment retermination.

Damaged or deteriorated wire rope shall be removed by cutoff and the rope reterminated where there is--

(a) More than one broken wire at an attachment;

(b) Improper installation of an attachment;

(c) Slippage at an attachment; or

(d) Evidence of deterioration from corrosion at an attachment.

30 CFR § 57.19028

End attachment replacement.

Wire rope attachments shall be replaced when cracked, deformed, or excessively worn.

30 CFR § 57.19030

Safety device attachments.

Safety device attachments to hoist ropes shall be selected, installed, and maintained according to manufacturers' specifications to minimize internal corrosion and weakening of the hoist rope.

HEADFRAMES AND SHEAVES

30 CFR § 57.19035

Headframe design.

HEADFRAMES AND SHEAVES

All headframes shall be constructed with suitable design considerations to allow for all dead loads, live loads, and wind loads.

30 CFR § 57.19036

Headframe height.

Headframes shall be high enough to provide clearance for overtravel and safe stopping of the conveyance.

30 CFR § 57.19037

Fleet angles.

Fleet angles on hoists installed after November 15, 1979, shall not be greater than one and one-half degrees for smooth drums or two degrees for grooved drums.

30 CFR § 57.19038

Platforms around elevated head sheaves.

Platforms with toeboards and handrails shall be provided around elevated head sheaves.

CONVEYANCES

30 CFR § 57.19045

Metal bonnets.

CONVEYANCES

Man cages and skips used for hoisting or lowering employees or other persons in any vertical shaft or any incline shaft with an angle of inclination of forty-five degrees from the horizontal, shall be covered with a metal bonnet.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.19049

Hoisting persons in buckets.

Buckets shall not be used to hoist persons except during shaft sinking operations, inspection, maintenance, and repairs.

30 CFR § 57.19050

Bucket requirements.

Buckets used to hoist persons during vertical shaft sinking operations shall--

(a) Be securely attached to a crosshead when traveling in either direction between the lower and upper crosshead parking locations;

(b) Have overhead protection when the shaft depth exceeds 50 feet;

(c) Have sufficient depth or a suitably designed platform to transport persons safely in a standing position; and

(d) Have devices to prevent accidental dumping where the bucket is supported by a bail attached to its lower half.

30 CFR § 57.19054

Rope guides.

Where rope guides are used in shafts other than in shaft sinking operations, the rope guides shall be a type of lock coil construction.

HOISTING PROCEDURES

30 CFR § 57.19055

Availability of hoist operator for manual hoists.

HOISTING PROCEDURES

When a manually operated hoist is used, a qualified hoistman shall remain within hearing of the telephone or signal device at all times while any person is underground.

30 CFR § 57.19056

Availability of hoist operator for automatic hoists.

When automatic hoisting is used, a competent operator of the hoist shall be readily available at or near the hoisting device while any person is underground.

30 CFR § 57.19057

Hoist operator's physical fitness.

No person shall operate a hoist unless within the preceding 12 months he has had a medical examination by a qualified, licensed physician who shall certify his fitness to perform this duty. Such certification shall be available at the mine.

30 CFR § 57.19058

Experienced hoist operators.

Only experienced hoistmen shall operate the hoist except in cases of emergency and in the training of new hoistmen.

30 CFR § 57.19061

Maximum hoisting speeds.

The safe speed for hoisting persons shall be determined for each shaft, and this speed shall not be exceeded. Persons shall not be hoisted at a speed faster than 2,500 feet per minute, except in an emergency.

30 CFR § 57.19062

Maximum acceleration and deceleration.

Maximum normal operating acceleration and deceleration shall not exceed 6 feet per second per second. During emergency braking, the deceleration shall not exceed 16 feet per second per second.

30 CFR § 57.19063

Persons allowed in hoist room.

Only authorized persons shall be in hoist rooms.

30 CFR § 57.19065

Lowering conveyances by the brakes.

Conveyances shall not be lowered by the brakes alone except during emergencies.

30 CFR § 57.19066

Maximum riders in a conveyance.

In shafts inclined over 45 degrees, the operator shall determine and post in the conveyance or at each shaft station the maximum number of persons permitted to ride in a hoisting conveyance at any one time. Each person shall be provided a minimum of 1.5 square feet of floor space.

30 CFR § 57.19067

Trips during shift changes.

During shift changes, an authorized person shall be in charge of each trip in which persons are hoisted.

30 CFR § 57.19068

Orderly conduct in conveyances.

Persons shall enter, ride, and leave conveyances in an orderly manner.

30 CFR § 57.19069

Entering and leaving conveyances.

Persons shall not enter or leave conveyances which are in motion or after a signal to move the conveyance has been given to the hoistman.

30 CFR § 57.19070

Closing cage doors or gates.

Cage doors or gates shall be closed while persons are being hoisted; they shall not be opened until the cage has come to a stop.

30 CFR § 57.19071

Riding in skips or buckets.

Persons shall not ride in skips or buckets with muck, supplies, materials, or tools other than small hand tools.

30 CFR § 57.19072

Skips and cages in same compartment.

When combinations of cages and skips are used in the same compartment, the cages shall be enclosed to protect personnel from flying material and the hoist speed reduced to man-speed as defined in standard 57.19061, but not to exceed 1,000 feet per minute. Muck shall not be hoisted with personnel during shift changes.

30 CFR § 57.19073

Hoisting during shift changes.

Rock or supplies shall not be hoisted in the same shaft as persons during shift changes, unless the compartments and dumping bins are partitioned to prevent spillage into the cage compartment.

30 CFR § 57.19074

Riding the bail, rim, bonnet, or crosshead.

Persons shall not ride the bail, rim, bonnet, or crosshead of any shaft conveyance except when necessary for inspection and maintenance, and then only when suitable protection for persons is provided.

30 CFR § 57.19075

Use of open hooks.

Open hooks shall not be used to hoist buckets or other conveyances.

30 CFR § 57.19076

Maximum speeds for hoisting persons in buckets.

When persons are hoisted in buckets, speeds shall not exceed 500 feet per minute and shall not exceed 200 feet per minute when within 100 feet of the intended station.

30 CFR § 57.19077

Lowering buckets.

Buckets shall be stopped about 15 feet from the shaft bottom to await a signal from one of the crew on the bottom for further lowering.

30 CFR § 57.19078

Hoisting buckets from the shaft bottom.

All buckets shall be stopped after being raised about three feet above the shaft bottom. A bucket shall be stabilized before a hoisting signal is given to continue hoisting the bucket to the crosshead. After a hoisting signal is given, hoisting to the crosshead shall be at a minimum speed. The signaling device shall be attended constantly until a bucket reaches the guides. When persons are hoisted, the signaling devices shall be attended until the crosshead has been engaged.

30 CFR § 57.19079

Blocking mine cars.

Where mine cars are hoisted by cage or skip, means for blocking cars shall be provided at all landings and also on the cage.

30 CFR § 57.19080

Hoisting tools, timbers, and other materials.

When tools, timbers, or other materials are being lowered or raised in a shaft by means of a bucket, skip, or cage, they shall be secured or so placed that they will not strike the sides of the shaft.

30 CFR § 57.19081

Conveyances not in use.

When conveyances controlled by a hoist operator are not in use, they shall be released and the conveyances shall be raised or lowered a suitable distance to prevent persons from boarding or loading the conveyances.

30 CFR § 57.19083

Overtravel backout device.

A manually operated device shall be installed on each electric hoist that will allow the conveyance or counterbalance to be removed from an overtravel

position. Such device shall not release the brake, or brakes, holding the overtravelled conveyance or counterbalance until sufficient drive motor torque has been developed to assure movement of the conveyance or counterbalance in the correct direction only.

SIGNALING

30 CFR § 57.19090

Dual signaling systems.

SIGNALING

There shall be at least two effective approved methods of signaling between each of the shaft stations and the hoist room, one of which shall be a telephone or speaking tube.

30 CFR § 57.19091

Signaling instructions to hoist operator.

Hoist operators shall accept hoisting instructions only by the regular signaling system unless it is out of order. In such an event, and during other emergencies, the hoist operator shall accept instructions to direct movement of the conveyances only from authorized persons.

30 CFR § 57.19092

Signaling from conveyances.

A method shall be provided to signal the hoist operator from cages or other conveyances at any point in the shaft.

30 CFR § 57.19093

Standard signal code.

A standard code of hoisting signals shall be adopted and used at each mine. The movement of a shaft conveyance on a "one bell" signal is prohibited.

30 CFR § 57.19094

Posting signal code.

A legible signal code shall be posted prominently in the hoist house within easy view of the hoistmen, and at each place where signals are given or received.

30 CFR § 57.19095

Location of signal devices.

Hoisting signal devices shall be positioned within easy reach of persons on the shaft bottom or constantly attended by a person stationed on the lower deck of the sinking platform.

30 CFR § 57.19096

Familiarity with signal code.

Any person reponsible for receiving or giving signals for cages, skips, and mantrips when persons or materials are being transported shall be familiar with the posted signaling code.

SHAFTS

30 CFR § 57.19100

Shaft landing gates.

SHAFTS

Shaft landings shall be equipped with substantial safety gates so constructed that materials will not go through or under them; gates shall be closed except when loading or unloading shaft conveyances.

30 CFR § 57.19101

Stopblocks and derail switches.

Positive stopblocks or a derail switch shall be installed on all tracks leading to a shaft collar or landing.

30 CFR § 57.19102

Shaft guides.

A means shall be provided to guide the movement of a shaft conveyance.

30 CFR § 57.19103

Dumping facilities and loading pockets.

Dumping facilities and loading pockets shall be constructed so as to minimize spillage into the shaft.

30 CFR § 57.19104

Clearance at shaft stations.

Suitable clearance at shaft stations shall be provided to allow safe movement of persons, equipment and materials.

30 CFR § 57.19105

Landings with more than one shaft entrance.

A safe means of passage around open shaft compartments shall be provided on landings with more than one entrance to the shaft.

30 CFR § 57.19106

Shaft sets.

Shaft sets shall be kept in good repair and clean of hazardous material

30 CFR § 57.19107

Precautions for work in compartment affected by hoisting operation.

Hoistmen shall be informed when persons are working in a compartment affected by that hoisting operation and a "Men Working in Shaft" sign shall be posted at the hoist.

30 CFR § 57.19108

Posting warning signs during shaft work.

When persons are working in a shaft "Men Working in Shaft" signs shall be posted at all devices controlling hoisting operations that may endanger such persons.

30 CFR § 57.19109

Shaft inspection and repair.

Shaft inspection and repair work in vertical shafts shall be performed from substantial platforms equipped with bonnets or equivalent overhead protection.

30 CFR § 57.19110

Overhead protection for shaft deepening work.

A substantial bulkhead or equivalent protection shall be provided above persons at work deepening a shaft.

30 CFR § 57.19111

Shaft-sinking ladders.

Substantial fixed ladders shall be provided from the collar to as near the shaft bottom as practical during shaft-sinking operations, or an escape hoist powered by an emergency power source shall be provided. When persons are on the shaft bottom, a chain ladder, wire rope ladder, or other extension ladders shall be used from the fixed ladder or lower limit of the escape hoist to the shaft bottom.

INSPECTION AND MAINTENANCE

30 CFR § 57.19120

Procedures for inspection, testing, and maintenance.

INSPECTION AND MAINTENANCE

A systematic procedure of inspection, testing and maintenance of shaft and hoisting equipment shall be developed and followed. If it is found or suspected that any part is not functioning properly, the hoist shall not be used until the malfunction has been located and repaired or adjustments have been made.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.19121

Recordkeeping.

At the time of completion, the person performing inspections, tests, and maintenance of shafts and hoisting equipment required in standard 57.19120 shall certify, by signature and date, that they have been done. A record of any part that is not functioning properly shall be made and dated. Certifications and records shall be retained for one year.

(§ 101, Pub. L. 91-173 as amended by Pub. L. 95-164, 91 Stat. 1291 (30 U.S.C. 811))

[60 FR 33719, June 29, 1995]

30 CFR § 57.19122

Replacement parts.

Parts used to repair hoists shall have properties that will ensure the proper and safe function of the hoist.

30 CFR § 57.19129

Examinations and tests at beginning of shift.

Hoistmen shall examine their hoists and shall test overtravel, deadman controls, position indicators, and braking mechanisms at the beginning of each shift.

30 CFR § 57.19130

Conveyance shaft test.

Before hoisting persons and to assure that the hoisting compartments are clear of obstructions, empty hoist conveyances shall be operated at least one round trip after--

(a) Any hoist or shaft repairs or related equipment repairs that might restrict or obstruct conveyance clearance;

(b) Any oversize or overweight material or equipment trips that might restrict or obstruct conveyance clearance;

(c) Blasting in or near the shaft that might restrict or obstruct conveyance clearance; or

(d) Remaining idle for one shift or longer.

30 CFR § 57.19131

Hoist conveyance connections.

Hoist conveyance connections shall be inspected at least once during any 24-hour period that the conveyance is used for hoisting persons.

30 CFR § 57.19132

Safety catches.

(a) A performance drop test of hoist conveyance safety catches shall be made at the time of installation, or prior to installation in a mockup of the actual installation. The test shall be certified to in writing by the manufacturer or by a registered professional engineer performing the test.

(b) After installation and before use, and at the beginning of any seven day period during which the conveyance is to be used, the conveyance shall be suitably rested and the hoist rope slackened to test for the unrestricted functioning of the safety catches and their activating mechanisms.

(c) The safety catches shall be inspected by a competent person at the beginning of any 24-hour period that the conveyance is to be used.

30 CFR § 57.19133

Shaft.

Shafts that have not been inspected within the past 7 days shall not be used until an inspection has been conducted by a competent person.

30 CFR § 57.19134

Sheaves.

Sheaves in operating shafts shall be inspected weekly and kept properly lubricated.

30 CFR § 57.19135

Rollers in inclined shafts.

Rollers used in operating inclined shafts shall be lubricated, properly aligned, and kept in good repair.

Subpart S—Miscellaneous

30 CFR § 57.20001

Intoxicating beverages and narcotics.

Intoxicating beverages and narcotics shall not be permitted or used in or around mines. Persons under the influence of alcohol or narcotics shall not be permitted on the job.

30 CFR § 57.20002

Potable water.

(a) An adequate supply of potable drinking water shall be provided at all active working areas.

(b) The common drinking cup and containers from which drinking water must be dipped or poured are prohibited.

(c) Where single service cups are supplied, a sanitary container for unused cups and a receptacle for used cups shall be provided.

(d) When water is cooled by ice, the ice shall either be of potable water or shall not come in contact with the water.

(e) Potable water outlets shall be posted.

(f) Potable water systems shall be constructed to prevent backflow or backsiphonage of non-potable water

30 CFR § 57.20003

Housekeeping.

At all mining operations--

(a) Workplaces, passageways, storerooms, and service rooms shall be kept clean and orderly;

(b) The floor of every workplace shall be maintained in a clean and, so far as possible, dry condition. Where wet processes are used, drainage shall be maintained, and false floors, platforms, mats, or other dry standing places shall be provided where practicable; and

(c) Every floor, working place, and passageway shall be kept free from protruding nails, splinters, holes, or loose boards, as practicable.

30 CFR § 57.20005

Carbon tetrachloride.

Carbon tetrachloride shall not be used.

30 CFR § 57.20008

Toilet facilities.

(a) Toilet facilities shall be provided at locations that are compatible with the mine operations and that are readily accessible to mine personnel.

(b) The facilities shall be kept clean and sanitary. Separate toilet facilities shall be provided for each sex except where toilet rooms will be occupied by no more than one person at a time and can be locked from the inside.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.20009

Tests for explosive dusts.

Dusts suspected of being explosive shall be tested for explosibility. If tests prove positive, appropriate control measures shall be taken.

30 CFR § 57.20010

Retaining dams.

If failure of a water or silt retaining dam will create a hazard, it shall be of substantial construction and inspected at regular intervals.

30 CFR § 57.20011

Barricades and warning signs.

Areas where health or safety hazards exist that are not immediately obvious to employees shall be barricaded, or warning signs shall be posted at all approaches. Warning signs shall be readily visible, legible, and display the nature of the hazard and any protective action required.

30 CFR § 57.20013

Waste receptacles.

Receptacles with covers shall be provided at suitable locations and used for the disposal of waste food and associated materials. They shall be emptied frequently and shall be maintained in a clean and sanitary condition.

30 CFR § 57.20014

Prohibited areas for food and beverages.

No person shall be allowed to consume or store food or beverages in a toilet room or in any area exposed to a toxic material.

30 CFR § 57.20020

Unattended mine openings.

Access to unattended mine openings shall be restricted by gates or doors, or the openings shall be fenced and posted.

30 CFR § 57.20021

Abandoned mine openings.

Upon abandonment of a mine, the owner or operator shall effectively close or fence off all surface openings down which persons could fall or through which persons could enter. Upon or near all such safeguards, trespass warnings and appropriate danger notices shall be posted.

30 CFR § 57.20031

Blasting underground in hazardous areas.

In underground areas where dangerous accumulations of water, gas, mud, or fire atmosphere could be encountered, persons shall be removed to safe places before blasting.

30 CFR § 57.20032

Two-way communication equipment for underground operations.

Telephones or other two-way communication equipment with instructions for their use shall be provided for communication from underground operations to the surface.

AUTHORITY: 30 U.S.C. 811.

SOURCE: 52 FR 24941, July 1, 1987, unless otherwise noted.

Subpart T--Safety Standards for Methane in Metal and Nonmetal Mines
GENERAL

30 CFR § 57.22001

Scope.

GENERAL

This subpart T sets forth procedures and safety standards for each metal and nonmetal underground mine subject to the Federal Mine Safety and Health Act of 1977. All metal and nonmetal mines will be placed into one of the categories or subcategories defined in this subpart. Mines shall operate in accordance with the applicable standards in this subpart to protect persons against the hazards of methane gas and dust containing volatile matter. The standards in this subpart apply to underground mines as well as surface mills at Subcategory I-C mines. These mines are also required to be operated in accordance with the other applicable health and safety standards published in 30 CFR part 57.

30 CFR § 57.22002

Definitions.

The following definitions apply in this subpart:

Competent person. A person designated by the mine operator who has sufficient experience and training to perform the assigned task.

Explosive material. Explosives, blasting agents, and detonators. Explosives are substances classified as explosives by the Department of Transportation in §§173.53, 173.88, and 173.100 of Title 49 of the Code of Federal Regulations (1986 Edition). Blasting agents are substances classified as blasting agents by the Department of Transportation in §173.114(a) of Title 49 of the Code of Federal Regulations (1986 Edition). Detonators are devices containing a detonating charge used to initiate explosives. Examples of detonators are blasting caps, electric or non-electric instantaneous or delay blasting caps and delay connectors. [A copy of Title 49 is available at any Metal and Nonmetal Mine Safety and Health District Office of the Mine Safety and Health Administration].

Substantial construction. Construction of such strength, material, and workmanship that the object will withstand air blasts, blasting shock, ground movement, pressure differentials, wear, and usage which may be expected to occur in the mining environment.

MINE CATEGORIZATION

30 CFR § 57.22003

Mine Category or subcategory.

MINE CATEGORIZATION

(a) All underground mines, and the surface mills of Subcategory I-C mines (gilsonite), shall be placed into one of the following categories or subcategories to protect persons against the hazards of methane and dusts containing volatile matter. Categories and subcategories are defined as follows:

(1) *Category I* applies to mines that operate within a combustible ore body and either liberate methane or have the potential to liberate methane based on the history of the mine or the geological area in which the mine is located. Category I is divided into Subcategories I-A, I-B, and I-C as follows:

(a)(1) (i) *Subcategory I-A* applies to mines that operate within a combustible ore body and liberate methane and in which--

(a)(1)(i) (A) A concentration of 0.25 percent or more methane has been detected in the mine atmosphere and confirmed by laboratory analysis; or

(a)(1)(i) (B) An ignition of methane has occurred.

(a)(1) (ii) *Subcategory I-B* applies to mines that operate within a combustible ore body and have the potential to liberate methane based on the history of the mine or geological area in which the mine is located and in which--

(a)(1)(ii) (A) A concentration of 0.25 percent or more methane has not been detected in the mine atmosphere; and

(a)(1)(ii) (B) An ignition of methane has not occurred.

(a)(1) (iii) *Subcategory I-C* applies to mines in which the product extracted is combustible and the dust has a volatile matter content of 60 percent or more measured on a moisture free basis[1] .

[1] Measured by the American Society for Testing and Materials, ASTM D 3175-82, Standard Test Method for Volatile Matter in the Analysis Sample of Coal and Coke. (This document is available at any Metal and Nonmetal Mine Safety and Health District Office of the Mine Safety and Health Administration).

(2) *Category II* applies to domal salt mines where the history of the mine or geological area indicates the occurrence of or the potential for an outburst. Category II is divided into Subcategories II-A and II-B as follows:

(a)(2) (i) *Subcategory II-A* applies to domal salt mines where an outburst reportable under §57.22004(c)(1) has occurred.

(a)(2) (ii) *Subcategory II-B* applies to domal salt mines where an outburst reportable under §57.22004(c)(1) has not occurred, but which have the potential for an outburst based on the history of the mine or geological area in which the mine is located.

(3) *Category III* applies to mines in which noncombustible ore is extracted and which liberate a concentration of methane that is explosive, or is capable of forming explosive mixtures with air, or have the potential to do so based on the history of the mine or the geological area in which the mine is located. The concentration of methane in such mines is explosive or is capable of forming

explosive mixtures if mixed with air as illustrated by Table 1 below, entitled "Relation Between Quantitative Composition and Explosibility of Mixtures of Methane and Air".

Table 1

See MSHA Illus. 27

Relation Between Quantitative Composition and Explosibility of Mixtures of Methane and Air

(4) *Category IV* applies to mines in which noncombustible ore is extracted and which liberate a concentration of methane that is not explosive nor capable of forming explosive mixtures with air based on the history of the mine or the geological area in which the mine is located. The concentration of methane in such mines is not explosive nor capable of forming explosive mixtures if mixed with air as illustrated by Table 1 above, entitled "Relation Between Quantitative Composition and Explosibility of Mixtures of Methane and Air".

(5) *Category V* applies to petroleum mines. Category V is divided into Subcategories V-A and V-B as follows:

(a)(5) (i) *Subcategory V-A* applies to petroleum mines that operate entirely or partially within an oil reservoir; and all other petroleum mines in which--

(a)(5)(i) (A) A concentration of 0.25 percent or more methane has been detected in the mine atmosphere and confirmed by laboratory analysis; or

(a)(5)(i) (B) An ignition of methane has occurred.

(a)(5) (ii) *Subcategory V-B* applies to petroleum mines that operate outside of and drill into an oil resevoir and in which--

(a)(5)(ii) (A) A concentration of 0.25 percent or more methane has not been detected in the mine atmosphere; and

(a)(5)(ii) (B) An ignition of methane has not occurred.

(6) *Category VI* applies to mines in which the presence of methane has not been established and are not included in another category or subcategory.

(b) Category or subcategory placement or change in placement shall include consideration of the following:

(1) The history and geology of the mine or of the geological area in which the mine is located;

(2) The ore body and host rock;

(3) The character, amount, duration, origin, and nature of methane emission and the presence of explosive dust and inert gases; and

(4) Whether or not conditions encountered during primary or access development are transient or permanent.

(c)(1) Gas samples for the purpose of category or subcategory placement or change in placement, and for determining action levels, shall be taken in the mine atmosphere. Gas samples taken to determine the nature and extent of an occurrence under §57.22004 (c) and (d) may be taken at any location, including the source, point of entry and the mine atmosphere.

(2) Tests for methane shall be made with hand-held methanometers, methane monitors, atmospheric monitoring systems, devices used to provide laboratory analysis of samples, or with other equally effective sampling devices. However, only methane samples that have been confirmed by laboratory analysis shall be used for category or subcategory placement or change in placement.

(d) Each mine and mill shall be required to operate in accordance with the safety standards applicable to its particular category or subcategory.

30 CFR § 57.22004

Category placement or change in placement.

The Administrator for Metal and Nonmetal Mine Safety and Health (Administrator) shall be responsible for category and subcategory placement, change in placement, and notification of placement of mines.

(a) The Administrator's proposed notice of placement or change in placement shall be sent to the mine operator and the appropriate representative of miners and shall include--

(a) (1) The category or subcategory;

(a) (2) The reasons for placement or change in placement;

(a) (3) The data considered;

(a) (4) The applicable standards and a time schedule for the mine operator to achieve compliance;

(a) (5) Whether or not conditions encountered during primary or access development are transient or permanent; and

(a) (6) Notification of the right to appeal the Administrator's determination under §57.22005.

(b) The operator or the representative of the miners shall have the right to request of the Administrator reassignment of the mine to a more appropriate category or subcategory if, based on operating experience, the conditions set forth in §57.22003(b) indicate that the hazards of methane exist under circumstances more appropriately governed by a different category or subcategory. In response to such a request, the procedures set forth in paragraph (d) of this section shall apply. While the request for category or subcategory reassignment is pending, the mine shall continue to operate under the standards for the category or subcategory to which originally assigned.

(c) MSHA shall be notified as soon as possible if any of the following events occur:

(c) (1) An outburst that results in 0.25 percent or more methane in the mine atmosphere;

(c) (2) A blowout that results in 0.25 percent or more methane in the mine atmosphere;

(c) (3) An ignition of methane; or

(c) (4) Air sample results that indicate 0.25 percent or more methane in the mine atmosphere of a Subcategory I-B, I-C, II-B, V-B or Category VI mine.

(d) The Administrator shall promptly appoint an MSHA committee to investigate occurrences reported in accordance with paragraph (c) of this section or requests filed in accordance with paragraph (b) of this section. Upon completion of an investigation, the committee shall make a written report of the findings. These investigations may include an evaluation of the following:

(d) (1) Source, nature, and extent of occurrences;

(d) (2) Conditions under which the incident occurred;

(d) (3) Samples and tests;

(d) (4) Physical conditions at the time of the occurrence;

(d) (5) Charts, logs, and records related to the occurrence;

(d) (6) Whether the occurrence is isolated, continuous, or could recur;

(d) (7) Conditions indicating that the hazards of methane no longer exist or exist

under circumstances more appropriately governed by a different category or subcategory;

(d) (8) The geology of the mine and the geological area in which the mine is located; and

(d) (9) Statements by witnesses, company officials, employees, and other persons having knowledge of the mine or the occurrence. Representatives of the mine operator, the miners and the appropriate State agency may participate in the investigation.

[52 FR, 24941, July 1, 1987, as amended at 52 FR 41397, Oct. 27, 1987; 60 FR 33719, June 29, 1995]

30 CFR § 57.22005

Notice and appeal of placement or change in placement.

(a) The Administrator's determination of category or subcategory placement or change in placement shall become final upon the 30th day after it is served on the mine operator and representative of miners, unless a request for a hearing has been filed. Service of the Administrator's determination is complete upon mailing by registered or certified mail, return receipt requested.

(b) The mine operator or representative of miners may obtain review of the Administrator's determination by filing a request for a hearing with the Assistant Secretary of Labor for Mine Safety and Health, Mine Safety and Health Administration, 1100 Wilson Boulevard Room 2322, Arlington, Virginia 22209-3939 within 30 days of the Administrator's determination. Service of a request for hearing is completed upon mailing by registered or certified mail, return receipt requested. Requests for a hearing shall be in writing and contain the following information:

(1) Name, address, and mine identification number;

(2) A concise statement of the reason why the Administrator's determination is inappropriate; and

(3) A copy of the Administrator's determination.

(c) The mine operator shall post a copy of the Administrator's determination and the request for a hearing on the mine bulletin board, and shall maintain the posting until the placement becomes final.

(d) Promptly after receipt of the request for a hearing, the Assistant Secretary shall refer to the Chief Administrative Law Judge, United States Department of Labor, the following:

(1) The request for a hearing;

(2) The Administrator's determination; and

(3) All information upon which the Administrator's determination was based.

(e) The hearing shall be regulated and conducted by an Administrative Law Judge in accordance with 29 CFR part 18, entitled, "Rules of Practice and Procedure for Administrative Hearings Before the Office of Administrative Law Judges." Once the Administrative Law Judge has made an initial decision and served each party, the decision shall be final on the 30th day after service, unless discretionary review is undertaken by the Assistant Secretary or an appeal is filed by the mine operator or representative of the miners under paragraph (f) of this section.

(f) Within 30 days after service of an initial decision of an Administrative Law Judge, the Assistant Secretary for Mine Safety and Health may undertake a discretionary review of the initial decision, or the mine operator, or representative of the miners may appeal the initial decision of the Administrative Law Judge to the Assistant Secretary.

(1) The Assistant Secretary shall give notice of discretionary review to the mine operator and representative of the miners. The mine operator or representative of the miners shall give notice of an appeal to the other party. The notice shall specify the suggested changes and refer to the specific findings of fact, conclusions of law, and terms of the initial decision to be reviewed or appealed. The Assistant Secretary shall fix a time for filing any objections to the suggested changes and supporting reasons.

(2) The Assistant Secretary shall promptly notify the Administrative Law Judge of a discretionary review or an appeal. The entire record of the proceedings shall be transmitted to the Assistant Secretary for review.

(3) The Assistant Secretary shall make the final decision based upon consideration of the record of the proceedings. The final decision may affirm, modify, or set aside in whole or in part, the findings and conclusions contained in the initial decision. A statement of reasons for the action taken shall be included in the final decision. The final decision shall be served upon the mine operator and representative of the miners.

(g) Unless a decision by the Administrator for Metal and Nonmetal Mine Safety and Health, or the initial decision of the Administrative Law Judge, is appealed

within 30 days, it becomes final, and is not subject to judicial review for the purposes of 5 U.S.C. 704. Only a decision by the Assistant Secretary shall be considered final Agency action for purposes of judicial review. Any such appeal must be filed in the appropriate circuit of the United States Court of Appeal.

(h) While a final decision of category placement is pending the following procedures shall apply:

(1) Where a mine has been classified as gassy prior to the effective date of these standards, existing gassy mines standards 30 CFR 57.21001 through 57.21101 (1986 Edition) shall continue to be applicable until placement is final.

(2) Where a mine has not been classified as gassy prior to the effective date of these standards and it is placed in Categories I through V, the mine shall comply with Category VI standards (§§57.22231, 57.22232, 57.22236, and 57.22238) until placement is final.

(3) Where a mine has been classified in Categories I through V after the effective date of these standards and category reassignment is being considered, the mine shall comply with the standards applicable to the category to which presently assigned until category placement is final.

[52 FR 24941, July 1, 1987; 52 FR 27903, July 24, 1987]

FIRE PREVENTION AND CONTROL

30 CFR § 57.22101

Smoking (I-A, II-A, III, and V-A mines).

FIRE PREVENTION AND CONTROL

[NOTE: The Category or Subcategory applicability of each standard appears in the parentheses of each standard's title line].

Persons shall not smoke or carry smoking materials, matches, or lighters underground. The operator shall institute a reasonable program to assure that persons entering the mine do not carry such items.

30 CFR § 57.22102

Smoking (I-C mines).

(a) Persons shall not smoke or carry smoking materials, matches, or lighters underground or within 50 feet of a mine opening. The operator shall institute a reasonable program to assure that persons entering the mine do not carry such items.

(b) Smoking is prohibited in surface milling facilities except in designated, dust-free smoking areas.

30 CFR § 57.22103

Open flames (I-A, II-A, III, and V-A mines).

Open flames shall not be permitted underground except for welding, cutting, and other maintenance operations, and for igniting underground retorts in a Subcategory I-A mine. When using open flames in other than fresh air, or in places where methane may enter the air current, tests for methane shall be conducted by a competent person before work is started and every 10 minutes until the job is completed. Continuous methane monitors with audible alarms may be used after the initital test has been conducted as an alternative to the ten-minute interval testing requirement. Open flames shall not be used in atmospheres containing 0.5 percent or more methane.

30 CFR § 57.22104

Open flames (I-C mines).

(a) Open flames, including cutting and welding, shall not be used underground.

(b) Welding and cutting shall not be done within 50 feet of a mine opening unless all persons are out of the mine and the mine opening is covered. The cover shall be a substantial material, such as metal or wood, topped with a layer of wetted material to prevent sparks and flames from entering the mine opening.

30 CFR § 57.22105

Smoking and open flames (IV mines).

Smoking or open flames shall not be permitted in a face or raise, or during release of gas from a borehole until tests have been conducted in accordance with §57.22226 and the methane level has been determined to be below 0.5 percent.

30 CFR § 57.22106

Dust containing volatile matter (I-C mines).

Dust containing volatile matter shall not be allowed to accumulate on the surfaces of enclosures, facilities, or equipment used in surface milling in amounts that, if suspended in air, would become an explosive mixture. An explosive mixture of dust containing volatile matter is 0.02 ounce or more per cubic foot of air.

VENTILATION

30 CFR § 57.22201

Mechanical ventilation (I-A, I-B, I-C, II-A, II-B, III, IV, V-A, and V-B mines).

VENTILATION

All mines shall be ventilated mechanically.

30 CFR § 57.22202

Main fans (I-A, I-B, I-C, II-A, III, V-A, and V-B mines).

(a) Main fans shall be--

(a) (1) Installed on the surface in noncombustible housings provided with noncombustible air ducts;

(a) (2) Except in Subcategory I-A mines, provided with an automatic signal device to give an alarm when the fan stops. The signal device shall be located so that it can be seen or heard by a person designated by the mine operator.

(b) Fan installations shall be--

(b) (1) Offset so that the fan and its associated components are not in direct line with possible explosive forces;

(b) (2) Equipped with explosion-doors, a weak-wall, or other equivalent devices located to relieve the pressure that would be created by an explosion underground. The area of the doors or weak-wall shall be at least equivalent to the average cross-sectional area of the airway.

(c)(1) All main fan-related electrical equipment and cables located within or

exposed to the forward or reverse airstream shall be approved by MSHA under the appliable requirements of 30 CFR part 18;

(c) (2) Drive belts and nonmetallic fan blades shall be constructed of static-conducting material; and

(c) (3) Aluminum alloy fan blades shall not contain more than 0.5 percent magnesium. [Paragraph (c)(3) of this section does not apply to Subcategory I-C mines].

(d) When an internal combustion engine is used to power a main fan or as standby power, the engine shall be--

(d) (1) Installed in a noncombustible housing;

(d) (2) Protected from a possible fuel supply fire or explosion; and

(d) (3) Located out of direct line with the forward and reverse airstream provided by the fan. Engine exhaust gases shall be vented to the atomsphere so that exhaust cannot contaminate mine intake air.

(e) For Subcategory I-A mines only: Main exhaust fans shall be equipped with methane monitors to give an alarm when methane in the return air reaches 0.5 percent. The alarm shall be located so that it can be seen or heard by a person designated by the mine operator.

[52 FR, 24941, July 1, 1987, as amended at 52 FR 41397, Oct. 27, 1987]

30 CFR § 57.22203

Main fan operation (I-C mines).

Main fans shall be operated continuously while ore production is in progress.

30 CFR § 57.22204

Main fan operation and inspection (I-A, II-A, III, and V-A mines).

Main fans shall be--

(a) Provided with a pressure-recording system; and

(b) Inspected daily while operating if persons are underground. Certification of inspections shall be made by signature and date. Certifications and pressure recordings shall be retained for at least one year and made available to an authorized representative of the Secretary.

[52 FR, 24941, July 1, 1987, as amended at 52 FR 41397, Oct. 27, 1987; 60 FR 33719, June 29, 1995]

30 CFR § 57.22205

Doors on main fans (I-A, II-A, III, and V-A mines).

In mines ventilated by multiple main fans, each main fan installation shall be equipped with noncombustible doors. Such doors shall automatically close to prevent air reversal through the fan. The doors shall be located so that they are not in direct line with explosive forces which could come out of the mine.

30 CFR § 57.22206

Main ventilation failure (I-A, II-A, III, and V-A mines).

(a) When there has been a main ventilation failure, such as stoppage of main fans or failure of other components of the main ventilation system, tests for methane shall be conducted in affected active workings until normal air flow has resumed.

(b) If a total failure of ventilation occurs while all persons are out of the mine and the failure lasts for more than 30 minutes, only competent persons shall be allowed underground to examine the mine or to make necessary ventilation changes. Other persons may reenter the mine after the main fans have been operational for at least 30 minutes, or after the mine atmosphere has been tested and contains less than 1.0 percent methane. Persons other than examiners shall not reenter a Subcategory II-A mine until the methane level is less than 0.5 percent.

30 CFR § 57.22207

Booster fans (I-A, II-A, III, and V-A mines).

(a) Booster fans shall be approved by MSHA under the applicable requirements of 30 CFR part 18, and be

(1) Provided with an automatic signal device located so that it can be seen or heard by a person designated by the mine operator to give an alarm when the fan stops or when methane reaches the following levels:

(a)(1)(i) 1.0 percent at the fan in Subcategory I-A, Category III, and Subcategory V-A mines; and

(a)(1)(ii) 0.5 percent at the fan in Subcategory II-A mines.

(2) Equipped with a device that automatically deenergizes power in affected workings should the fan stop; and

(3) Equipped with starting and stopping controls located at the fan and at another accessible remote location.

(b) Booster fan installations, except for booster fans installed in ducts, shall be--

(1) Provided with doors which open automatically when all fans in the installation stop; and

(2) Provided with an air lock when passage through the fan bulkhead is necessary.

30 CFR § 57.22208

Auxiliary fans (I-A, II-A, III, and V-A mines).

(a) Auxiliary fans, except fans used in shops and other areas which have been so designed that methane cannot enter the airway, shall be approved by MSHA under the applicable requirements of 30 CFR part 18, and be operated so that recirculation is minimized. Auxiliary fans shall not be used to ventilate work places during the interruption of normal mine ventilatioin.

(b) Tests for methane shall be made at auxiliary fans before they are started.

30 CFR § 57.22209

Auxiliary fans (I-C mines).

Electric auxiliary fans shall be approved by MSHA under the applicable requirements of 30 CFR part 18. Tests for methane shall be made at electric auxiliary fans before they are started. Such fans shall not be operated when air passing over or through them contains 0.5 percent or more methane.

30 CFR § 57.22210

In-line filters (I-C mines).

Filters or separators shall be installed on air-lift fan systems to prevent explosive concentrations of dust from passing through the fan.

30 CFR § 57.22211

Air flow (I-A mines).

The average air velocity in the last open crosscut in pairs or sets of developing entries, or through other ventilation openings nearest the face, shall be at least 40 feet per minute. The velocity of air ventilating each face at a work place shall be at least 20 feet per minute.

30 CFR § 57.22212

Air flow (I-C, II-A, and V-A mines).

Air flow across each working face shall be sufficient to carry away any accumulation of methane, smoke, fumes, and dust.

30 CFR § 57.22213

Air flow (III mines).

The quantity of air coursed through the last open crosscut in pairs or sets of entries, or through other ventilation openings nearest the face, shall be at least 6,000 cubic feet per minute, or 9,000 cubic feet per minute in longwall and continuous miner sections. The quantity of air across each face at a work place shall be at least 2,000 cubic feet per minute.

30 CFR § 57.22214

Changes in ventilation (I-A, II-A, III, and V-A mines).

(a) Changes in ventilation which affect the main air current or any split thereof and which adversely affect the safety of persons in the mine shall be made only when the mine is idle.

(b) Only persons engaged in making such ventilation changes shall be permitted in the mine during changes.

(c) Power shall be deenergized in affected areas prior to making ventilation changes, except power to monitoring equipment determined by MSHA to be intrinsically safe under 30 CFR part 18. Power shall not be restored until the results of the change have been determined and a competent person has examined affected working places for methane.

30 CFR § 57.22215

Separation of intake and return air (I-A, II-A, III, and V-A mines).

Main intake and return air currents shall be coursed through separate mine openings and shall be separated throughout the mine, except--

(a) Where multiple shafts are used for ventilation and a single shaft contains a curtain wall or partition for separation of air currents. Such wall or partition shall be constructed of reinforced concrete or other noncombustible equivalent, and provided with pressure-relief devices.

(b) During development of openings to the surface--

(1) Ventilation tubing approved by MSHA in accordance with 30 CFR part 7 or previously issued a BC or VT acceptance number by the MSHA Approval and Certification Center may be used for separation of main air currents in the same opening. Flexible ventilation tubing shall not exceed 250 feet in length.

(2) Only development related to making a primary ventilation connection may be performed beyond 250 feet of the shaft.

[52 FR 24941, July 1, 1987, as amended at 54 FR 30508, July 20, 1989]

30 CFR § 57.22216

Separation of intake and return air (I-C mines).

The main intake and return air currents in single shafts shall be separated by ventilation tubing, curtain walls, or partitions. Ventilation tubing shall be constructed of noncombustible material. Curtain walls or partitions shall be constructed of reinforced concrete or other noncombustible equivalent, and provided with pressure-relief devices.

30 CFR § 57.22217

Seals and stoppings (I-A, I-B, and I-C mines).

All seals, and those stoppings that separate main intake from main return airways, shall be of substantial construction and constructed of noncombustible materials, except that stoppings constructed of brattice materials may be used in face areas.

30 CFR § 57.22218

Seals and stoppings (III, V-A, and V-B mines).

(a) All seals, and those stoppings that separate main intake from main return airways, shall be of substantial construction, except that stoppings constructed of brattice materials may be used in face areas.

(b) Exposed surfaces on the intake side of stoppings constructed of combustible materials or foam-type blocks shall be coated with at least one inch of construction plaster containing perlite and gypsum; at least one inch of expanded vermiculite, Portland cement and limestone; or other coatings with equivalent fire resistance. Stoppings constructed to phenolic foam blocks at least 12 inches thick need not be coated for fire resistance. All foam-type blocks used for stopping construction shall be solid.

(c) Exposed surfaces on the fresh air side of seals constructed of combustible materials shall be coated with at least one inch of construction plaster containing perlite and gypsum; at least one inch of expanded vermiculite, Portland cement and limestone; or other coatings with equivalent fire resistance. Foam-type blocks shall not be used for seals.

30 CFR § 57.22219

Seals and stoppings (II-A mines).

(a) Exposed surfaces on the intake side of stoppings constructed of combustible materials, except brattice, shall be coated with at least one inch of construction plaster containing perlite and gypsum; at least one inch of expanded vermiculite, Portland cement and limestone; or other coatings with equivalent fire resistance.

(b) Seals shall be of substantial construction. Exposed surfaces on the fresh air side of seals constructed of combustible materials shall be coated with at least one inch of construction plaster containing perlite and gypsum; at least one inch of expanded vermiculite, Portland cement and limestone; or other coatings with equivalent fire resistance. Foam-type blocks shall not be used for seals.

30 CFR § 57.22220

Air passing unsealed areas (I-A, II-A, III, and V-A mines).

Air that has passed by or through unsealed abandoned or unsealed inactive areas and contains 0.25 percent or more methane shall--

(a) Be coursed directly to a return airway;

(b) Be tested daily for methane by a competent person; and

(c) Not be used to ventilate work places.

30 CFR § 57.22221

Overcast and undercast construction (I-A, II-A, III, and V-A mines).

Overcasts and undercasts shall be--

(a) Of substantial construction;

(b)(1) Constructed of noncombustible materials; or

(b)(2) Where constructed of combustible materials, the outside surfaces shall

be coated with at least one inch of construction plaster containing perlite and gypsum; at least one inch of expanded vermiculite, Portland cement and limestone; or other coatings with equivalent fire resistance;

(c) Kept clear of obstructions.

30 CFR § 57.22222

Ventilation materials (I-A, I-B, I-C, II-A, III, V-A, and V-B mines).

Brattice cloth and ventilation tubing shall be approved by MSHA in accordance with 30 CFR part 7, or shall bear a BC or VT acceptance number issued by the MSHA Approval and Certification Center.

[54 FR 30508, July 20, 1989]

30 CFR § 57.22223

Crosscuts before abandonment (III mines).

A means of ventilating faces shall be provided before workings are abandoned in unsealed areas, unless crosscuts are provided within 30 feet of the face.

30 CFR § 57.22224

Auxiliary equipment stations (I-A and III mines).

Battery charging stations, compressor stations, pump stations, and transformer stations shall be installed in intake air at locations which are sufficiently ventilated to prevent the accumulation of methane.

30 CFR § 57.22225

Auxiliary equipment stations (I-C mines).

Battery charging stations, compressor stations, and electrical substations shall not be installed underground or within 50 feet of a mine opening.

30 CFR § 57.22226

Testing for methane (IV mines).

Tests for methane shall be conducted in the mine atmosphere by a competent person--

(a) At least once each shift prior to starting work in each face and raise; and

(b) Upon initial release of gas into the mine atmosphere from boreholes.

30 CFR § 57.22227

Approved testing devices (I-A, I-B, I-C, II-A, II-B, III, IV, V-A, and V-B mines).

(a) Methane monitoring devices and portable, battery-powered, self-contained devices used for measuring methane, other gases, and contaminants in mine air shall be approved by MSHA under the applicable requirements of 30 CFR parts 18, 21, 22, 23, 27, and 29. Such devices shall be maintained in accordance with manufacturers' instructions, or an equivalent maintenance and calibration procedure.

(b)(1) Flame safety lamps shall not be used to test for methane except as supplementary devices.

(2) Flame safety lamps shall not be used in Subcategory I-C mines.

(c)(1) If electrically powered, remote sensing devices are used, that portion of the instrument located in return air or other places where combustible gases may be present shall be approved by MSHA under the applicable requirements of 30 CFR parts 18, 22, 23, 27, and 29.

(2) If air samples are delivered to remote analytical devices through sampling tubes, such tubes shall be provided with in-line flame arrestors. Pumping equipment and analytical instruments shall be located in intake air.

30 CFR § 57.22228

Preshift examination (I-A, I-C, II-A, III, and V-A mines).

(a) Preshift examinations shall be conducted within three hours prior to the start of the shift for which the examination is being made.

(b) Prior to the beginning of a shift following an idle shift, a competent person shall test the mine atmosphere for methane at all work places before persons other than examiners enter the mine.

(c) When one shift immediately follows another, a competent person shall test the mine atmosphere at each active working face for methane before work is started on that shift.

(d) A competent person shall test the mine atmosphere at each face blasted before work is started.

(e) Except in Subcategory I-C or Category III mines, vehicles used for transportation when examining the mine shall be approved by MSHA under the applicable requirements of 30 CFR parts 18 through 36.

[52 FR, 24941, July 1, 1987, as amended at 53 FR 9615, Mar. 24, 1988]

30 CFR § 57.22229

Weekly testing (I-A, III, and V-A mines).

(a) The mine atmosphere shall be tested for methane and carbon monoxide at least once every seven days by a competent person or an atmospheric monitoring system, or a combination of the two. Such testing shall be done at the following locations:

(1) The return of each split where it enters the main return;

(2) Adjacent to retreat areas, if accessible;

(3) At least one seal of each sealed area, if accessible;

(4) Main returns;

(5) At least one entry of each intake and return;

(6) Idle workings; and

(7) Return air from unsealed abandoned workings.

(b) The volume of air (velocity in Subcategory I-A mines) shall be measured at least once every seven days by a competent person. Such measurement shall be done at the following locations:

(1) Entering main intakes;

(2) Leaving main returns;

(3) Entering each main split;

(4) Returning from each main split; and

(5) In the last open crosscuts or other ventilation openings nearest the active faces where the air enters the return.

(c) Where such examinations disclose hazardous conditions, affected persons shall be informed and corrective action shall be taken.

(d) Certification of examinations shall be made by signature and date. Certifications shall be retained for at least one year and made available to authorized representatives of the Secretary.

[52 FR, 24941, July 1, 1987, as amended at 52 FR 41397, Oct. 27, 1987]

30 CFR § 57.22230

Weekly testing (II-A mines).

(a) The mine atmosphere shall be tested for methane at least once every seven days by a competent person or an atmospheric monitoring system, or a combination of the two. Such testing shall be done at the following locations:

(1) Active mining faces and benches;

(2) Main returns;

(3) Returns from idle workings;

(4) Returns from abandoned workings; and

(5) Seals.

(b) Where such examinations disclose hazardous conditions, affected persons shall be informed and corrective action shall be taken.

(c) Certification of examinations shall be made by signature and date. Certifications shall be kept for at least one year and made available to authorized representatives of the Secretary.

[52 FR, 24941, July 1, 1987, as amended at 52 FR 41397, Oct. 27, 1987; 60 FR 33719, June 29, 1995]

30 CFR § 57.22231

Actions at 0.25 percent methane (I-B, II-B, V-B, and VI mines).

If methane reaches 0.25 percent in the mine atmosphere, changes shall be made to improve ventilation, and MSHA shall be notified immediately.

30 CFR § 57.22232

Actions at 0.5 percent methane (I-B, II-A, II-B, IV, V-B, and VI mines).

If methane reaches 0.5 percent in the mine atmosphere, ventilation changes shall be made to reduce the level of methane. Until methane is reduced to less than 0.5 percent, electrical power shall be deenergized in affected areas, except power to monitoring equipment determined by MSHA to be intrinsically safe under 30 CFR part 18. Diesel equipment shall be shut off or immediately removed from the area and no other work shall be permitted in affected areas.

[52 FR 24941, July 1, 1987; 52 FR 27903, July 24, 1987]

30 CFR § 57.22233

Actions at 0.5 percent methane (I-C mines).

If methane reaches 0.5 percent in the mine atmosphere, ventilation changes shall be made to reduce the level of methane. Until methane is reduced to less than 0.5 percent, no other work shall be permitted in affected areas.

[52 FR 24941, July 1, 1987; 52 FR 27903, July 24, 1987]

30 CFR § 57.22234

Actions at 1.0 percent methane (I-A, I-B, III, V-A, and V-B mines).

(a) If methane reaches 1.0 percent in the mine atmosphere, ventilation changes shall be made to reduce the methane. Until such changes are achieved--

(1) All persons other than competent persons necessary to make the ventilation changes shall be withdrawn from affected areas;

(2) Electrical power shall be deenergized in affected areas, except power to monitoring equipment determined by MSHA to be intrinsically safe under 30 CFR part 18; and

(3) Diesel equipment shall be shut off or immediately removed from the area.

(b) If methane reaches 1.0 percent at a main exhaust fan, electrical power underground shall be deenergized, except power to monitoring equipment determined by MSHA to be intrinsically safe under 30 CFR part 18, and all persons shall be withdrawn from the mine.

(c) If methane reaches 1.0 percent at a work place and there has been a failure of the main ventilation system, all persons shall be withdrawn from the mine.

[52 FR, 24941, July 1, 1987, as amended at 53 FR 9615, Mar. 24, 1988]

30 CFR § 57.22235

Actions at 1.0 percent methane (I-C, II-A, II-B, and IV mines).

(a) If methane reaches 1.0 percent in the mine atmoshpere, all persons other than competent persons necessary to make ventilation changes shall be withdrawn from affected areas until methane is reduced to less than 0.5 percent.

(b) If methane reaches 1.0 percent at a work place and there has been a failure of the main ventilation system, all persons shall be withdrawn from the mine.

30 CFR § 57.22236

Actions at 1.0 percent methane (VI mines).

If methane reaches 1.0 percent in the mine atmosphere, all persons other than competent persons necessary to make ventilation changes shall be withdrawn from affected areas until methane is reduced to less than 0.5 percent.

30 CFR § 57.22237

Actions at 2.0 to 2.5 percent methane in bleeder systems (I-A and III mines).

If methane reaches 2.0 percent in bleeder systems at the point where a bleeder split enters a main return split, mining shall not be permitted on ventilation splits affected by the bleeder system. If methane has not been reduced to less than 2.0 percent within 30 minutes, or if methane levels reach 2.5 percent, all persons other than competent persons necessary to take corrective action shall be withdrawn from affected areas.

30 CFR § 57.22238

Actions at 2.0 percent methane (I-B, II-B, V-B, and VI mines).

If methane reaches 2.0 percent in the mine atmosphere, all persons other than competent persons necessary to make ventilation changes shall be withdrawn from the mine until methane is reduced to less than 0.5 percent.

30 CFR § 57.22239

Actions at 2.0 percent methane (IV mines).

If methane reaches 2.0 percent in the mine atmosphere, all persons other than competent persons necessary to make ventilation changes shall be withdrawn from the mine until methane is reduced to less than 0.5 percent. MSHA shall be notified immediately.

[52 FR, 24941, July 1, 1987, as amended at 52 FR 41397, Oct. 27, 1987; 60 FR 33719, June 29, 1995]

30 CFR § 57.22240

Actions at 2.0 percent methane (V-A mines).

If methane reaches 2.0 percent in the mine atmosphere, all persons other than competent persons necessary to make ventilation changes shall be withdrawn from affected areas until methane is reduced to less than 1.0 percent.

[52 FR 24941, July 1, 1987; 52 FR 27903, July 24, 1987]

30 CFR § 57.22241

Advance face boreholes (I-C mines).

(a) Boreholes shall be drilled at least 25 feet in advance of a face whenever the work place is within--

(A) (1) 50 feet of a surveyed abandoned mine or abandoned workings which cannot be inspected; or

(A) (2) 200 feet of an unsurveyed abandoned mine or abandoned workings which cannot be inspected.

(b) Boreholes shall be drilled in such a manner to insure that the advancing face will not accidently break into an abandoned mine or abandoned working.

EQUIPMENT

30 CFR § 57.22301

Atmospheric monitoring systems (I-A, II-A, and V-A mines).

EQUIPMENT

(a) An atmospheric monitoring system shall be installed to provide surface readings of methane concentrations in the mine atmosphere from underground locations. Components of the system shall be approved by MSHA under the applicable requirements of 30 CFR parts 18, 22, 23, and 27; or be determined by MSHA under 30 CFR part 18 to be intrinsically safe or explosion-proof.

(b) Atmospheric monitoring systems shall--

(1) Give warnings on the surface and underground when methane at any sensor reaches 0.5 percent or more, and when power to a sensor is interrupted. Warning devices shall be located so that they can be seen and heard by a person designated by the mine operator; and

(2) Automatically deenergize power in affected areas, except power to monitoring equipment determined by MSHA to be intrinsically safe under 30 CFR part 18, when methane at any sensor reaches--

(b)(2)(i) 1.0 percent in a Subcategory I-A or V-A mine; or

(b)(2)(ii) 0.5 percent while persons are underground and 1.0 percent during blasting in a Subcategory II-A mine. Timing devices are permitted to avoid nuisance tripping for periods not to exceed 30 seconds, except during blasting or the ventilation time following a blast in a Subcategory II-A mine.

(c) Atmospheric monitoring systems shall be checked with a known mixture of methane, and calibrated if necessary at least once every 30 days. Certification of calibration tests shall be made by signature and date. Certifications of tests shall be retained for at least one year and made available to authorized representatives of the Secretary.

30 CFR § 57.22302

Approved equipment (I-A and V-A mines).

Equipment used in or beyond the last open crosscut shall be approved by MSHA under the applicable requirements of 30 CFR parts 18 through 36. Equipment shall not be operated in atmospheres containing 1.0 percent or more methane.

For more information: See MSHA'S Program Policy Manual

30 CFR § 57.22303

Approved equipment (I-C mines).

Only electrical equipment that is approved by MSHA under the applicable requirements of 30 CFR parts 18 through 28 or approved under 30 CFR part 29 contained in the 30 CFR, parts 1-199, edition, revised as of July 1, 1999, shall be used underground, except for submersible sump pumps.

30 CFR § 57.22304

Approved equipment (II-A mines).

(a) Cutting and drilling equipment used at a face or bench shall be approved by MSHA under the applicable requirements of 30 CFR parts 18 through 36.

(b) While cutting or drilling is in progress, equipment not approved by MSHA under the applicable requirements of 30 CFR parts 18 through 36 shall remain at least 100 feet from the face or bench being mined.

(c) Tests for methane shall be conducted immediately before nonapproved equipment is taken to a face or bench after blasting.

(d) Mine power transformers and stationary equipment not approved by MSHA under the applicable requirements of 30 CFR parts 18 through 36 shall be installed in fresh air or downwind from an atmospheric methane monitor sensor.

30 CFR § 57.22305

Approved equipment (III mines).

Equipment used in or beyond the last open crosscut and equipment used in areas where methane may enter the air current, such as pillar recovery workings, longwall faces and shortwall faces, shall be approved by MSHA under the applicable requirements of 30 CFR parts 18 through 36. Equipment shall not be operated in atmospheres containing 1.0 percent or more methane.

30 CFR § 57.22306

Methane monitors (I-A mines).

(a) Methane monitors shall be installed on continuous mining machines, longwall mining systems, and on loading and haulage equipment used in or beyond the last open crosscut.

(b) The monitors shall--

(1) Give warning at 1.0 percent methane;

(2) Automatically deenergize electrical equipment, except power to monitoring equipment determined by MSHA to be intrinsically safe under 30 CFR part 18, and prevent starting such equipment when methane levels reach 1.5 percent. Diesel equipment shall be shut off or immediately removed from the affected area; and

(3) Automatically deenergize electrical equipment when power to a sensor is interrupted. Diesel equipment shall not be operated if the monitor is inoperative.

(c) Sensing units of monitors shall be positioned at a location which provides for the most effective measurement of methane.

30 CFR § 57.22307

Methane monitors (II-A mines).

(a) Methane monitors shall be installed on continuous mining machines, longwall mining systems, bench and face drills, and undercutting machines used in or beyond the last open crosscut.

(b) The monitors shall--

(1) Give warning at 0.5 percent methane;

(2) Automatically deenergize electrical equipment, except power to monitoring equipment determined by MSHA to be intrinsically safe under 30 CFR part 18, and prevent starting such equipment when methane levels reach 1.0 percent; and

(3) Automatically deenergize the equipment when power to a sensor is interrupted.

(c) Sensing units of monitors shall be positioned at a location which provides for the most effective measurement of methane.

30 CFR § 57.22308

Methane monitors (III mines).

(a) Methane monitors shall be installed on continuous mining machines and longwall mining systems.

(b) The monitors shall--

(1) Give warning at 1.0 percent methane;

(2) Automatically deenergize electrical equipment, except power to monitoring equipment determined by MSHA to be intrinsically safe under 30 CFR part 18, and prevent starting such equipment when methane levels reach 1.5 percent; and

(3) Automatically deenergize the equipment when power to a sensor is interrupted.

(c) Sensing units of monitors shall be positioned at a location which provides for the most effective measurement of methane.

CFR § 57.22309

Methane monitors (V-A mines).

(a) Methane monitors shall be installed on continuous mining machines used in or beyond the last open crosscut.

(b) The monitors shall--

(1) Give warning at 1.0 percent methane.

(2) Automatically deenergize electrical equipment, except power to monitoring equipment determined by MSHA to be intrinsically safe under 30 CFR part 18, and prevent starting of such equipment when methane levels reach 1.5 percent; and

(3) Automatically deenergize the equipment when power to a sensor is interrupted.

(c) Sensing units of monitors shall be positioned at a location which provides for the most effective measurement of methane.

30 CFR § 57.22310

Electrical cables (I-C mines).

Electrical cables used to power submersible sump pumps shall be accepted or approved by MSHA as flame resistant, or be installed in continuous metal conduit or metal pipe. The ends of such conduit or pipe shall be sealed to prevent entry of explosive gas or dust.
[57 FR 61223, Dec. 23, 1992]

30 CFR § 57.22311

Electrical cables (II-A mines).

Only jacketed electrical cables accepted or approved by MSHA as flame resistant shall be used to supply power to distribution boxes and electrical equipment operating in face and bench areas.

[57 FR 61223, Dec. 23, 1992]

30 CFR § 57.22312

Distribution boxes (II-A and V-A mines).

Distribution boxes containing short circuit protection for trailing cables of approved equipment shall be approved by MSHA under 30 CFR part 18.

30 CFR § 57.22313

Explosion-protection systems (I-C mines).

Pressure-relief systems including vents, or explosion suppression systems, shall be provided on explosive dust handling and processing equipment and on facilities housing such equipment. Vents shall be installed so that forces are directed away from persons should an explosion occur. The ratio of vent size to internal size of the equipment or facility shall not be less than one square foot of vent for each 80 cubic feet of volume or space.

30 CFR § 57.22314

Flow-control devices (V-A and V-B mines).

Oil recovery drill holes that penetrate oil bearing formations shall have devices to control the release of liquid hydrocarbons and hazardous gases during the drilling process. Such devices may be recovered for reuse after the formation has been depressurized or the well or borehole has been capped or connected to a collection system.

30 CFR § 57.22315

Self-contained breathing apparatus (V-A mines).

Self-contained breathing apparatus of a duration to allow for escape from the mine and sufficient in number to equip all persons underground shall be strategically located throughout the mine. Such apparatus shall be approved by MSHA and NIOSH under 42 CFR part 84 and shall be maintained in accordance with manufacturers' specifications. This standard does not apply to double entry mining systems where crosscut intervals do not exceed 250 feet.
[60 FR 30398, June 8, 1995]

UNDERGROUND RETORTS

30 CFR § 57.22401

Underground retorts (I-A and I-B mines).

UNDERGROUND RETORTS

(a) Retorts shall be provided with--
(1) Two independent power sources for main mine ventilation fans and those fans directly ventilating retort bulkheads, and for retort blowers, and provisions for switching promptly from one power source to the other; and
(2) An alarm system for blower malfunctions and an evacuation plan to assure safety of personnel in the event of a failure.
(b) Prior to the ignition of underground retorts, a written ignition and operation plan shall be submitted to the MSHA District Manager for the area in which the mine is located. The mine operator shall comply with all provisions of the retort plan. The retort plan shall include--

(1) Acceptable levels of combustible gases and oxygen in retort off-gases during start-up and during burning; levels at which corrective action will be initiated; levels at which personnel will be removed from the retort areas, from the mine, and from endangered surface areas; and the conditions for reentering the mine;
(2) Specification and locations of off-gas monitoring procedures and equipment;
(3) Specifications for construction of retort bulkheads and seals, and their locations;
(4) Procedures for ignition of a retort and for reignition following a shutdown; and
(5) Details of area monitoring and alarm systems for hazardous gases and actions to be taken to assure safety of personnel.
[52 FR, 24941, July 1, 1987, as amended at 52 FR 41397, Oct. 27, 1987; 60 FR 33719, June 29, 1995]

ILLUMINATION

30 CFR § 57.22501

Personal electric lamps (I-A, I-B, I-C, II-A, II-B, III, IV, V-A, and V-B mines).

ILLUMINATION

Electric lamps used for personal illumination shall be approved by MSHA under the requirements of 30 CFR parts 19 or 20, as applicable.

EXPLOSIVES

30 CFR § 57.22601

Blasting from the surface (I-A mines).

EXPLOSIVES

(a) All development, production, and bench rounds shall be initiated from the surface after all persons are out of the mine. Persons shall not enter the mine until ventilating air has passed over the blast area and through at least one atmospheric monitoring sensor.

(b) After blasting, if the monitoring system indicates that methane in the mine is less than 1.0 percent, persons may enter the mine. All places blasted shall be tested for methane by a competent person before work is started.

(c) If the monitoring system indicates the presence of 1.0 percent or more methane, persons other than examiners shall not enter the mine until the mine has been examined by a competent person and the methane content has been reduced to less than 1.0 percent.

(d) Vehicles used for transportation when examining the mine shall be approved by MSHA under the applicable requirements of 30 CFR parts 18 through 36.

[52 FR, 24941, July 1, 1987, as amended at 53 FR 9615, Mar. 24, 1988]

EFFECTIVE DATE NOTE: At 53 FR 9615, Mar. 24, 1988, §57.22601 was stayed until further notice.

30 CFR § 57.22602

Blasting from the surface (I-C mines).

(a) All blasting shall be initiated from the surface after all persons are out of the mine and any connecting mines.

(b) Persons shall not enter the mine until a competent person has examined the blast sites and methane concentrations are less than 0.5 percent.

30 CFR § 57.22603

Blasting from the surface (II-A mines).

(a) All development, production, and bench rounds shall be initiated from the surface after all persons are out of the mine. Persons shall not enter the mine until the mine has been ventilated for at least 15 minutes and the ventilating air has passed over the blast area and through at least one atmospheric monitoring sensor.

(b) If the monitoring system indicates that methane in the mine is less than 0.5 percent, competent persons may enter the mine to test for methane in all blast areas.

(c) If the monitoring system indicates that methane in the mine is 0.5 percent or more, the mine shall be ventilated and persons shall not enter the mine until the monitoring system indicates that methane in the mine is less than 0.5 percent.

(d) If the monitoring system is inoperable or malfunctions, the mine shall be ventilated for at least 45 minutes and the mine power shall be deenergized before persons enter the mine. Only competent persons necessary to test for methane may enter the mine until the methane in the mine is less than 0.5 percent.

(e) Vehicles used for transportation when examining the mine shall be approved by MSHA under the applicable requirements of 30 CFR parts 18 through 36. Vehicles shall not be used to examine the mine if the monitoring system is inoperable or has malfunctioned.

30 CFR § 57.22604

Blasting from the surface (II-B mines).

All development, production, and bench rounds shall be initiated from the surface after all persons are out of the mine. Persons other than those designated by the mine operator to make methane tests shall not enter the mine until all blast areas have been tested for methane.

30 CFR § 57.22605

Blasting from the surface (V-A mines).

(a) All development and production blasting shall be initiated from the surface after all persons are out of the mine. Persons shall not enter the mine until ventilating air has passed over the blast area and through at least one atmospheric monitoring sensor.

(b) If the monitoring system indicates that methane in the mine is less than 1.0 percent, persons may enter the mine, and all places blasted shall be tested for methane by a competent person before work is started.

(c) If the monitoring system indicates the presence of 1.0 percent or more methane, persons other than examiners shall not enter the mine until the mine has been examined by a competent person and the methane level is less than 1.0 percent.

(d) Vehicles used for transportation when examining the mine shall be approved by MSHA under the applicable requirements of 30 CFR parts 18 through 36.

(e) This standard applies only to mines blasting within an oil reservoir.

30 CFR § 57.22606

Explosive materials and blasting units (III mines).

(a) Mine operators shall notify the appropriate MSHA District Manager of all nonapproved explosive materials and blasting units to be used prior to their use. Explosive materials used for blasting shall be approved by MSHA under 30 CFR part 15, or nonapproved explosive materials shall be evaluated and determined by the District Manager to be safe for blasting in a potentially gassy environment. The notice shall also include the millisecond-delay interval between successive shots and between the first and last shot in a round.

(b) Faces shall be examined for proper placement of holes, possible breakthrough, and water. Ammonium nitrate blasting agents shall not be loaded into wet holes.

(c) Multiple-shot blasts shall be initiated with detonators encased in copper-based alloy shells. Aluminum and aluminum alloy-cased detonators, nonelectric detonators, detonating cord, and safety fuses shall not be used. All detonators in a round shall be made by the same manufacturer.

(d) Nonapproved explosives shall be used only as primers with ammonium nitrate-fuel oil blasting agents. Such primers shall be placed at the back or bottom of the hole.

(e) Blast holes shall be stemmed with a noncombustible material in an amount to confine the explosive charge. Breakthrough holes shall be stemmed at both ends.

(f) Mudcaps or other nonapproved unconfined shots shall not be blasted.

(g)(1) Blasting units shall be approved by MSHA under 30 CFR part 25; or

(2) Blasting units used to fire more than 20 detonators shall provide at least 2 amperes through each detonator but not more than an average of 100 amperes through one ohm for 10 milliseconds, and provide the necessary current for at least the first 5 milliseconds with a cutoff not to exceed 10 milliseconds.

[52 FR, 24941, July 1, 1987, as amended at 52 FR 41397, Oct. 27, 1987]

30 CFR § 57.22607

Blasting on shift (III mines).

When blasting on shift, tests for methane shall be made in the mine atmosphere by a competent person before blasting. Blasting shall not be done when 1.0 percent or more methane is present.

30 CFR § 57.22608

Secondary blasting (I-A, II-A, and V-A mines).

Prior to secondary blasting, tests for methane shall be made in the mine atmosphere at blast sites by a competent person. Secondary blasting shall not be done when 0.5 percent or more methane is present.

Section IX

Title 30 Code of Federal Regulations
30 CFR § 57.6000

General Definitions

Disclaimer

The definitions provided herein are solely for the purpose of general information. They should not be substituted for technical a questions. These definitions are not necessarily intended to conform to those set forth in any governmental regulations or guidelines, nor are they intended to describe any manufacturer's particular product configuration.

AC Alternating current.

Acceptor A charge of explosives or blasting agent receiving an impulse from an exploding donor charge.

Adobe Charge A mud-covered or unconfined explosive charge fired in contact with a rock surface without the use of a borehole-, Synonymous with Bulldoze and Mudcapping.

Air Blast The airborne shock wave or acoustic transient generated by an explosion.

American Table of Distances The quantity-distance table, prepared and approved by IME, for storage of explosive materials to determine safe distances from inhabited buildings, public highways, passenger railways, and other stored explosive materials.

Ammonium Nitrate The ammonium salt of nitric acid represented by the NH_4NO_3

Ampere A unit of electrical current produced by 1 volt acting through a resistance of I ohm.

ANFO An explosive material consisting of ammonium nitrate and fuel oil.

ANSI American National Standards Institute, a nongovernmental organization concerned with developing safety and health standards for industry.

Approved, Approval, or Authorized Terms that mean Approved, Approval, or Authorized by the authority having jurisdiction.

Artificial Barricade An artificial mound or revetted wall of earth of a minimum thickness of 3 ft.

Authorized Person An individual approved or assigned by management to perform a specific duty or duties or to be at a specific location or locations.

Authority Having Jurisdiction The governmental agency, office, or individual responsible for approving equipment, an installation, or a procedure.

Available Energy The energy from an explosive material that is capable of performing useful work.

Back Break Rock broken beyond the limits of the last row of holes in a blast.

Ballistic Mortar A laboratory instrument used for measuring the relative power or strength of an explosive material.

Barricaded The effective screening of a building containing explosives from a magazine or other building, railway, or highway by a natural or an artificial barrier. A straight line from the top of any sidewall of the building containing explosives to the eave line of any magazine or other building or to a point 12 ft above the center of a railway or highway shall pass through such barrier.

Base Charge The main explosive charge in the base of a detonator.

Bench A horizontal ledge in or at the top of a highwall from which holes are drilled vertically down into the material to be blasted; benching is a process of excavating where a highwall is worked in steps or lifts.

Bench Height The vertical distance from the top of a bench to the floor or to the top of the next lower bench.

Black Powder A deflagrating or low-explosive compound of an intimate mixture of sulfur, charcoal, and an alkali nitrate, usually potassium or sodium nitrate.

Blast, Blasting The firing of explosive materials for such purposes as breaking rock or other material, moving material, or generating seismic waves; the assembly of explosive materials for such purpose.

Blast Area The area of a blast within the influence of flying rock missiles, gases, and concussion.

Blast Pattern The plan of the drill holes laid out on a bench; an expression of the burden distance and the spacing distance and their relationship to each other.

Blast Site The area where explosive material is handled during loading, including the perimeter of blastholes and 50 ft in all directions from loaded holes or holes to be loaded. In underground mines, 15 ft of solid rib or pillar can be substituted for the 50-ft distance.

Blaster That qualified person in charge of, and responsible for the loading and firing of a blast (same as *Shot Firer).*

Blasting Accessories Nonexplosive devices and materials used in blasting, such as, but not limited to, cap crimpers, tamping bags, blasting machines, blasting galvanometers, and cartridge punches.

Blasting Agent An explosive material that meets prescribed criteria for insensitivity to initiation. For storage, Title 27, Code of Federal Regulations, Section 555.11 defines a blasting agent as any material or mixture, consisting of fuel and oxidizer intended for blasting, not otherwise defined as an explosive, provided that the finished product, as mixed for use or shipment, cannot be detonated by means of a No. 8 test blasting cap when unconfined (Bureau of Alcohol. Tobacco and Firearms Regulation). For transportation, Title 49, Code of Federal Regulations defines a blasting agent as a material designed for blasting that has been tested in accordance with Section 173.114a and found to be so insensitive that there is very little probability of accidental initiation to explosion or transition from deflagration to detonation (U.S. Department of Transportation Regulation).

Blasting Cap A detonator that is initiated by a safety fuse (see Fuse Cap)

Blasting Crew A group of persons who assist the blaster in loading, tying in, and firing a blast.

Blasting Galvanometer An electrical resistance instrument designed specifically for testing electric detonators and circuits containing them. Along with blasting ohmmeters and blaster's multimeters, it is used to measure resistance or to check electrical continuity.

Blasting Log A written record of information about a specific blast as may be required by law or regulation.

Blasting Machine An electrical or electromechanical device that provides electrical energy for the purpose of energizing detonators in an electric blasting circuit.

Blasting Machine-CD Type See Capacitor-Discharge Blasting Machine.

Blasting Machine-Generator Type A hand-operated electromechanical device that provides an output current to energize electric detonators.

Blasting Machine Rheostat A graduated electrical resistance device used to simulate electric detonator resistances in the testing of blasting machines.

Blasting Mat A mat of woven steel wire, rope, scrap tires, or other suitable material or construction to cover blastholes for the purpose of preventing flying rock missiles.

Blasting Vibrations The energy from a blast that manifests itself in earthborne vibrations that are transmitted through the earth away from the immediate blast area.

Block-Holing The breaking of boulders by loading and firing small explosive charges in small-diameter drilled holes.

Booster An explosive charge, usually of high strength and high detonation velocity, used to improve the initiation of less sensitive explosive materials.

Bootleg The part of a drilled blasthole that remains when the force of the explosion does not break the rock completely to the bottom of the hole.

Borehole (Blasthole) A hole drilled in the material to be blasted, for the purpose of containing an explosive charge.

Breakage A term used to describe the size distribution of the rock fragments created by a blast.

Bridgewire A resistance wire connecting the ends of the legwires inside an electric detonator and which is imbedded in the ignition charge of the detonator.

Brisance The shattering power of an explosive material as distinguished from its total work capacity.

Bulk Mix A mass of explosive material prepared for use in bulk form without packaging.

Bulk Mix Delivery Equipment Equipment (usually a motor vehicle with or without a mechanical delivery device) that transports explosive materials in bulk form for mixing and/or loading directly into blastholes.

Bulk Strength The strength per unit volume of an explosive calculated from its weight strength and density.

Bulldoze A mud-covered or unconfined explosive charge fired in contact with a rock surface without the use of a borehole; Synonymous with Adobe Charge and Mudcapping.

Bullet-Resistant Magazine walls or doors of construction resistant to penetration of a bullet of 150-grain M2 ball ammunition having a nominal muzzle velocity of 2,700 ft/sec fired from a .30-caliber rifle from a distance of 100 ft perpendicular to the wall or door. When a magazine ceiling or roof is required to be bullet-resistant, the ceiling or roof shall be constructed of materials comparable to the sidewalls or of other materials that will withstand penetration of the bullet described above when fired at an angle of 45 degrees from the perpendicular. Tests to determine bullet resistance should be conducted on test panels or empty magazines that will resist penetration of 5 out of 5 shots placed independently of each other in an area at least 3 ft. x 3 ft.

Bullet-Sensitive Explosive Material Explosive material that can be detonated by 150-grain M2 ball ammunition having a nominal muzzle velocity of 2,700 ft/sec when the bullet is fired from a .30-caliber rifle at a distance of not more than 100 ft and the test material, at a temperature of 70 - 75°F, is placed against a backing material of $^1/_2$-in. steel plate.

Bureau of Explosives A bureau of the Association of American Railroads that the U.S. Department of Transportation may consult for recommendations on classification of explosive materials for the purpose of interstate transportation

Burden The distance from the borehole and the nearest free face or the distance between boreholes measured perpendicular to the spacing. Also the total amount of material to be blasted by a given hole, usually measured in cubic yards or tons.

Bureau of Alcohol, Tobacco, and Firearms (BAFT) A bureau of the Department of Treasury having responsibility for the promulgation and enforcement of regulations related to the unlawful use of explosive materials under 18 U.S.C. Chapter 40, Section 847.

Bureau of Mines See U.S. Bureau of Mines.

Bus Wire Expendable heavy-gauge bare copper wire used to connect detonators or series of detonators in parallel

Cap Crimper A mechanical device for crimping the metallic shell of a fuse detonator or igniter cord connector securely to a section of inserted safety fuse.

Cap Sensitivity The sensitivity of an explosive to initiation by a detonator. An explosive material is considered to be cap sensitive if it detonates with an IME No. 8 Test Detonator.

Capacitor-Discharge Blasting Machine A blasting machine in which electrical energy, stored on a capacitor, is discharged into a blasting circuit containing electric detonators..

Carton A lightweight inner container for explosive materials, usually encased in a substantial shipping container called a case.

Cartridge An individual closed shell, bag, or tube of circular cross section containing explosive material.

Cartridge Count (Stick Count) The number of cartridges in a standard case. A standard case typically contains about 50 LB of explosive material.

Cartridge Punch A wooden, plastic, or nonsparking metallic device used to punch an opening in an explosive cartridge to accept a detonator or a section of detonating cord.

Cartridge Strength Same as *Bulk Strength*.

Case An outer substantial shipping container meeting DOT specifications for explosive materials.

Case Liner A plastic or paper barrier used to prevent the escape of explosive materials from a case.

Cast, Extrude, or Pressed Booster A cast, extruded, or pressed solid high explosive used to detonate less sensitive explosive materials.

Certified Blaster A blaster certified by a governmental agency to prepare, execute, and supervise blasting.

Chemical Manufacturers Association (CMA) A nonprofit chemical trade organization of companies in the United States and Canada who manufacture chemicals for sale.

Circuit A completed path for conveying electrical current.

Class A Explosives Explosives, as defined by the U.S. Department of Transportation, that possess detonating or otherwise maximum hazard, such as, but not limited to, dynamite, nitroglycerin, lead azide, blasting caps, and detonating primers

Class B Explosives Explosives, as defined by the U.S. Department of Transportation, that possess flammable hazard, such as, but not limited to, propellant explosives. photographic flash powders, and some special fireworks.

Class C Explosives Explosives, as defined by the U.S. Department of Transportation, that contain Class A or Class B explosives, or both, as components but in restricted quantities.

Collar The term applied to the timbering or concrete around the mouth or top of a shaft. It also refers to the mouth or top of a drill hole in blasting.

Column Charge A charge of explosives in a blasthole in the form of a long, continuous unbroken column.

Column Depth/Column Height The length of each portion of a blast hole filled with explosive materials.

Commercial Explosives Explosives designed, produced, and used for commercial or industrial applications rather than for military purposes.

Confined Detonation Velocity The detonation velocity of an explosive material in a substantial container or a borehole.

Connecting Wire Wire used to extend the firing line or legwires in an electric blasting circuit.

Core Load The explosive core of detonating cord, expressed as the number of grains of explosive per foot.

Coupling The degree to which an explosive fills the cross section of a borehole; bulk-loaded explosives are completely coupled; untamped cartridges are decoupled.

Coyote Shooting A method of blasting using a number of relatively large concentrated charges of explosives placed in one or more small tunnels driven in a rock formation.

Crimp The folded ends of paper explosive cartridges, the circumferential depression at the open end of a fuse cap or igniter cord connector that serves to secure the fuse; or the circumferential depression in the blasting cap shell that secures a sealing plug or sleeve into electric or nonelectric detonators.

Crimping The act of securing a fusecap or igniter cord connector to a section of a safety fuse by compressing the metal shell of the cap against the fuse by means of a cap crimper.

Critical Diameter The minimum diameter for propagation of a detonation wave at a stable velocity. Critical diameter is affected by conditions of confinement, temperature, and pressure on the explosive.

Crosscut A horizontal opening driven across the course of a vein or in general across the direction of the main workings. a connection from a shaft to a vein.

Current Leakage Portion of the firing current bypassing part of the blasting circuit through unintended paths.

Current-Limiting Device An electric or electromechanical device that limits:
1) current amplitude,
2) duration of current flow. or
3) total energy of the current delivered to an electric blasting circuit
Cushion Blasting A blasting technique used to produce competent slopes. The cushion holes, fired after the main charge, have a reduced spacing and employ decoupled charges.

Cutoff A break in a path of detonation or initiation caused by extraneous interference, such as flyrock or shifting ground.

Date-Shift Code A code applied by manufacturers to the outside shipping containers, and, in many instances, to the immediate containers of explosive materials to aid in their identification and tracing.

D'Autriche Method-Detonation Velocity A method of determining the detonation velocity of an explosive material by employing detonating cord and a witness plate.

DC Direct current.

Decibel A unit of air overpressure commonly used to measure air blast.

Deck Loading(Decking) A method of loading blastholes in which the explosive charges, called decks or deck charges, in the same hole are separated by stemming or an air cushion.

Decks An explosive charge that is separated from other charges in the blasthole by stemming or an air cushion.

Deflagration An explosive reaction such as a rapid combustion that moves through an explosive material at a velocity less than the speed of sound in the material.

Delay A distinct pause of predetermined time between detonation or initiation impulses, to permit the firing of explosive charges separately.

Delay Blasting The practice of initiating individual explosive decks, boreholes, or rows of boreholes at predetermined time intervals using delay detonators, as

compared to instantaneous blasting where all holes are fired essentially simultaneously.

Delay Detonator An electric or nonelectric detonator used to introduce a predetermined lapse of time between the application of a firing signal and the detonation of the base charge.

Delay Element The device in a delay detonator that produces the predetermined time lapse between the application of a firing signal and detonation.

Delay Interval The nominal time between the detonations of delay detonators of adjacent periods in a delay series; the nominal time between successive detonations in a blast.

Delay Period A designation given to a delay detonator to show its relative or absolute delay time in a given series.

Delay Series A series of delay detonators designed to satisfy specific blasting requirements. There are basically two types of delay series: millisecond (MS) with delay intervals on the order of milliseconds, and long period (LP) with delay times on the order of seconds.

Delay Tag A tag, band, or marker on a delay detonator that denotes the delay series, delay period, and/or delay time of the detonator.

Delay Time The lapse of time between the application of a firing signal and the detonation of the base charge of a delay detonator.

Density The mass of an explosive per unit of volume, usually expressed in grams per cubic centimeter or pounds per cubic foot.

Department of Transportation (DOT) A cabinet-level agency of the federal government. It has the responsibility for the comprehensive regulation of transportation safety and issues regulations governing interstate shipments of explosives and other hazardous materials.

Detonating Cord A flexible cord containing a center core of high explosive and used to initiate other explosives.

Detonating Cord Downline The section of detonating cord that extends within the blasthole from the ground surface down to the explosive charge.

Detonating Cord MS Connectors Nonelectric, short-interval (millisecond) delay devices for use in delaying blasts that are initiated by detonating cord.

Detonating Cord Trunkline The line of detonating cord that is used to connect and initiate other lines of detonating cord.

Detonating Primer A name applied for transportation purposes to a device consisting of a detonator and an additional charge of explosives, assembled as a unit.

Detonation An explosive reaction that moves through an explosive material at a velocity greater than the speed of sound in the material.

Detonation Pressure The pressure produced in the reaction/zone of a detonating explosive.

Detonation Velocity The velocity at which a detonation progresses through an explosive.

Detonator Any device containing any initiating or primary explosive that is used for initiating detonation. A detonator may not contain more than 10 g of total explosives by weight, excluding ignition or delay charges. The term includes, but Is not limited to, electric blasting caps of instantaneous and delay types, blasting caps for use with safety fuses, detonating cord delay connectors, and nonelectric instantaneous and delay blasting caps that use detonating cord, shock tube, or any other replacement for electric legwires.

Development The work of driving openings to and in a proved ore body, to prepare it for mining and transporting the ore.

Diameter The cross-sectional width of a borehole or an explosive cartridge.

Ditch Blasting The formation of a ditch by the detonation of a series of explosive charges.

Ditching Dynamite A nitroglycerin-type explosive especially designed to propagate sympathetically from hole to hole in ditch blasting.

Donor An exploding charge producing an impulse that impinges upon an explosive "acceptor" charge.

Dope Individual, dry, nonexplosive ingredients that comprise a portion of an explosive formulation.

Do's and Don'ts A list of precautions *(IME Safety Library Publication No. 4)* printed by the Institute of Makers of Explosives pertaining to the transportation, storage, handling, and use of explosive materials and inserted in cases of explosive materials and cartons of detonators.

Downline A line of detonating cord or plastic tubing in blasthole that transmits the detonation from the trunkline or surface delay system down the hole to the primer.

Drift A horizontal opening in or near an ore body and parallel to the course of the vein or long dimension of the ore body.

Drill Hole A hole drilled in the material to be blasted for the purpose of containing an explosive charge, also called *Blasthole or Borehole.*

Drilling Pattern The location of blastholes in relationship to each other and the free face, if any.

Dynamite A high explosive used for blasting, consisting essentially of a mixture of, but not limited to, nitroglycerin, nitrocellulose, ammonium nitrate, sodium nitrate, and carbonaceous materials.

Electric Blasting Circuit An electric circuit containing electric detonators and associated wiring.

Electric Detonator A detonator designed for, and capable of, initiation by means of an electric current.

Electrical Storm An atmospheric disturbance characterized by intense electrical activity, producing lightning strokes and strong electric and magnetic fields.

Emergency Procedure Card Instructions carried on a truck transporting explosive materials and giving specific procedures in case of emergency.

Emulsion An explosive material containing substantial amounts of oxidizers dissolved in water droplets, surrounded by an immiscible fuel.

Energy A measure of the potential for the explosive to do work.

Exploration The work involved in gaining a knowledge of the size, shape, position, and value of an ore body.

Explosion A chemical reaction involving an extremely rapid expansion of gases, usually associated with the liberation of heat

Explosive Any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion.

Explosive-Actuated Device Any tool or special mechanized device that is actuated by explosives. The term does not include propellant-actuated devices.

Explosive Charge The quantity of explosive material used in a blasthole, coyote tunnel, or explosive device.

Explosive Loading Factor The amount of explosive used per unit of rock; also called *Powder Factor*

Explosive Materials These include explosives, blasting agents, and detonators. The term includes, but is not limited to, dynamite and other high explosives; slurries, emulsions, and water gels; black powder and pellet powder; initiating explosives; detonators (blasting caps); safety fuse; squibs; detonating cord; igniter cord; and igniters. A list of explosive materials determined to be within the coverage of 18 USC Chapter 40, "Importation, Manufacture, Distribution, and Storage of Explosive Materials" is issued at least annually by the Director of the Bureau of Alcohol, Tobacco, and Firearms of the Department of the Treasury. The U.S. Department of Transportation classifications of explosive materials used in commercial blasting operations are not identical with the statutory definitions of the Organized Crime Control Act of 1970, Title 18 USC, Section 84 1. To achieve uniformity in transportation, the U.S. Department of Transportation in Title 49, *Code of Federal Regulation.* Parts 1-999 subdivides these materials into:

Class A Explosives-detonating or otherwise maximum hazard
Class B Explosives-flammable hazard
Class C Explosives-minimum hazard
Blasting Agents-see definition of *Blasting Agent*

Explosive Oils Liquid sensitizers for explosives such as nitroglycerin, ethylene glycol dinitrate, and metriol trinitrate.

Explosive Strength The amount of energy released by an explosive upon detonation that is an indication of the capacity of the explosive to do work.

Extra (Ammonia) Dynamite A dynamite that derives a major portion of its energy from reaction of ammonium nitrate.

Extraneous Electricity Electrical energy, other than actual firing current or the test current from a blasting galvanometer, that is present at a blast site and that could enter an electric blasting circuit. It includes stray current, static electricity, RF (electromagnetic) waves, and time-varying electric and magnetic fields.

Fertilizer-Grade Ammonium Nitrate A grade of ammonium nitrate as defined by The Fertilizer Institute.

Fire Extinguisher Rating A rating set forth in the National Fire Code that may be identified on an extinguisher by a number (5, 20, 30, etc.) indicating the extinguisher's relative effectiveness followed by a letter (A, B, C, etc.) indicating

the class or classes of fires for which the extinguisher has been found to be effective.

Fire-Resistant Construction designed to offer reasonable protection against fire.

Fireworks Combustible or explosive compositions or manufactured articles designed and prepared for the purpose of producing audible or visible effects.

Firing Current An electric current of recommended magnitude and duration to sufficiently energize an electric detonator or a circuit of electric detonators.
Firing Line The wire(s) connecting the electrical power source with the electric blasting circuit.

Flags-Danger Flags, usually red, that may or may not be Imprinted with a warning and used to caution personnel around explosives operations, or displayed on trucks transporting explosives.

Flammability The ease with which an explosive material may be ignited by flame and heat.

Flare A pyrotechnic device designed to produce a single source of intense light.

Flashover The sympathetic detonation between explosive charges or between charged blastholes.

Flash Point The lowest temperature at which vapors from a volatile combustible substance ignite in air when exposed to flame, as determined in an apparatus specifically designed for such testing.

Flyrock Rocks propelled from the blast area by the force of an explosion.

Foot Wall The wall or rock under a vein. It's called the floor in bedded deposits.

Forbidden or Not Acceptable Explosives Explosives that are forbidden or not acceptable for transportation by common, contract, or private carriers, by rail freight, rail express, highway, air, or water in accordance with the regulations of the U.S. Department of Transportation.

Fragmentation The breaking of a solid mass into pieces by blasting.

Free Face A rock surface exposed to air or water that provides room for expansion upon fragmentation; sometimes called open face.

Freezing The semifusing and nonejection of the pulverized rock or ore in the cut portion of a blasting round; generally caused by providing insufficient void space

for the initial holes blasted in the cut, little or no delay between charges, and/or excessive charge weights.

Fuel A substance that may react with oxygen to produce combustion
Fume Classification See *IME Fume Classification*

Fumes The gaseous products of an explosion. For the purpose of fume classification, only poisonous or toxic gases, such as carbon monoxide, hydrogen sulfide, and nitrogen oxides are considered.

Fuse See Safety Fuse.
Fuse Cap (Fuse Detonator) A detonator that is initiated by a safety fuse; also referred to as an ordinary blasting cap.

Fuse Cutter A mechanical device for cutting safety fuse clean and at right angles to its long axis.

Fuse Lighters Pyrotechnic devices for the rapid and certain lighting of safety fuse.

Gauge (Wire) A series of standard sizes such as the American Wire Gauge (AWG), used to specify the diameter of wire

Galvanometer See Blasting Galvanometer.

Gap Sensitivity The maximum distance for propagation between standard charge sizes of explosive donor and acceptor. It is used for measuring the likelihood of sympathetic propagation.

Gelatin Dynamite A type of highly water-resistant dynamite characterized by its gelatinous consistency.

Geology A description of the types and arrangement of rock in an area; the description usually includes the dip and strike, the type and extent of preexisting breaks in the rock, and the hardness and massiveness of the rock as these affect blast design.

Grains A system of weight measurement where 7,000 grains are equivalent to one standard 16-ounce pound (0.45 kg).

Ground Fault An electrical contact between part of the blasting circuit and earth.

Ground Vibration Shaking of the ground, by elastic waves emanating from a blast, usually measured in inches per second of particle velocity.

GVW-Gross vehicle weight.

Hangfire The detonation of an explosive charge at some nondetermined time after its normally designed firing time.

Hanging Wall The wall or rock on the upperside of an inclined vein. It is called the roof in bedded deposits.

Hardwood Red oak, white oak, hard maple, ash, or hickory, free from loose knots, wind shakes, or similar defects.

Heading Refers to the driving of openings of the various exploration and development passageways.

Hertz (Hz) A synonym for "cycles per second".

High Explosives Explosives that are characterized by a very high rate of reaction, high pressure development, and the presence of a detonation wave in the explosive.

Highwall A nearly vertical face at the edge of a bench, bluff or ledge on a surface excavation.

Highway Any public street, public alley, or public road.

Hole Diameter The cross-sectional width of the borehole.

Igniter Cord A small-diameter pyrotechnic cord that burns at a uniform rate with an external flame and used to ignite a series of safety fuses.

IME Fume Classification A classification indicating the amount of poisonous or toxic gases produced by an explosive or blasting agent. The IME Fume Classification is expressed as follows:

Fume Class	Cubic Feet of Poisonous Gases Per (1 $^{1}/_{4}$' x 8") Cartridge of Explosive Material
1	Less than 0.16
2	0.16 - 0.33
3	0.33 - 0.67

Incendivity The property of an igniting agent (e.g., spark, flame, or hot solid) whereby the agent can cause ignition.

Inhabited Building A building regularly occupied in whole or part as a habitation for human beings. or any church, schoolhouse, railroad station, store, or other

structure where people are accustomed to assemble, except any building or structure occupied in connection with the manufacture, transportation, storage, or use of explosive materials.

Initiation The act of causing an explosive material to detonate or deflagrate.

Initiator A detonator or detonating cord used to start detonation in an explosive material.

Instantaneous Detonator A detonator that has a firing time of essentially 0 sec as compared to delay detonators with firing times of from several milliseconds to several seconds.

Institute of Makers of Explosives (IME) A nonprofit safety-oriented trade association representing leading producers of commercial explosive materials in the United States and Canada and dedicated to safety in the manufacture, transportation, storage, handling, and use of explosive materials.

Institute of Makers of Explosives No. 8 Test Detonator IME No. 8 test detonator has 0.40 - 0.45 g of PETN base charge pressed to a specific gravity of 1.4 g/cc and primed with standard weights of primer, depending on manufacturer.

Inventory A listing of all explosive materials stored in a magazine.

Issuing Authority The governmental agency, office, or official vested with the authority to issue permits or licenses.

Jackleg A single rotary-percussion pneumatically actuated machine with a hinged air-assisted feedleg; primarily used in small development headings and production stopes for drilling holes up to $1^{3}/_{4}$ in. in diameter.

Jumbo Vehicle mounted, boom-fed rotary-percussion drills, actuated by either compressed air or hydraulics, primarily used in large tunnels and room-and-pillar mining applications; generally capable of drilling holes $1^{3}/_{4}$ - $3^{1}/_{2}$ in. in diameters.

Kelly Bar A hollow bar attached to the top of the drill column in rotary drilling; also called grief joint, kelly joint, kelly stem.

Leading(Lead) Lines or Wires The wire(s) connecting the electrical power source with the circuit containing electric detonators.

Leakage Resistance The resistance between the blasting circuit (including lead wires) and the ground.

Legwires The two single wires or one duplex wire extending out from an electric detonator.

Level Mines are customarily worked from shafts through horizontal passages or drifts called levels. These are commonly spaced at regular intervals in depth and are either numbered from the surface in regular order or designated by their actual elevation below the top of a shaft..

Liquid Fuels Fuels in a liquid state. They may be used with oxidizers to form explosive materials.

Loading Placing explosive material in a blasthole or against the material to be blasted.

Loading Density The weight of explosive loaded per unit length of borehole occupied by the explosive, expressed as pounds per foot or kilograms per meter of borehole.

Loading Pole A nonmetallic pole used to assist the placing and compacting of explosive charges in boreholes.

Low Explosives Explosives that are characterized by deflagration or a low rate of reaction and the development of low pressure.

Magazine Any building, structure, or container, other than an explosives manufacturing building, approved for the storage of explosive material.

Magazine Keeper A person responsible for the inventory and safe storage of explosive materials, including the proper maintenance of explosive materials, storage magazines, and areas.

Magazine, Surface A specially designed and constructed structure for the storage of explosive materials on the surface of the ground.

Magazine, Underground A specially designed and constructed structure for the storage of explosive materials underground.

Main Explosive Charge The explosive material that performs the major work of blasting.

Manufacturing Codes Code markings stamped on explosive materials packages, indicating, among other information, the date of manufacture.

Mass Detonate (Mass Explode) Explosive materials mass detonate (mass explode) when a unit or any part of a larger quantity of explosive material explodes and causes all or a substantial part of the remaining material to detonate or explode simultaneously. With respect to detonators, "a substantial part" means 90% or more.

Maximum Recommended Firing Current The highest recommended electric current to ensure safe and effective performance of an electric detonator.

Millisecond One thousandth of a second.

Mine Safety and Health Administration (MSHA) An agency of the Department of Labor concerned with promulgation and enforcement of health and safety regulations in the mining field.

Miniaturized Detonating Cord Detonating cord with a core load of 5 or less grains of explosive per foot.

Minimum Recommended Firing Current The lowest recommended electric current to ensure reliable performance of an electric detonator.

Minimum Gap Sensitivity An air gap, measured in inches, that determines whether the explosive material is within specific tolerances for gap sensitivity.

Misfire A blast that fails to detonate completely after an attempt at initiation; also the explosive material itself that failed to detonate as planned.

Motor Vehicle Any self-propelled vehicle, truck, tractor, semitrailer, or full trailer used for the transportation of freight over public highways.

MS Connectors Nonelectric, short-interval (millisecond) delay devices for use in delaying blasts that are initiated by detonating cord.

Muck The broken rock or ore displaced from its position in the earth by blasting or caving.

Muckpile The pile of broken material resulting from a blast.

Mudcapping A mud-covered or unconfined explosive charge fired in contact with a rock surface without the use of a borehole.

Munroe Effect The concentration of explosive action through the use of a shaped charge.

National Fire Protection Association (NFPA) Standards Standards for explosive materials and ammonium nitrate issued by the National Fire Protection Association.

National Safety Council (NSC) A non profit organization chartered by Congress to provide a regular information service on the causes of accidents and ways to prevent them.

Natural Barricade Natural features of the ground, such as hills, or timber of sufficient density that the surrounding exposures that require protection cannot be seen from the magazine when the tress are bare of leaves.

Nitroglycerin An explosive chemical compound used as a sensitizer in dynamite and represented by the formula $C_3H_5(ONO_2)_3$.

No. 8 Test Cap See Institute of Makers of Explosives No. 8 Test Detonator.

Nonelectric Detonator A detonator that does not require the use of electric energy or safety fuse to function.

Nonsparking Metal A metal that will not produce a spark when struck with other tools, rock, or hard surfaces.

Occupational Safety and Health Administration (OSHA) An agency of the Department of Labor active in eliminating occupational hazards and promoting employee health and safety.

Office of Surface Mining (OSM) An agency of the U.S. Department of the Interior regulating surface coal mining and the surface effects of underground coal mining.

Overburden Worthless material lying on top of a deposit of useful material

Oxidizer or Oxidizing Material A substance, such as a nitrate, that readily yields oxygen or other oxidizing substances to stimulate the combustion of organic matter or other fuel.

Oxygen Balance The theoretical percentage of oxygen in an explosive material or ingredient that exceeds (+) or is less than (-) what is needed to produce ideal reaction products.

Parallel Blasting Circuit An electric blasting circuit in which the legwires of each detonator are connected across the firing line directly or through buswires.

Parallel-Series Circuit See Series in Parallel Blasting Circuit.

Particle Board A composition board made of small pieces of wood bonded together.

Particle Velocity A measure of the intensity of ground vibration, specifically the time rate of change of the amplitude of ground vibration.

Parting A rock mass located between two seams of coal; a joint or crack in rock.

Passenger Railway Any steam, electric, or other railroad or railway that carries passengers for hire.

Pellet Powder Blackpowder pressed into cylindrical pellets 2 in. in length and $1^1/_4$ in. in diameter.

Permissible Diameter (Smallest) The smallest diameter of a permissible explosive, as approved by the Mine Safety and Health Administration (MSHA)

Permissible Explosives Explosives that are permitted for use in gassy and dusty atmospheres and that must be approved by the Mine Safety and Health Administration. Permissible explosives must be used and stored in accordance with certain conditions specified by the Mine Safety and Health Administration (MSHA).

Person Any individual, corporation, company, association, firm, partnership, society, or joint stock company.

PETN An abbreviation for the name of the explosive, pentaerythritoltetranitrate.

Placards Signs placed on vehicles transporting hazardous materials (including explosive materials) indicating the nature of the cargo.

Plywood Exterior construction-grade plywood.

Pneumatic Loading The loading of explosive materials into a borehole using compressed air as the loading or conveying force.

Powder A common synonym for explosive materials.

Powder Factor The amount of explosive used per unit of rock.

Power Source The source of power for energizing electric blasting circuits, e.g., a blasting machine or power line.

Preblast Survey A documentation of the existing condition of structures near an area where blasting is to be conducted.

Premature Firing The detonation of an explosive charge before the intended time.

Presplitting (Preshearing) A smooth blasting method in which cracks for the final contour are created by firing a single row of holes prior to the initiation of the rest of the holes in the blast pattern.

Prilled Ammonium Nitrate Ammonium nitrate in a pelleted or prilled form.

Primary Blast A blast used to fragment and displace material from its original position to facilitate subsequent handling and crushing.

Primary Explosive A sensitive explosive that nearly always detonates by simple ignition from such means as spark, flame, impact, friction, or other primary heat sources of appropriate magnitude.

Primer A unit. package, or cartridge of explosives used to initiate other explosives or blasting agents, and which contains;
1) a detonator, or
2) detonating cord to which is attached a detonator designed to initiate the detonating cord.

Propagation The detonation of explosive charges by an impulse received from adjacent or nearby explosive charges.

Propellant Explosive An explosive material that normally functions by deflagration and is used for propulsion purposes. It may be a Class A or Class B explosive, depending upon its susceptibility to detonation.

Propellant-Actuated Power Device Any tool or special mechanized device or gas generator system that is actuated by a propellant or that releases and directs work through a propellant charge.

Public Conveyance Any railroad car, streetcar, ferry, cab, bus, aircraft, or other vehicle that carries passengers for hire.

Pyrotechnics Any combustible or explosive compositions or manufactured articles designed and prepared for the purpose of producing audible or visible effects. Pyrotechnics are commonly referred to as fireworks.

Quantity-Distance Table A table listing minimum recommended distances from explosive materials stores of various weights to a specific location.

Radio Frequency Energy (RF) The energy transferred by electromagnetic wave in the radio frequency spectrum.

Radio Frequency Transmitter An electronic device that radiates radio frequency waves; the device may be fixed (stationary) or mobile.

Railway Any steam, electric, or other railroad or railway that carries passengers for hire.

Raise A vertical or incline opening driven upward from a level to connect with the level above, or to explore the ground for a limited distance above one level. After two levels are connected, the connection may be a winze or a raise, depending upon which level is taken as the point of reference.

Receptor (Acceptor) A charge of explosive materials receiving an impulse from an exploding donor charge.

Regulations-Federal, State, Local Regulations promulgated by federal, state, or local regulatory agencies governing the manufacture, transportation. storage, sale, possession, handling, and use of explosive materials.

Relief The effective distance from a blasthole to the nearest free face.

Resistance The measure of opposition to the flow of electrical current, expressed in ohms

Rotational Firing Delay blasting system used so that the detonating explosives will successively displace the burden into the void created by previously detonated explosives in holes that fired at an earlier delay period.

Round A set of holes drilled and charged with explosives in any phase of underground work, which are fired instantaneously or with delay detonators.

Safety Fuse A flexible cord containing an internal burning medium by which fire or flame is conveyed at a continuous and uniform rate from the point of ignition to the point of use, usually a fuse detonator.

Safety Standard Suggested precautions relative to the safety practices to be employed in the manufacture, transportation, storage, handling, and use of explosive materials.

Scaled Distance A factor relating similar blast effects from various size charges of the same explosive at various distances. Scaled distance referring to blasting effects is obtained by dividing the distance of concern by a fractional power of the weight of the explosive materials.

Seam A stratum or bed of coal or other mineral.

Secondary Blasting Blasting to reduce the size of boulders resulting from a primary blast.

Seismograph An instrument, useful in monitoring blasting operations, that records ground vibration. Particle velocity, displacement, or acceleration is generally measured and recorded in three mutually perpendicular directions.

Semiconductive Hose A hose used for pneumatic conveying of explosive materials having an electrical resistance high enough to limit flow of stray electric currents to safe levels, yet not so high as to prevent drainage of static electric charges to ground. Hose of not more than 2 megohms resistance over its entire length and of not less than 5,000 ohms per foot meets the requirements.

Sensitiveness A measure of an explosive's cartridge-to-cartridge propagating ability under certain test conditions. It is expressed as the distance through air at which a primed half-cartridge (donor) will detonate an unprimed half-cartridge (receptor).

Sensitivity A physical characteristic of an explosive material classifying its ability to be initiated upon receiving an external impulse such as impact, shock, flame, friction, or other influences that can cause explosive decomposition.

Separation Distances Minimum recommended distances from explosive materials accumulations to certain specific locations.

Series Blasting Circuit An electric blasting circuit that provides one continuous path for the current through all caps in the circuit.

Series in Parallel Blasting Circuit An electric blasting circuit in which the ends of two or more series of electric detonators are connected across the firing line directly or through buswire.

Shaft A vertical or inclined excavation in a mine extending downward from the surface or from some interior point as a principal opening through which the mine is exploited. A shaft is provided with a hoisting engine at the top for handling men, rock, and supplies, or it may be used only in connection with pumping or ventilating operations.

Shaped Charge An explosive with a shaped cavity, specifically designed to produce a high-velocity cutting or piercing jet of product reaction; usually lined with metal to create a jet of molten liner material.

Shelf Life The length of time of storage during which an explosive material retains adequate performance characteristics.

Shock Wave A transient pressure pulse that propagates at supersonic velocity.

Short-Delay Blasting The practice of detonating blastholes in successive intervals where the time difference between any two successive detonations is measured in milliseconds.

Shot Anchor A device that anchors explosive material charges in the borehole so that the charges will not be blown out by the detonation of other charges.

Shot Firer That qualified person in charge of and responsible for the loading and firing of a blast (same as a *Blaster).*

Shunt The shorting together of the free ends of :
1) electric detonator legwires, or
2) the wire ends of an electric blasting circuit or part thereof-, the name of an electrical shorting device applied to the free ends of electric detonators by the manufacturer.

Signs-Explosive (Placards) Signs, called placards, placed on vehicles transporting explosives denoting the character of the cargo, or signs placed near storage areas as a warning to unauthorized personnel.

Silver Chloride Cell A special battery of relatively low current output used in a blasting galvanometer.

Slurry An explosive material containing substantial portions of a liquid, oxidizers, and fuel, plus a thickener.

Small-Arms Ammunition Any cartridge for shotgun, rifle, pistol, revolver. and cartridges for propellant-actuated power devices and industrial guns. Military-type ammunition containing explosive bursting charges or any incendiary, tracer, spotting, or pyrotechnic projectile is excluded from this definition.

Small-Arms Ammunition Primers Small percussion-sensitive explosive charges encased in a cap or capsule and used to ignite propellant powder.

Smoke The airborne suspension of solid particles from the products of detonation or deflagration.

Smokeless Propellant (Smokeless Powder) Solid propellant, commonly called smokeless powder in the trade, used in small-arms ammunition, cannon, rockets, propellant-actuated power devices, etc.

Snakehole A borehole drilled in a slightly downward direction from the horizontal into the floor elevation of a quarry face: also, a hole driven under a boulder.

Softwood Douglas fir or other wood of equal bullet resistance and free from loose knots, wind shakes, or similar defects.

Spacing The distance between boreholes. In bench blasting, the distance is measured parallel to the free face and perpendicular to the burden.

Specific Gravity The ratio of the weight of any volume of substance to the weight of an equal volume of pure water.

Springing The practice of enlarging the bottom of a blasthole by the use of a relatively small charge of explosive material; typically used in order that a larger charge of explosive material can be loaded in a subsequent blast in the same borehole.

Squib A firing device that burns with a flash and used for igniting black powder or pellet powder.

Stability The ability of an explosive material to retain chemical and physical properties specified by the manufacturer when exposed to specific environmental conditions over a particular period of time.

Static Electricity Electric charge at rest on a person or object. It is most often produced by the contact and separation of dissimilar insulating materials.

Steady State Velocity The characteristic velocity at which a specific explosive at a given charge diameter will detonate.

Steel General purpose (hot or cold rolled) low-carbon steel, such as specification ASTM A366 or equivalent.

Stemming Inert material placed in a borehole after the explosive; used for the purpose of containing explosive materials or to separate charges of explosive material in the same borehole.

Stope An excavation from which ore has been extracted. The term stoping is commonly applied to the extraction of ore, but does not include the ore removed in sinking shafts and in driving levels, drifts. and other development openings.

Storage The safekeeping of explosive materials, usually in specially designed structures called magazines.

Stray Current A flow of electricity outside an insulated conductor system

Subdrilling The practice of drilling boreholes below floor level or working elevation to ensure breakage of rock to working elevation.

Subsonic Less than the speed of sound.

Supersonic Greater than the speed of sound.

Sympathetic Propagation The detonation of an explosive material as the result of receiving an impulse from another detonation through air, earth, or water.

Table of Recommended Separation Distances of Ammonium Nitrate and Blasting Agents from Explosives or Blasting Agents A quantity-distance table from National Fire Protection Association Standard No. 495.

Tachograph A recording device in a truck that indicates on a time basis the running and stopping times of a vehicle.

Tamping The action of compacting the explosive charge or the stemming in a blasthole.

Tamping Bags Cylindrical bags containing stemming material and used in boreholes to confine the explosive material charge.

Tamping Pole A wooden or plastic pole used to compact explosive charges or stemming.

Test Blasting Cap No. 8 See Institute of Makers o Explosive No. 8 Test Detonator.

Theft-Resistant Construction designed to deter illegal entry into facilities used for the storage of explosive materials.

Toe In bench blasting, the distance from the free face to the blasthole, measured at the floor level of the bench.

Trunkline The line of detonating cord on the ground surface that connects detonating cord downlines.

Tunnel A horizontal or nearly horizontal underground passage that is open to the atmosphere at both ends. The term is loosely applied in many cases to an adit.

Unbarricaded The absence of a natural or artificial barricade around explosive storage areas of facilities.

Unconfined Detonation Velocity The detonation velocity of an explosive material without confinement, for example, a charge fired in the open.

Underwriters Laboratory, Inc. (UL) A nationally recognized incorporated testing laboratory qualified and equipped to conduct the necessary tests to determine compliance with appropriate standards and the satisfactory performance of materials or equipment in actual usage.

Volt The unit of electromotive force. It is the difference in potential required to make a current of 1amp flow through a resistance of 1 ohm.

Volume Strength Same as Cartridge Strength or Bulk Strength.

Warning Signal A visual or audible signal that is used for warning personnel in the vicinity of the blast area of the impending explosion.

Waste Acid Residual or spent acid from a nitration process.

Water Gel An explosive material containing substantial portions of water, oxidizers, and fuel, plus a cross-linking agent

Water Stemming Bags Water-filled plastic bags with a self-sealing valve classified as a permissible stemming device by the Mine Safety and Health Administration (MSHA)

Watt A unit of electrical power equal to 1 joule/sec

Weather-Resistant Construction designed to offer reasonable protection against weather.

Weight Strength The energy of an explosive material per unit of weight expressed as a percentage of the energy per unit of weight of a specified explosive standard.

Winze A vertical or inclined opening sunk from a point inside a mine for the purpose of connecting with a lower level and exploring the ground for a limited depth below a level.

Section X

Department of Environmental Protection
Bureau of Mine Safety

Calculations

Borehole Diameter

Selection of the proper hole diameter is important to obtain maximum fragmentation at minimum cost. For best fragmentation and design control, the rule of thumb is that the borehole diameter in inches should be approximately one tenth of the face height in feet.

$$D = \frac{H}{10}$$

Where
D = borehole diameter (inches)
H = bench height (feet)

Burden

Burden is defined as the distance from a borehole to the nearest free face at the time of detonation.
Burden is a function of charge diameter. The rule of thumb for burden calculation is dependent on the borehole diameter.

Burden Calculation:

$$B = \frac{25\text{-}35 \times D_e}{12}$$

Where
B = burden (feet)
D_e = explosive column diameter (inches)

For a given rock type, explosive, and blast hole spacing, there is an optimum burden dimension. The optimum burden dimension depends upon a combination of variables, which include the borehole diameter, the borehole depth, spacing between boreholes, the millisecond delay pattern, the explosive used, the rock mass characteristics, and degree of fragmentation and muck pile shape sought.

Spacing

The distance between adjacent blastholes, measured perpendicular to the burden, is defined as the spacing. Spacing calculations are a function of the burden.

S = 1.8 x B

Where
S = spacing (feet)
B = burden (feet)

Spacings that are significantly less than the burden tend to cause early stemming ejection and premature splitting between blastholes. These effects encourage rapid release of gases to the atmosphere, and result in noise and air blast. Conversely, when the spacing is too large, the rock may be inadequately fragmented between holes, leaving an uneven floor. Consequently, burden and spacing decisions are made by careful analysis of geology, explosives, conditions at the site, and experience.

Bench Height

To maintain a successful blast design, it is important that the burden and bench height are reasonably compatible. However, the face height is often determined by other factors; the rule of thumb covers only the recommended minimum.

H = 2 x B

Where
H = bench height (feet)
B = burden (feet)

Stemming

Stemming is an inert substance, loaded on top of the explosive charge to give confinement of the explosion gases. The amount of stemming required may be calculated from the burden dimension using the following formula:

T = 0.7 – 1.3 x B

Where
T = stemming (feet)
B = burden (feet)

Explosive Column Weight

The explosive column weight per borehole is a function of the density of the explosive, its diameter, and the explosive column length. The explosive column weight can be calculated by using the following formula:

$E_w = 0.34 \times D_e^2 \times \rho \times E_{cl}$

Where

E_w = explosives column weight (pounds)
D_e = diameter of explosive column (inches)
ρ = density of explosives (grams per cubic centimeter)
0.34 = coefficient of determination
E_{cl} = explosives column length (feet)

For example, given an explosive column diameter of 6.25 in. and 50 ft. in length and ANFO at a density of 0.81 g/cc, the charge weight is calculated by:

$E_w = 0.34 \times D_e^2 \times \rho \times E_{cl}$
$E_w = (0.34)\ (6.25)^2\ (0.81)\ (50)$
$E_w = (0.34)\ (39.06)\ (0.81)\ (50)$
$E_w = 537.9$ lb.

Powder Factor

Powder factor is the mathematical relationship between the weight of explosives and a given quantity of rock. The explosive weight is normally expressed in pounds and the rock quantity is normally expressed in cubic yards or tons. There are four methods of expressing powder factor.

1. Pounds of explosive per cubic yard of rock.
2. Pounds of explosive per ton of rock.
3. Cubic yards of rock per pound of explosive.
4. Tons of rock per pound of explosive.

- ***Cubic Yards*** To calculate cubic yards per borehole, the following formula is used:

$$\mathbf{V = \frac{B \times S \times H}{27}}$$

Where

B = burden dimension (feet)
S = spacing dimension (feet)
H = Bench height (feet)
V = rock volume (cubic yards)

For example, given a burden of 10 ft., a spacing of 15 ft., a bench height of 50 ft., the calculated rock volume is as follows:

$$V = \frac{B \times S \times H}{27}$$

$$V = \frac{10 \times 15 \times 50}{27}$$

$$V = \frac{7{,}500}{27}$$

V = 277.77 cu yd per borehole

➢ ***Tons*** To calculate the tons of rock per borehole, the following formula is used:

$$\mathbf{W = \frac{B \times S \times H}{27} \times \frac{27\rho}{2{,}000}}$$

Where

B = burden dimension (feet)
S = spacing dimension (feet)
H = bench height (feet)
ρ = rock density (pounds per cubic foot)
W = rock tonnage

For example, given a burden of 10 ft., a spacing of 15 ft., a bench height of 50 ft., and a rock density of 168 lb/cu ft, the calculation for the total rock weight per borehole is as follows:

$$W = \frac{B \times S \times H}{27} \times \frac{27\rho}{2{,}000}$$

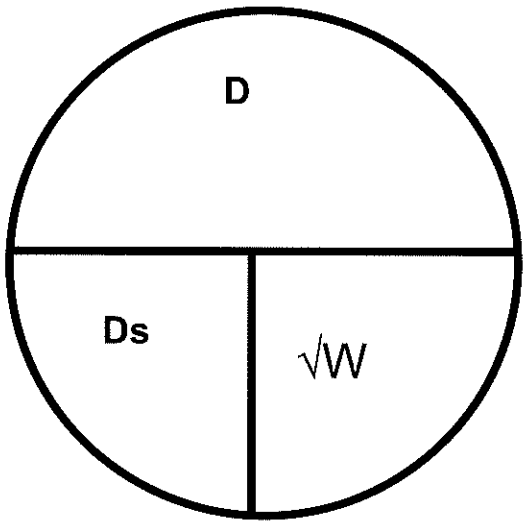
$$W = \frac{B \times S \times L}{27} \times \frac{(27)\,(168)}{2{,}000}$$

$$W = \frac{277.77}{} \times \frac{4{,}536}{2{,}000}$$

W = 277.77 cu yd x 2.268 tons per cubic yards

W = 629.98 tons per hole

Powder factor has generally been equated with the amount of explosive energy required to fragment and displace rock. A powder factor of 0.75-lb/cu yd would be expected to exhibit relatively less fragmentation and displacement than a powder factor of 1.0 lb/cu yd.



Scaled Distance

$$Ds = \frac{D}{\sqrt{W}}$$

W = Explosives Weight Per Delay Period
D = Actual Distance
Ds = Scaled Distance

We shall designate the W, D, and Ds relationships shown in the above chart as follows:

Equation #1:

$$W = \left(\frac{D}{Ds}\right)^2$$

Equation #2:

$$\sqrt{W} = \frac{D}{Ds}$$

Equation #3:

$$Ds = \frac{D}{\sqrt{W}}$$

Equation #4:

$$D = Ds\sqrt{W}$$

Scaled Distance

The four equations cited above are very useful, in fact necessary, tools for the licensed blaster. Here are a few examples of how they work.

A blast is to be fired at a distance (D) of 1,000 feet from a residence, and it is desired that the Scaled Distance, (Ds) value be not less than 50. To find the weight (W) of explosive per delay period, which will give a Ds value of 50, substitute the values for D and Ds in Equation 1 or Equation 2. It will be found that 400 pounds of explosives may be used per delay period.

Given a blast involving 400 pounds (W) of explosives per delay period to be fired at a distance (D) of 1,000 feet from an office building. Commonwealth of PA regulations require seismograph readings on any blast having a Scaled Distance value below 50. Will the Ds value be 50 or greater and so make seismograph readings unnecessary. To arrive at the answer to this question, substitute the eight and distance values in Equation 3. A Scaled Distance of 50 will be found. Thus, seismograph readings will not be required by Regulations for this blast. Had the distance (D) been 800 feet the Ds value would have been 40 and seismograph recordings would have been required.

A 52 – hole blast is planned in which each hole will contain 181 pounds of explosives, and it is to be wired four holes (724 lbs. Of explosives) per delay period. This will require 13 delay periods: 0, 2-13. There is a residence 1,000 feet distant. It is desired to hold the Scaled Distance value above 50. To verify the accuracy of planning, substitute the above W and D values in Equation 3. Calculation shows a Ds value of 37, far below the desired value of 50.

Wiring the blast at two holes per delay period, that is, 362 pounds for explosives per period, should resolve the problem, although twice as many delay periods will be required. When the W value is used in Equation 3, one finds an acceptable Ds value of 53. Seismograph readings will not be required.

1. A certain blasting operation, located 1263 feet from a residence, consists of 60 holes, each containing 242 pounds of explosives. The blast is wired two holes (484 lbs.) per delay period. Using Equation 3, it will be found that the Ds value is 58.

   Desiring to maintain a Ds value of 58 in another blast only 900 feet from the same residence, what will be the maximum quantity of explosives permitted per delay period? Substituting the D and Ds values in Equation 1 or Equation 2 on finds a maxim weight of 240 pounds per delay period.

   Since the Ds value above is greater than 50, what would be the closest distance to the house that blasting could be done and yet maintain a Ds value of 50, using 240 pounds (W) of explosive per delay period? To find the answer to this problem, substitute a Ds value of 50 and the W value in Equation 4. By this procedure, one finds the closest distance (D) to be 775 feet.

1. A home is 900' away from a Blast; you have 120 lbs. per delay. What is the Scaled Distance?

$$Ds = \frac{D}{\sqrt{W}}$$
$$Ds = \frac{900'}{\sqrt{120 \text{ lbs.}}} \qquad \sqrt{120} = 10.95$$
$$Ds = \frac{900'}{10.95}$$
$$Ds = 82.19$$

You have 400 lbs. per delay and you want to have a Scaled Distance of 90. How do you do this? What is the distance to the home?

$$D = Ds \sqrt{W}$$
$$D = 90 (\sqrt{400}) \qquad \sqrt{400} = 20$$
$$D = 90 (20)$$
$$D = 1800 \text{ ft.}$$

You have a home 1500 ft. away. You want a Scaled Distance of 90. What are the pounds per delay to keep a Scaled distance of 90?

$$W = \left(\frac{D}{Ds} \right)^2$$
$$W = \left(\frac{1500'}{90} \right)^2$$
$$W = (16.66)^2$$
W = 277.56 Maximum Pounds per Delay

A home is 1100 ft. away from a Blast; you have 140 lbs. per delay. What is the Scaled Distance?

$$Ds = \frac{D}{\sqrt{W}}$$
$$Ds = \frac{1100'}{\sqrt{140 \text{ lbs.}}} \qquad \sqrt{140} = 11.83$$
$$Ds = \frac{1100'}{11.83}$$
$$Ds = 92.98$$

You have a 500-pound per delay. You want a Scaled distance of 90. What can be the closest dwelling to the Blast

$D = Ds \sqrt{W}$
$D = 90 (\sqrt{500})$ $\sqrt{500} = 222.36$
$D = 90 (22.36)$
$D = 2012$ ft.

You have a home 1300 ft. away. You want a scaled distance of 95. What are the pounds per delay?

$$W = \left(\frac{D}{Ds} \right)^2$$
$$W = \left(\frac{1300'}{95} \right)^2$$
$W = (13.68)^2$
W = 187.25 Maximum Pounds per Delay

Planning the Firing Circuit

Ohms Law:

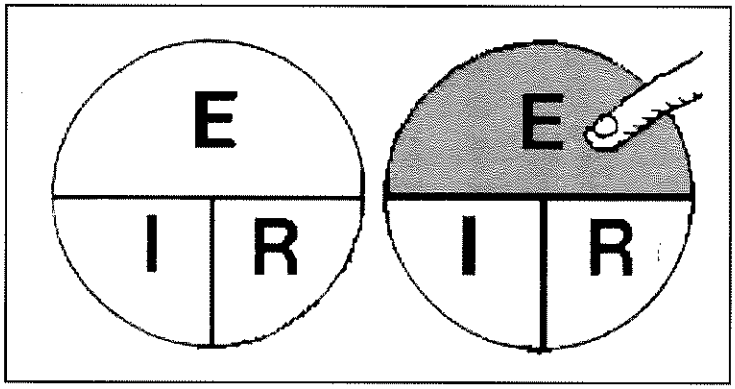
Electric current initiates electric blasting caps. Too little current will not provide enough energy to initiate a cap, while too much current can cause arcing. The blaster can calculate the amount of current using OHMS LAW. OHMS LAW states: VOLTAGE (in volts) is equal to the current (in amperes) MULTIPLIED BY THE RESISTANCE (in ohms), or;

E = I X R

Where: E is the voltage (in volts) of the power source,
I is the current (in amperes) flowing in the circuit, and
R is the resistance (in ohms) of the circuit.

Using basic algebra, OHMS LAW can be rearranged as:

$I = \frac{E}{R}$ or $R = \frac{E}{I}$



NOTE: Put your finger over the unknown that you want to find. For example, cover E (voltage), and I (current) times R (resistance) remains. Similarly, cover R (resistance), and E divided by I (current) remaer E (voltage), and I (current) times R (resistance) remains. Similarly, cover R (resistance), and E divided by

Blasting Circuitry Design and Analysis

Capacitor discharge blasting machines, when used properly, are the most dependable means of firing electric detonators. Power lines can also be used to fire electric detonators. With any power source it is essential that sufficient energy be provided to initiate all detonators in a few milliseconds.

When firing from power lines, the calculations required to provide sufficient current to every detonator in the circuit are straight forward by applying the basic principles of Ohm's and Kirchhoff's Laws.

The problem is more complex with capacitor discharge machines. The discharge current from a capacity-type machine decays exponentially from a high initial value to near zero within a short period of time. The concept of steady minimum firing currents, as demanded for AC and DC power-line firing, cannot be used. Ohm's and Kirchhoff's Laws must be supplemented by transient circuit calculations to determine the effective firing current required from a capacitor discharge blasting machine must be considerably in excess of the minimum DC firing current required for a circuit because of the rapid current decay.
To have a thorough understanding of blasting circuit design, it is necessary to apply the basic principles of Ohm's and Kirchhoff's Laws.
Ohm's Law – The current flowing in an electrical circuit is equal to the applied voltage divided by the resistance.

$$I = \frac{E}{R}$$

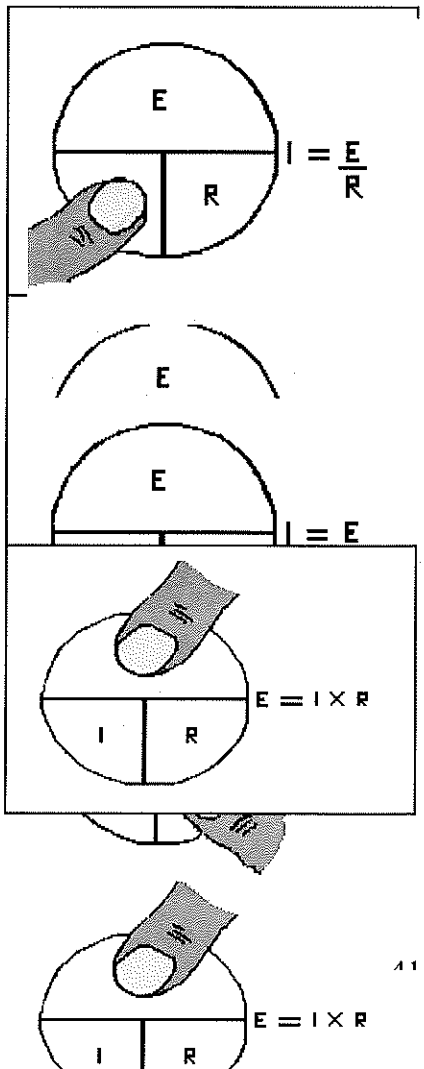
Where:
I = Current in amperes
V = Applied voltage in volts
R = Resistance in Ohms.

This may also be expressed as:

$$R = \frac{E}{I}$$

or:

$$E = I \times R$$



Kirchhoff's Law

1. The algebraic sum of all applied voltages and potential differences in any closed circuit is equal to zero.

$V_0 = I.\ R. - I_2R_2 - I_3R_3 - \ldots I_MR_M - 0$

2. The algebraic sum of all currents flowing to any point in a circuit is equal to zero.

$$I_0 - I_1 - I_3 - \ldots I_M - 0$$

Resistance of a Series Circuit (ohms)

$$R = R_1 + R_2 + R_3 + 0$$

Resistance of a Parallel Circuit (ohms)

$$\frac{1}{R} + \frac{1}{R_1} + \frac{1}{R_2} + \frac{1V}{R_3} \ldots \frac{1}{R_M}$$

Planning The Series Firing Circuit

Before loading a blast you must determine how much explosive will be needed. You should also determine what type of wiring circuit will be used, and then make the calculations that show you the basting machine will supply adequate current to fire the blast. Of the three wiring circuits used in electrical blasting, the series circuit is the simplest and most commonly used. In planning the series circuit, follow these steps:
Determine the *TOTAL RESISTANCE* (ohms) of the circuit.
Calculate the *CURRENT* (amperes) that the power source will deliver the total resistance.
Compare the calculated current with the recommended minimum firing current requirements for a series circuit.

FINDING TOTAL RESISTANCE (R_1)

For a series circuit, the total resistance (R_1) is simply the sum of all the individual resistances in the circuit. This will include the detonators (R_1), connecting wire (R_2), and firing line (R_3).

The formula is:
$R_T = R_1 + R_2 + R_3$

EXAMPLE:

Consider a series circuit with 20 Millidet delay electric blasting detonators having 40 ft. long copper leg wires, 200 lineal ft. of #20 B&S copper connecting wire and a 1,200 ft. long #14 B&S copper firing line. For the resistance values, ***see Table I and II.***

Resistance of one Millidet detonator with 40 ft. copper leg wire = *2.72 ohms.*
Resistance of 20 Millidet detonators = 20 x 2.272 ohms = ***54 ohms***

Resistance of #20 B&S connecting wire = *10.15 ohms per 1,000 ft.*
Resistance of 200 lineal ft. - $\frac{200 \times 10.15 \text{ ohms}}{1{,}000} \times 2^*$ = ***4 ohms***

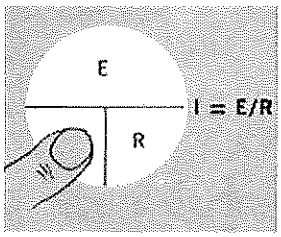
Resistance of #14 B&S firing line = *2.52 ohms per 1,000 ft.*
Resistance of 1,200 lineal ft. – $\frac{1{,}200 \times 2.52}{1{,}000} \times 2^*$ = ***6 ohms***

Total resistance $R_t = R_1 + R_2 + R_3$
$R_t = 54$ *ohms* + 4 *ohms* + 6 *ohms*
$R_t = 64$ *ohms*

*Multiply by 2 because the firing cable and connecting wire have 2 wires.

Calculating Current (I)

Use Ohms Law to calculate the current for the circuit described under total resistance.



Example:

Consider a condenser-discharge blasting machine with a 225-volt output. Now, applying Ohms Law:

Current (I) = $\frac{225 \text{ volts (E)}}{\text{ohms (R)}}$

I = 35 amperes

Compare:

The minimum recommended firing current (***Table III***) required for a series circuit is 1.5 amps DC or 3 amps AC. In the examples given, the answer for the calculated current is 3.5 amps DC. This is greater than 1.5, the minimum, so the amperage in this case is adequate. If the current is not adequate, here are some alternatives:

1. Use a blasting machine that will deliver the needed current, or

2. Use a different wiring circuit. A series-in-parallel circuit can reduce the total resistance without the need for reducing the number of holes (detonators).

Leg Wire Length	Instadet*	Millidet* and Superdet*	Instadet*	Millidet, Superdet, and Coaldet*
4	1.41	1.86	2.25	2.7
6	1.49	1.94	2.75	3.2
8	1.58	2.03	3.25	3.7
10	1.66	2.11	3.75	4.2
12	1.74	2.19	4.25	4.7
14	1.82	2.27	4.75	5.2
16	1.9	2.35	5.25	5.7
20	2.06	2.51	6.25	6.7
24	2.22	2.68	7.25	7
No 12 Copper Wire				
30	2.02	2.47		
40	2.27	2.72		
50	2.53	2.98		
60	2.79	3.21		
70	3.04	3.49		
80	3.3	3.75		
100	3.81	4.26		
120	4.33	4.77		
150	5.09	5.54		
200	6.37	6.82		
250	7.65	8.1		
300	8.93	9.38		
350	10.16	10.66		
400	11.49	11.94		

B&S Gauge	Ohms per 1,000 ft.
No. 8	0.628
No. 10	0.999
No. 12	1.59
No. 14	2.52
No. 16	4.02
No. 18	6.38
No. 20	10.15
No. 22	16.14

* **CAUTION:** These resistance values apply only to detonators manufactured by Hercules Incorporated. Do not use these values with detonators made by other manufacturers.

Table III: RECOMMENDED MINIMUM FIRING CURRENT	
Series Wiring	1.5 amps DC or 3 amps AC
Parallel Wiring	1 amp AC or DC per Detonator
Series-In-Parallel Wiring	2 amps AC or DC per Series
Maximum recommended firing current is not to exceed 10 amperes continuous current through any detonator.	

Section XI
Department of Environmental Protection
Bureau of Mine Safety

Series Circuit
The total resistance of a series circuit is equal to the resistance of each detonator multiplied by the number of detonators plus the resistance of the lead line and connecting wire.

Example 1
Assume a series circuit of 25 40-foot copper wire delay detonators with a 600-foot 14-gauge copper lead line:

Step 1 – Determine the resistance of the detonator circuit.
Consult ***Table 16.1*** for the resistance of a 40 foot copper wire Delay. This is 2.06 ohms/detonator.

Resistance of Detonator Circuit = No. of Detonators x Resistance/detonator
R = 25x 2.06
R = 51.5 ohms

Step 2 – Determine resistance of the lead line:
Consult ***Table 16.2*** for the resistance of 14-gauge copper wire.
This is 2.525 ohms/1000 feet. A lead line that is 600 feet long has 1200 feet of wire.
(600 feet x 2 conductors = 12000 feet)

Resistance of Lead Line = Length of Wire x Resistance / 1000 ft.
1000

R = 1200 x 2.525
1000
R = 3.03 ohm

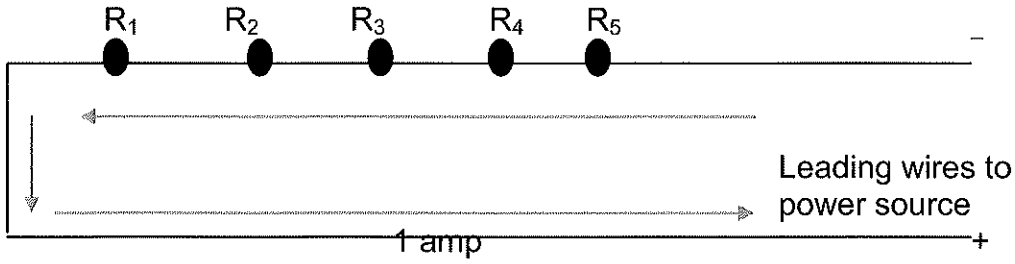
Step 3 – Determine total resistance of the blasting circuit.

Total Resistance = Detonator Circuit Resistance + Lead Line Resistance
R = 51.5 + 3.03
R = 54.53 ohms

On a "swing needle" type tester the needle on the instrument must be adjusted to "zero" when it is shorted between terminals. Digital instruments should show "zero" on the readout. The terminals are then connected to the lead line. The instrument should then read approximately 54 to 55 ohms. Too low a reading indicates some detonators are not connected into the circuit. Too high a reading indicates too many detonators in the series or loose or dirty connections.

Series Circuit

A series circuit provides a single path for the current through all detonators.
The same current flows through each part of a series circuit.
The total resistance of a series circuit is equal to the sum of individual resistances.
Voltage applied to a series circuit is equal to the sum of the individual voltage drops.
The voltage drop across a resistor in a series circuit is directly proportional to the size of the resistor.
If the circuit is broken at any point, no current will flow.



In a series circuit, the amperage at any point in the circuit is the same. This will help in calculating circuit values using Ohm's Law.
In a series circuit you will need to calculate the total resistance of the circuit in order to figure out the amperage. This is done by adding up the individual values of each component in series.
In this example we have three resistors. To calculate the total resistance we use the formula:

$$R_T = R_1 + R_2 + R_3 + R_4 + R_5$$

Parallel Circuit

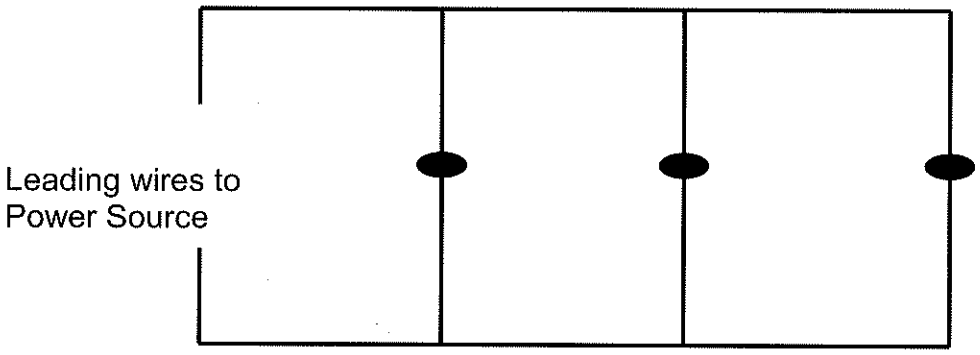
A parallel circuit cannot be tested with the instruments usually available in field operation as the total resistance of the circuit is so small it will read close to zero resistance on the instrument and will not indicate a meaningful reading. This is true whether using a "swing needle" or digital meter.

A Parallel circuit has certain characteristics and basic rules surmised here:
A parallel circuit has two or more paths for current to flow through.
Voltage is the same across each component of the parallel circuit.
The sum of the currents through each path is equal to the total current that flows from the source.

You can find total resistance in a Parallel circuit with the following formula:

1/Rt = 1/R1 + 1/R2 + 1/R3 + Rt = R (t)otal

If one of the parallel paths is broken, current will continue to flow in all the other paths.



Series-In-Parallel

In a series-in-parallel circuit each series should be electrically balanced with each series reading the same number of ohms. Usually, an equal number of detonators in each series will produce a balanced series.

In a balanced series-in- parallel circuit, the resistance of one series divided by number of series will equal the total resistance of the circuit.

Example 2

Assume a blast of 300 50-foot copper wire MS delays connected in six series with 50 detonators-per-series and a 700-foot 14-gauge copper wire lead line.

Step 1 – Determine the resistance of a single series. Resistance of one series = No. of Detonators x Resistance of each. Consult **Table 16.1** for detonator and wire resistance.
R = 50 x 2.32
R = 116 ohms

Step 2 – Determine the resistance as each series is connected to the lead line or bus wire:
Resistance = Resistance / Series

No of Series

One Series Resistance = $\frac{116.0}{1}$

Two Series Resistance = $\frac{116.0}{2}$

Three Series Resistance = $\frac{116.0}{3}$

Series-in-Parallel

The series-in-parallel circuit is the most common type of circuit used in blasting. The simplest series-in-parallel circuit is made by dividing a single series into two series as shown in ***Figure 16.6***. As shown, each of the two rows of electric detonators is connected in a straight series. The two free ends from each series are connected together and these are connected to the lead line.

The main advantage of the series-in-parallel circuit is the large number of detonators, which can be fired from a blasting machine without a large input voltage requirement. A series-in-parallel hookup with five balanced series is shown in
Figure 16.7.

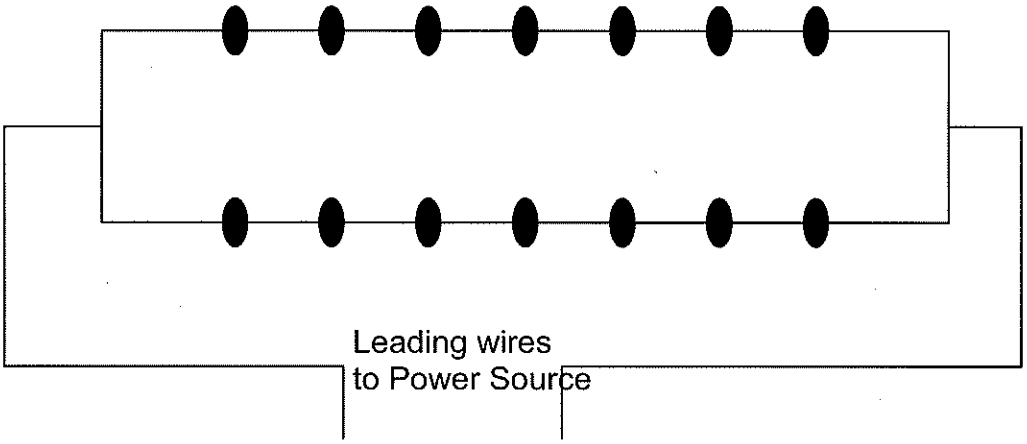


Figure 16.6 – Simplest series-in-parallel circuit is made by dividing a single series into two series. The two free ends from each series are then connected to the lead line.

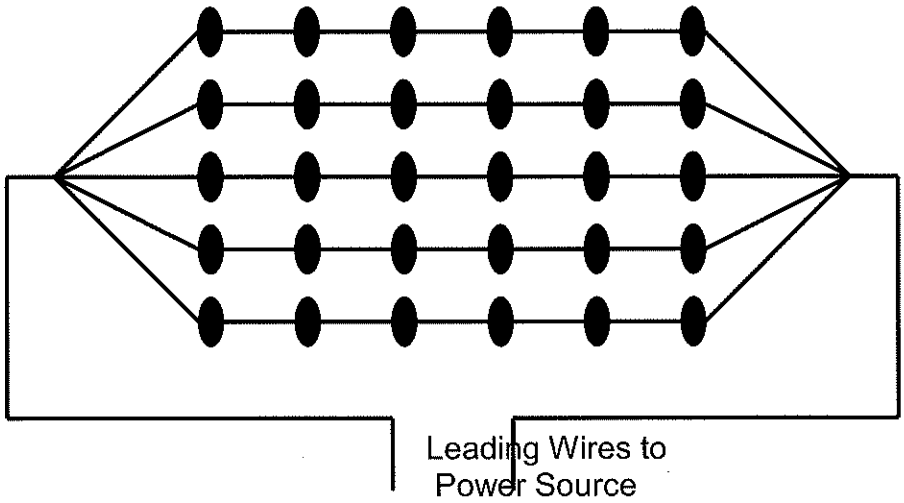
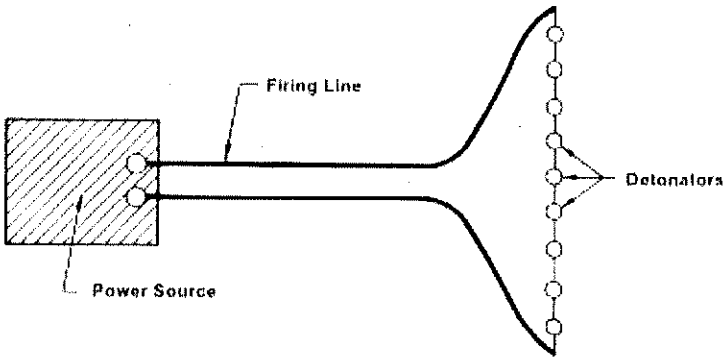
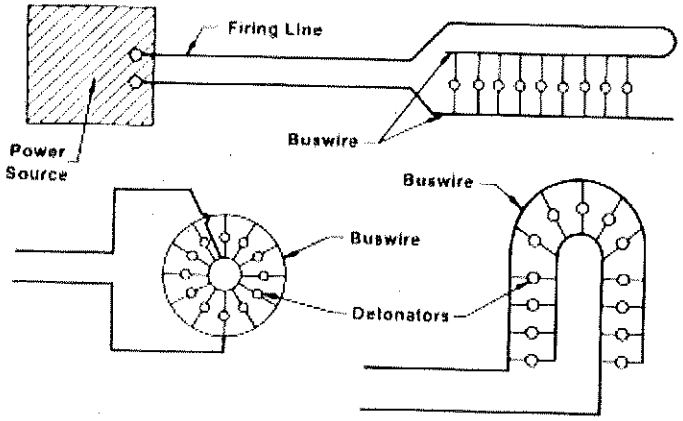


Figure 16.7 – Main advantage of the series-in-parallel is large number of detonators that can be fired from the blasting machine without large input voltage requirement.

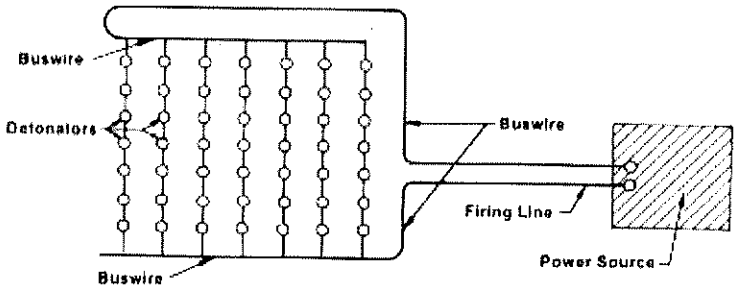
Single-Series Electric Blasting Circuit



Parallel Electric Blasting Circuit



Parallel Series Electric Circuit



Electric Firing Techniques

Electric blasting, with such refinements as delay detonators and electronic timers, has made possible the safe firing of a large number of charges in a predesigned sequence from a remote, safe location with precise control over the time of firing. The remarkable safety record compiled by explosives consumers is the result of knowledge applied with care.

Successful electrical blasting depends on four general principles: (1) proper selection and layout of the blasting circuit; (2) an adequate energy source compatible with the type of blasting circuit selected; (3) recognition and elimination of all electrical hazards; and (4) circuit balancing, good electrical connections, and careful circuit testing.

The selection of the circuit will depend on the number of detonators to be fired and type of operation. In general, a simple series circuit is used on small blasts consisting of less than 50 electric detonators. A series-in-parallel circuit is used where a large number of detonators are involved.

In almost every application capacitor discharge blasting machines offer the safest, cost dependable, and economical source of electrical energy for blasting.

Elimination of electrical hazards must be the first consideration before starting to load any blast.

Lack of attention to details is the most frequent cause of electrical misfires resulting in fatal or serious injury and costly property damage. The electrical connections must be tight, clean, and insulated from the ground. Care must be taken to avoid abrading or stripping the leg wires either in the hole or on the surface. Lead lines should be inspected and tested prior to every blast.

The resistance of all circuits should be calculated, and a Blaster's Multimeter or Blasting Ohmmeter should be used to verify the calculations. No attempt should be make to fire the blast until the theoretical calculations and test readings are the same.
In brief, extreme care in wiring and testing the circuit is absolutely necessary to avoid misfires.

Current Requirements

Successful simultaneous initiation of a large number of electric detonators requires delivery of sufficient current to all devices with a few milliseconds. The time required to heat the bridgewire in an electric detonator or to a temperature that will cause burning of the ignition charge is a function of the current intensity.

Although manufacturer's specifications may vary, the bridgewire in domestic commercial detonators is approximately 0.5 millimeters in diameter and requires 1 to 1.5 amperes for reliable initiation. The bridgewire heats up very quickly, but it rapidly transfers heat to the bridge posts and ignition mix. As a result, energy delivered over a time interval of more than 10 milliseconds is not as efficient in heating the bridge wire as the same amount of energy delivered in a few milliseconds.

The importance of delivering sufficient current to all detonators in the circuit within a few milliseconds cannot be overemphasized. At marginal low current levels, slight differences from one device to another can result in large variations in initiation times. In series circuits this can result in one detonator functioning prior to initiation of others in the circuit. This fast firing of one detonator cuts off the flow of current before all others have been initiated and results in failure of one or more detonators.

The internal construction of electric detonators manufactured by different companies varies considerably. As a result, they are not compatible in the same blasting circuit. Therefore, electric detonators of different manufacturers must never be used in the same blast. Such a practice is almost certain to result in dangerous misfires. Further, in the U.S., it is in direct violation of MSHA regulation 30 CFR 56/57.6400.

Basic Safety Requirements

In any blasting operation the blasting machine, or blasting switch, should be directly under the control of the blaster in charge. It should be kept locked while not in use with the key in blaster's possession.

The lead wires should never be laid out until the blast circuit is completely wired and all unnecessary personnel have been removed to a safe location. After the lead line is laid out, it should be checked electrically with a Blaster's Multimeter for continuity of circuit. It should also be visually inspected for cuts and serious abrasions in the insulation. The end of the lead line must be shunted before the other end of the line is connected to the blasting circuit. After the final connections are completed, the resistance of the entire circuit should be tested with a Blaster's Multimeter or a Blasting Ohmmeter (Blasting Galvanometer). The calculated resistance of the entire circuit must always agree with the readings on the instrument or no attempt should be made to fire the blast. If proper readings are not obtained, reshunt the lead line before returning to the blast area to locate and correct the source of trouble. Do not allow the bare ends of the circuit or the lead line to come in contact with the ground or with any metallic object.

When the instrument readings confirm the calculated resistance, the blasting machine, or blasting switch, can be unlocked and the lead lines can be connected for firing.

After the blast, the blasting machine, or blasting switch, should be locked before returning to the blast area. Never leave a blasting machine or blasting switch unguarded.

Lead Lines

Lead lines or firing lines are an essential part of the blasting circuit and must be inspected, tested, and kept in good repair to insure a successful blast.

Well-insulated, solid-core copper wire or 10-gauge to 14-gauge is recommended for series and series-in-parallel circuits of normal size. Where the basting line is soled on a reel after every blast, stranded wire should never be used because individual strands may break due to flexing. This results in a reduced load-carrying capacity that is not readily detectable with the instruments normally available in the field.

The lead line should be tested with a Blaster's Multimeter for continuity of circuit before every blast. It should be replaced when there is any evidence of physical damage to the insulation.

Where lead lines are permanently installed, the lines should be tested under load by an electrician. This test should be carried out on a regular schedule.

Connecting Wires

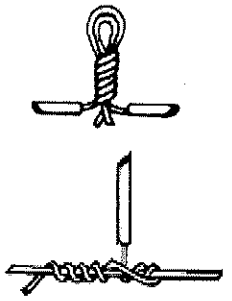
Connecting wire is usually 16-gauge to 20 gauge, plastic-insulated copper wire used to connect between holes or to connect individual series to the lead line. They are always subject to damage by the blast and should be considered expendable. Never reuse connecting wire.

Bus Wire

Bus wire is usually 10, 12, or 14-gauge, solid-core uninsulated copper wire used in connecting parallel circuits in tunnel and shaft rounds. Aluminum bus wire is not recommended because oxidation of the aluminum can result in high resistance connections.

Splices

The reliability of every circuit is dependent on the number and quality of the wire splices in that circuit. Their importance is as significant as any other factor in good blasting practice.



The twisted loop shown is recommended for joining light gauge wires of similar size (legwire to legwire or connecting wire). It is easy and quick to make, yet strong and reliable. It is also a highly visible splice that is easy to disassemble if a circuit has to be taken apart for any reason

When joining lighter gauge legwires or connecting wire to heavier gauge firing line or buswire, the lighter gauge wire is wrapped around the heavier gauge wire as shown. These splices are easy to make and provide a strong and

To prevent current leakage or the shorting out of two wires, the bare wire at the splices should be insulated with electrical tape. If insulating tape is not available, support the splices in the air by propping up the wire on boxes or dry cardboard and staggering their locations so that they cannot accidentally short out. The need to make a splice stronger and keep the bare wire connections from pulling apart can be accomplished by various means. One method is to join the insulated portion of the wires about 4 in. back from the splice by tying or twisting the together. This secondary connection will then absorb strain induced into the wire and prevent separation of the splices. It is now easier to position the bare wire splice so that it is off the ground, hence reducing the chance of current leakage.

Extraneous Electricity

Sources of hazardous extraneous electricity include: (1) Lightning discharges to ground from electrical storms; (2) Stray ground currents from poorly insulated and improperly grounded electrical equipment; (3) Radio Frequency (RF) energy from transmitters; (4) Induced currents, present in alternating electromagnetic fields, such as those commonly found near high-voltage transmission lines; (5) Static electricity generated by wind-driven dust and snow storms, by moving conveyor belts, and by the pneumatic conveying of ANFO; (6) Galvanic currents generated by dissimilar metals touching or separated by a conductive material.

The accepted "safe" level of extraneous electricity for electrical blasting is derived from the current required to detonate the most sensitive commercial electric detonators plus a safety factor. The minimum firing current for commercial electric detonators presently manufactured in the United States is approximately 0.25 amperes (250 milliamperes). The Institute of Makers of Explosives (IME) has established the maximum "safe" current permitted to flow through an electric detonator without hazard of initiation as one-fifth of the minimum firing current, or 0.05 amperes (50 milliamperes). Operators using electric detonators must be alerted to the measure of extraneous current and if a source is suspected, should measure for extraneous currents in the area of the blast site at frequent intervals to insure that all extraneous currents are at a safe level.

When extraneous currents exceed 0.05 amperes (50 milliamperes), the source of the current must be traced and eliminated before electric detonators can be safely used. If the source of the current cannot be traced and eliminated, a Nonelectric initiating system must be utilized. It must be remembered however that high voltages such as lightning can potentially initiate even Nonelectric initiating devices. Extremely high static levels also can be reached by the pneumatic loading of ANFO.

ELECTRICAL HAZARDS TO BLASTING

Electrical Energy	**Source**	Products Affected	**Safety** Measures	Shunt Protection
Lightning (DC)	Atmosphere	Direct hit, all Products, Nearby, Electric Detonators	Detect potential Lightning, Clear & guard	No help, keep shunted but don't assume protected
Stray Current (AS and DC)	Leaking power Source, utilities & Machinery	Electric Detonators	Stray Current Test, Place wires safely	Yes, Keep detonators & circuits shunted
Radio Frequency (AC)	RF Transmitters	Electric Detonators in use, & in original package.	Follow IME Safety Library Publication No.20	No Help
Induced Current (AC)	AC Power Lines	Electric Detonators	Keep shunted & avoid high voltage transmission lines	Some protection, Keep shunted until blast
Static (DC)	Pneumatic loading of ANFO, dust & snow storms, belts	Electric and Nonelectric detonators, cap and fuse	Do not use in dust or snowstorms. Use grounded semi-conductive hose	Some protection. Keep shunted until blast
Galvanic Current (DC)	Dissimilar metals in ionic solutions	Electric Detonators	Keep shunted until blast	Yes

Mechanical Static

The following recommended precautions should be taken for cases in which static electricity is generated mechanically.
All parts of moving equipment in the vicinity of blasting operations should be electrically connected at a common point and this common point should be connected to a good earth ground rod.
All conductors and metal parts of the system should be kept away from electric detonators and blasting circuit wires.
The ground wires and earth ground rod for the system should be kept away from rails, wiring, and piping that might conduct stray currents from these sources to the blasting site.
All moving equipment in the immediate area that might be capable of generating static electricity should be shut down while the blasting circuits are being connected and until the blast has been fired.

Electrostatic Discharges
Lightning
Lightning undoubtedly represents the greatest single hazard to blasting because of its erratic nature and high energy. A lightning strike can have over a million volt potential and discharge currents of over 100,000 ampere. If lightning strikes a blast area, all or part of the blast probably will be detonated. Because of the extremely high currents involved, even distant lightning strikes can be hazardous to electric initiating systems in both underground and surface operations.

Therefore, in the interest of safety, blasting on land, on water, and in some underground operations should be suspended, and all personnel should be evacuated to a safe distance from the blast area whenever lightning storms are in the vicinity.

The danger from lightning is considerably increased if there is a transmission line, water line, compressed air line, fence, stream, or other conductor available to carry the current between the storm and the shot location.

Where permanent firing lines and electric blasting caps are used, typically in underground operations, a 15-foot (4.6m) air gap should be provided to act as a "lightning break" between the blasting system and the supply power circuit. This air gap should be bridged by a flexible jumper cable just prior to firing the bla

Blasting operations must constantly be alert to atmospheric conditions that indicate the possibility of lightning and be prepared to temporally abandon all explosive loading activities until the threat passes. Lightning storms tend to be somewhat seasonal and often occur during the late afternoon and early evening hours. Scheduling blasting to avoid these hours is a common sense option.

A common sense rule is to evacuate the shot area when thunderstorm activity comes within 5 miles of the shot site. Regulations require that electric blasting circuits be shunted at all times unless being tested or tied in. In wiring situations where some series are complete and shunted and some are incomplete and in the process of being wired and the approach of thunderstorm activity is noted, common sense dictates that the shot wiring activity be abandoned and the area cleared and guarded.

Radio Frequency (RF)

All radio transmitters send out energy in the form of electromagnetic waves; leg wires and lead lines can act as antennae, converting energy from these waves into electrical energy in the wire.

The amount of electric produced in the wires depends upon: the output power of wattage of the transmitter; the frequency of the radio waves; he distance from the source of the RF energy to the blast site; the configuration of the wires which act as the antenna

The hazard exists regardless of whether the wires are shunted (short circuited) or left unshunted (open circuit).

Recommended Distances for Blasting
50,000 watt AM radio (540 – 16500 KHz).....2900 ft (880 m)

100,000 watt FM radio (88 – 108 MHz).....2600 ft (790 m)

300,000 watt VHFTV (Channels 7-13).....2500 ft (760 m)

1,000,000 watt UHFTV (Channels 14-83).....2000 ft (610 m)

100 watt mobile police radio (35-44 MHz).....260 ft (80 m)

5 watt Citizen's Band radio (26.96 – 27.41 MHz).....5 ft (1.5 m)

Precaution

Keep mobile transmitters away from the area.
Posting adequate signs to remind operators to turn off radio transmitters.

Testing Blasting Circuits

A Blaster's Multimeter, Blasting Ohmmeter or Blasting Galvanometer can be used to test blasting circuits for continuity and resistance.

Never use any test instruments not specifically designed for blasting circuits.

Before using an instrument, make certain the needle can be adjusted to "zero" when the terminals are shunted. Digital meters should read, "zero" in the display. If not replace the batteries and make the necessary adjustments as recommended in the meter instructions.

Replace the battery with the same type of battery specified by the manufacturer for use in the blasting instrument. If in doubt, contact your supplier's technical representative. Do not change batteries in the presence of electric detonators.

To properly test the circuit, the theoretical resistance of the circuit must be calculated. ***Table 16.1*** gives the resistance of a typical series of electric detonators with copper and iron leg wire of various lengths. This table is presented only for purposes of illustrating how to make circuit calculations. The actual resistances of the electrical detonators available to the blaster from the various manufacturers may vary widely from those shown in the table. Be sure to use your manufacturer's data when actually making circuit calculations in the field. ***Table 16.2*** gives the resistance per 1,000 feet for the various types of wire.

NOMINAL RESISTANCE* OF ELECTRIC BLASTING DETONATORS IN OHMS PER DETONATOR

(This is for example calculation only: refer to your supplier for actual resistances of your products)

COPPER WIRE			IRON WIRE		
Length of Wire in Feet	Instantaneous Delay Detonators	Delay Detonators	Instantaneous Detonator	Delay Detonators	Length of Wire in Feet
4	1.26	1.16	2.10	2.00	4
6	1.34	1.24	2.59	2.49	6
7	-	-	2.84	-	7
8	1.42	1.32	3.09	2.99	8
9	-	-	3.34	-	9
10	1.50	1.40	3.59	3.49	10
12	1.58	1.48	4.09	3.99	12
14	1.67	1.57	4.58	4.48	14
16	1.75	1.65	5.08	4.98	16
20	1.91	1.81	6.06	5.98	20
24	2.07	1.97			24
30	2.31	2.21			30
40	2.15	2.06			40
50	2.42	2.32			50
60	2.69	2.59			60
80	2.71	2.61			80
100	3.11	3.01			100
120	3.51	3.41			120
150	4.11	4.01			150
200	5.12	5.02			200
250	6.12	6.02			250
300	7.13	7.03			300
400	9.13	9.03			400

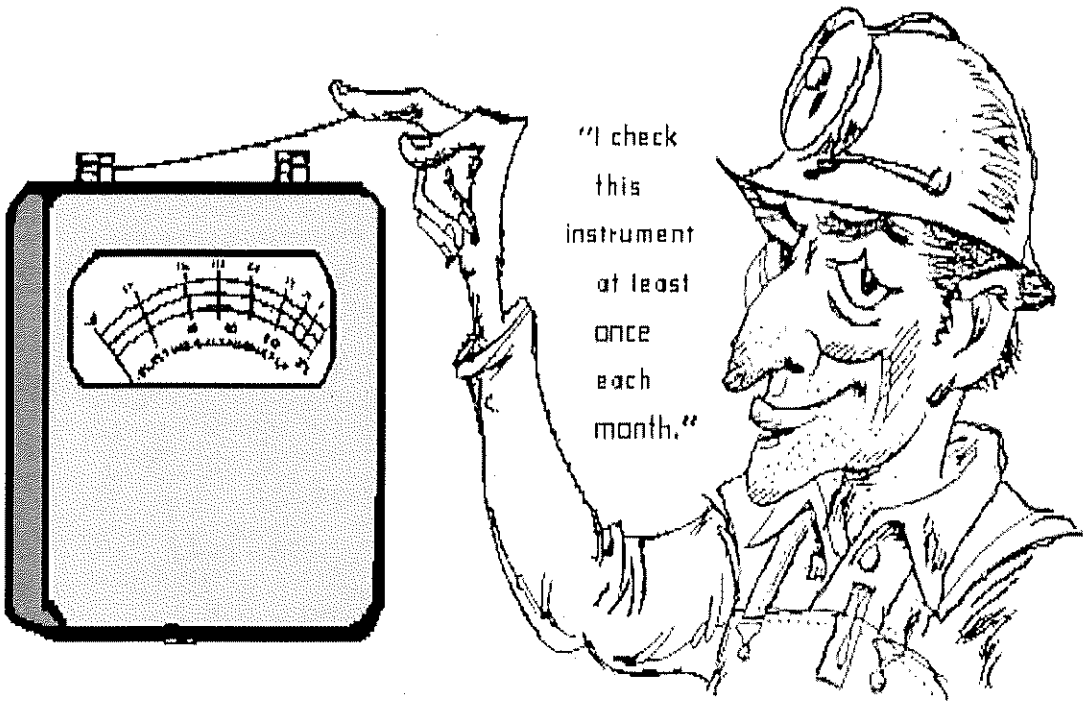
Table 16.1

*At 68^0 Fahrenheit

Resistance* of Copper Wire	
AWG Gauge No.	Ohms per 1,000 Feet
6	0.395
8	0.628
10	0.999
12	1.588
14	2.525
16	4.02
18	6.39
20	10.15
22	16.14

*At 68^0 Fahrenheit

Table 16.2 – Resistance* of Copper Wire



USING A BLASTING GALVANOMETER

Proper use of the blasting galvanometer helps assure safe blasting practice. You should consider using this test instrument in some, or all, of the following cases:

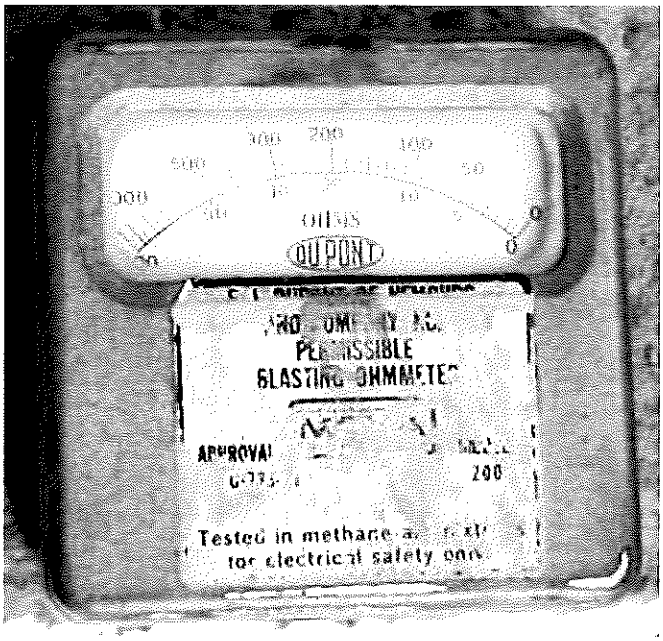
Check electric blasting caps for circuit continuity prior to stemming the hole. If this is done, be sure to twist the cap leg wires together after the test, so that they are short-circuited.
When wiring a blasting circuit series-in-parallel, check each series after wiring is completed and also when hooking up to the bus line or firing cable. Note the galvanometer reading. Readings should be approximately the same for every series. This assures an equal current distribution to each series.
Check firing cables in both the open are shunted positions. This will verify that there are no shorts or breaks in the cable.
When placing protective mats over a shot, lead wires on the terminals of the blasting galvanometer and make sure there is no change in instrument reading. If mats are of wire cable good practice to tape each leg wire connection.
Upon completion of all wiring, check circuit continuity at the firing end of the firing cable. Read the continuity check immediately prior to hooking up to the blasting machine.
Inspect the shot after blasting for possible missed holes. Use the galvanometer to check suspected misfired caps.

Blaster Multimeter

The Blaster's Multimeter is a compact volt-ohm-milli-volt meter specifically designed to measure resistance, voltage, and current in electric blasting operations. As with all blasting test devices, be certain the name includes the work ***Blaster's***. **A standard multimeter should never be used to test a blasting circuit.**

This versatile meter can be used to:
Measure the resistance of a single blasting circuit for continuity, and the total resistance in a series-in-parallel circuit, with a high degree of precision and accuracy.
Survey blast sites in order to determine if extraneous current hazards exist. For operating instructions, refer to stray current measurement methods recommended by the manufacturer.
Measure a wide range of resistances necessary to investigate static electricity hazards, such as those possible in a pneumatic loading operation.
Measure power line voltages up to 1500 volts AC and DC.

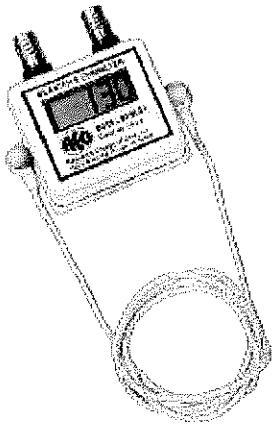
Blasting Ohmmeter



The Blasting Ohmmeter (sometimes called "Blaster's Ohmmeter") is an analog ("swing needle") device utilized to measure the resistance in ohms of the blasting circuit: (1) in order to determine if the bridgewire of an individual electric detonator is intact; (2) to determine the continuity of an electric detonator series circuit, (3) to locate broken wires and connections in a series or series-in-parallel circuit. To measure resistance with this compact instrument, place each of the two lead-in wires from the open end of the circuit on the two contact posts that extend out of the top of the Blasting Ohmmeter. The meter reading will approximate the circuit's resistance (number of ohms). To determine if the meter is functioning properly, short circuit the contact posts and determine if the meter is reading zero. If not, turn the adjustment screw on the instrument until the needle indicates zero ohms on the scale that will be used to test the circuit. If the needle cannot be adjusted to zero, or the needle is drifting when the instrument is shorted, the battery may be weak or other circuitry must be repaired prior to use. Never use an instrument that cannot be adjusted to zero.

Some Blasting Ohmmeters use special silver chloride batteries. When the battery is exhausted, it must be replaced with the same type of cell. Never attempt to replace it with a standard battery. Never change batteries near electric detonators. Never allow the silver chloride cell, or any battery, to come in direct contact with electric detonators.

Blasting Digital Ohmmeter



The Blasting digital ohmmeter is used to measure the resistance of blasting circuits and individual detonators in the same manner as the Blasting Ohmmeter, but with greater accuracy and range. Blasting Digital Ohmmeters are available in both permissible and non-permissible versions. Never use a non-permissible instrument underground in a gassy environment. The Blasting Digital Ohmmeter will give a direct reading of the resistance (ohms) of the blasting circuit when the two wires from the circuit are placed against the posts of the ohmmeter. A test of the ohmmeter can be made by shorting across the posts. The reading should be zero.

Blasters must use only the recommended batteries in these machines. Other batteries will produce a hazardous current level. Never test an electric detonator or blasting circuit directly with a battery, recommended or otherwise, and never allow any battery to come in direct contact with electric detonators.

Date / Plant / Shift Code

In 1971 IME member companies implemented a product identification system for packaged explosive products manufactured in the United States.

The code for the date, work shift and plant of manufacture is plainly marked on each unit to be identified. Marked units include all cartridges of dynamite, blasting agent, water gel, slurry, cast boosters, primers, cartons of detonating cord, containers of blasting caps and similar accessories. The shipping case bears the same number as the units.

The following is the format for the Date / Plant / Shift code used for product tracing:

Day	Month	Year	Location	Shift or Machine
2 digits	2 digits	2 digits	1 digit	1 digit
Numeric	**Alpha**	**Numeric**	**Alpha**	**Numeric**

When writing months, a two letter abbreviation is used:

January	**JA**	**July**	**JY**
February	**FE**	**August**	**AU**
March	**MA**	**September**	**SE**
April	**AP**	**October**	**OC**
May	**MY**	**November**	**NO**
June	**JU**	**December**	**DE**

As an example, a product manufactured on September 30, 1997 during the first shift at a plant which the manufacturer has assigned the letter "A" would be **30SE97A1**.

Manufacturers advise the Bureau of Alcohol, Tobacco and Firearms (BATF) when codes are changed.

Approved by the IME Board of Governors December 8-9, 1987

Ammonium Nitrate Oil (ANFO)

Ammonium nitrate is an essential ingredient in nearly all-commercial explosives including dynamite, emulsions, and water gels. Its predominant use, however, is in the form of a small porous pellet, called a prill, mixed with fuel oil. Nearly four billion pounds of these mixtures, commonly referred to as ANFO, are consumed each year in the U.S. They account for approximately 80 percent of the domestic commercial explosive market.

Since their introduction in the 1950's, ANFO products have found extensive use in a wide variety of blasting applications such as surface mining of coal, metal mining, quarrying, and construction. Their dominant use is attributed to economy and convenience.

Their limitations—no water resistance and low-product density—should be recognized as product deficiencies prior to introducing ANFO into a blasting system.

The most widely used ANFO product is an oxygen-balanced, free flowing mixture of about 94 percent ammonium nitrate prills and 6 percent No. 2 diesel fuel oil. Other ANFO products are modifications of this basic ANFO formula in which:

Substances such as finely-sized aluminum or carbon aceous materials are used in conjunction with No. 2 diesel fuel, or,
The AN prill is crushed, mixed with No. 2 diesel fuel (and possibly other substances), and packaged in water resistant package for use in damp to slightly wet boreholes.

The AN Blasting prill

This material is also frequently referred to by the terminology *porous, explosive-grade, industrial,* or *low-density* prilled ammonium nitrate.

Production of ammonium nitrate (AN) prills is a multi-step process that begins with natural gas and air.

The end point in this process involves spraying a concentrated (94% to 96%) AN solution through perforated plates or shower heads at the top of a prill tower. Liquid AN droplets are formed as the solution exits the shower heads.

During a free fall of 100 to 200 feet (30.5 – 61m), the droplets crystallize into spherical AN prills. These prills are dried, cooled, and may be coated with anti-setting agents prior to shipment.

A major domestic use of AN prills is for agricultural fertilizers. However, the agricultural AN prill differs from the AN prills most suitable for explosive use. Blasting prills are usually less dense and, consequently, more porous.

Density

Prills best suited for blasting products have a particle density in the range of 1.3 to 1.5 g/cc. AN prills with particle densities approaching the density of solid ammonium nitrate (slightly over 1.7 g/cc) are less sensitive to detonation. The voids in the porous, less dense blasting prill serve two functions:
They enable the prill to absorb and retain fuel oil in a uniform and intimate manner; and
They improve sensitivity by acting as sites for high-temperature "hot spots" or ignition points.

Anti-setting Coating

Liquid surface-active agents (surfactants) and finely ground (minus 325 mesh) kaolin or talc coat prill to disperse ambient humidity. This retards the prill's affinity for moisture on its surface, thereby minimizing caking. In some cases, the use of the surfactant alone has proven to be an effective anti-setting coating. Excessive amounts of talc or kaolin will, 1) decrease ANFO sensitivity because of the inert nature of those minerals and 2) interfere with the oil distribution, which will affect ANFO performance. Excessive quantities of certain surfactants may affect the stability of the emulsifier in blasting emulsions. This could in turn affect the performance of ANFO/emulsion blends. A good blasting rill has typically less than 1.0 percent anti-setting coating.

Loading of Holes

ANFO is extensively used because of the low cost advantages. When property stored, handled, and used, ANFO will give good performance. ANFO mixed to the proper proportion (94.3% ammonium nitrate and 5.7% fuel oil or Corvus oil for less oil fumes) has a Fume Class 1 rating. However, improper storage or usage can result in the generation of toxic fumes. Prolonged storage can also result in evaporation of the fuel oil. Ammonium nitrate is highly hydroscopic and will absorb moisture from the humid mine air if left stored in an open container. The loading of wet holes must also be avoided. Excessive moisture and/or unbalanced fuel ratios will result in poor sensitivity reduced explosive efficiency, and the generation of toxic fumes.

ANFO is normally packaged in 50-lb pillow - type or poly-burlap bags for easy handling by the mine personnel. However, recently some mine operators have adopted a bulk handling system to reduce handling cost. Since mine layout and systems vary greatly, any bulk handling system must be evaluated and designed for each situation.

Pneumatic Loading

The degree of sensitivity of ANFO mixes allows for the use of pneumatic loaders. Pneumatic loaders can be classified into three categories: pressure pots, Venturi loaders, or a combination of both systems.

A pressure pot consists of a pressure vessel with a conical base and a loading hose of proper diameter and length, the pot is sealed and a pressure of 25 - 40 psi is applied. The flow of ANFO is controlled by a ball valve at the base. Pressure pots can load at a rate of 25-50 lb per minute through a 100 ft 1in. ID hose. A disadvantage of a pressure pot is that it will not crush or compact the ANFO in the blast hole because of its lower air stream velocity in the loading hole as efficiently as the Venturi loader. This will result in lower velocity of detonation, density, and energy. Boreholes that are inclined upward cannot readily be loaded with the pressure pot system.

A Venturi loader consists of a hopper with suction at its base supplied by a Venturi. Venturi loaders are simple, portable, and inexpensive. This is offset by slow loading rates of 8-15 lb per minute. They are also restricted to short boreholes, but provide very good compaction of the ANFO prill in the blast hole.

The pressure pot/Venturi loader combines the advantages of both loaders. It has a high loading rate (50 - 75 lb per minute) with good crushing and compaction of the ANFO in the blast hole.

Static Electricity

Static electricity is a form of potential energy in which electric charges are stored on some person or object. When the static electricity is converted to kinetic energy by means of a static discharge, it represents a possible hazard to the use of flammable or explosive materials. When considering commercial blasting, the primary concern is that static electricity may cause a premature detonation when blasting electrically. Experience has shown, however, that static electricity, under some conditions, may also represent a hazard to nonelectric blasting.

The safety procedures that eliminate the accumulation of a static charge are listed below. They should be made an integral part of the pneumatic loading Operation, since they are the principal mechanism for minimizing the static electricity hazard.

1. *Ground the Pneumatic Loader* The pneumatic loader (includes both pressure pot and Venturi types) should be constructed of a conductive material and should be grounded to earth. The resistance between the loader and earth should be a maximum of 1,000,000 ohms. This can usually be accomplished by physical contact between the loader and earth. If the loader is mounted on a vehicle of some type, a positive grounding means should be used. One grounding method that has proved satisfactory is to bolt or weld one end of a heavy, flexible wire to

the loader. The opposite end should be connected to a metal rod imbedded in the earth. If the loader is moved often, the opposite end of the wire should be bolted or welded to a metal plate (about 8" x 8" x 1/2" thick with a handle for easy handling) that is rested on wetted earth during loading. Never ground the loader to metal air or water lines, metal support frames, or to any fixture that is also used to ground electrical equipment, as these may be sources of stray currents.

2. *Use a Semi conductive Loading Hose* when loading ANFO pneumatically, use a semi conductive hose that is electrically connected to the pneumatic loader. In most cases, this can be accomplished by clamping the hose to the outlet from the loader. The semi conductive hose should have a minimum resistance of 5,000 ohms per foot and a maximum total resistance of 2,000,000 ohms. There are a number of companies that manufacture acceptable semi conductive hoses.

3. *The Operator Handling the Loading Hose Should Not Wear Gloves* unless some other positive means is utilized to ground the operator, he or she should be in direct physical contact with the semi conductive loading hose. This is necessary to prevent the accumulation of a static charge on his or her person. If he or she wears gloves, the direct physical contact between the two cannot be achieved.

4. The Resistance of the Earth between the Ground from the Pneumatic Loader and the Boreholes Should Be a Maximum of 1,000,000 0hms The resistance of the ore body and/ or rock between the ground from the pneumatic loader and the location of the boreholes being pneumatically loaded must be less than 1,000,000 ohms, so that the charge on the ANFO particles can neutralize the opposite charge that is left on the loading hose. Experience has shown that this requirement is easily satisfied in most mines.

5. *The Ambient Relative Humidity Should Be a Minimum of 5O%* Humidity serves two functions in minimizing the accumulation of static electricity, Under conditions of high humidity, a thin film of moisture condenses onto the surfaces of objects on which static accumulates. The moisture film is usually sufficiently conductive that it backs up the grounding procedures by permitting electrostatic charges to drain to earth as they are being generated. The humidity in the compressed air that conveys the ANFO to the boreholes provides moisture that is absorbed by the ANFO particles. This provides a conductive film on the surfaces of the particles that drains any electrostatic charges to earth that may be on the ANFO as it is packed in the borehole.

6. *Avoid the Use of Nonconductive Borehole Liners* A plastic liner is sometimes used to keep the water in the borehole away from the ANFO or to prevent the ANFO from escaping from the borehole into cavities, cracks, or vugs. The nonconductive nature of these liners prevents the grounding of the static charge on the ANFO particles. Hence, they should not be used in boreholes that are pneumatically loaded unless some positive means is provided to drain

electrostatic charges to earth from inside the liner. There are semi conductive ground straps available to accomplish this grounding.

7. *Make Periodic Tests to Check the Effectiveness of the Recommended Safety Procedures* There are three types of tests that should be made prior to the introduction of pneumatic loading and periodically thereafter. These are:
1) Grounding resistance measurements,
2) Static voltage measurements, and
3) Relative humidity measurements.
The purpose of the grounding resistance measurements is to ensure that static charges will be dissipated to earth and neutralized instead of accumulating on some person or object. They entail checking the resistance of the loading hose, the pneumatic loader grounding, and the surrounding ore body to ascertain that they do not exceed the maximum values previously recommended. The purpose of the static voltage measurements is also to ensure that static electricity is not being accumulated. These measurements entail using an electrostatic voltmeter to monitor the pneumatic loader, the loading hose, the operator, and the ANFO particles as they are packed into the borehole for the presence of excessive electrostatic' voltages. Although condensation on the surfaces of objects is not depended only to drain off static charges, experience has shown that static is more likely to be a problem when the relative humidity is low less than 50%. Therefore, measurements of the relative humidity of the ambient air and the compressed air that services the pneumatic loader will help to further define the overall background conditions. The test instruments and procedures that are used in making the grounding resistance, static voltage, and relative humidity measurements are discussed in the next section.

When blasting non-electrical, the safety procedures listed above should be followed to eliminate the accumulation of static electricity generated by pneumatic loading.

Emulsion Explosives

Explosive Properties--Physical Form

An emulsion is an intimate mixture of two immiscible liquids with one liquid phase dispersed uniformly throughout the second phase. Emulsion explosives are dispersions of water solutions of oxidizers in oil medium or "water-in-oil" emulsions. It is this unique structure and high ratio of oxidizer to fuel that give emulsion explosives their special characteristics.

The oil or fuel phase is known as the continuous or external phase because it surrounds and coats all of the oxidizer droplets. The fuel phase is generally oil or

wax or a combination of the two. No. 2 diesel fuel oil (FO) is common to emulsion explosives.

The water or oxidizer solution phase is called the discontinuous or internal phase because the microscopically fine droplets are kept apart and surrounded by the continuous fuel phase. The oxidizer phase always contains ammonium nitrate. Other salts such as sodium nitrate, calcium nitrate and ammonium or sodium perchlorate may also be included.

The oxidizer remains dispersed in the fuel to form a stable emulsion through the action of a surfactant (emulsifier). For example, oil and vinegar are held together by egg yolks to form the emulsion known as mayonnaise. There are many different emulsifiers, and choosing which one to use depends on the particular requirements for the product. The emulsion formed from the fuel phase, oxidizer phase and emulsifier, before any addition of bulking agent, aluminum, or solid ammonium nitrate, is called the matrix and is the foundation of subsequent products.

Structure

Because of the necessity to have close to zero oxygen balance, emulsion explosives need the volume of oxidizer to be much greater than the volume of fuel: the ratio is approximately 9 to 1. Because the relative volume of fuel is so much less than tat of the oxidizer, it must be spread in a very thin layer in order to cover all of the oxidizer droplets. The size of the droplets is very small: and, due to the oxidizer/fuel ratio, the droplets are in the shape of many-sided polyhedrons. Droplets are usually in the range of 0.2-10 microns in diameter, or about $1/4^{th}$ to $1/2000^{th}$ the size of a grain of table salt.

The rheology or viscosity of the emulsion is controlled by the nature of the fuel phase and the droplet size. The composition (wax, oil, emulsifier) of the full fuel phase has the greatest influence on the final viscosity of the product. Low viscosity oils, such as No. 2 diesel fuel, can be used to make pumpable emulsions. Waxes and high viscosity oils are used to make thick, putty-like packaged products. The droplet size is controlled by the amount of work pt into the emulsion. The faster and longer it is stirred, the greater the work input and the smaller the droplet size and size distribution. The smaller the droplet size, the thicker the emulsion.

Thermochemical Energy

The addition of aluminum or ANFO to an emulsion explosive can be used to increase its energy (cal/g). Aluminum does not significantly increase the sensitivity of emulsions, so a much coarser and less costly aluminum can be used rather than the high cost paint-grade aluminum used to attain sensitivity in some water gels. Theoretically, an addition of 5% aluminum will increase the

energy of the emulsion by about 25-35%. Ten percent aluminum increases the energy by about 40-60%. Above 10% the addition of aluminum may not be cost effective.

ANFO added to emulsions can increase the energy by about 5% for every 10% increment added. ANFO also has the added advantage of producing only gaseous detonation products, and therefore, an increase in gas volume is also realized. An increase in gas volume usually leads to better heave and throw of rock being blasted.

The ratio of the amount of energy released to the calculated thermochemical energy is the measure of the efficiency of an explosive. Water gels generally have a liquid and a solid phase. They are generally made at elevated temperatures; as the product cools, oxidizer salt crystals begin to form. The colder the product becomes, the greater the tendency for crystals to form. The more crystals present and the larger they are, the more insensitive and less efficient the product becomes. The components are not intimately associated with one another because a relatively large amount of oxidizer surrounds a relatively small amount of fuel. In contrast, the increased intimacy between fuel and oxidizer in emulsions, and the very small particle size of the droplets, is believed to be responsible for the greater efficiency and enhanced detonation properties of these products.

The emulsions are two phase systems. In order to have a suitable oxygen balance, only a very small amount of fuel is available to spread over each individual oxidizer droplet. This results in a very intimate mixture. Because there are so many oxidizer droplets and because they are so small, the oxidizer salts, regardless of temperature, will not easily crystallize and grow. Since the oxidizer salts remain in solution, the detonation properties of emulsion explosives remain unchanged for long periods of time and over wide temperature ranges.

Detonation, Physical and Safety Properties

Safety

Emulsions fail to detonate in impact and friction tests, which have been standard to the explosive industry for years. When placed against a metal plate, the emulsions fail to detonate under the impact of a 30-06 projectile. Other high velocity impact tests with larger caliber projectiles show emulsions to have a greater resistance to initiation by impact than either water gels or dynamites. Normally, emulsion explosives will not detonate during burning, but there is no guarantee of this, particularly if the material is contaminated with foreign materials such as rust, detonators, dynamites or aluminum powders. When pumping emulsions, care must be taken so that the pump does not run dry or against a closed system ("deadhead"). In either case, friction can raise the temperature of the emulsion in the pump beyond the decomposition point of

ammonium nitrate or other ingredients. If this happens a detonation can occur. Remember—it can be just as hazardous to pump unsensitized emulsion oxidizers, as it is to pump sensitized ones. Although tests have demonstrated that emulsions offer a great degree of safety, they will detonate if subjected to severe conditions. They are explosives, and regardless of their degree of safety should never be abused.

Velocity

It is an established fact that the smaller the particle size of the ingredients of an explosive, the higher the velocity of detonation (VOD). Since the droplet size of emulsions is so fine, the VOD of explosive emulsions is very high – close too theoretical. The VOD does decrease somewhat as the charge diameter decreases or as solids such as aluminum or AN prills are added, but the VOD generally remains relatively high when compared to most water gels.

Detonation Pressure

Since emulsions have a high velocity of detonation and a reasonable density, they also have a relatively high detonation pressure. Emulsion detonation pressures measured by the "aquarium" technique are found to be between 100 and 120 Kbar/(1.45-1.74 x 10^6 psi). As a result, emulsions are particularly well-suited for improving fragmentation in hard massive rock, for breaking hard bottom rock, and for use as a booster for ANFO mixtures and other blasting agents.

Sensitivity

Because emulsions have a very fine particle size and are an extremely intimate mixture of fuel and oxidizer, only a density reducing agent needs to be added to make them detonate. It is not necessary to use high explosives or chemical sensitizers for sensitivity. The density can be reduced by occluded air, chemically generated gas, perlite, expanded plastic, hollow glass or phenolic microspheres, or even AN prills. The sensitivity of the emulsions can be made to vary from that of a No. 8 strength detonator (or less) for a high explosive classification at 68°F (-20°C) to booster sensitivity for blasting agent 1.5D products. The emulsions are sensitive over a wide temperature range, and they also maintain their sensitivity over a wide range of diameters (7/8 inch [22mm] and up for "Explosive, Blasting, type E 1.5D" [blasting agent]). Different density reducing agents are used for different reasons, but the glass microspheees are the most common, although chemical gassing is becoming popular. Because certain glass microspheres will withstand high pressures, they are especially useful in sensitizing emulsion products for use in deep bore holes or close borehole spacing where high hydrostatic or shock pressures are likely to be encountered.

Generally, the lower the density of an emulsion explosive, the more sensitive it becomes. Also, the lower the water content of the emulsion explosive, the more sensitive it becomes. The water content of blasting agents is usually higher than that of 1.1D emulsions, but so is the density. This keeps the overall bulk strength energy level of blasting agents close to that of the high explosive emulsions.

Water Resistance

Water-in-oil emulsions have a continuous, water-immiscible oil phase and are extremely water resistant. They do not depend upon the integrity of the package for water resistance. Emulsions are a good choice when wet holes are encountered, because they will perform successfully after sleeping underwater for weeks or even months.

DYNAMITES

Straight Dynamite

Guhr dynamite, originally formulated by Nobel in 1864, was the forerunner of today's straight dynamites. Nobel's guhr dynamite contained kieselguhr totally saturated with liquid NG. The kieselguhr absorbes three times its weight in NG; as such, guhr dynamite contained about 75% NG. Kieselguhr, being inert, detracted from the explosive strength. In time, this problem was solved by using sawdust to absorb the NG, which added to the energy.

Present-day straight dynamites are no longer straight because they contain various proportions of active ingredients substituted for much of the kieselguhr, with resulting higher performance. Among the ingredients added to increase the performance was sodium nitrate, which created higher energy and a more favorable oxygen balance.
High density and high velocity result in good *brisance*, the shattering effect. They generally have fair water resistance, but poor fume characteristics, which disqualifies them for underground applications. Because of their high cost, industrial use and importance are declining, with ammonia dynamites being used as a substitute. Today straight dynamite is used in ditch blasting in wet soil by the sympathetic propagation technique.

Ammonia Dynamite

The first use of ammonium nitrate in explosives was patented by Nobel in 1867. In the first ammonia dynamite, ammonium nitrate was mixed with charcoal and nitroglycerin. This was an advancement, as the ammonium nitrate decomposes

completely, adding to the energy. It also supplies oxygen to the reaction for better fume characteristics.

Since a portion of the NG is replaced by ammonium nitrate, ammonia dynamite generally has a lower density and higher shock and friction tolerance. Ammonia dynamites have low to medium VODs and exhibit good heaving action due to increased gas production. Ammonia dynamites are suited for use in relatively soft ground. The strength and density of ammonia dynamite can be varied greatly by changing the ingredient ratios. Most ammonia dynamites, however, have poor to fair water resistance and are thus limited in their use.

Gelatin Dynamite

In 1862, Alfred Nobel first prepared nitrocotton (nitrocellulose), searching for a substance that would retain NG in the presence of water. Guncotton (i.e., nitrocotton or nitrocellulose), listed as an absorbent in a dynamite patent by Nobel in 1863, did not perform as desired. In 1873, Maynard, an American medical student, found that a nitrocellulose with a lower nitrogen content than that used earlier by Nobel would produce a solution called collodion. Initially, it was used as a protective film over a cut as it dried into a thin tough coating. In 1875, Nobel cut his finger and applied the collodion. He then decided to try its effects on NG, which resulted in a very plastic and cohesive gelatin.

Straight Gelatin Dynamite

Straight gelatin contains a high ratio of nitrocellulose to nitroglycerin. Because of its highly gelatinous "rubber like" consistency, it has excellent water resistance. Nobel's straight gelatin composition contained 91% NG, 8% nitro cotton, and 1% chalk, and produced a plastic substance resembling crepe rubber in appearance and texture. This was called 100% blasting gelatin. Similar to the development of the straight dynamites, sodium nitrate and other carbonaceous ingredients were added to obtain a closer oxygen balance and higher energy characteristics.

Ammonia Gelatin Dynamite

This type of gelatin dynamite has ammonium nitrate substituted for some of the nitroglycerin to form a plastic cohesive product with good water resistance. Ammonia gelatins have high densities and high velocities, giving them high detonation pressure, which make them excellent boosters. Because of high-energy output, they are particularly suited for shooting tough rock.

Semi-gelatin Dynamite

A semi-gelatin is a cross between the high-density ammonia dynamites and the ammonia gelatins. The semi-gelatin dynamites exhibit moderately high detonation pressure and an adequate amount of water resistance for all but the most severe conditions. The rationale of the semi-gelatin dynamite is based upon economics. They have a higher cartridge count per case and cost less per cartridge than gelatins of equivalent strength, but exhibit less water resistance.

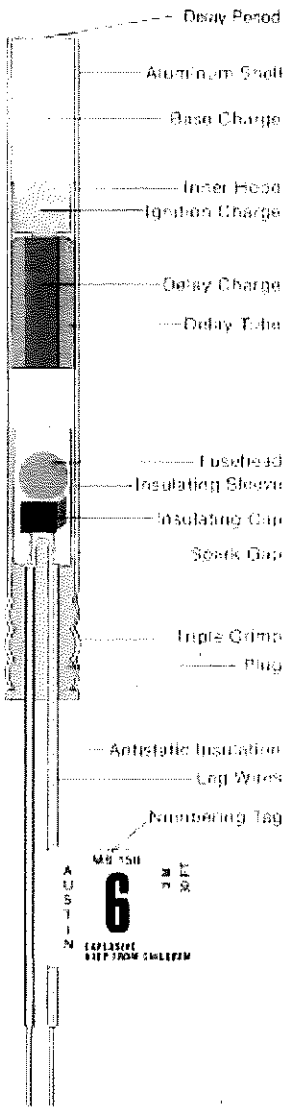
Permissible Dynamite

Permissible dynamites are specifically formulated and developed for underground coal mining. Each formula must pass many tests conducted by the U.S. Bureau of Mines and has been assigned an individual permissible certificate by MSHA. They are also subject to periodic testing to ensure permissibility for use in underground coal and gaseous metal and nonmetal mines.

Electric Detonators

This classification includes high, medium, and low firing-current electric detonators, semiconductor bridge detonators, toroid induction/electric blasting detonator. Exploding bridgewire (EBW) detonators and the electronic detonator.

Over the years, in the North American market the most widely used electric detonator has been of the low firing-current variety. With the proper electrical energy source and blast circuitry, large numbers of electric detonators can be initiated on command from a location that is safely removed from the immediate blast area.



The electric detonator consists of a metal shell containing a high explosive base charge designed to initiate other explosives. Above the base charge is a small charge of primary explosive (primer charge) that converts a burning reaction transmitted from the ignition or pyrotechnic fuse into a detonating reaction. Above the primer charge, in delay detonators, is a pyrotechnic delay element that burns at a known rate and whose length and composition control the transit time of the burning front. Detonators classified as instantaneous or zero delay does not contain a delay feature. The topmost reactive element in the electric detonator is the ignition area where a bridge wire is attached between the leg wire pins and is embedded in an ignition mixture. The ignition mixture may be in the form of loose powder, a primer spotcal current passes through the system, a bridge becomes hot enough to ignite the ignition mixture. The majority of electric detonators surround the ignition area with a plastic ferrule that insulates and protects the ignition mixture from the shell. The leg wire pins are embedded in a thermosetting resin plug, and are connected to the detonator's leg wires within an electrometric material above the resin plug. The electrometric material top seal is securely crimped near the open end of the initiator shell, forming a water-resistant closure that firmly positions and secures the lewires inside the shell.

All modern commercial electric detonators include an internal feature to prevent electrostatic energy from accidentally initiating the detonator. There are several designs, some of which provide a bypass path around the bridgewire using a semi conductive material and others, which utilize a printed circuit, which provides a controlled path to ground.

Detonator leg wires are made of solid copper, iron, or copper-clad iron wire in a variety of gauges and lengths. Iron or copper-clad iron leg wires are designed for use in operations where it is desirable or necessary to remove the leg wire remnants from the blasted rock by magnetic means. Plastic insulation provides insulation, abrasion resistance, and flexibility. The wire insulations typically color-coded to provide product identification with maximum visibility and to assist in wiring hookups. Most short-length electric detonator leg wires are coiled in a figure eight fold that is secured with a paper band. Longer length detonator wires are usually supplied as either duplex wire with a single color and wound on spools or single individually colored wires that are coiled in a figure eight fold. Longer length leg wires are typically heavier gauge wire in order to provide improved tensile strength and lower resistance per unit of length.

All electric detonators produced in North America have shuts on the free ends of the leg wires to provide a low resistance path to prevent current from flowing through the bridgewire. In addition, some designs completely enclose the ends of the wires in order to prevent corrosion and to keep bare wires from contacting extraneous electrical current sources. In one design the shunt consists of aluminum foil with an insulation layer on the outside.

Electric detonators are supplied with a distinctive, numbered tag to facilitate easy identification of the delay period.

Instantaneous Electric Detonators generally contain the same charges as fuse caps and function in a similar manner with the exception that the activating energy is applied electrically.

Two electrical wires, commonly called leg wires, enter the shell through a non-conductive plug of rubber or plastic around which the shell is crimped during manufacture. These are connected to each other within the shell at a point within or close to the ignition charge by a high resistance bridge wire or match head. The plug through which the leg wires enter prevents moisture or other contaminants from reaching the ignition charge. Electric detonators are not as subject to mass detonation as are fuse caps provided that the leg wires are kept folded until the cap is to be used. They are, however more subject to accidental initiation by extraneous electricity.

When the proper amount of current is passed through the leg wires, the high resistance of the bridge wire or match head causes it to heat very quickly. This

heat ignites the ignition charge and from that point functioning is essentially the same as in a fuse cap.

Leg wires may be made of copper or iron. Iron wires are normally used only in coal and salt mines where the iron can later be magnetically separated from the coal or salt. Where iron wires are used, they are available in standard lengths from 4 to 20 ft.

Electric detonators with copper legwires are most commonly used because of their lower electrical resistance. Generally, they are available in standard lengths from 4 ft. to 400 ft. Other lengths are available on special order.

Because of differences in resistance, timing characteristics and designation of delay periods, brands of different manufacture should never be mixed in the same round, as risk of misfire is likely.

For all practical purposes, instantaneous electric detonators detonate when sufficient current is applied, although there actually is a measurable interval between the application of the current and the development of sufficient heat in the bridge wire or matchhead to activate the cap. This interval varies so slightly within **caps of the same manufacturer** that it can normally be ignored so long as sufficient current is applied. Thus, instantaneous electric detonators, unlike fuse caps, can be used for reliable simultaneous detonation of a large number of separate charges.

Long period electric detonators contain a delay train as an additional component. The delay train is interposed between the ignition and primer charges and delays detonation of the cap by the amount of time required to burn through it. This may depend on either the composition or the length or diameter of the delay train or both. Because the time interval between successive delay periods approximates one-half second, this type is sometimes referred to as slow or long delay electric detonators. It should be clearly understood, however, that each manufacturer establishes his own delay interval and numbers his delays in accordance with his own system. These facts provide an additional reason why caps of different manufacture must not be used in the same round.

Long period detonators are numbered to indicate progression and can normally also be identified by the manufacturers color code system. The lowest number, normally "0", indicates the shortest delay while the highest, presently 14 or 15, indicates the highest. It is emphasized that a "0" delay is not an instantaneous cap and that it will delay from 8 to 25 thousandths of a second, depending on the brand.

Primer:

A unit, package, or cartridge of explosives used to initiate other explosives or blasting agents, and which contains:

1) **A detonator, or**
2) **Detonating cord to which is attached a detonator designed to initiate the detonating cord.**

MAKING PRIMERS WITH ELECTRIC / ELECTRONIC DETONATORS

SMALL DIAMETER CARTRIDGES

(Less than four inches in diameter) –

Step 1: Punch a hole straight into one end of cartridge,
Step 2: Insert the detonator into the hole.
Step 3: Tie leg wires around the cartridge using a half hitch.
NEVER pull the wires too **tightly.** This may break them or damage the insulation

NEVER pull the wires too **tightly.** This may break them or damage the insulation

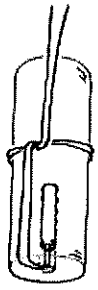


Figure 1: Recommended method of making primer with small diameter cartridge and electric detonator.

LARGE DIAMETER CARTRIDGE

(Four inches and larger in diameter) –

Step 1: Punch a slanting hole from the center of one end of the cartridge coming out through the side two or more inches from the end.
Step 2: Fold over the leg wires about 12 inches from the detonator to form a sharp bend.
Step 3: Push the folded wires through the hole starting at the end of the cartridge and coming out through the side.
Step 4: Open the folded wires and pass the loop over the other end of the cartridge
Step 5: Punch another hole straight into the end of the cartridge beside the first, insert the detonator in this hole, and take up all the slack in the wires.

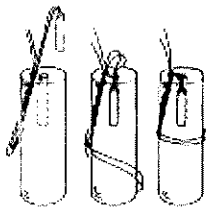


Figure 2: Recommended method of making primer with large diameter cartridge and electric / electronic detonator.

CAST BOOSTERS –

ALWAYS follow the manufacturer's recommendations for the attachment and use of detonators with cast or manufactured boosters.

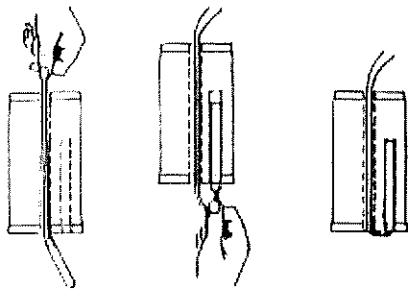


Figure 3: Recommended method of making primer with cast booster and electric detonator.

PLASTIC FILM CARTRIDGES –

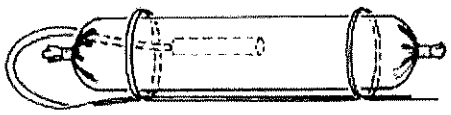


Figure 4: Recommended method of making primer with plastic film cartridge and electric / electronic detonator.

MAKING PRIMERS WITH FUSE OR NONELECTRIC DETONATORS

SIDE PRIMING METHOD –

Step 1: Punch a hole in the side of the cartridge. Make the hole deeper than length of detonator and pointed downward rather than acrossk the fuse, shock tube o plastic tubing over theend so that it lies alon the length of the cartr*p 4*: Tape the fuse, shock tube or plastic tubing over the end so that it lies along the length of the cartridge.

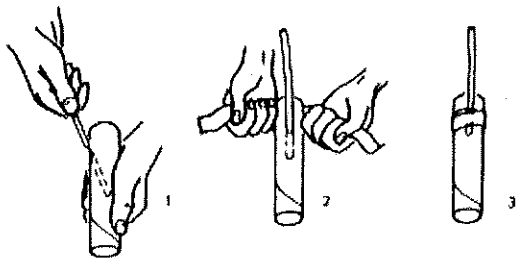


Figure 5: ***Recommended method of making primer using the side priming method.***

REVERSE PRIMING METHOD

Step 1: Punch a hole in the side of the cartridge. Make the hole deeper than length of detonator.
Step 2: Insert the detonator.
Step 3: Fold back the fuse, shock tube or plastic tubing over the end so that it lies along the length of the cartridge.
Step 4: Tape the fuse, shock tube to the cartridge.

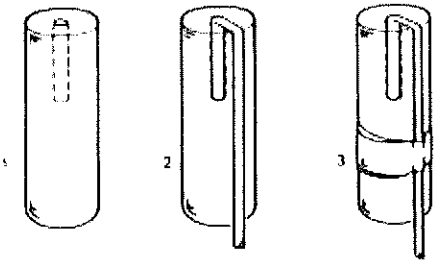


Figure 6: ***Recommended method for making primer by reverse priming method.***

- *CAUTION:* If miniaturized detonating cord is used, the explosives must be insensitive to initiation by the detonating cord for this method to work.

PLASTIC FILM CARTRIDGE PRIMER –

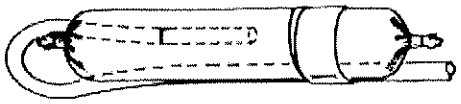


Figure 7: ***Recommended method of making primer with plastic film cartridge and fuse or nonelectric detonator.***

MAKING PRIMERS WITH DETONATING CORD

DETONATING CORD WITH CAST BOOSTERS –

ALWAYS follow manufacturer's recommendations for using detonating cord with cast or manufactured boosters.

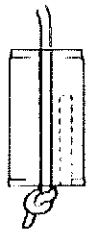


Figure 8: ***Recommended method for making primer with cast booster and detonating cord.***

MISCELLANEOUS TYPES OF PRIMERS

ALWAYS follow manufacturer's recommendations for preparation of primers not covered elsewhere in these recommendations.

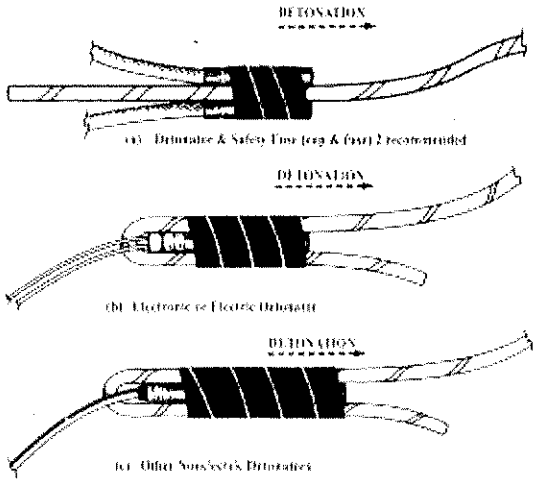


Figure 9: Methods for attaching detonators to detonating cord.

ALWAYS use a detonating cord matched to the blasting methods and type of explosive materials being used.
ALWAYS Handle detonating cord as carefully as other explosive materials.
ALWAYS Cut the detonating cord from the spool before loading the rest of the explosive material.
ALWAYS Use a sharp knife, razor blade, or instrument designed for cutting detonating cord.
ALWAYS Make tight connections, following manufacture's directions.
ALWAYS Attach detonators to detonating cord with tape or methods recommended by the manufacturer.
ALWAYS Point the detonators toward the direction of detonation.

ALWAYS use a detonating cord matched to the blasting methods

ALWAYS Attach the cord initiating detonator at least six inches from the cut end of the detonating cord.
ALWAYS Use a suitable booster to initiate wet detonating cord.
ALWAYS Use surface delay connectors designed for use with detonating cord.
NEVER Make loops, kinks, sharp angles in the cord, which might direct the cord back toward the oncoming line of detonation.
NEVER Damage detonating cord prior to firing.
NEVER Attach detonators for initiating the blast to detonating cord until the blast area has been cleared and secured for the blast.
NEVER use damaged detonating cord.
NEVER cut detonating cord with devices such as scissors, pliers type cutters, cap crimpers, or similar instruments.

Detonating Cord

Standard detonating cords commonly consist of a core of PETN (Pentaerythritoltetranitrate) encased in various textile wrappings and waterproofing compounds for the purpose of either:

1) Direct initiation of high explosives at any one point along its length and;

2) Propagation of the detonation wave from one detonating cord to another or;

3) Propagation of the detonation wave of the detonating cord to a non-electric delay detonator, by transmission of the detonation wave in the core.

The various textile wrappings and waterproofing compounds that encase the core are intended to:

1) Provide protection of the core from abrasion.

2) Provide a reasonable working tensile strength.

3) Resist side penetration of contaminating fluids.

4) Enhance knot-tying characteristics while maintaining flexibility.

Therefore, any procedure that may damage the protective encasement of the core, or permitting contaminating fluid to reach the core, will result in erratic performances.

DESCRIPTION AND APPLICATION OF DETONATING CORD

Type of Cord

1. Fineline, 10 grain, 100 lb. tensile strength, magenta in color.

General Applications: Recommended for use as a downline when used with a specially designed Austin Powder cast booster.

2. Lite Line, 15 grain, 230 lb. tensile strength, pink in color.

General Applications: Downline or upline under all but the most severe conditions.

3. Scotch Cord, 18 grain, 230 lb. tensile strength, orange in color.

General Applications: Surface trunklines, secondary blasting and downlines in shallow small diameter holes.

4. "A" Cord, 25 grain, 230 lb. tensile strength, green in color.

General Applications: Small, medium and large hole downlines and trunklines, secondary blasting and one hole blasting underground.

5. 50 Reinforced, 50 grain, 250 lb. tensile strength, yellow in color.

General Applications: Excellent general purpose cord for reliable blasting initiation under virtually all conditions.

6. Heavy Duty, 100, 150, and 200 grain. 100 grain has 200 lb. tensile strength and is orange in color, 150 grain has 275 lb. tensile strength and is purple in color, and 200 grain has 275 lb. tensile strength and is red in color.

General Applications: Constructed for severe service to meet a wide range of specialized applications such as presplit or dimensional stone.

7. Slide Line, different core loads available, 15 grain through 50 grain
General Applications: For use with bulk loaded blends and emulsions.

Selection of Detonating Cord

1. Type of explosives being used (example, whether using ANFO, Emulsions or High Explosives)

2. Hole Diameter (example, if using detonating cord in small diameter holes in the lowest core load is preferred.

3. Using cord as trunkline, things to consider:

A. Locations (example, if you are close to a dwelling or other structures where airblast or noise is a problem, you should use a lower core load detonating cord and cover it with at least 6" of dirt or sand.

B. Avoid using sharp angles such as 10^0.

C. Avoid kinks in the trunkline or downlink.

4. Using detonating cord with NDS (Non-Electric Delay Slider).

A low core load of 15 gr/ft to 25 gr/ft is a must when using NDS, because if you use a 50 grain cord, you will destroy the delay element attached to the booster.

5. Slide Line - Slide Line is detonating cord without the woven outer layer. It is used when using bulk emulsions or blends, because of the build-up of product along the cord length prohibiting the NDS booster from easily sliding down the cord.

6. When tying detonating cord to downlines or trunklines, make sure the knots are snug to the cord for detonation. A square knot will do fine in splicing.

7. When hooking a detonator to detonating cord, a few things must be considered:

1 . The detonator must be attached pointing in the direction of detonation.

2. The detonator should be attached several inches from the end of the cord because of PETN leakage from the core. If the cord is wet at the end, the PETN will not perfor

Firing with Detonating Cord

Detonating cord is a flexible cord containing a center core of a high velocity, detonator-sensitive explosive, usually PETN, which is used to:
Detonate other high explosives with which it comes in contact.
Transmit a detonation wave from one detonating cord to another or to a nonelectric delay detonator.

Other core loadings, such as RDX and HMX are used in cords designed for specialized uses, such as in oil wells or other hot environments. If such applications arise, contact the cord manufacturer for recommendations.

The number of grains of explosive per linear foot and the type and thickness of countering (coverings or wrappings) determine the cord's priming ability. With this product, the term "50 grain" used in relation to cord means "50 grains per linear foot of cord." The various combinations of textile and plastic wrappings provide the cord's tensile strength, tie-in characteristics, and abrasion and water resistance.

Although PETN detonating cords are sensitive enough to be initiated by all strengths of commercial detonators, they are relatively resistant to accidental detonation from impact, shock, friction, or extraneous electricity.

The most widely used detonating cords have 15 to 50 grains of PETN per foot (3.2 – 10.6 g/m) of cord. All cords detonate at approximately 23,000 fps (7,000 m/s). Their explosives initiating energy varies with the core load. In all cases, they will initiate nitroglycerin-based explosives and many other detonator-sensitive products. Some products may not be initiated, but might be dead pressed or otherwise damaged by the energy output of cord. Consult with the

explosive manufacturer as to which products can safely be used with detonating cord. Detonating cord initiation is particularly well suited for:

- Operators who prefer a nonelectric blasting system because potentially hazardous stray currents may be present.
- Firing multiple charges of explosives without significant delay between charges (e.g., as done in preshear blasting).
- Multiple priming or decking in deep, large-diameter boreholes.
- Coyote blasting or for large blasts to fracture low-grade ore bodies for in situ leaching.

Initiating chute-blasting charges in underground mines.
Submarine blasting where it is difficult to insulate electrical connections.
Firing a single down line to initiate multiple nonelectric delay detonators for each explosive deck.

Fumes

The reaction product gases resulting from the detonation of commercial explosives and blasting agents consist principally of carbon dioxide, nitrogen, and water vapor (steam). Admixed with air these are, in the ordinary sense nontoxic. However, poisonous gases, including carbon monoxide and nitrogen oxides, are also present in some small concentration in the detonation reaction products from all real explosives. In the explosives industry these toxic gases are called fumes. The toxic gas components, carbon monoxide and nitrogen oxides are sometimes referred to jointly as noxious gas. Fumes should not be confused with smoke, which is composed mainly of steam and the solid products of combustion or detonation. Although smoke is nontoxic, excessive exposure to smoke, especially that produced by dynamite, can cause severe headaches and should be avoided. The headache may be the result of small particles of unreacted or partially reacted nitroglycerin/nitro glycol in the smoke. Both the nature and the total quantity of poisonous gases and smoke vary between types of explosives. For example, the detonation of emulsion explosives or water gels may produce significantly less smoke than dynamite. Fumes may also vary according to conditions of use. Anything that tends to cool the gases quickly increases the formation of oxides of nitrogen.

In open blasting, fumes cause little concern if they can be quickly dispersed by air movement, but in underground work the type and amount of explosive, the conditions, ventilation, and other factors should be considered.

Where fumes can be a problem, properly formulated and manufactured explosives and basting agents will give minimum quantities of toxic gases. However, it must be recognized that some carbon monoxide and some oxides of nitrogen will result from every detonation of an explosive or blasting agent and that conditions of use can drastically shift the types of gases produced.

Some factors that increase fumes are poor product formulation, inadequate priming, insufficient water resistance, lack of confinement, reactivity of the product with the rock or other material being blasted, and incomplete product reaction. Adequate waiting periods before returning to the blast area are mandatory. This is important because some toxic gases are odorless and colorless. Absence of post blast smoke is no guarantee that hazardous levels of toxic gases are not still present. Never return to an area before ventilation has cleared the fumes from the area.

IME Fume Classification

A classification indicating the amount of poisonous or toxic gases produced by an explosive or blasting agent. The IME Fume Classification is expressed as follows:

Fume Class	Cubic Feet of Poisonous Gases Per (1 ¼" x 8") Cartridge of Explosive Material
1	Less than 0.16
2	0.16 – 0.33
3	0.33 – 0.67

Note: The U.S. Bureau of Mines limits poisonous or toxic gases to 2.5 cu ft per pound of permissible explosive

For the purpose of fume classification, only poisonous or toxic gases, such as carbon monoxide, hydrogen sulfide, and nitrogen oxides are considered.

Section XII

Department of Environmental Protection
Bureau of Mine Safety

Category of gases

Noxious: **Asphyxiant due to lack of oxygen**

Toxic: **Poisonous - short term exposure**

Physics of gases

Specific Gravity / Vapor Density: The weight of a ratio of a specific gas compared to the same ratio of air. (Air = 1.000)

Temperature: Cold gases will diffuse slowly - hot gases will diffuse quickly

Barometric Pressure: The lower the pressure, the faster a gas will diffuse.

Solubility: The ability to dissolve in water (taste and / or smell)

Exposure Limits

Threshold Limit Value (TLV): The amount of a gas exposure for an 8-hour day for 5 days a week without any harmful effects.

Ceiling Limits: The amount of gas at no time a person can be exposed to.

Immediately dangerous to life or health (IDLH): The maximum concentration of a gas, incase of SCBA failure, one could escape without any irreversible health effects.

Measurement of Gases

Parts Per Million (PPM): The most accurate measurement of a contaminant in the atmosphere.

PERCENT	PPM
1.0	10,000
.1	1,000
.01	100
.001	10
.0001	1

MINE GASES & THEIR COMPONENTS

Air:

Chemical Formula: None
Specific Gravity: 1.00
Source: Atmosphere
Characteristics: No color, odor, or taste

Pure dry air at sea level contains the following:

Oxygen	20.94 %
Nitrogen	78.09 %
Argon	0.94 %
Carbon Dioxide	0.03 %

Oxygen:

Chemical Formula: O_2
Specific Gravity: 1.105
Source: Atmosphere
Characteristics: No color, odor, or taste, Oxygen will not burn or explode.

Note: When another gas is introduced into the atmosphere of artificial environment, such as a mine, tunnel or manholes, oxygen is usually displaced causing asphyxiation.
Health Effects:

CONCENTRATION (%)	PHYSIOLOGICAL EFFECT
21 %	Breathing easiest
19.5 %	Minimum required by law
17 %	Breathing faster and deeper, possible impaired judgment
16.25 %	First signs of anoxia or hypoxia occur
15 %	Dizziness, buzzing in ears, headache, blurred vision, rapid breathing
12 % to 16 %	Rapid breathing and pulse, impaired muscular coordination
10 % to 12 %	Emotional upset and abnormal fatigue on exertion
6 % to 10 %	Nausea and vomiting, inability to move, unconsciousness
< 6 %	Convulsive movements, gasping respiration, breathing ceases, cardiac arrest occurs

CARBON MONOXIDE

Chemical Formula: (CO)
Specific Gravity: 0.967
Source: Carbon monoxide results from incomplete combustion of organic carbon-based materials. It is also an after-product of detonated explosives and diesel engines. Carbon monoxide is highly toxic to the body. When inhaled, CO quickly bonds with the body's hemoglobin, thus reducing the blood's ability to carry oxygen throughout the body.

Characteristics: Flammable, Colorless, Tasteless, Odorless, Lighter than air.
Ignition Temperature: 1100°
Explosive Range: 12.5 % to 74 %
Limits: TLV – 50 PPM
Ceiling – 200 PPM
IDLH – 1500 PPM

Health Effects:

CONCENTRATION (PPM)	PHYSIOLOGICAL EFFECT
200	Slight headache, tiredness, dizziness, and nausea after 2 to 3 hrs.
400	Frontal headache within 1 to 2 hrs, life threatening after 3 hrs.
800	Dizziness, nausea and convulsions within 45 minutes. Unconsciousness within 2 hours. Death in 2 to 3 hours.
1,600	Headache, dizziness, nausea within 20 minutes. Death within 1 hour.
3,200	Headache, dizziness, and nausea within 5 to 10 minutes. Death within 30 minutes.
6,400	Headache, dizziness, and nausea within 1 to 2 minutes. Death within 10 to 15 minutes.

NITROGEN

Chemical Formula: (N_2)
Specific Gravity: 0.967
Source: Nitrogen composes 78.09 % of the atmosphere. It is a non-flammable gas.
Characteristics: Colorless, Odorless, Tasteless, Non-flammable, Lighter than air.
Limits: Ceiling – 810,000 PPM

NITROGEN DIOXIDE

Chemical Formula: (NO_2)
Specific Gravity: 1.589
Source: Nitrogen dioxide is an extremely toxic gas to the human body. It is produced from the detonation of explosives and it is found in diesel exhaust. It is a non-flammable gas that is heavier than air. In high concentrations, nitrogen dioxide forms nitric acid in the lungs causing pulmonary edema.

Characteristics: Reddish-brown color in high concentrations, Acrid or "bleach" odor, Non-flammable, Heavier than air.

Limits: TLV – 1 PPM
Ceiling – 5 PPM
IDLH – 50 PPM

Health Effects:

CONCENTRATION (PPM)	**PHYSIOLOGICAL EFFECT**
1 to 13	Irritation of nose and throat
10 to 20	Mild irritation of eyes, nose and upper respiratory tract
80	Tightness in chest after 3 to 5 minutes
90	Pulmonary edema after 30 minutes

HYDROGEN SULFIDE

Chemical Formula: (H_2S)
Specific Gravity: 1.191
Source: Hydrogen sulfide is an extremely toxic gas. It blocks the use of oxygen by the body's cells. It is produced when sulfur compounds decompose. It is commonly associated with acid mine water. This gas is released whenever a mine pool is agitated. Can be produced in mine fires should sulfide ores be present.

Characteristics: Colorless, Sweet taste, Odor similar to rotten eggs at very low concentrations (0.003 PPM), Extremely flammable, heavier than air, highly soluble.
Ignition Temperature: 700°
Explosive Range: 4.3 % to 46 %
Limits: TLV – 10 PPM
Ceiling 15 PPM
IDLH 300 PPM

Health Effects:

CONCENTRATION (PPM)	PHYSIOLOGICAL EFFECT
10	Obvious and unpleasant odor (rotten eggs)
50	Mild conjunctivitis, respiratory tract irritation in 30 to 60 minutes
100	Kills sense of smell in 3 to 5 minutes, may sting eyes and throat
200	Stings eyes and throat
250	Exposure for 1 hour is the Hazardous Limit concentration which may cause death
300	Immediately dangerous to life
500	Dizziness, coughing, breathing ceases within minutes, artificial respiration required
600	May cause death within 2 minutes
700	Unconscious quickly, death if not rescued immediately
1000	Unconscious instantly, breathing ceased, death within a few breaths. Death may occur even if rescued immediately.

SULFUR DIOXIDE

Chemical Formula: (SO_2)
Specific Gravity: 2.264
Source: Sulfur dioxide is produced when iron pyrite burns in gob fires or by blasting sulfide ores. It is also found in diesel exhaust. Sulfur dioxide has the same effect on the body as nitrogen dioxide, except that sulfuric acid is created in the lungs. It is a non-flammable gas.

Characteristics: Colorless, Heavy sulfur odor, Acidic taste, Heavier than air, Non-flammable.
Limits: TLV – 5 PPM
Ceiling – 10 PPM
IDLH – 100 PPM

Health Effects:

CONCENTRATION (PPM)	PHYSIOLOGICAL EFFECT
0.3 to 1	Detectable by taste rather than odor
3 to 5	Detectable odor
10	Maximum concentration allowable for prolonged exposure
20	Least amount causing coughing and irritation of eyes
50	Irritation to eyes, lungs, throat
50 to 100	Maximum concentration for short exposure (30 to 60 minutes)
150	May be endured for several minutes. Extremely disagreeable
400 to 500	Life threatening

CARBON DIOXIDE

Chemical Formula: (CO_2)
Specific Gravity: 1.529
Source: Carbon Dioxide is a natural component of air at approximately 0.03 %. It is also a key component of Black Damp, caused by biological oxidation such as rotting mine timbers. Increased concentrations of carbon dioxide replace the oxygen content of the mine air thus producing a toxic atmosphere.

Characteristics: Colorless, Odorless, Heavier than air, Acidic taste at high concentrations.
Health Effects: At 5 %, stimulated respiration
At 7 % to 10 %, unconsciousness after few minutes of exposure.

Limits: Ceiling – 1.5 %
IDLH – 50,000 PPM

METHANE

Chemical Formula: CH_4
Specific Gravity: 0.555
Source: Carbon products decaying in anoxic environment.
Characteristics: No color, odor or taste. Needs 12.5 % O_2 to ignite.
Ignition Temperature: 1100° -1300° F
Explosive Range: 5 – 15 %

HYDROGEN

Chemical Formula: (H_2)
Specific Gravity: 0.0695
Source: Hydrogen is an extremely explosive gas that is commonly found in battery charging stations. It can also be created when water is applied to super hot mine fires or from the incomplete combustion in explosions. Adding strong acids to iron or steel can also release hydrogen into the atmosphere.

Characteristics: Colorless, Odorless, Tasteless, Flammable, Lighter than air, Explosive when exposed to heat or flame, Needs 5 % oxygen to ignite.
Ignition Temperature: 1030° - 1130° F
Explosive Range: 4.1 % - 74 %
Health Effects: Asphyxiant at high concentrations

Hand Held Detecting devices

THE WHEATSTONE BRIDGE- catalyst diffusion

Resistor R1 is the reference element. It is a fixed resistor, but its value will vary slightly with atmospheric temperature. It is mounted near the sensing element to compensate for atmospheric effects upon RX.

Resistor R3 has a fixed resistance.

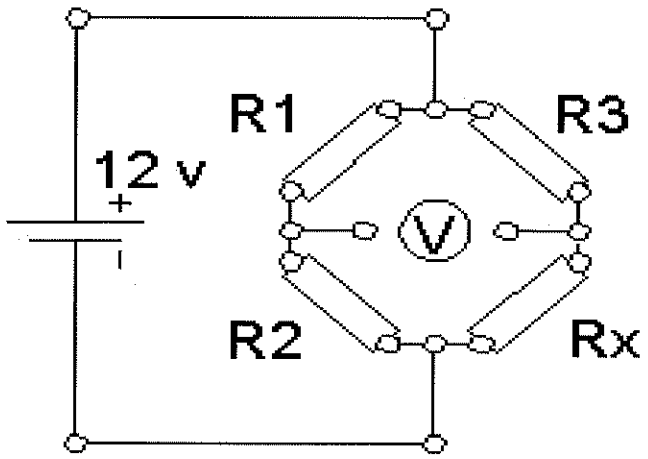
Resistor RX is the sensing element. Its resistance will vary according to some variable factor, which will be measured.

Resistor R2 is a potentiometer, which has variable resistance. By the use of R2, we adjust the balance of the bridge until the meter reads zero. (This is electrical zero).

When the bridge is balanced, there is no difference in potential between points A and C, thus no current through the meter, and it will read zero.

At this time, the voltage drop across RX is equal to that of R2, and the voltage drop across R1 is equal to that of R3.

A balanced bridge has a formula of $\frac{R_X}{R_1} = \frac{R_2}{R_3}$



Electrochemical sensors:

Infrared sensors:

HAND HELD DETECTORS

CSE 102 METHANOMETER (single gas)
Gases detected: Methane (Pre-Set)
Range of Detection: 0% to 9.9%
Display: L.E.D.
Principal of Operation: Catalytic Diffusion
Sampling Method: Manual Operated Internal Pump

MSA METHANE SPOTTER (single gas)
Gases detected: Methane (Pre-Set)
Range of Detection: 0% to 9.9%
Display: Needle & gage
Principal of Operation: Catalytic Diffusion
Sampling Method: Manually Operated Internal Pump

INDUSTRIAL SCIENTIFIC CD210 (single gas)
Gases Detected: Methane (Pre-Set)
Range of Detection: 0% to 9.9%
Display: L.E.D.
Principal of Operation: Catalytic Diffusion
Sampling Method: Manually Operated Internal Pump

INDUSTRIAL SCIENTIFIC MDU420 (single gas)
Gases Detected: Methane (Pre-Set)
Range of Detection: 0% to 100%
Display: L.C.D.
Principle of Operation: Non-Dispersive Infrared Absorption (NDIR)
Sampling Method: Internal Constant Flow Pump

INDUSTRIAL SCIENTIFIC MX240/250 (two gas)
Gases Detected: Methane & Oxygen (Pre-Set)
Range of Detection: 0% to 9.9% Methane
0% to 30% Oxygen
Display: L.C.D.
Principal of Operation: Catalytic Diffusion, Electrochemical Sensor
Sampling Method: Internal Constant Flow Pump

INDUSTRIAL SCIENTIFIC CMX 270 (three gas)
Gases Detected: Methane/Oxygen/Carbon Monoxide (Pre-Set)
Range of Detection: 0% to 9.9% Methane
0% to 30% Oxygen
0 ppm to 999 ppm Carbon Monoxide
Display: L.C.D.
Principle of Operation: Catalytic Diffusion, Electrochemical Sensor
Sampling Method: Internal Constant Flow Pump

CSE EXPLORER (three gas)
Gases Detected: Methane/Oxygen/Carbon Monoxide
Hydrogen Sulfide (Interchangeable)
Range of Detection: 0% to 5%-Methane
0% to 25%-Oxygen
N/A-Carbon Monoxide/Hydrogen Sulfide
Display: L.E.D.
Principle of Operation: Catalytic Diffusion, Electrochemical Sensor
Sampling Method: Internal Constant Flow Pump

MSA FIVESTAR PASSPORT (four gas)
Gases Detected: Methane /Oxygen/Carbon Monoxide/Hydrogen Sulfide
Sulfur Dioxide/Nitrogen Dioxide/Nitric Oxide
Range of Detection: 0% to 5%-Methane
0% to 30%-Oxygen
N/A-Carbon Monoxide/Hydrogen Sulfide/Sulfur Dioxide
Nitrogen Dioxide/Nitric Oxide
Display: L.C.D.
Principle of Operation: Catalytic Diffusion, Electrochemical Sensor
Sampling Method: Internal Constant Flow Pump

INDUSTRIAL SCIENTIFIC CO 262 (single gas)
Gases Detected: Carbon Monoxide (Pre-Set)
Range of Detection: 0 ppm to 999 ppm
Display: L.C.D
Principle of Operation: Electrochemical Sensor
Sampling Method: Internal Constant Flow Pump

DRAGER MULTI WARN (five gas)
Gases Detected: Methane/Oxygen/Carbon Monoxide/ Nitrogen Dioxide
Hydrogen Sulfide/Nitric Oxide/Carbon Dioxide (Interchangeable)
Range of Detection: 0% to 100%-Methane
0% to 25%-Oxygen
0 ppm to 2000 ppm-Carbon Monoxide
0 ppm to 100 ppm-Hydrogen Sulfide
0 ppm to 20 ppm-Sulfur Dioxide
0 ppm to 20 ppm-Nitrogen Dioxide
0 ppm to 100 ppm-Nitric Oxide
0% to 25%-Carbon Dioxide
Display: L.C.D
Principal of Operation: Electrochemical Sensor, Catalytic Diffusion, Infrared Sensor

INDUSTRIAL SCIENTIFIC TMX412 (four gas)
Gases Detected: Methane/Oxygen/Hydrogen Sulfide/ Carbon Monoxide
Nitrogen Dioxide/Sulfur Dioxide (Interchangeable)
Range of Detection: 0% to 5%-Methane
0% to 30%-Oxygen
0 ppm to 999 ppm-Carbon Monoxide
0 ppm to 999 ppm-Hydrogen Sulfide
0 ppm to 99.9 ppm-Sulfur Dioxide
0 ppm to 99.9 ppm-Nitrogen Dioxide
Display: L.C.D.
Principal of Operation: Catalytic Diffusion, Electrochemical Sensor
Sampling Method: Internal Constant Flow Pump

DRAGER MULTIGAS DETECTOR (single gas)
Gases Detected: Available Sampling Tubes from Manufacturer
Range of Detection: Determined by Sampling Tube
Display: Increments on Tube
Principle of Operation: Atmospheric reaction to Chemical in Preset Tubes
Sampling Method: Hand Operated Bellows Pump

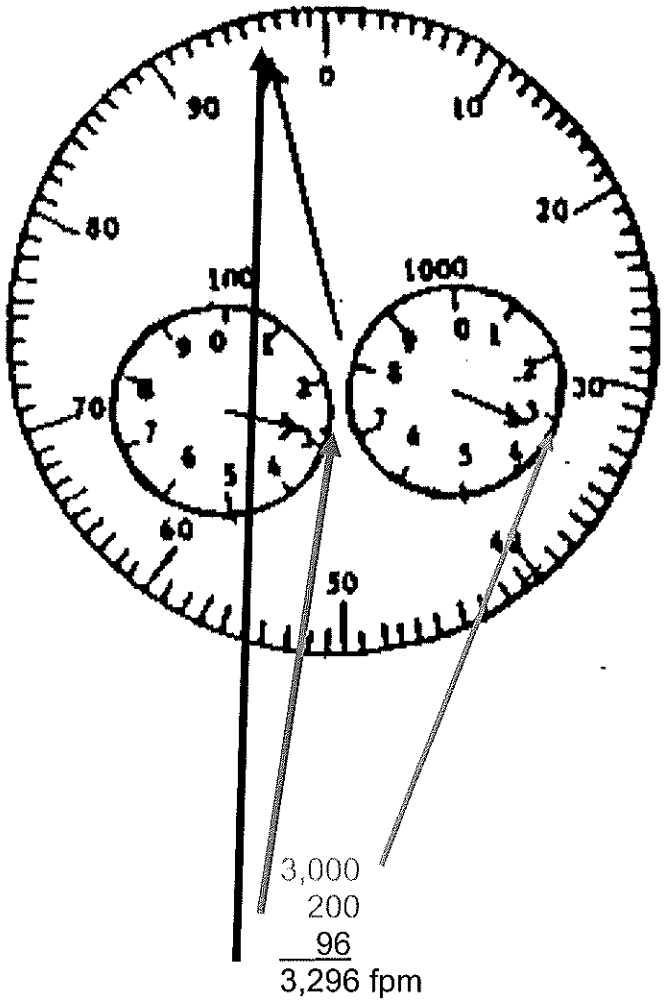
INDUSTRIAL SCIENTIFIC STX 70 (single gas)
Gases Detected: Oxygen/Carbon Monoxide/Hydrogen Sulfide/Nitrogen Dioxide
Nitric Oxide/Sulfur Dioxide
Range of Detection: 0% to 30%-Oxygen
0 ppm to 999 ppm-Carbon Monoxide
0 ppm to 999 ppm-Hydrogen Sulfide
0 ppm to 999 ppm-Nitric Oxide
0 ppm to 99.9 ppm-Nitrogen Dioxide
0 ppm to 99.9 ppm-Sulfur Dioxide
Display: L.C.D.Principal of Operation: Electrochemical Sensor
Sampling Method: Internal Constant Flow Pump

Section XIII
Ventilation

Anemometer

Most common instrument to measure air velocity over 100 feet per minute.
The air flowing against the vanes causes the wheel to rotate which in turn cause the dals to move.
Large dial registers a velocity of 1 to 100 feet per minute.
Smaller dials registers 100+ and 1000+
When neddle is not on a number, go back to the preceding number.
Usually anemometer reading is taken over 1 minute.

Reading is 3,296, taken for one (1) minute.
If taken for more than one (1) minute, divide the reading by the time in minutes.
If taken for more than one (1) minute, divide the reading by the time in minutes.
If taken under one (1) minute, multiply the reading.
Example:
30 second reading = x 2
15 second reading = x 4
All readings are in feet per minute.



CORRECTING ANEMOMETER READINGS

The indicated velocity (dial reading) does not indicate true air velocity. Therefore, a correction table is provided with each instrument.

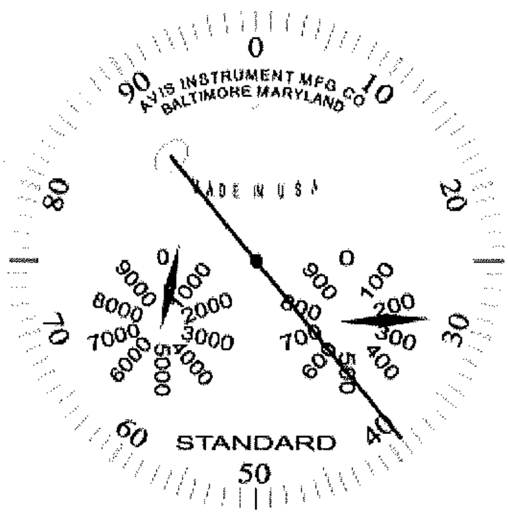
An example is shown below. Each anemometer has a unique correction table and cannot be used with any other anemometer.

Calibration Factor Chart

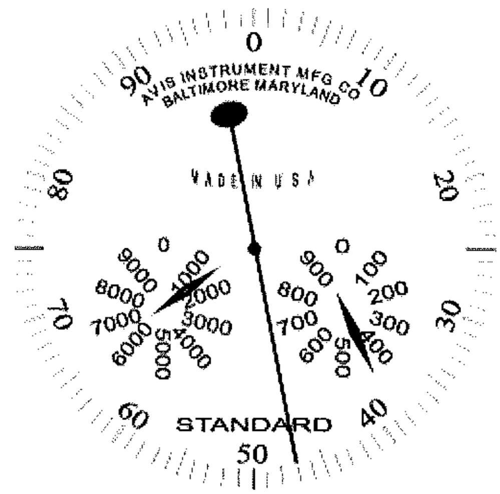
Serial Number	**52832**		
Date	04/14/99		
Ind. Vel.	Correction	Ind. Vel.	Correction
50	+64	500	-15
75	+53	550	-19
100	+41	600	-22
125	+33	700	-27
150	+27	800	-33
175	+21	900	-40
200	+17	1000	-45
250	+9	1200	-56
300	+2	1400	-65
350	-3	1600	-84
400	-8	1800	-104
450	-12	2000	-112
When sign is: + Add	- Subtract		

Practice Reading

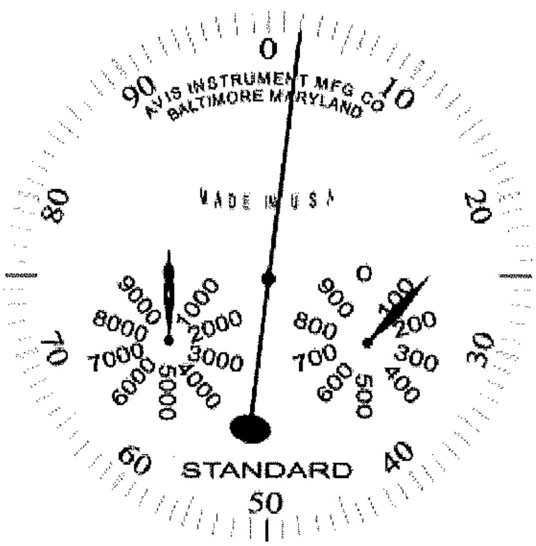
(Use Correction Chart on preceding page)



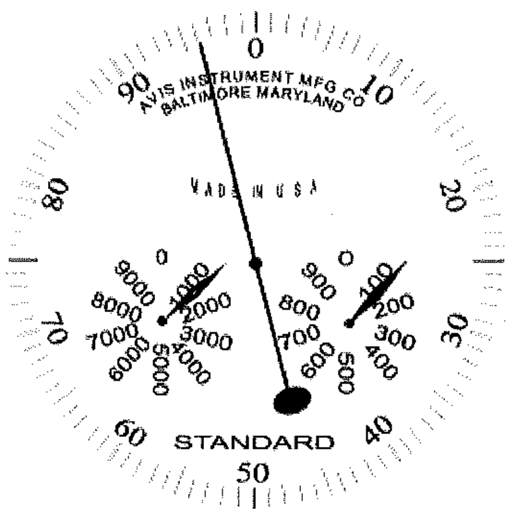
Reading: ______________



Reading: ______________



Reading: ______________

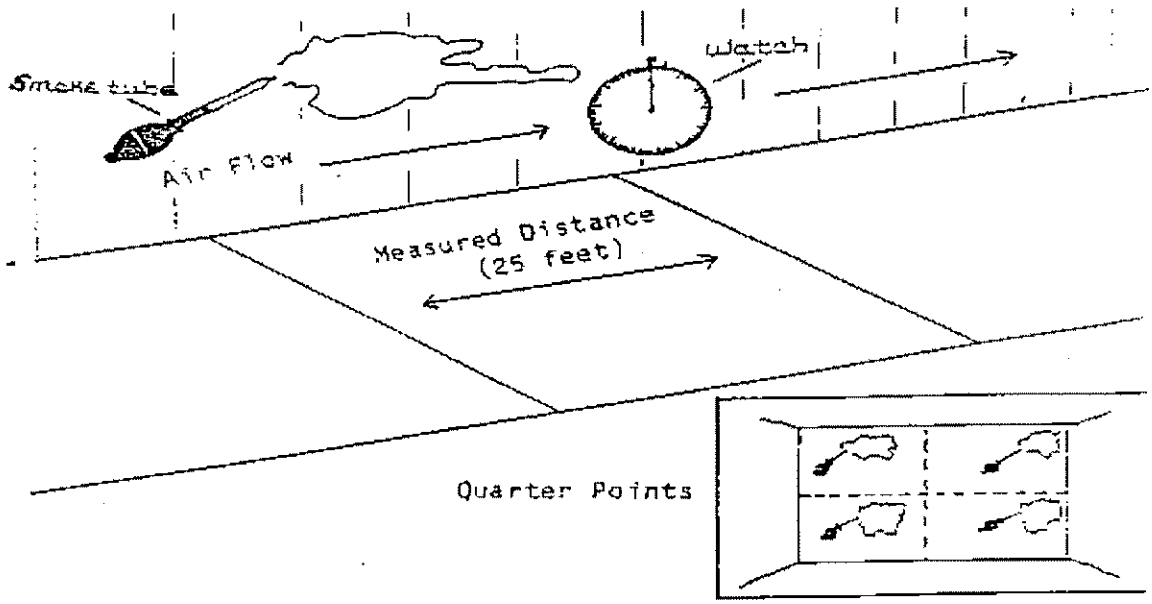


Reading: ______________

Smoke Tube Velocity Readings

When air velocity is less than 100 fpm, the dial on the anemometer hardly turns.

Items needed: aspirator bulb, smoke tubes, tape measure, watch, and two persons are needed to perform this task.



- To calculate air velocity using a smoke tube.
- As shown above, the measured distance is 25 ft., and it averages 23 seconds to travel to the down wind point.
- You first have to convert the smoke tube reading into feet per minute.
- Find the decimal equivalent of 23 seconds of 60 seconds.
    - To find what fraction of a minute is:

$\frac{23 \text{ seconds}}{60 \text{ seconds}}$ = .38 minute, then $\frac{25 \text{ feet of travel}}{.38 \text{ minute}}$ = 67.7 feet per minute

Velocity = 67.7

Use the Quantity Formula to calculate the Quantity of Air: Q = A x V

Section XIV
Basic Math & Problem Solving

Review of Formula Terms
a = sectional area of airway, in square feet ($ft.^2$)
v = velocity of air current, in feet per minute (fpm)
q = quantity of air, in cubic feet per minute (cfm)

COMMON AREA FORMULAS

Rectangular or Square Dimension:
Area = Height X Width

Note: Please remember to convert inches into the decimal equivalent of one foot - inches divided by 12.

Practice Problems – Area ; Rectangle

Determine the area of a mine entry that is 19 feet wide and 7 feet high:

Solution:
A = W x H
A = 19 x 7'
A = 133 sq. ft.

Practice Problems – Area ; Rectangle
Determine the area of a mine entry that is 18 feet wide and 5 feet, 6 inches high:

Solution:
A = W x H
A = 5.5' x 18'
A = 99 sq. ft.

Practice Problems
Determine the area of a mine entry that is 17 feet 3 inches wide and 6 feet 9 inches high:

Solution:
A = W x H
A = 17.25' x 6.75'
A = 116.43 sq. ft.

COMMON AREA FORMULAS

Practice Problems – Area; Trapezoid

Determine the area of a mine entry that is 6 foot high, and 18 feet wide across the top, and is 19 feet wide across the bottom.

Solution:

$$\text{Area} = \frac{\text{Top Width + Bottom Width} \times \text{Height}}{2}$$

$$A = \frac{18' + 19'}{2} \times 6'$$

$$A = \frac{37'}{2} \times 6'$$

$$A = 18.5' \times 6'$$

A = 111.00 sq. ft.

Practice Problems – Area; Trapezoid

Determine the area of a mine entry that is 5 foot high, and 20 feet wide across the top, and is 22 feet wide across the bottom.

Solution:

$$\text{Area} = \frac{\text{Top Width + Bottom Width} \times \text{Height}}{2}$$

$$A = \frac{20' + 22'}{2} \times 5'$$

$$A = \frac{42'}{2} \times 5'$$

$$A = 21' \times 5'$$

A = 105 sq. ft.

Practice Problems

Determine the area of a mine entry that is 4 foot 6 inches high, and 17 feet wide across the top, and is 20 feet wide across the bottom.

Solution:

$$\text{Area} = \frac{\text{Top Width + Bottom Width} \times \text{Height}}{2}$$

$$A = \frac{17' + 20'}{2} \times 4.5'$$

$$A = \frac{37'}{2} \times 4.5'$$

$$A = 18.5' \times 4.5'$$

A = 83.25 sq. ft.

COMMON AREA FORMULAS
Practice Problems – Area; Circle

Circular:

$A = \frac{¶ \times D^2}{4}$

or

$A = ¶ \times R^2$

Please use the following For Pi.....$¶ = 3.1416$

Practice Problems –Area; Circle
Determine the area of a circle that has an diameter of 20 feet 9inches.

Solution:
$A = ¶ \times R^2$

$R = \frac{20.75}{2} = 10.375$

$A = 3.1416 \times 10.375^2$

$A = 3.1416 \times 107.640$

$A = 338.16$ sq. ft.

Area - Circle
Determine the area of a circular airshaft with a diameter of 20 feet
Solution:

$A = ¶ \times R^2$

$R = \frac{20}{2} = 10$

$A = 3.1416 \times 10^2$

$A = 3.1416 \times 100$

$A = 314.16$ sq. ft.

Practice Problems

Determine the area of a circle that has an diameter of 17 feet.

Solution:

$A = \P \times r^2$

$R = \frac{17}{2} = 8.5$

$A = 3.1416 \times 8.5^2$

$A = 3.1416 \times 72.25$

$A = 226.98$ sq. ft.

Formula Equations

Quantity of Air (cfm)

$Q = AV$

Quantity = Area X Velocity

Velocity of air (fpm)

$V = \frac{Q}{A}$

Velocity = Quantity ÷ Area

Area (when velocity and quantity a known)

$A = \frac{Q}{V}$

Area = Quantity ÷ Velocity

Practice Problem – Quantity

Find the quantity of air passing thru an entry 17 feet 6 inches wide and 9 feet high, with 180 fpm registered on the anemometer.

$A = WH$

$Q = AV$

Solution:

$A = WH$

$A = 17.5' \times 9'$

$A = 157.5$ sq. ft.

$Q = AV$

$Q = (157.5 \text{ sq.ft.})(180 \text{ fpm})$

$Q = 28{,}350$ CFM

Practice Problem – Quantity

Find the quantity of air passing thru and entry 18 feet wide and 6 feet 6 inches high, with 110 fpm registered on the anemometer.

A = WH
Q = AV

Solution:

A = WH
A = 18' x 6.5'
A = 117 sq. ft.

Q = AV
Q = (117 sq.ft.)(110 fpm)
Q = 12,870 CFM

Practice Problem – Velocity

What is the velocity in a entry 10 feet high and 22 feet wide, with a quantity of 11,380 CFM?

A = WH

$$V = \frac{Q}{A}$$

Solution:

A = WH
A = 22 ft. x 10 ft.
A = 220 sq. ft.

$$V = \frac{Q}{A}$$

$$V = \frac{11{,}380 \text{ CFM}}{220 \text{ sq.ft.}}$$

V = 51.72 fpm

Practice Problem – Area

An entry has 12,500 CFM of air with a velocity of 150 fpm. What is the area of the entry?

$$A = \frac{Q}{V}$$

Solution:

$$A = \frac{Q}{V}$$

$$A = \frac{12{,}500 \text{ CFM}}{150 \text{ fpm}}$$

A = 83.33 sq. ft.

References

Hopler, Robert A., *Blasters' Handbook,* 17th Edition, published 1998, Second Printing 2000.

Safety Library Publications, Institute of Makers of Explosives, Vols. 1-22, (August 1993).

Morhard, Robert C., 1954, Explosives and Rock Blasting (copyright 1987 by Atlas Powder Company).

Code of Federal Regulations, Parts 1- 199, (July 1, 2001)

Internet Citations

U.S. Department of Labor, Mine Safety and Health Administration: http://www.msha.gov/regdata/CFRINTRO.HTM

Pennsylvania Department of Environmental Protection, Bureau of Mine Safety: http://www.dep.state.pa.us/dep/deputate/minres/dms/website/laws/mininglaw.htm

U.S. Department of Justice, Bureau of Alcohol, Tobacco, Firearms, and Explosives: http://www.atf.gov

United States Mine Rescue Association: http://usmra.com/popquiz.htm

Pennsylvania Department of Environmental Protection, Bureau of Mining and Reclamation:
http://www.dep.state.pa.us/dep/deputate/minres/districts/Blasting/training.htm

NIOSH National Institute of Occupational Health and Safety: http://www.cdc.gov/niosh/mining/comp2000/tffb.html