

NFPA 495 Explosive Materials Code

1996 Edition



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An International Codes and Standards Organization

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NFPA 495

Explosive Materials Code

1996 Edition

This edition of NFPA 495, *Explosive Materials Code*, was prepared by the Technical Committee on Explosives and acted on by the National Fire Protection Association, Inc. at its Annual Meeting held May 20–23, 1996, in Boston, MA. It was issued by the Standards Council on July 18, 1996, with an effective date of August 9, 1996, and supersedes all previous editions.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

This document has been submitted to ANSI for approval.

Origin and Development of NFPA 495

This code was originally issued in 1912 under the title *Suggested State Law to Regulate the Manufacture, Storage, Sale, and Use of Explosives*. The second edition was issued in 1941 by the Committee on Laws and Ordinances and retitled *Suggested Explosives Ordinance for Cities*. Later, the document was designated as NFPA 495L.

After being assigned to the Committee on Chemicals and Explosives, a new edition was issued in 1959. This was retitled as the *Code for the Manufacture, Transportation, Storage, and Use of Explosives and Blasting Agents* and redesignated as NFPA 495.

Following the reorganization of the committee in 1960, the responsibility for amendments to NFPA 495 was assigned to the Sectional Committee on Explosives. This committee reported to the Correlating Committee of the Committee on Chemicals and Explosives. Revised editions were issued in 1962, 1965, 1967, 1968, 1969, and 1970. A new edition was issued in 1972, with the document title revised to *Code for the Manufacture, Transportation, Storage, and Use of Explosive Materials*. A subsequent edition followed in 1973.

Following the issuance of the 1973 edition, the Sectional Committee on Explosives was redesignated as a Technical Committee. In 1976, the committee began a detailed review intended to amend requirements to eliminate conflicts with the regulations promulgated by the various federal agencies concerned with explosive materials (e.g., U.S. Bureau of Alcohol, Tobacco, and Firearms, U.S. Mine Safety and Health Administration, and U.S. Department of Transportation). This effort resulted in the 1982 edition, which was subsequently followed by a new edition in 1985. In 1990, the document was again revised and the title changed to *Explosive Materials Code*. The 1992 edition incorporated various technical and editorial amendments.

The latest edition, issued in 1996, incorporates changes in the classification of explosives to conform with recent U.S. Department of Transportation "Hazardous Materials Regulations," which in turn are based on United Nations Recommendations on the Transport of Dangerous Goods. The 1996 edition also includes technical and editorial amendments.

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents safeguarding against the fire and life hazards associated with explosives and related materials during their manufacture, storage, transportation and use. The sale and use of fireworks and model rockets are the responsibility of the Technical Committee on Pyrotechnics.

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Appendix A.

Information on referenced publications can be found in Chapter 11 and Appendices D and F.

Chapter 1 General

1-1 Scope.

1-1.1 This code shall apply to the manufacture, transportation, storage, sale, and use of explosive materials.

1-1.2 This code shall not apply to the transportation of explosive materials where under the jurisdiction of the U.S. Department of Transportation (DOT). It shall apply, however, to state and municipal supervision of compliance with "Hazardous Materials Regulations," U.S. Department of Transportation, Title 49, *Code of Federal Regulations*, Parts 100-199.

1-1.3 This code shall not apply to the transportation and use of military explosives by federal or state military agencies, nor shall it apply to the transportation and use of explosive materials by federal, state, or municipal agencies while engaged in normal or emergency performance of duties.

1-1.4 This code shall not apply to the manufacture of explosive materials under the jurisdiction of the U.S. Department of Defense. This code also shall not apply to the distribution of explosive materials to or storage of explosive materials by military agencies of the United States, nor shall it apply to arsenals, navy yards, depots, or other establishments owned by or operated by or on behalf of the United States.

1-1.5 This code shall not apply to pyrotechnics such as flares, fuses, and railway torpedoes. It also shall not apply to fireworks and pyrotechnic special effects as defined in NFPA 1123, *Code for Fireworks Display*; NFPA 1124, *Code for the Manufacture, Transportation, and Storage of Fireworks*; and NFPA 1126, *Standard for the Use of Pyrotechnics before a Proximate Audience*.

1-1.6 This code shall not apply to model and high power rocketry as defined in NFPA 1122, *Code for Model Rocketry*; NFPA 1125, *Code for the Manufacture of Model Rocket and High Power Rocket Motors*; and NFPA 1127, *Code for High Power Rocketry*.

1-1.7 This code shall not apply to the use of explosive materials in medicines and medicinal agents in the forms prescribed by the United States Pharmacopeia or the National Formulary.

1-2 Purpose. This code is intended to provide reasonable safety in the manufacture, storage, transportation, and use of explosive materials.

1-3 Equivalency. The authority having jurisdiction shall be permitted to authorize alternate provisions to those in this code to meet unusual conditions, provided such alternate provisions are of substantially equivalent degrees of safety and security.

1-4 Definitions. The following definitions shall apply for the purposes of this code.

Acceptor. A charge of explosives or blasting agent receiving an impulse from an exploding donor charge.

Ammonium Nitrate. A chemical compound represented by the formula NH_4NO_3 .

ANFO (Ammonium Nitrate Fuel Oil Mixture). A blasting agent (Explosive 1.5D) that contains no essential ingredients other than prilled ammonium nitrate and fuel oil.

Approved. Acceptable to the authority having jurisdiction.

NOTE: The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations that is in a position to determine compliance with appropriate standards for the current production of listed items.

Authority Having Jurisdiction. The organization, office, or individual responsible for approving equipment, an installation, or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

Binary Explosive. A blasting explosive formed by mixing or combining two phosphoric materials (e.g., ammonium nitrate and nitromethane).

Blast Area. The area including the blast site and the immediate adjacent area within the influence of flying rock, missiles, and concussion.

Blaster. A person qualified to be in charge of and responsible for the loading and firing of a blast.

Blasting Agent*. A material or mixture intended for blasting that meets the requirements of the DOT "Hazardous Materials Regulations," as set forth in Title 49, *Code of Federal Regulations*, Parts 173.56, 173.57, and 173.58, Explosive 1.5D.

Blast Site.* The area where explosive material is handled during loading of the blasthole, including 50 ft (15.2 m) in all directions from the perimeter formed by loaded holes. A minimum of 30 ft (9.1 m) can replace the 50-ft (15.2-m) requirement if the perimeter for loaded holes is marked and separated from nonblast site areas by a barrier. The 50-ft (15.2-m) or 30-ft (9.1-m) distance requirements, as applicable, apply in all directions along the full depth of the blast-

hole. In underground mines, at least 15 ft (4.6 m) of a solid rib, pillar, or broken rock can be substituted for the 50-ft (15.2-m) distance.

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 or loading directly into boreholes, or both.

Bullet-Resistant Construction.* Refers to magazine walls or doors, constructed to resist penetration of a bullet of 150-grain M2 ball ammunition having a nominal muzzle velocity of 2700 fps (824 mps) when fired from a 0.30-caliber rifle from a distance of 100 ft (30.5 m) perpendicular to the wall or door.

Bullet-Sensitive Explosive Material. Explosive material that can be detonated by 150-grain M2 ball ammunition having a nominal muzzle velocity of 2700 fps (824 mps) when fired from a 0.30-caliber rifle at a distance of 100 ft (30.5 m), measured perpendicularly. The test material is at a temperature of 70°F to 75°F (21°C to 24°C) and is placed against a 1/2-in. (12.7-mm) steel plate.

Cap-Sensitive Explosive Material.* Any explosive material that can be detonated by means of a No. 8 blasting cap or its equivalent.

Composite Propellant. A mixture consisting of an elastomeric-type fuel and an oxidizer. Composite propellants are used in gas generators and rocket motors.

Detonating Cord. A flexible cord containing a center core of high explosive used to detonate other explosives.

Detonator. Any device containing an initiating or primary explosive that is used for initiating detonation. A detonator is not permitted to contain more than 10 g of total explosive material per unit, excluding ignition or delay charges. The term includes, but is not limited to, electric detonators of the instantaneous and delay types, detonators for use with safety fuses, detonating cord delay connectors, and nonelectric detonators of the instantaneous and delay types that consist of a detonating cord, a shock tube, or any other replacement for electric leg wires.

Donor. An exploding charge producing an impulse that impinges upon an explosive acceptor charge.

Emulsion Explosive. An explosive material that consists of a slurry of substantial amounts of ammonium nitrate dissolved in water droplets surrounded by an oil-like material.

Explosive.* Any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion. The term includes, but is not limited to, dynamite, black powder, pellet powder, initiating explosives, detonators, safety fuses, squibs, detonating cord, igniter cord, and igniters.

The term includes any material determined to be within the scope of Title 18, *United States Code*, Chapter 40, "Importation, Manufacture, Distribution and Storage of Explosive Materials," and also includes any material classified as an explosive by the U.S. Department of Transportation, "Hazardous Materials Regulations," 49 CFR, Parts 100-199.

Explosive-Actuated Device. Any tool or special mechanized device that is actuated by explosive materials. The term does not include propellant-actuated devices (*see definition of Propellant-Actuated Device*). Examples of explosive-actuated devices are jet-tappers and jet perforators.

Explosive Material. Any explosive, blasting agent, emulsion explosive, water gel, or detonator.

Fire Extinguisher Rating. A rating set forth in NFPA 10, *Standard for Portable Fire Extinguishers*. This rating is identified on an extinguisher by a number (e.g., 5, 20, 70), indicating relative effectiveness, followed by a letter (e.g., A, B, C, or D) indicating the class or classes of fires for which the extinguisher has been found to be effective.

Fire-Resistant. Construction designed to provide reasonable protection against fire. For exterior walls of magazines constructed of wood, this is defined as the fire resistance equivalency provided by sheet metal of not less than 26 gauge.

Flash Point.* The lowest temperature at which vapors from a volatile combustible substance ignite in air when exposed to flame.

Fuel. Any substance that reacts with the oxygen in the air or with the oxygen yielded by an oxidizer to produce combustion.

Hardwood. Any close-grained wood such as oak, maple, ash, or hickory that is free from loose knots, wind shakes, or similar defects.

High Explosive Materials. Explosive materials that are characterized by a very high rate of reaction, high pressure development, and the presence of a detonation wave.

Highway. Any public street, public alley, or public road.

Inhabited Building. Any building or structure regularly used in whole or part as a place of human habitation. The term includes any church, school, store, railway passenger station, airport passenger terminal, and any other building or structure where people are accustomed to congregate or assemble. The term does not include any building or structure occupied in connection with the manufacture, transportation, storage, or use of explosive materials.

Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Listed. Equipment, materials, or services included in a list published by an organization acceptable to the authority having jurisdiction and concerned with evaluation of products or services that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services and whose listing states either that the equipment, material, or service meets identified standards or has been tested and found suitable for a specified purpose.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

Low Explosive Material. Explosive material that is characterized by deflagration or a low rate of reaction and the development of low pressure.

Magazine. A building or structure, other than an explosives manufacturing building, approved for the storage of explosive materials.

Manufacturing. Mixing, blending, extruding, assembling, disassembling, chemical synthesis, and other functions involved in making a product or device that is intended to explode.

Mass Detonate (Mass Explode). Simultaneous detonation or explosion of the total amount or a substantial amount of a quantity of explosive material caused by the explosion of a unit or part of the explosive material.

Misfire. A charge of explosive material that fails to detonate completely after initiation.

Motor Vehicle. Any self-propelled vehicle, truck, tractor, semitrailer, or truck-trailer combination used for the transportation of freight over public highways.

Nonelectric Delay Device. A detonator with an integral delay element used in conjunction with and capable of being initiated by a detonating impulse.

Oxidizing Material.* Any solid or liquid that readily yields oxygen or other oxidizing gas or that readily reacts to oxidize combustible material.

Person. Any individual, firm, copartnership, corporation, company, association, or joint stock association, including any trustee, receiver, assignee, or personal representative thereof.

Phosphoric Materials. Two or more unmixed, commercially manufactured prepackaged chemical ingredients (including oxidizers, flammable liquids or solids, or similar ingredients) that are *not* classified as explosives but that, where mixed or combined, form a blasting explosive.

Plywood. Exterior grade plywood.

Primer. A unit, package, or cartridge of explosive material used to initiate other explosives or blasting agents and that contains (1) a detonator, or (2) a detonating cord to which is attached a detonator designed to initiate the cord.

Propellant. An explosive that normally functions by deflagration and is used for propulsion purposes. It is classified by the U.S. Department of Transportation, "Hazardous Materials Regulations" as 1.1 (Class A) or 1.3 (Class B), depending on its susceptibility to detonation.

Propellant-Actuated Device. Any tool or special mechanized device or gas generator system that is actuated by a propellant or that releases or directs work through a propellant charge.

Public Conveyance. Any railroad car, streetcar, ferry, cab, bus, airplane, or other vehicle that carries passengers for hire.

Railway. Any steam, electric, diesel electric, or other railroad or railway that carries passengers for hire on a particular line or branch in the vicinity of an explosives storage or manufacturing facility.

Semiconductive Hose. Any hose with an electrical resistance sufficient to limit the flow of stray electric currents to safe levels, yet not high enough to prevent the relaxation of static electric charges to ground. Any hose having a resistance of no more than 2.0 megohms over its entire length and a resistance of no less than 1000 ohms/ft (3280 ohms/m) meets this definition.

Sensitivity. A characteristic of an explosive material, classifying its ability to detonate upon receiving an external impulse such as impact shock, flame, or other influence that can cause explosive decomposition.

Shock Tube. A small diameter plastic tube used for initiating detonators. It contains only a limited quantity of reactive material so that the energy that is transmitted through the tube by means of a detonation wave is guided through and confined within the walls of the tube.

Small Arms Ammunition. Any shotgun, rifle, or pistol cartridge and any cartridge for propellant-actuated devices. This definition does not include military ammunition containing bursting charges or incendiary, tracer, spotting, or pyrotechnic projectiles.

Small Arms Ammunition Primers. Small percussion-sensitive explosive charges encased in a cap and used to ignite propellant powder.

Smokeless Propellants. Solid propellants, commonly referred to as smokeless powders, used in small arms ammunition, cannons, rockets, or propellant-actuated devices.

Softwood. Any coarse-grained wood such as fir, hemlock, spruce, or pine that is free from loose knots, wind shakes, or similar defects.

Special Industrial Explosives Device. Explosive-actuated devices and propellant-actuated devices.

Special Industrial Explosive Material.* Shaped materials, sheet forms, and various other extrusions, pellets, and packages of high explosives used for high-energy-rate forming, expanding, and shaping in metal fabrication and for dismemberment and reduction of scrap metal.

Steel. General purpose, hot- or cold-rolled, low carbon steel, such as ASTM A 366, *Specifications for Commercial Quality Cold-Rolled Carbon Steel Sheets*, or equivalent.

Theft-Resistant. Construction designed to deter illegal entry into facilities for the storage of explosive material.

Two-Component Explosive. See Binary Explosive.

Water Gel.* Any explosive or blasting agent that contains a substantial portion of water.

Weather-Resistant. Construction designed to offer reasonable protection against weather.

Chapter 2 Security and Safety of Explosive Materials

2-1 Basic Requirements.

2-1.1 No attempt shall be made to fight a fire that cannot be contained or controlled before it reaches explosive materials. In such cases, all personnel shall be evacuated immediately to a safe location, and the area shall be guarded from entry by spectators or intruders.

2-1.2 The local fire department and other local emergency response agencies shall be notified of the location of all magazines and shall be notified of any changes in location.

2-1.3 The manufacture of any explosive material, as defined by this code, shall be prohibited unless such manufacture is authorized by federal license and is conducted in accordance with recognized safe practices.

Exception: This requirement shall not apply to hand loading of small arms ammunition prepared for personal use and not for resale.

2-1.4 The manufacture of explosive materials shall be prohibited where such manufacture presents an undue hazard to life or property.

2-1.5 The authority having jurisdiction shall be permitted to restrict the quantity of explosive materials that is handled at any location.

2-1.6 All explosive materials and any newly developed and unclassified explosive materials shall meet the license and permit requirements of this chapter.

Exception: This requirement shall not apply to stocks of small arms ammunition and components thereof, to the extent that they are covered by the provisions of Title 18, United States Code, Chapter 44, "Gun Control Act of 1968."

2-1.7 A person intending to engage in business as an importer of, a manufacturer of, or dealer in explosive materials shall obtain a federal license in accordance with Title 18, *United States Code*, "Organized Crime Control Act of 1970," in Chapter 40.

2-1.8 This chapter is intended to supplement existing federal laws and regulations. Therefore, any person who possesses a license or permit under Title 18, *United States Code*, Chapter 40, that properly covers the activities of such person shall not be required to obtain a permit under this chapter.

2-1.9 All normal access roads to explosive storage magazines shall be posted with the following warning sign:

DANGER
NEVER FIGHT EXPLOSIVE FIRES
EXPLOSIVES ARE STORED ON THIS SITE
CALL _____

The sign shall be weather-resistant with a reflective surface and lettering at least 2 in. (50 mm) high.

2-1.10 Placarding shall only apply to Type 5 magazines as defined by Title 27, *Code of Federal Regulations*, Part 55 (Bureau of Alcohol, Tobacco, and Firearms).

2-2 Permit Requirements.

2-2.1 No person shall be in possession of explosive materials, or conduct an operation or activity requiring the use of explosive materials, or perform or supervise the loading and firing

of explosive materials without first obtaining the proper permit.

2-2.2 Explosive materials shall not be sold, given, delivered, or transferred to any person not possessing a valid permit.

2-2.3 Every person conducting an operation or activity that uses explosive materials shall obtain a permit to use explosive materials and shall be responsible for the results and consequences of any loading or firing of explosive materials. Such person also shall ensure that loading and firing are performed or supervised by a person possessing a permit to blast.

Exception: Laboratories engaged in testing explosive materials, other than where conducting test blast explosions, shall require only a permit to use.

2-3 Permit Classes.

2-3.1 Permit to Use. Before a person conducts an operation or activity that uses explosive materials, that person shall obtain a permit to use, which provides authorization to purchase, possess, store, and use such materials.

2-3.2 Permit to Blast. Before a person supervises and performs the loading and firing of explosive materials, that person shall obtain the appropriate permit to blast, as specified in Table 2-3.2:

Table 2-3.2 Classifications for Permit to Blast

Class	Category	Blasting Permitted
A	Unlimited	All types of blasting
B	General aboveground	All phases of blasting operations in quarries, open pit mines, and aboveground construction
C	General underground	All phases of blasting operations in underground mines, shafts, tunnels, and drifts
D	Demolition	All phases of blasting in demolition projects
E	Seismic	All phases of blasting in seismic prospecting
F	Agriculture	All phases of blasting in agriculture, but limited to not more than 50 lb (22.7 kg) per blast
G	Special	Special blasting as described on the permit

2-4 Requirements for Blaster's Permit.

2-4.1 The applicant for an initial permit to supervise and perform the loading and firing of explosive materials, as specified in 2-3.2, shall demonstrate adequate training and experience in the use of explosive materials in the class authorized by the specific permit for which application is made.

2-4.2 Each applicant shall pass a qualifying examination. The examination may be written, oral, or by such other means as necessary to determine that the applicant is competent to conduct blasting operations and to perform the duties of a blaster.

2-4.3 Any holder of a permit to blast who is convicted of a violation of any explosives law or regulation shall be required to pass a qualifying examination as a condition of retention of the permit.

2-4.4 Any person whose permit to blast has been revoked shall be required to pass a qualifying examination as a condition of reinstatement of the permit.

2-4.5 Any person whose permit to blast has lapsed for a period of 1 year or longer shall be required to pass a qualifying examination as a condition of renewal of the permit.

2-5 Posting of Permits.

2-5.1 Permit to Use. A copy of the permit shall be posted at each place of operation.

2-5.2 Permit to Blast. A copy of the permit shall be carried by the permit holder during blasting operations.

2-5.3 Permit holders shall take every reasonable precaution to protect their permits from loss, theft, defacement, destruction, or unauthorized duplication. Any such occurrence shall be reported immediately to the issuing authority.

2-6 Permit Restrictions.

2-6.1 No permit shall be permitted to be assigned or transferred.

2-6.2 No permit shall be issued to a person under 21 years old.

2-6.3 Permits shall be dated and numbered and shall be valid for no longer than 3 years from the date of issue.

2-7 Denial or Revocation of Permits.

2-7.1 A permit for the possession and use of explosive materials shall be denied or revoked for any of the following reasons:

- (a) Noncompliance with any order of the issuing authority within the time specified by such order;
- (b) Proof that the permit applicant or holder is under indictment for, or has been convicted of, a crime punishable by imprisonment for a term exceeding 1 year;
- (c) The applicant or holder is a fugitive from justice;
- (d) The applicant or holder is an unlawful user of, or is addicted to, narcotics or dangerous drugs;
- (e) The applicant has been adjudicated as mentally defective;
- (f) Proof that the permit applicant or holder advocates, or knowingly belongs to, any organization or group that advocates violent overthrow of or violent action against any federal, state, or local government;
- (g) Proof that the permit applicant or holder suffers from a mental or physical defect that would interfere with the safe handling of explosives; or
- (h) Violation by the permit applicant or holder of any provision of any explosives law or regulation, or proof that false information was provided or a misrepresentation was made to obtain the permit by the applicant or holder.

2-7.2 In any case in which the issuing authority denies or revokes a permit, the issuing authority shall notify the permit applicant or holder promptly. Such notification shall specify the basis for denial or revocation of the permit and shall state that, upon written request by the applicant or holder, a hearing before the issuing authority is to be held within 10 days after the date of the request.

2-7.3 In cases where a hearing is held, the issuing authority shall state its findings and conclusions in writing and shall transmit a copy to the applicant or former permit holder promptly.

2-7.4 Upon notice of the revocation of any permit, the former permit holder shall surrender the revoked permit and all copies thereof to the issuing authority immediately.

2-8 Record Keeping and Reporting.

2-8.1 A holder of a permit to use shall keep a record of all transactions or operations involving explosive materials. Such record shall be retained for 5 years and shall be made available to the issuing authority upon request.

2-8.2 An accumulation of invoices, sales slips, delivery tickets or receipts, or similar records representing individual transactions shall be considered to satisfy the requirements for record keeping, provided they include the signature of the receiver of the explosive materials.

2-8.3 A holder of a permit to blast shall keep a daily record of all explosive materials received and fired or otherwise disposed of by the permit holder. Such records shall be retained for 5 years and shall be made available to the issuing authority upon request.

2-8.4 A holder of a permit shall notify the issuing authority promptly of any change in address.

2-8.5* The loss, theft, or unlawful removal of explosive materials shall be reported within 24 hours to the Bureau of Alcohol, Tobacco, and Firearms; to the permit-issuing authority; and to the local law enforcement agency.

2-8.6 Accidents involving explosive material that cause a lost-time injury or property damage shall be reported immediately to the authority having jurisdiction.

2-9 Applications and Renewals.

2-9.1 An application for a permit or for renewal of a permit shall be made to the issuing authority on forms provided by the authority and shall contain such information as is required.

2-9.2 Where an application for renewal is filed with the issuing authority before expiration of the current permit, the renewal shall become effective upon expiration of the current permit. No renewal permit shall be issued more than 30 days prior to the expiration date of the current permit.

2-9.3 An application for renewal filed after the expiration date of the current permit shall be considered an application for a new permit.

Chapter 3 Blasting Agents

3-1 Scope.

3-1.1 Unless otherwise specified in this chapter, blasting agents shall be transported, stored, and used in the same manner as other explosive materials.

3-1.2 Water gels, slurries, and emulsion explosives shall not be subject to the requirements of this chapter. (*See Chapter 4.*)

3-2 Fixed Location Mixing.

3-2.1 Buildings or other facilities used for mixing blasting agents shall be located, in relation to inhabited buildings, passenger railroads, and public highways, in accordance with the American Table of Distances. (*See Table 6-4.1.*)

3-2.2 In determining the distance separating inhabited buildings, passenger railroads, or public highways from potential explosions, the sum of all masses that could propagate (i.e., are closer than the distances specified in Table 6-4.2) from either individual or combined donor masses shall be included. However, where ammonium nitrate is included, only 50 percent of its weight shall be used due to its reduced blast effect.

3-2.3 Buildings used for the mixing of blasting agents shall comply with the requirements of this subsection, unless otherwise specifically approved by the authority having jurisdiction.

3-2.3.1 Buildings shall be constructed of noncombustible materials or of sheet metal on wood studs.

3-2.3.2 Floors shall be of concrete or other noncombustible material. They shall be constructed without open floor drains and without piping into which molten materials could flow and become confined in the event of fire.

3-2.3.3 All fuel oil storage facilities shall be separated from the mixing building and located so that the oil drains away from the mixing plant building if the tank ruptures.

3-2.3.4 The mixing building shall be well ventilated.

3-2.3.5 Heating units that do not depend on the combustion of fuel shall be permitted to be used within the mixing building where properly designed and located. All direct sources of heat shall be provided exclusively from units located outside of the mixing building.

3-2.3.6 Internal combustion engines used to generate electrical power shall be located outside of the mixing building or shall be ventilated and isolated properly by a firewall. The engine exhaust system shall be located so that any spark emission cannot endanger any materials in or adjacent to the mixing building.

3-2.4 Equipment used for mixing blasting agents shall comply with the requirements of this subsection.

3-2.4.1 The design of the mixer shall minimize the possibility of frictional heating, compaction, and confinement. All bearings and drive assemblies shall be mounted outside the mixer and protected against the accumulation of dust. All surfaces shall be accessible for cleaning.

3-2.4.2 Mixing and packaging equipment shall be constructed of materials compatible with the blasting agent composition.

3-2.4.3 Means shall be provided to prevent the flow of fuel oil to the mixer in case of fire. In gravity flow systems, an automatic spring-loaded shutoff valve with a fusible link shall be installed.

3-2.5 The requirements of this subsection shall apply where mixing and handling blasting agent compositions.

3-2.5.1 Oxidizers of small particle size, such as crushed ammonium nitrate prills or fines, shall be handled with special care, due to the possibility of their greater sensitivity.

3-2.5.2 No hydrocarbon liquid fuel with a flash point lower than that of No. 2 fuel oil [i.e., 125°F (51.7°C) minimum or legal minimum] shall be used.

Exception: Fuel oils with flash points no lower than 100°F (37.8°C) shall be permitted to be used at ambient air temperatures below 45°F (7.2°C).

3-2.5.3 Reclaimed crankcase oil shall be permitted to be used, provided each new supply of oil is checked for its compliance with 3-2.5.2.

3-2.5.4 Metal powders, such as aluminum, shall be kept dry and shall be stored in containers or bins that are moisture-resistant and weathertight. Solid fuels shall be handled so that dust explosion hazards are minimized.

3-2.5.5 Peroxides or chlorates shall not be used.

3-2.5.6 The requirements of 3-2.5.3, 3-2.5.4, and 3-2.5.5 shall not apply to compositions that have been tested, classified, and approved by the Associate Administrator for Hazardous Materials Safety in accordance with the provisions of Title 49, *Code of Federal Regulations*.

3-2.6 All electrical switches, controls, motors, and lights located in the mixing room shall comply with NFPA 70, *National Electrical Code*[®], Article 502.

Exception: This requirement shall not apply to electrical wiring and equipment located outside the mixing building.

3-2.7 The frame of the mixer and all other equipment that are used shall be electrically bonded and grounded.

3-2.8 Safety precautions at mixing plants shall include the following requirements:

(a) Floors shall have no drains or piping into which molten materials could flow and become confined during a fire.

(b) The floors and equipment of the mixing and packaging rooms or areas shall be cleaned thoroughly on a regular basis to prevent accumulations of oxidizers, fuels, and sensitizers.

(c) The entire building shall be cleaned thoroughly on a regular basis to prevent the excessive accumulation of dust.

(d) Smoking, matches, open flames, spark-producing devices, and firearms shall not be permitted inside of or within 50 ft (15.25 m) of any building or facility used for the mixing of blasting agents.

Exception: Firearms shall be permitted to be carried by authorized guards where approved by the authority having jurisdiction.

(e) The area surrounding the mixing plant shall be kept clear of brush, dried grass, leaves, and other materials for a distance of at least 25 ft (7.63 m).

(f) Empty ammonium nitrate bags shall be disposed of daily in a safe manner.

(g) No welding or open flames shall be permitted in or around the mixing or storage area.

Exception: Where the equipment and the area have been completely washed down and all oxidizing material has been removed.

(h) Before welding on or making repairs to hollow shafts, all oxidizing material shall be removed from the outside and inside of the shaft, and the shaft shall be vented with a minimum 1/2-in. (13-mm) diameter opening.

(i) Other explosive materials shall not be stored inside of or within 50 ft (15.25 m) of any building or facility used for mixing blasting agents.

3-3 Bulk Mixing and Delivery Vehicles.

3-3.1 The provisions of Section 3-3 shall apply to all bulk mixing and delivery vehicles. The requirements of 3-2.5 also shall apply to bulk delivery and mixing vehicles.

3-3.2 The body of a vehicle for mixing and delivering blasting agents in bulk shall comply with the following requirements:

(a) The body shall be constructed of noncombustible materials.

(b) Vehicles used to transport bulk, premixed blasting agents shall have covered bodies.

(c) All moving parts of the mixing system shall be designed so that heat buildup is prevented. Shafts or axles that make contact with the product shall have outboard bearings with a minimum 1-in. (25.4-mm) clearance between the bearings and the outside of the product container. Attention shall be given to adequate clearance on all moving parts.

(d) The bulk delivery vehicle shall be strong enough to carry the load without difficulty and shall be in good mechanical condition.

3-3.3 Operation of bulk delivery vehicles shall comply with the following requirements:

(a) Vehicles transporting blasting agents shall be driven by and shall be in the charge of only those drivers who are at least 21 years old, who are capable, careful, and reliable, and who possess a valid motor vehicle operator's license. Drivers shall be familiar with all traffic regulations, applicable federal and state regulations pertaining to explosive materials, and the requirements of this code.

(b) The vehicle operator shall be trained in the safe operation of the vehicle and shall be knowledgeable of its mixing, conveying, and related equipment. The operator shall be familiar with the commodities being delivered and the general procedures for handling emergencies.

(c) No person shall be permitted to ride upon, drive, load, or unload a vehicle containing blasting agents while smoking or while under the influence of intoxicants, narcotics, or other dangerous drugs.

(d) Vehicles transporting blasting agents shall be in safe operating condition at all times.

(e) No person shall smoke, carry matches or any flame-producing device, or carry any firearms while in or around bulk vehicles effecting the mixing, transfer, or down-the-hole loading of blasting agents at or near the blasting site.

(f) Caution shall be exercised in moving the vehicle within the blasting area to avoid driving the vehicle over or dragging hoses over firing lines, cap wires, or explosive materials. The driver shall obtain the assistance of a second person to guide the driver's movements while moving the vehicle.

(g) Material shall not be mixed while in transit.

3-3.4 Pneumatic loading from bulk delivery vehicles into blast holes primed with electric blasting caps or other static-sensitive systems shall comply with the following requirements:

(a) A positive grounding device shall be used to prevent the accumulation of static electricity.

(b) A semiconductive discharge hose shall be used.

(c) A qualified person shall evaluate all systems to determine that they adequately dissipate static electricity under potential field conditions.

3-3.5 Repairs to bulk delivery vehicles shall comply with the following requirements:

(a) No welding or open flames shall be used on or around any part of the delivery equipment until all oxidizing material has been removed and the equipment has been washed down completely.

(b) Before welding on or making repairs to hollow shafts, all oxidizing material shall be removed from the outside and inside of the shaft, and the shaft shall be vented with a minimum $\frac{1}{2}$ -in. (13-mm) diameter opening.

3-4 Bulk Storage Bins.

3-4.1 The bin shall be a Type 5 magazine and shall be waterproof.

3-4.2* The bin, including supports, shall be constructed of compatible materials and shall be adequately supported and braced to withstand the combination of all loads, including impact forces arising from product movement within the bin and accidental contact between vehicles and the support legs of the bin.

3-4.3 The bin discharge gate shall be designed to provide a closure tight enough to prevent leakage of the stored product. Provision also shall be made for locking the discharge gate.

3-4.4 Bin-loading manways or access hatches shall be hinged or otherwise attached to the bin and shall be designed to allow locking.

3-4.5 Any electrically driven conveyors for loading or unloading bins shall comply with the requirements of NFPA 70, *National Electrical Code*. They shall be designed to minimize damage from corrosion.

3-4.6 Bins containing blasting agents shall be located in accordance with Table 6-4.1 with respect to inhabited buildings, passenger railroads, and public highways.

3-4.7 Bins containing blasting agents shall be located in accordance with Tables 6-4.1 and 6-4.2 with respect to the storage of other blasting agents or explosives.

3-4.8 Bins containing ammonium nitrate shall be separated from the storage of blasting agents and explosives in accordance with Table 6-4.2.

3-4.9 Good housekeeping shall be maintained in the vicinity of any bin containing ammonium nitrate or other blasting agent. This shall include keeping weeds and other combustible materials cleared within 25 ft (7.63 m) of the bin. Accumulations of spilled product shall be prevented.

3-5 Storage of Blasting Agents and Supplies.

3-5.1 Blasting agents and oxidizers used for the mixing of blasting agents shall be stored in accordance with the following requirements:

(a) Blasting agents or ammonium nitrate stored with other explosive materials shall be stored in accordance with the requirements of Section 3-5. The total mass of the blasting agents and $\frac{1}{2}$ of the mass of ammonium nitrate shall be included where computing the total quantity of explosive materials for determining separation distance requirements.

(b) Blasting agents stored entirely separate from other explosive materials shall be stored in a Type 5 magazine or a magazine of higher classification (i.e., lower number).

(c) Magazines in which blasting agents are stored shall be constructed so that there are no open floor drains or piping into which molten materials can flow and become confined in the event of fire.

(d) Semitrailer and trailer vans used for highway or on-site transportation of blasting agents shall be permitted to be used for temporary storage of these materials, provided they are located in accordance with Table 6-4.1 with respect to inhabited buildings, passenger railways, and public highways, and in accordance with Table 6-4.2 with respect to each other. Trailers and semitrailers shall be provided with substantial means for locking, and the doors shall be kept locked.

Exception: Where stocks of blasting agents are actually being placed or removed, the doors of trailers and semitrailers shall not be required to be locked.

3-5.2 Piles of ammonium nitrate and warehouses containing ammonium nitrate shall be separated adequately from readily combustible fuels.

3-5.3 Caked oxidizer, either in bags or in bulk, shall not be loosened by blasting.

3-5.4 Every magazine used for the storage of blasting agents shall be under the supervision of a competent person who shall be at least 21 years old.

3-6 Transportation of Packaged Blasting Agents.

3-6.1 Where blasting agents are transported in the same vehicle with other explosive materials, all the requirements of Chapter 5 shall be met.

3-6.2 Vehicles transporting blasting agents shall be driven by and shall be in the charge of only those drivers who are at least 21 years old, who are capable, careful, and reliable, and who possess a valid motor vehicle operator's license. The driver shall be familiar with state vehicle and traffic laws.

3-6.3 No matches, firearms, acids, or other corrosive liquids shall be carried in the bed or body of any vehicle carrying blasting agents.

3-6.4 No person shall be permitted to ride upon, drive, load, or unload a vehicle containing blasting agents while smoking or while under the influence of intoxicants, narcotics, or other dangerous drugs.

3-6.5 No person shall transport or carry any blasting agents on any public vehicle carrying passengers for hire.

3-6.6 Vehicles transporting blasting agents shall be in safe operating condition at all times.

3-6.7 Where blasting agents are transported over public highways, the packaging, marking, and labeling of containers of blasting agents shall comply with U.S. Department of Transportation regulations.

3-6.8 Vehicles used for transporting blasting agents on public highways shall be placarded in accordance with U.S. Department of Transportation regulations.

3-7 Use of Blasting Agents. Persons using blasting agents shall comply with all applicable requirements of Chapters 2 and 7.

Chapter 4 Water Gel and Emulsion Explosive Materials

4-1 Scope. For the purposes of this chapter, the term “water gel” refers to water gel explosive materials or emulsion explosive materials.

4-2 Types and Classifications. Water gels shall be classified as Division 1.1D or Division 1.5D Explosives in accordance with U.S. Department of Transportation regulations. They shall be manufactured, transported, stored, and used as specified by this code.

Exception: Where otherwise specified in this chapter.

4-3 Fixed Location Mixing.

4-3.1 Buildings or other facilities used for mixing water gels shall be located in accordance with Table 6-4.1 with respect to inhabited buildings, passenger railroads, and public highways.

In determining the distances separating highways, railroads, and inhabited buildings from potential explosions, as specified in Table 6-4.1, the sum of all masses that can propagate (i.e., that lie at distances less than those specified by Table 6-4.2) from either individual or combined donor masses shall be included. However, where ammonium nitrate is required to be included, only $1/2$ of its mass shall be used because of its reduced blast effects.

4-3.2 Buildings used for the mixing of water gels shall comply with the following requirements:

(a) Buildings shall be constructed of noncombustible materials or of sheet metal on wood studs.

(b) Floors shall be of concrete or other noncombustible material. They shall be constructed without open floor drains and without piping into which molten materials could flow and become confined in the event of fire.

(c) Where fuel oil is used, fuel oil storage facilities shall be separated from the mixing plant and located so that the oil will drain away from the mixing building in case of tank rupture.

(d) The mixing building shall be well ventilated.

(e) Heating units that do not depend on the combustion of fuel shall be permitted to be used in the mixing building, where properly designed and located. Direct-fired heating units shall be located outside of the mixing building.

(f) Internal combustion engines used to generate electrical power shall be located outside of the mixing building or shall be isolated by a fire partition and shall be ventilated properly. The engine exhaust system shall be located so that any sparks emission cannot endanger any materials in or adjacent to the mixing building.

Exception: Where otherwise specifically approved by the authority having jurisdiction.

4-3.3 The ingredients used in water gels shall comply with the following requirements:

(a) Ingredients classified as explosives shall be stored as required by Chapter 6.

(b) Nitrate-water solutions shall be stored in tank cars, tank trucks, or fixed tanks without quantity-distance limitations. Spills or leaks that could contaminate combustible materials shall be cleaned immediately.

(c) Metal powders, such as aluminum, shall be kept dry and shall be stored in containers or bins that are moisture-resistant or weathertight.

(d) Ingredients shall not be stored with incompatible materials.

(e) Peroxides or chlorates shall not be used.

4-3.4 Mixing equipment shall meet the following requirements:

(a) The design of the processing equipment, including mixing and conveying equipment, shall be compatible with the materials being handled. The equipment shall be designed to minimize frictional heating, compaction, overloading, and confinement.

(b) Equipment and handling procedures shall be designed to prevent the introduction of foreign objects or material.

(c) Mixers, pumps, valves, and related equipment shall be designed to allow regular and periodic flushing, cleaning, dismantling, and inspection.

(d) All electrical equipment and wiring shall comply with NFPA 70, *National Electrical Code*.

(e) Electric motors and generators shall be provided with suitable overload protection devices. All motors, generators, proportioning devices, and all other electrical enclosures shall be bonded. The grounding conductor to all such equipment shall be effectively bonded to the service-entrance ground connection and to all equipment ground connections in order to provide a continuous path to ground.

4-3.5 Mixing facilities shall meet the following requirements:

(a) The mixing, loading, and ingredient transfer areas where residues and spilled materials can accumulate shall be kept safe. A cleaning and collection system shall be provided for dangerous residues.

(b) A visual inspection of the mixing, conveying, and electrical equipment shall be made daily to ensure that all equipment is in good operating condition. A program of systematic maintenance shall be carried out on a regular schedule.

(c) Heating units that do not depend on the combustion of fuel shall be permitted to be used within the confines of the processing building or area, provided they are equipped with temperature and safety controls and provided they are located away from combustible materials and finished product.

4-4 Bulk Mixing and Delivery Vehicles.

4-4.1 Vehicle design shall meet the following requirements:

(a) Vehicles used for bulk transportation of water gels shall meet the requirements of Chapter 5 and Section 3-6.

(b) Where electrical power is supplied by a self-contained motor-generator located on the vehicle, the generator shall be separated from the discharge point of the water gel.

(c) Processing equipment shall comply with 4-3.3 and 4-3.4.

(d) A positive action parking brake that sets the brakes on at least one axle shall be provided on vehicles equipped with air brakes. This brake shall be used during bulk delivery operations. Where required, wheel chocks shall be used.

4-4.2 Operation of bulk mixing and delivery vehicles shall meet the following requirements:

(a) The vehicle operator shall be trained in the safe operation of the vehicle and shall be knowledgeable of its mixing,

conveying, and related equipment. The operator shall be familiar with the commodities being delivered and the general procedures for handling emergencies.

(b) No person shall smoke, carry matches or any flame-producing device, or carry any firearms while in or around bulk vehicles effecting the mixing, transfer, or down-the-hole loading of water gels at or near the blasting site.

(c) Caution shall be exercised in moving the vehicle within the blasting area to avoid driving the vehicle over or dragging hoses over firing lines, cap wires, or explosive materials. The driver shall obtain the assistance of a second person to guide the driver's movements while moving the vehicle.

(d) Material shall not be mixed while in transit.

(e) The location chosen for transferring the water gel or its ingredients from a support vehicle to the borehole-loading vehicle shall be away from the blast hole site where the boreholes are loaded or are in the process of being loaded.

4-5 Storage of Water Gels.

4-5.1 Water gels shall be stored as required by Chapter 6.

4-5.2 Where tests on specific formulations result in a Division 1.2 or Division 1.3 Explosives classification, bullet-resistant magazines shall not be required. (*See 6-2.4.*)

4-5.3 Semitrailer vans, trailer vans, or tanks used for the transportation of water gels shall be permitted for temporary storage of these materials, provided they are located in accordance with Table 6-4.1 with respect to inhabited buildings, passenger railways, and public highways, and in accordance with Table 6-4.2 with respect to each other. Trailers and semitrailers shall be provided with substantial means for locking, and the doors, hatches, and valves shall be kept locked. Locking mechanisms shall be as specified for Type 5 magazines. (*See 6-6.5.*)

Exception: Where stocks of water gels are actually being loaded or removed, the doors of trailers and semitrailers shall not be required to be locked.

Chapter 5 Transportation of Explosive Materials on Highways

5-1 Basic Requirements.

5-1.1 In addition to all other applicable requirements of this code, the transportation of explosive materials shall comply with U.S. Department of Transportation, Title 49, *Code of Federal Regulations*, "Hazardous Materials Regulations," Parts 100-179, and Title 49, *Code of Federal Regulations*, "Motor Carrier Safety Regulations," Part 397.

5-1.2 This chapter shall not apply to the transportation of small arms ammunition and components. (*See Chapter 11.*)

5-1.3 Explosive materials shall not be transported through any prohibited vehicular tunnel or subway or over any prohibited bridge, roadway, or elevated highway.

5-1.4 No person shall smoke or carry matches, flame-producing devices, or unauthorized firearms or cartridges while transporting explosive materials.

5-1.5 No person shall drive, load, or unload a motor vehicle transporting explosive materials in a careless or reckless manner.

5-1.6 Explosive materials shall not be carried or transported in or upon a public conveyance or vehicle carrying passengers for hire.

5-1.7 Explosive materials shall not be transferred from one vehicle to another without informing the local authority having jurisdiction. In the event of breakdown or collision, the local authority having jurisdiction shall be notified promptly to help safeguard such emergencies. Explosive materials shall be transferred from the disabled vehicle to another only where proper and qualified supervision is provided.

5-1.8 Detonators shall not be transported in the same vehicle with other Class 1 materials (Class A or Class B explosives).

Exception: As permitted by the U.S. Department of Transportation in Title 49, Code of Federal Regulations, Part 173.63.

5-2 Transportation Vehicles.

5-2.1 Vehicles used for transporting explosive materials shall be strong enough to carry the load and shall be in good mechanical condition.

5-2.2 Where explosive materials are transported on a vehicle with an open body, a portable magazine, securely fastened to the vehicle body, shall be used to store the explosive materials.

5-2.3 Vehicles used for transporting explosive materials shall have no exposed spark-producing surface on the inside of the body.

Exception: This requirement shall not apply to vehicles transporting blasting agents and oxidizing materials.

5-2.4 The floors of transportation vehicles shall be tight.

5-2.5 Motor vehicles used for transporting any quantity of explosive materials on public highways shall display all placards, lettering, or numbering required by the U.S. Department of Transportation.

5-2.6 Each motor vehicle used for transporting explosive materials shall be equipped with fire extinguishers in accordance with Table 5-2.6.

Table 5-2.6 Number of Extinguishers to Be Used According to Gross Vehicle Weight (GVW)

Trucks less than 14,000 lb (6350 kg)	At least 2 extinguishers having combined capacity of 4 A:20-B,C
Trucks 14,000 lb (6350 kg) or greater and tractor/semi-trailer units	At least 2 extinguishers having combined capacity of 4 units A:70-B,C.

5-2.6.1 Only listed fire extinguishers shall be used. Fire extinguishers shall be designed, constructed, and maintained to allow a visual determination that extinguishers are fully charged.

5-2.6.2 Extinguishers shall be located where they are accessible for immediate use.

5-2.6.3 Extinguishers shall be examined and recharged periodically according to manufacturers' recommendations.

5-2.6.4 Where motor vehicles are operated in temperatures below 0°F (-17.8°C), dry chemical extinguishers shall be pressurized with nitrogen.

5-2.7 A motor vehicle used for transporting explosive materials shall be inspected to determine that it is in proper condition. The following items shall be verified:

- (a) The fire extinguisher is filled and in working order.
- (b) All electrical wiring is completely protected and securely fastened to prevent short-circuiting.
- (c) The chassis, motor, oil pan, and body undersides are reasonably clean and free of excess oil and grease.
- (d) The fuel tank and fuel lines are secure and free of leaks.
- (e) The brakes, lights, horn, windshield wipers, and steering apparatus are functioning properly.
- (f) The tires are inflated properly and free of defects.
- (g) The vehicle is in the proper condition in every other respect and is acceptable for handling explosive materials.

5-2.8 Tires shall be checked for proper inflation and general condition after every 2 hours or 100 miles (161 km) of travel, whichever occurs first, and at every rest stop. Flat or overheated tires shall be removed from the vehicle immediately. After removal, the tire shall be placed far enough from the vehicle so that a spontaneous ignition of the tire does not endanger the vehicle or its cargo. The tire shall be cooled below the danger of ignition and the problem shall be corrected before it is replaced on the vehicle.

5-3 Operation of Transportation Vehicles.

5-3.1 Vehicles transporting explosive materials shall be driven by and be in the charge of only a properly licensed driver who is physically fit, careful, capable, reliable, and able to read and write the English language and who is not addicted to the use of, or under the influence of, intoxicants, narcotics, or other dangerous drugs.

5-3.2 The driver of a vehicle transporting explosive materials on public highways shall be not less than 21 years old. The driver shall be familiar with traffic regulations, applicable federal and state regulations concerning explosive materials, and the provisions of this chapter.

5-3.3 No vehicle transporting explosive materials shall be parked before reaching its destination, even while attended, on any public street adjacent to or in proximity to any bridge, tunnel, dwelling, building, or place where people work, congregate, or assemble.

Exception: This requirement shall not apply under emergency conditions.

5-3.4 Every motor vehicle transporting any quantity of Class A or B explosives shall, at all times, be attended by a driver or other qualified representative of the motor carrier operating the vehicle. This attendant shall have been made aware of the class of the explosive in the vehicle and its inherent dangers and shall have been instructed in the procedures to be followed in order to protect the public from those dangers. The attendant shall be familiar with the vehicle assigned and shall be provided with the training, necessary means, and authorization to move the vehicle where required.

5-3.5 For the purpose of this chapter, a motor vehicle shall be considered "attended" only when the driver or attendant is physically on or in the vehicle or when the vehicle is within his/her field of vision and the driver can reach it quickly and without interference. "Attended" also shall mean that the

driver or attendant is awake, alert, and not engaged in other duties or activities that could divert attention from the vehicle.

Exception No. 1: This requirement shall not apply where communication with public officers or representatives of the shipper, carrier, or consignee or absence from the vehicle to obtain food or provide for physical comfort is necessary.

Exception No. 2: A vehicle carrying explosive materials shall be permitted to be left unattended, provided it is parked in an area where such parking is permitted, such as an area meeting the requirements of NFPA 498, Standard for Safe Havens and Interchange Lots for Vehicles Transporting Explosives.

5-3.6 No spark-producing metal or tools, oils, matches, firearms, electric storage batteries, flammable materials, acids, oxidizers, or corrosives shall be carried in the body of any motor vehicle transporting explosive materials.

Exception: Where permitted by the U.S. Department of Transportation "Hazardous Materials Regulations."

5-3.7 Vehicles transporting explosive materials shall avoid congested areas and heavy traffic. Where routes through congested areas have been designated by the authority having jurisdiction, such routes shall be followed.

5-3.8 Delivery shall be made only to authorized persons and into authorized magazines or approved temporary storage or handling areas.

Chapter 6 Aboveground Storage of Explosive Materials

6-1 Scope.

6-1.1 Explosive materials shall be kept in magazines meeting the requirements of this chapter.

6-1.2 This chapter shall not apply to the storage of small arms ammunition, propellant-actuated cartridges, small arms ammunition primers, and smokeless propellants. (See Chapter 11.)

6-2 Basic Requirements.

6-2.1 All explosive materials not in the process of manufacture, transportation, or use shall be kept in storage magazines.

6-2.2 Ammonium nitrate shall be permitted to be stored in the same magazine with blasting agents. Ammonium nitrate and blasting agents shall be permitted to be stored in the same magazine with other explosive materials. (See 6-2.3.)

6-2.2.1 Where ammonium nitrate is stored in the same magazine with blasting agents, the magazine shall be suitable for the storage of blasting agents.

6-2.2.2 Where ammonium nitrate is stored in the same magazine with explosives or with explosives and blasting agents, the magazine shall be suitable for the storage of explosives.

6-2.2.3 In determining the maximum quantity of explosive material that shall be permitted to be placed in a magazine, 1/2 the weight of the ammonium nitrate shall be added to the weight of the explosive material.

6-2.3 Detonators shall be stored in a separate magazine for blasting supplies and shall not be stored in a magazine with other explosive materials.

6-2.4 Explosive materials classified as Division 1.1 or Division 1.2 by the U.S. Department of Transportation shall be stored in Type 1, 2, or 3 magazines.

Exception: Black powder shall be permitted to be stored in a Type 4 magazine or a magazine of higher classification (i.e., lower type number).

6-2.5 Division 1.5 explosive materials (blasting agents) shall be permitted to be stored in a Type 5 magazine or a magazine of higher classification (i.e., lower type number).

6-3 Classification and Use of Magazines.

6-3.1 Outdoor magazines shall be classified and used in accordance with Table 6-3.1.

Table 6-3.1 Construction Features and Allowable Storage in Magazines

Classification and Use of Magazines/Construction Features	Magazine Types				
	1	2	3	4	5
Permanent	X			X	X
Portable		X	X	X	X
Bullet-resistant	X	X			
Fire-resistant	X	X	X	X ²	X ²
Theft-resistant	X	X	X	X	X ¹
Weather-resistant	X	X	X	X	X
Ventilated	X	X	X	X ²	X ²

¹Each door of a mobile Type 5 magazine shall be equipped with at least one five-tumbler padlock having a 3/8-in. (9.5-mm) case-hardened shackle. The lock shall not be required to be hooded.

²Over-the-road trucks or semitrailers used for temporary storage as Type 4 or Type 5 magazines shall not be required to be fire-resistant or ventilated.

Storage in Magazines	Magazine Types				
	1	2	3	4	5
High explosives (1.1 D) (Class A explosives) including dynamites; cap-sensitive emulsions; slurries and water gels; cast boosters	X	X	X		
Black powder (1.1 D) (Class A explosives); defined as low explosive by the BATF for storage	X	X	X	X	
Detonators (1.1 B) (Class A explosives)	X	X	X		
Detonating cords (1.1 D, 1.2 D, 1.4 G) (Class A or Class C explosives)	X	X	X		
Detonators (1.4 B, 1.4 S) (Class C explosives)	X	X	X	X	
Safety fuse, electric squibs, igniters, and igniter cord (1.4 G, 1.4 S)	X	X	X	X	
Blasting agents (1.5 D) (blasting agents)	X	X	X	X	X
Propellants (1.3 C) (Class B explosives); defined as low explosive by the BATF for storage	X	X	X	X	

NOTE 1: Detonators that are mass detonating shall not be stored in the same magazine with other explosive materials.

NOTE 2: Detonators that are not mass detonating shall be permitted to be stored with safety fuses, electric squibs, igniters, or igniter cord in Type 1, 2, 3, or 4 magazines.

6-3.2 Indoor magazines used for the storage of 50 lb (22.7 kg) or less of explosive materials in warehouses and in wholesale or retail establishments shall be fire-resistant and theft-resistant and shall be subject to the approval of the authority having jurisdiction.

6-4 Location of Magazines.

6-4.1 All outdoor magazines other than Type 3 shall be located to comply with the American Table of Distances for Storage of Explosives (ADT) or the Table of Distances for Storage of Low Explosives, as applicable. (See Table 6-4.1 for the American Table of Distances. See Title 27, Code of Federal Regulations, Part 55, for the Table of Distances for Low Explosives.)

Table 6-4.1 The American Table of Distances for Storage of Explosives

The American Table of Distances is reprinted from IME Safety Library Publication No. 2 with permission of the Institute of Makers of Explosives, and was revised in June of 1991.

Quantity of Explosive Materials ^{1,2,3,4}		Distance in ft							
		Inhabited Buildings ⁹		Public Highways Class A to D ¹¹		Passenger Railways — Public Highways with Traffic Volume of More than 3000 Vehicles/Day ^{10,11}		Separation of Magazines ¹²	
Pounds Over	Pounds Not Over	Barricaded ^{6,7,8}	Unbarricaded	Barricaded ^{6,7,8}	Unbarricaded	Barricaded ^{6,7,8}	Unbarricaded	Barricaded ^{6,7,8}	Unbarricaded
0	5	70	140	30	60	51	102	6	12
5	10	90	180	35	70	64	128	8	16
10	20	110	220	45	90	81	162	10	20
20	30	125	250	50	100	93	186	11	22
30	40	140	280	55	110	103	206	12	24
40	50	150	300	60	120	110	220	14	28
50	75	170	340	70	140	127	254	15	30
75	100	190	380	75	150	139	278	16	32
100	125	200	400	80	160	150	300	18	36
125	150	215	430	85	170	159	318	19	38
150	200	235	470	95	190	175	350	21	42
200	250	255	510	105	210	189	378	23	46
250	300	270	540	110	220	201	402	24	48
300	400	295	590	120	240	221	442	27	54
400	500	320	640	130	260	238	476	29	58
500	600	340	680	135	270	253	506	31	62
600	700	355	710	145	290	266	532	32	64
700	800	375	750	150	300	278	556	33	66
800	900	390	780	155	310	289	578	35	70
900	1000	400	800	160	320	300	600	36	72
1000	1200	425	850	165	330	318	636	39	78
1200	1400	450	900	170	340	336	672	41	82
1400	1600	470	940	175	350	351	702	43	86
1600	1800	490	980	180	360	366	732	44	88
1800	2000	505	1010	185	370	378	756	45	90
2000	2500	545	1090	190	380	408	816	49	98
2500	3000	580	1160	195	390	432	864	52	104
3000	4000	635	1270	210	420	474	948	58	116
4000	5000	685	1370	225	450	513	1026	61	122
5000	6000	730	1460	235	470	546	1092	65	130
6000	7000	770	1540	245	490	573	1146	68	136
7000	8000	800	1600	250	500	600	1200	72	144
8000	9000	835	1670	255	510	624	1248	75	150
9000	10,000	865	1730	260	520	645	1290	78	156
10,000	12,000	875	1750	270	540	687	1374	82	164
12,000	14,000	885	1770	275	550	723	1446	87	174
14,000	16,000	900	1800	280	560	756	1512	90	180
16,000	18,000	940	1880	285	570	786	1572	94	188
18,000	20,000	975	1950	290	580	813	1626	98	196
20,000	25,000	1055	2000	315	630	876	1752	105	210
25,000	30,000	1130	2000	340	680	933	1866	112	224
30,000	35,000	1205	2000	360	720	981	1962	119	238
35,000	40,000	1275	2000	380	760	1026	2000	124	248
40,000	45,000	1340	2000	400	800	1068	2000	129	258
45,000	50,000	1400	2000	420	840	1104	2000	135	270

Table 6-4.1 The American Table of Distances for Storage of Explosives

The American Table of Distances is reprinted from IME Safety Library Publication No. 2 with permission of the Institute of Makers of Explosives, and was revised in June of 1991. (Continued)

Quantity of Explosive Materials ^{1,2,3,4}		Distance in ft							
		Inhabited Buildings ⁹		Public Highways Class A to D ¹¹		Passenger Railways — Public Highways with Traffic Volume of More than 3000 Vehicles/Day ^{10,11}		Separation of Magazines ¹²	
Pounds Over	Pounds Not Over	Barricaded ^{6,7,8}	Unbarricaded	Barricaded ^{6,7,8}	Unbarricaded	Barricaded ^{6,7,8}	Unbarricaded	Barricaded ^{6,7,8}	Unbarricaded
50,000	55,000	1460	2000	440	880	1140	2000	140	280
55,000	60,000	1515	2000	455	910	1173	2000	145	290
60,000	65,000	1565	2000	470	940	1206	2000	150	300
65,000	70,000	1610	2000	485	970	1236	2000	155	310
70,000	75,000	1655	2000	500	1000	1263	2000	160	320
75,000	80,000	1695	2000	510	1020	1293	2000	165	330
80,000	85,000	1730	2000	520	1040	1317	2000	170	340
85,000	90,000	1760	2000	530	1060	1344	2000	175	350
90,000	95,000	1790	2000	540	1080	1368	2000	180	360
95,000	100,000	1815	2000	545	1090	1392	2000	185	370
100,000	110,000	1835	2000	550	1100	1437	2000	195	390
110,000	120,000	1855	2000	555	1110	1479	2000	205	410
120,000	130,000	1875	2000	560	1120	1521	2000	215	430
130,000	140,000	1890	2000	565	1130	1557	2000	225	450
140,000	150,000	1900	2000	570	1140	1593	2000	235	470
150,000	160,000	1935	2000	580	1160	1629	2000	245	490
160,000	170,000	1965	2000	590	1180	1662	2000	255	510
170,000	180,000	1990	2000	600	1200	1695	2000	265	530
180,000	190,000	2010	2010	605	1210	1725	2000	275	550
190,000	200,000	2030	2030	610	1220	1755	2000	285	570
200,000	210,000	2055	2055	620	1240	1782	2000	295	590
210,000	230,000	2100	2100	635	1270	1836	2000	315	630
230,000	250,000	2155	2155	650	1300	1890	2000	335	670
250,000	275,000	2215	2215	670	1340	1950	2000	360	720
275,000	300,000	2275	2275	690	1380	2000	2000	385	770

Superscript numerals refer to explanatory footnotes.

Explanatory Notes Essential to the Application of the American Table of Distances for Storage of Explosives

Note 1: "Explosive materials" means explosives, blasting agents, and detonators.

Note 2: "Explosives" means any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion. A list of explosives determined to be within the coverage of Title 18, *United States Code*, 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. For quantity and distance purposes, detonating cord of 50 grains per foot should be calculated as equivalent to 8 lb (3.7 kg) of high explosives per 1000 ft (305 m). Heavier or lighter core loads should be rated proportionately.

Note 3: "Blasting agents" means any material or mixture consisting of fuel and oxidizer, intended for blasting, and 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 where unconfined.

Note 4: "Detonator" means any device containing any initiating or primary explosive that is used for initiating detonation. A detonator may not be permitted to 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 leg wires. All types of detonators in strengths through No. 8 cap should be rated at 1½ lb (0.7 kg) of explosives per 1000 caps. Note 5: For strengths higher than No. 8 cap, the manufacturer should be consulted.

Note 5: "Magazine" means any building, structure, or container, other than an explosives manufacturing building, approved for the storage of explosive materials.

Note 6: "Natural barricade" means natural features of the ground, such as hills, or timber of sufficient density that the surrounding exposures that need protection cannot be seen from the magazine when the trees are bare of leaves.

Note 7: "Artificial barricade" means an artificial mound or revetted wall of earth of a minimum thickness of 3 ft (0.9 m).

Note 8: "Barricaded" means the effective screening of a building containing explosive materials from the magazine or another building, a railway, or a highway by a natural or an artificial barrier. A straight line from the top of any sidewall of the building containing explosive materials to the eave line of any magazine or other building or to a point 12 ft (3.7 m) above the center of a railway or highway shall pass through such barrier.

Note 9: "Inhabited building" means 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, but does not include any building or structure occupied in connection with the manufacture, transportation, storage, or use of explosive materials.

Note 10: "Railway" means any steam, electric, or other railroad or railway that carries passengers for hire.

Note 11: "Highway" means any public street, public alley, or public road.

Note 12: Where two or more storage magazines are located on the same property, each magazine shall comply with the minimum distances specified from inhabited buildings, railways, and highways, and, in addition, they should be separated from each other by not less than the distances shown for "separation of magazines," except that the quantity of explosive materials contained in detonator magazines shall govern with regard to the spacing of said detonator magazines from magazines containing other explosive materials. If any two or more magazines are separated from each other by less than the specified "separation of magazines" distances, such magazines, as a group, shall be considered as one magazine, and the total quantity of explosive materials stored in such group shall be treated as if stored in a single magazine located on the site of any magazine of the group, and shall comply with the minimum specified distances from other magazines, inhabited buildings, railways, and highways.

Note 13: Storage in excess of 300,000 lb (136,200 kg) of explosive materials in one magazine generally is not necessary for commercial enterprises.

Note 14: This table applies only to the manufacture and permanent storage of commercial explosive materials. It is not applicable to the transportation of explosives or any handling or temporary storage necessary or incident thereto. It is not intended to apply to bombs, projectiles, or other heavily encased explosives.

Note 15: Where a manufacturing building on an explosive materials plant site is designed to contain explosive materials, the building shall be located at a distance from inhabited buildings, public highways, and passenger railways in accordance with the American Table of Distances based on the maximum quantity of explosive materials permitted to be in the building at one time.

6-4.2 Blasting agent manufacturing plants and storage of blasting agents and ammonium nitrate shall be located in compliance with the Table of Recommended Separation Dis-

tances of Ammonium Nitrate and Blasting Agents (SDT) as well as with the American Table of Distances. (See Tables 6-4.1 and 6-4.2.)

Table 6-4.2 Table of Recommended Separation Distances of Ammonium Nitrate and Blasting Agents from Explosives or Blasting Agents^{1,6}

Donor Weight		Minimum Separation Distance of Acceptor when Barricaded ² (ft)		Minimum Thickness of Artificial Barricades ⁵ (in.)
Pounds Over	Pounds Not Over	Ammonium Nitrate ³	Blasting Agent ⁴	
	100	3	11	12
100	300	4	14	12
300	600	5	18	12
600	1000	6	22	12
1000	1600	7	25	12
1600	2000	8	29	12
2000	3000	9	32	15
3000	4000	10	36	15
4000	6000	11	40	15
6000	8000	12	43	20
8000	10,000	13	47	20
10,000	12,000	14	50	20
12,000	16,000	15	54	25
16,000	20,000	16	58	25
20,000	25,000	18	65	25
25,000	30,000	19	68	30
30,000	35,000	20	72	30
35,000	40,000	21	76	30
40,000	45,000	22	79	35
45,000	50,000	23	83	35
50,000	55,000	24	86	35
55,000	60,000	25	90	35
60,000	70,000	26	94	40
70,000	80,000	28	101	40
80,000	90,000	30	108	40
90,000	100,000	32	115	40
100,000	120,000	34	122	50
120,000	140,000	37	133	50
140,000	160,000	40	144	50
160,000	180,000	44	158	50
180,000	200,000	48	173	50
200,000	220,000	52	187	60
220,000	250,000	56	202	60
250,000	275,000	60	216	60
275,000	300,000	64	230	60

For SI Units: 1 lb = 0.454 kg; 1 ft = 0.305 m; 1 in. = 2.54 cm

Notes to Table of Recommended Separation Distances of Ammonium Nitrate and Blasting Agents from Explosives or Blasting Agents

Note 1: Recommended separation distances are to prevent explosion of ammonium nitrate and ammonium nitrate-based blasting agents by propagation from nearby stores of high explosives or blasting agents referred to in the table as the "donor." Ammonium nitrate, by itself, is not considered to be a donor where applying this table. Ammonium nitrate, ammonium nitrate-fuel oil, or combinations thereof are acceptors. If stores of ammonium nitrate are located within the sympathetic detonation distance of explosives or blasting agents, 1/2 the mass of the ammonium nitrate shall be included in the mass of the donor.

Note 2: Where the ammonium nitrate or blasting agent, or both, is not barricaded, the distances shown in the table shall be multiplied by 6. These distances allow for the possibility of high velocity metal fragments from mixers, hoppers, truck bodies, sheet metal structures, metal containers, and the like that could enclose the donor. Where storage is in bullet-resistant magazines¹ recommended for explosives or where the storage is protected by a bullet-resistant wall, distances and barricade thicknesses in excess of those prescribed in the American Table of Distances are not required.

Note 3: The distances in the table apply to ammonium nitrate that passes the insensitivity test prescribed in the definition of ammonium nitrate fertilizer promulgated by the Fertilizer Institute;² ammonium nitrate failing to pass said test shall be stored at separation distances determined by competent persons and approved by the authority having jurisdiction.

Note 4: These distances apply to blasting agents that pass the insensitivity test prescribed in regulations of the U.S. Department of Transportation and the U.S. Department of the Treasury, Bureau of Alcohol, Tobacco, and Firearms.

Note 5: Earth, sand dikes, or enclosures filled with the prescribed minimum thickness of earth or sand shall be permitted to be used as artificial barricades. Natural barricades, such as hills or timber of sufficient density that the surrounding exposures that need protection cannot be seen from the donor when the trees are bare of leaves, also shall be permitted to be used.

Note 6: For determining the distances to be maintained from inhabited buildings, passenger railways, and public highways, Table 6-4.1, the American Table of Distances for Storage of Explosives, shall be used.

¹For construction of bullet-resistant magazines, see Appendix C.

²Definition and Test Procedures for Ammonium Nitrate Fertilizer, Fertilizer Institute, November 1964.

6-4.3 The separation distances provided by the American Table of Distances or the Table of Recommended Separation Distances, or both, shall be used to determine minimum separation of storage facilities for explosives, blasting agents, and ammonium nitrate. The tables to be used shall be as specified in Table 6-4.3.

Table 6-4.3 Application of Separation Distance Tables

Type of Donor	Type of Acceptor	Table	Distances Listed Under
Explosives	Explosives	ATD	Separation of magazines
Explosives	Ammonium nitrate	SDT	Ammonium nitrate
Explosives	Blasting agent	SDT	Blasting agent
Blasting agent	Explosives	ATD	Separation of magazines
Blasting agent	Blasting agent	SDT	Blasting agent
Blasting agent	Ammonium nitrate	SDT	Ammonium nitrate

6-4.4 An indoor magazine shall be located only on a floor that has an entrance at or a ramp to grade level. It shall be located no more than 10 ft (3 m) from the entrance. It shall be located as approved by the authority having jurisdiction to facilitate rapid removal in an emergency.

6-4.5 Two magazines shall be permitted to be located in the same building, provided one magazine is used solely for the storage of detonators in quantities not exceeding 5000. A distance of 10 ft (3 m) shall be maintained between the magazines.

6-4.6 The local fire department and other local emergency response agencies shall be notified of the location of all magazines and shall be notified of any changes in location.

6-4.7 Type 3 magazines shall be located as far away as practicable from neighboring inhabited buildings, railways, highways, and other magazines.

6-4.8 Type 3 magazines shall be attended where explosive materials are stored within. All explosive materials shall be removed to appropriate storage magazines for unattended storage at the end of the work day.

6-4.9 Two Type 3 magazines shall be permitted to be located at a blasting site, provided one magazine is used solely for the storage of detonators.

6-4.10 A Type 5 magazine shall not be located in a residence or dwelling.

6-5 Magazine Construction — Basic Requirements.

6-5.1 Magazines shall be constructed to comply with Section 6-5 or in a manner substantially equivalent to the requirements for safety and security embodied in this section.

6-5.2 The ground in the vicinity of magazine shall be graded so that water drains away from the magazine.

6-5.3 Heated magazines shall be heated by either hot water radiant heating within the magazine building or by indirect warm air heating.

6-5.4 Indirect warm air shall be heated by either hot water or low pressure [15 psig (103 kPa) or less] steam coils located outside the magazine building.

6-5.5 Magazine heating systems shall meet the following requirements:

(a) Radiant heating coils within the building shall be installed so that explosive materials or their containers cannot contact the coils and so that air is free to circulate between the coils and the explosive materials. The surface temperature of the coils shall not exceed 165°F (74°C).

(b) Heating ducts shall be installed so that the hot air discharged from the ducts is not directed against explosive materials or containers.

(c) The heating system shall be controlled so that the ambient temperature of the magazine does not exceed 130°F (54°C).

(d) Any electric fan or pump used in the heating system shall be located outside the magazine, separate from the magazine walls, and shall be grounded.

(e) Any electric motor and any controls for electric heating devices used to heat water or produce steam shall have overload devices and disconnects that comply with NFPA 70, *National Electrical Code*. All electrical switch-gear shall be located at least 25 ft (7.6 m) from the magazine.

(f) Any fuel-fired heating source for the hot water or steam shall be separated from the magazine by a distance of not less than 25 ft (7.6 m). The area between the heating unit and the magazine shall be cleared of all combustible material.

(g) Explosive materials stored in magazines shall be arranged so that uniform circulation of air is ensured.

6-5.6 Where lighting is necessary within the magazine, electric safety flashlights or electric safety lanterns shall be used.

6-5.6.1 Electric lighting shall be permitted to be used within a magazine, provided the installation meets the following requirements:

(a) Junction boxes containing fuses or circuit breakers and electrical disconnects shall be located at least 25 ft (7.6 m) from the magazine.

(b) Disconnects, fuses, and circuit breakers shall be protected by a voltage surge arrester capable of handling 2500 amperes for 0.1 seconds.

(c) All wiring from switches, both inside and outside the magazine, shall be installed in rigid conduit. Wiring leading to the magazine shall be installed underground.

(d) Conduit and light fixtures inside the magazine shall be protected from physical damage by suitable guards or by their location.

(e) Light fixtures shall be suitably enclosed to prevent sparks or hot metal from falling onto the floor or onto material stored in the magazine.

(f) Junction boxes located within the magazine shall have no openings and shall be equipped with close-fitting covers.

(g) Magazines containing explosive materials that could release flammable vapors shall have wiring and fixtures that meet the requirements of NFPA 70, *National Electrical Code*, Article 501.

(h) Lights inside magazines shall not be left on while the magazine is unattended.

6-5.7 There shall be no exposed ferrous metal on the interior of a magazine where it has the potential to contact packages of explosives.

Exception: This requirement shall not apply to Type 5 magazines.

6-6 Magazine Construction — Requirements for Specific Types.

6-6.1 Type 1 Magazines. A Type 1 magazine shall be a permanent structure, such as a building or igloo, that is bullet-resistant, fire-resistant, theft-resistant, weather-resistant, and ventilated.

(a) Walls and doors shall be bullet-resistant and shall be permitted to be constructed in accordance with any of the specifications in Appendix C.

(b) The roof shall be permitted to be constructed of any type of structurally sound materials that are or have been made fire-resistant on the exterior.

(c) * Where the natural terrain around a Type 1 magazine makes it possible for a bullet to be shot through the roof and ceiling at such an angle that the bullet can strike the explosive materials within, the roof or the ceiling shall be of bullet-resistant construction.

(d) The foundation shall be permitted to be of masonry, wood, or metal and shall be enclosed completely. A wood foundation enclosure shall be covered on the exterior with metal of not less than 26-gauge thickness.

Exception: Openings to provide cross ventilation shall not be required to be enclosed.

(e) The floor shall be constructed of wood or other suitable material. Floors constructed of materials that could cause sparks shall be covered with a nonsparking surface, or the packages of explosive materials shall be placed on pallets of nonsparking material.

(f) Type 1 magazines shall be ventilated to prevent dampness or heating of explosive materials. Ventilation openings shall be screened to prevent the entrance of sparks. Ventilators in sidewalls shall be offset or shielded. Magazines having foundation and roof ventilators, with the air circulating between the sidewalls and floor and between the sidewalls and ceiling, shall have a wood lattice lining or equivalent means to prevent packages of explosive materials from being stacked against the sidewalls and blocking air circulation. A 2-in. (51-mm) air space shall be provided between the sidewalls and the floor.

(g) Each door of a Type 1 magazine shall be equipped with one of the following locking systems:

1. Two mortise locks;
2. Two padlocks in separate hasps and staples;
3. A mortise lock and a padlock;
4. A mortise lock that requires two keys to open; or
5. A three-point lock or an equivalent lock that secures the door to the frame at more than one point.

Padlocks shall be steel, shall have at least five tumblers, and shall have at least a $\frac{3}{8}$ -in. (9.5-mm) case-hardened shackle. All padlocks shall be protected by steel hoods installed to discourage the insertion of bolt cutters. Doors secured by a substantial internal bolt shall not require additional locking devices. Hinges and hasps shall be fastened securely to the magazine, and all locking hardware shall be secured rigidly and directly to the door frame.

6-6.2 Type 2 Magazines. A Type 2 magazine shall be a portable or mobile structure, such as a box, skid-magazine, trailer, or semitrailer that is fire-resistant, theft-resistant, weather-

resistant, and ventilated. Where used for outdoor storage, Type 2 magazines also shall be bullet-resistant.

6-6.2.1 Type 2 Outdoor Magazines.

(a) The walls and roof or ceiling shall be constructed in accordance with the provisions of 6-6.1(a), (b), and (c).

(b) Doors shall be of metal, constructed in accordance with the provisions of 6-6.1(a), or shall have a metal exterior with an inner door meeting the provisions of 6-6.1(a).

(c) Floors constructed of ferrous metal shall be covered with a nonsparking surface.

(d) A top-opening magazine shall have a lid that overlaps the sides by at least 1 in. (25.4 mm) when in the closed position.

(e) The magazine shall be supported so that its floor does not directly contact the ground.

(f) Magazines of less than 1 yd³ (0.766 m³) shall be fastened securely to a fixed object to prevent theft of the entire magazine.

(g) Hinges, hasps, locks, and locking hardware shall comply with 6-6.1(g).

Exception: Padlocks on vehicular magazines shall not be required to be protected by steel hoods.

(h) Whenever a vehicular magazine is left unattended, its wheels shall be removed, its kingpins shall be locked, or it otherwise shall be effectively immobilized.

6-6.2.2 Type 2 Indoor Magazines.

(a) The magazine shall have substantial wheels or casters to facilitate its removal from the building in case of emergency.

(b) The cover of the magazine shall have substantial strap hinges and a means for locking. The magazine shall be kept locked with a five-tumbler padlock or its equivalent.

Exception: The magazine shall be permitted to be unlocked during placement or removal of explosive materials.

(c) The magazine shall be painted red, and the top shall bear the words "Explosives — Keep Fire Away" in white letters at least 3 in. (76 mm) high.

(d) Type 2 indoor magazines constructed of wood shall have sides, bottoms, and covers or doors constructed of 2-in. (51-mm) hardwood that are well braced at corners. The magazines shall be covered with sheet metal of not less than 26 gauge. Nails exposed to the interior of the magazines shall be countersunk.

(e) Type 2 indoor magazines constructed of metal shall be of 12-gauge sheet metal and shall be lined with a nonsparking material. The edges of metal covers shall overlap the side by at least 1 in. (25.4 mm).

6-6.3 Type 3 Magazines. A Type 3 magazine is a "day box" or portable structure used for the temporary storage of explosive materials. A Type 3 magazine shall be fire-resistant, theft-resistant, and weather-resistant.

(a) The magazine shall be equipped with one steel padlock (which shall not be required to be protected by a steel hood) having at least five tumblers and a case-hardened steel shackle at least $\frac{3}{8}$ in. (9.5 mm) in diameter. Doors shall overlap the sides by at least 1 in. (25.4 mm). Hinges and hasps shall be attached by welding, riveting, or bolting (nuts on inside).

(b) The magazine shall be constructed of not less than 12-gauge [0.1046-in. (2.66-mm)] steel, lined with at least 1/2-in. (12.7-mm) plywood or 1/2-in. (12.7-mm) masonite-type hardboard.

(c) Type 3 magazines containing explosive materials shall be within line-of-site vision of a blaster.

6-6.4 Type 4 Magazines. A Type 4 magazine shall be a permanent, portable, or mobile structure such as a building, igloo, box, semitrailer, or other mobile container that is fire-resistant, theft-resistant, and weather-resistant.

6-6.4.1 Type 4 Outdoor Magazine.

(a) A Type 4 outdoor magazine shall be constructed of masonry and wood covered with sheet metal, fabricated metal, or a combination of these materials. Doors shall be metal or wood covered with metal.

(b) Permanent Type 4 magazines shall comply with 6-6.1(d), (f), and (g).

(c) Vehicular Type 4 magazines shall comply with 6-6.2.1(g) and shall be immobilized while unattended, as described in 6-6.2.1(h).

6-6.4.2 Type 4 Indoor Magazine. A Type 4 indoor magazine shall comply with all provisions of 6-6.2.2.

6-6.5 Type 5 Magazines. A Type 5 magazine shall be a permanent, portable, or mobile structure such as a building, igloo, box, bin, tank, semitrailer, bulk trailer, tank trailer, bulk truck, tank truck, or other mobile container that is theft-resistant. No ventilation shall be required, and ferrous metal shall not be required to be covered with nonsparking material.

6-6.5.1 Type 5 Outdoor Magazine.

(a) A Type 5 permanent outdoor magazine shall be weather-resistant and shall be locked with at least one steel five-tumbler padlock having at least a 3/8-in. (9.5-mm) case-hardened shackle. A hood for the padlock shall not be required.

(b) Hinges and hasps shall be fastened securely to the magazine and all locking hardware shall be secured rigidly and directly to the door frame.

(c) A vehicular Type 5 magazine shall be immobilized while unattended as described in 6-6.2.1(h).

6-6.5.2 Type 5 Indoor Magazine. A Type 5 indoor magazine shall be constructed in accordance with the requirements for Type 5 outdoor magazines.

Exception: A Type 5 indoor magazine shall not be required to be weather-resistant.

6-7 Storage within Magazines.

6-7.1 Magazines shall be supervised by a competent person at all times. This person shall be at least 21 years old and shall be responsible for the enforcement of all safety precautions.

6-7.2 All magazines containing explosive materials shall be opened and inspected at maximum intervals of 3 days to determine whether there has been unauthorized or attempted entry into the magazines or whether there has been unauthorized removal of the magazines or their contents.

6-7.3 Magazine doors shall be kept locked.

Exception: Magazine doors shall be permitted to be unlocked during placement or removal of explosives or during inspection.

6-7.4 Safety rules covering the operations of magazines shall be posted on the interior side of the magazine door.

6-7.5 Where explosive materials are removed from the magazine for use, the oldest stock shall be used first.

6-7.6 Corresponding grades and brands of explosive materials shall be stored together so that brand and grade markings are readily visible. All stocks shall be stored in a manner that allows them to be easily counted and checked.

6-7.7 Containers of explosive materials shall be piled in a stable manner and laid flat with the top side up.

6-7.8 Open containers of explosive materials shall be closed securely before being returned to a magazine. No container without a closed lid shall be permitted to be stored in the magazine. Only fiberboard containers shall be permitted to be opened in the magazine.

6-7.9 Containers of explosive materials other than fiberboard shall not be unpacked or repacked inside or within 50 ft (15.25 m) of a magazine or in close proximity to other explosive materials.

6-7.10 Tools used for opening containers of explosive materials shall be constructed of nonsparking material.

Exception: Metal slitters shall be permitted to be used for opening fiberboard containers.

6-7.11 Magazines shall be used exclusively for the storage of explosive materials, blasting materials, and blasting accessories. Metal tools other than nonferrous transfer conveyors shall not be stored in a magazine containing explosives or detonators.

Exception: Ferrous metal conveyor stands protected by a coat of paint shall be permitted to be stored within a magazine.

6-7.12 Magazine floors shall be regularly swept and kept clean, dry, and free of grit, paper, empty packages, and rubbish. Brooms and other cleaning utensils shall not have any spark-producing metal parts. Sweepings from magazine floors shall be disposed of in accordance with the manufacturers' instructions.

6-7.13 Where any explosive material has deteriorated to the extent that it is in an unstable or dangerous condition or if nitroglycerine or other liquid is leaking from any explosive, the person responsible for the explosives shall contact the manufacturer for assistance immediately. Magazine floors stained with nitroglycerine or other liquid shall be cleaned in accordance with the manufacturers' instructions.

6-7.14 Before making repairs to the interior of a magazine, all explosive materials shall be removed and the floor shall be cleaned.

6-7.15 In making repairs that could result in sparks or fire to the exterior of a magazine, all explosive materials shall be removed.

6-7.16 Explosive materials removed from a magazine undergoing repair shall be placed either in another magazine or at a safe distance from the magazine. They shall be guarded and protected properly. Upon completion of the repairs, they shall be returned to the magazine promptly.

6-8 Miscellaneous Safety Precautions.

6-8.1 Smoking, matches, open flames, spark-producing devices, and firearms shall not be permitted inside of or within 50 ft (15.25 m) of a magazine.

Exception: Firearms carried by authorized guards.

6-8.2 The area around a magazine shall be kept clear of brush, dried grass, leaves, and similar combustibles for a distance of at least 25 ft (7.63 m).

6-8.3 Combustible materials shall not be stored within 50 ft (15.25 m) of magazines.

6-8.4 Explosive materials recovered from blasting misfires shall be stored in a separate magazine until disposal instructions have been received from the manufacturer. Such explosive materials then shall be disposed of in the manner recommended by the manufacturer. Detonators recovered from blasting misfires shall not be reused.

6-8.5 Property on which Type 1 magazines and outdoor magazines of Types 2, 4, and 5 are located shall be posted with signs reading "Explosives — Keep Off." Such signs shall be located to minimize the possibility that a bullet shot at the sign hits the magazine.

6-8.6 Where Division 1.5 Explosives are stored in an over-the-road trailer Type 5 storage magazine, it shall be placarded with an approved U.S. Department of Transportation placard for Division 1.5 Explosives until it is empty.

Chapter 7 Use of Explosive Materials for Blasting**7-1 Basic Requirements.**

7-1.1 All federal, state, and local laws and regulations applicable to obtaining, owning, transporting, storing, handling, and using explosive materials shall be followed.

7-1.2 Explosive materials shall be protected from unauthorized possession and shall not be abandoned.

7-1.3 Explosive materials shall be used only by experienced persons who are familiar with the hazards involved and who hold all required permits.

7-1.3.1 Loading and firing shall be performed or supervised only by a person possessing an appropriate blaster's permit.

7-1.3.2 Trainees, helpers, and other persons who do not hold the required permits shall work only under the supervision of persons holding such permits.

7-1.4 No explosive materials shall be located or stored where they have the potential to be exposed to flame, excessive heat, sparks, or impact.

7-1.4.1 No firearms shall be discharged into or in the vicinity of a vehicle containing explosive materials or into or in the vicinity of a location where explosive materials are being handled, used, or stored.

7-1.4.2 No smoking shall be permitted within 50 ft (15.25 m) of any location where explosives are being handled or used.

7-1.4.3 No person within 50 ft (15.25 m) of any location where explosives are being handled or used shall carry any matches, open light, or other fire or flame.

Exception: This requirement shall not apply to suitable devices for lighting safety fuses.

7-1.5 No person under the influence of intoxicating beverages, narcotics, or other dangerous drugs shall be permitted to handle explosive materials.

7-1.6 No attempt shall be made to fight a fire that cannot be contained or controlled before it reaches explosive materials. In such cases, all personnel shall be evacuated immediately to a safe location, and the area shall be guarded from entry by spectators or intruders.

7-1.7 Unauthorized or unnecessary personnel shall not be present where explosive materials are being handled, used, or stored.

7-1.8 Explosive materials shall be kept in closed containers or packages while being transported between the storage magazine and the blasting site.

Exception: Partial reels of detonating cord shall not be required to be kept in closed containers, unless transported over public highways.

7-1.9 Containers of explosive materials shall not be opened in any magazine or within 50 ft (15.25 m) of any magazine.

Exception: This requirement shall not apply to explosive materials in fiberboard containers.

7-1.10 Nonsparking tools shall be used for opening any package or container of explosive materials.

Exception: Metal slitters shall be permitted to be used for opening fiberboard containers.

7-1.11 No blasting operation shall be performed in a manner contrary to the instructions of the manufacturer of the explosive materials being used.

7-1.12 Where blasting is done in a congested area or in close proximity to a structure, railway, or highway, or any other installation that could be affected, special precautions shall be taken to prevent damage and to minimize earth vibrations and air blast effects. Blasting mats or other protective devices shall be used to prevent fragments from being thrown.

7-1.13 Persons authorized to prepare explosive charges or to conduct blasting operations shall use every reasonable precaution including, but not limited to, warning signals, flags, barricades, mats, or other equally effective means to ensure the safety of the general public and workers.

7-1.14 Surface blasting operations shall be conducted during daylight hours only.

Exception: This requirement shall not apply where approved by the authority having jurisdiction.

7-1.15 Where blasting is conducted in the vicinity of utility lines or rights-of-way, the blaster shall notify the appropriate representatives of the utilities at least 24 hours in advance of blasting, specifying the location and the intended time of such blasting. Verbal notice shall be confirmed with written notice.

Exception: In an emergency situation, this time limit shall be permitted to be waived by the authority having jurisdiction.

7-1.16 Precautions shall be taken to prevent accidental discharge of electric detonators from currents induced by radar and radio transmitters, lightning, adjacent power lines, dust and snow storms, or other sources of extraneous electricity. These precautions shall include:

(a) The posting of signs warning against the use of mobile radio transmitters on all roads within 350 ft (107 m) of blasting operations.

(b) * Observance of the latest recommendations with regard to blasting in the vicinity of radio transmitters or power lines.

(c) The discontinuance of surface use, underground use, and all handling of explosive materials during the approach of and for the duration of an electrical storm. All personnel shall move to a safe location.

(d) Consideration to the fact that lightning has been known to follow steel, piping, and conductive ore into underground mines.

7-1.17 Precautions shall be taken to prevent accidental initiation of nonelectric detonators from stray currents induced by lightning or static electricity.

7-2 Preblast Operations.

7-2.1 During the time that holes are being loaded or are loaded with explosive materials, blasting agents, or detonators, the blast site shall be off limits to all but those persons authorized to engage in the drilling and loading operations or who are otherwise authorized to enter the site. The blast site shall be guarded or barricaded and posted.

7-2.2 Drill holes shall be large enough to allow free insertion of cartridges of explosive materials. Drill holes shall not be colared in bootlegs or in holes that previously contained explosive materials. Holes shall not be drilled where there is a danger of intersecting another hole containing explosive material.

7-2.3 All drill holes shall be inspected and cleared of any obstruction before loading.

7-2.4 Pneumatic loading of blasting agents into blast holes primed with electric detonators or other static-sensitive initiation systems shall comply with the following requirements:

(a) A positive grounding device shall be used for the equipment to prevent the accumulation of static electricity.

(b) A semiconductive discharge hose shall be used.

(c) A qualified person shall evaluate all systems to ensure that they adequately dissipate static charges under field conditions.

7-2.5 Tamping shall be performed only with wooden rods or approved plastic poles having no exposed metal parts.

Exception: Nonsparking metal connectors shall be permitted to be used on jointed tamping poles.

7-2.5.1 Violent tamping shall be avoided.

7-2.5.2 The primer shall not be tamped at any time.

7-2.6 After the loading for a blast is completed and before firing, all excess explosive materials shall be removed from the area and returned to the proper storage facilities.

7-2.7 As soon as practicable after all blast holes are connected, prior to connecting to a source of initiation such as a blasting

machine, and continuing until the shot has been fired and subjected to post-blast examination, the blast area shall be guarded or barricaded and posted.

7-3 Initiating Blasts.

7-3.1 Cap and fuse shall not be used to initiate blasts in congested areas or on or adjacent to highways open to traffic.

7-3.2 Where a safety fuse is used, the burning rate shall be determined and in no case shall fuse lengths of less than 120 seconds be used. The detonator shall be attached securely to the fuse with a standard ring-type cap crimper.

7-3.3 Where electric detonators are used, stray current tests shall be made as frequently as necessary. Maximum stray current shall not exceed 0.05 amperes through a 1-ohm resistor, measured at the blast site. Nonelectric initiating systems shall be used unless corrective action is taken to reduce the stray current below the limits indicated in this paragraph.

7-3.4 Electric detonators of different brands shall not be used in the same firing circuit.

7-3.5 All electric blasting circuits and other initiating systems whose continuity can be tested (such as gas detonator initiating systems) shall be tested with a blasting galvanometer or other blast continuity test instrument, as appropriate, that has been designed and approved for the purpose. All electrically initiated blasts shall be made by using blasting machines suitable for the circuitry being fired.

7-3.6 No detonator shall be inserted in explosive materials that do not have a cap well without first making a hole in the cartridge with a proper size nonsparking tool or the appropriate pointed handle of an approved cap crimper.

7-3.6.1 Primers shall not be assembled closer than 50 ft (15.25 m) from any magazine. Primers shall be assembled only when and as necessary for immediate needs.

7-3.6.2 Adequate priming shall be used. If any uncertainty exists regarding the amount of priming necessary, the manufacturer shall be consulted.

7-3.6.3 Primers shall be assembled only at the time of use and as close to the blast site as conditions allow.

7-3.6.4 Where using nonelectric initiation systems:

(a) The selection of the initiation system and the design of the blast shall be under the supervision of the blaster in charge;

(b) The initiation system shall be used in accordance with the manufacturer's instructions;

(c) The blaster in charge shall conduct a visual check after blast hookup;

(d) The blast layout shall be tested for continuity as recommended by the manufacturer where using a system that can be tested for continuity; and

(e) A double trunk line or closed-loop hookup shall be used where judged to be necessary by the blaster in charge.

7-3.7 Only the person making the lead line connections or the blaster in charge shall fire the blast. All connections shall be made progressively from the borehole back to the initiation point. Blasting lead lines shall remain shunted (shorted) and shall not be connected to the blasting machine or other source of current until the blast is to be fired.

7-3.8 No blast shall be fired until the blaster in charge has made certain that all surplus explosive materials are in a safe place, all persons and equipment are at a safe distance or under sufficient cover, and an adequate warning signal has been given.

7-4 Procedures after Blasting.

7-4.1 No person shall return to the blast area until permitted to do so by the blaster.

7-4.2 The blaster shall allow sufficient time for smoke and fumes to dissipate and for dust to settle before returning to the blast site.

7-4.3 The blaster shall inspect the entire blast site for misfires before allowing other personnel to return to the blast area.

7-5 Misfires.

7-5.1 Where a misfire is found, the blaster shall provide the proper safeguards for excluding all personnel from the blast area. Misfires shall be reported to the supervisor immediately.

7-5.2 No additional work, other than that necessary to remove the hazard, shall be performed. Only those persons needed to do such work shall remain at the blast site.

7-5.3 No attempt shall be made to extract explosive materials from a misfired hole. A new primer shall be inserted, and the hole shall be reblasted.

Exception: Where reblasting presents a hazard, the explosive materials shall be permitted to be washed out with water, or, where the misfire is under water, blown out with air.

7-5.4 Where there are misfires using cap and fuse, all personnel shall stay clear of the blast site for at least 1 hour.

7-5.5 Where there are misfires using other nonelectric detonators (i.e., other than cap and fuse) or using electric detonators, all personnel shall stay clear of the blast site for at least 30 minutes.

7-5.6 Misfires shall be the responsibility of the person in charge of the blasting operation.

7-5.7 Where a misfire is suspected, all initiating circuits (electric or nonelectric) shall be traced carefully and a search made for unexploded charges.

7-5.8 No drilling, digging, or picking shall be permitted until all misfires have been detonated or until the authority having jurisdiction approves the resumption of work.

7-6 Disposal of Explosive Materials.

7-6.1 Empty containers and paper and fiber packing materials that previously contained explosive materials shall be disposed of or reused in an approved manner.

7-6.2 All personnel shall remain at a safe distance from the disposal area.

7-6.3 All explosive materials that are obviously deteriorated or damaged shall not be used and shall be destroyed in accordance with the requirements of 6-7.13.

7-6.4* In the event that it becomes necessary to destroy any explosives, either because of damage to containers, deterioration, or any other reason, all handling of explosives shall cease and the manufacturer shall be contacted for assistance immediately.

The manufacturer's advice shall be followed without deviation.

Chapter 8 Ground Vibration, Airblast, Flyrock

8-1 Ground Vibration.

8-1.1 At all blasting operations, the maximum ground vibration at any dwelling, public building, school, church, or commercial or institutional building adjacent to the blasting site shall not exceed the limitations specified in Table 8-1.1.

Exception: As otherwise authorized or restricted by the authority having jurisdiction.

Table 8-1.1 Peak Particle Velocity Limits

Distance from Blasting Site	Maximum Allowable Peak Particle Velocity ¹
0 ft to 300 ft (0 m to 91.4 m)	1.25 in./sec (31.75 mm/s)
301 ft to 5000 ft (91.5 m to 1524 m)	1.00 in./sec (25.4 mm/s)
5001 ft (1525 m) and over	0.75 in./sec (19 mm/s)

¹Peak particle velocity shall be measured in three (3) mutually perpendicular directions, and the maximum allowable limits shall apply to each of these measurements.

8-1.2 Frequency Versus Particle Velocity Graphs. In lieu of Table 8-1.1, a blasting operation shall have the option to use the graphs shown in either Figure 8-1.2(a) or (b) to limit peak particle velocity based upon the frequency of the blast vibration. If either graph in Figure 8-1.2(a) or (b) is used to limit vibration levels, the methods for monitoring vibration and calculating frequency shall be approved by the authority having jurisdiction.

8-1.3 Scaled Distance Equations. Unless a blasting operation uses a seismograph to monitor a blast to ensure compliance with Table 8-1.1 or Figure 8-1.2(a) or (b), or has been granted special permission by the authority having jurisdiction to utilize a modified scaled distance factor, the operation shall comply with the scaled distance equations shown in Table 8-1.3.

Table 8-1.3 Scaled Distance Equations

Distance from Blasting Site	Scaled Distance ¹ Equation
0 ft to 300 ft (0 m to 91.4 m)	$W \text{ (lb)} = (D \text{ (ft)}/50)^2$ $[W \text{ (kg)} = (D \text{ (m)}/22.6)^2]$
301 ft to 5000 ft (92 m to 1524 m)	$W \text{ (lb)} = (D \text{ (ft)}/55)^2$ $[W \text{ (kg)} = (D \text{ (m)}/24.9)^2]$
5001 ft (1525 m) and over	$W \text{ (lb)} = (D \text{ (ft)}/65)^2$ $[W \text{ (kg)} = (D \text{ (m)}/29.4)^2]$

W = The maximum weight of explosives in pounds (or kilograms) that can be detonated per delay interval of 8 milliseconds or longer.

D = The distance in feet (or meters) from the blast to the nearest dwelling, public building, school, church, or commercial or institutional building not owned, leased, or contracted by the blasting operation, or on property for which the owner has not provided a written waiver to the blasting operation.

¹To convert English units of scaled distances (ft/lb²) to metric units (m/kg²), divide by a factor of 2.21.

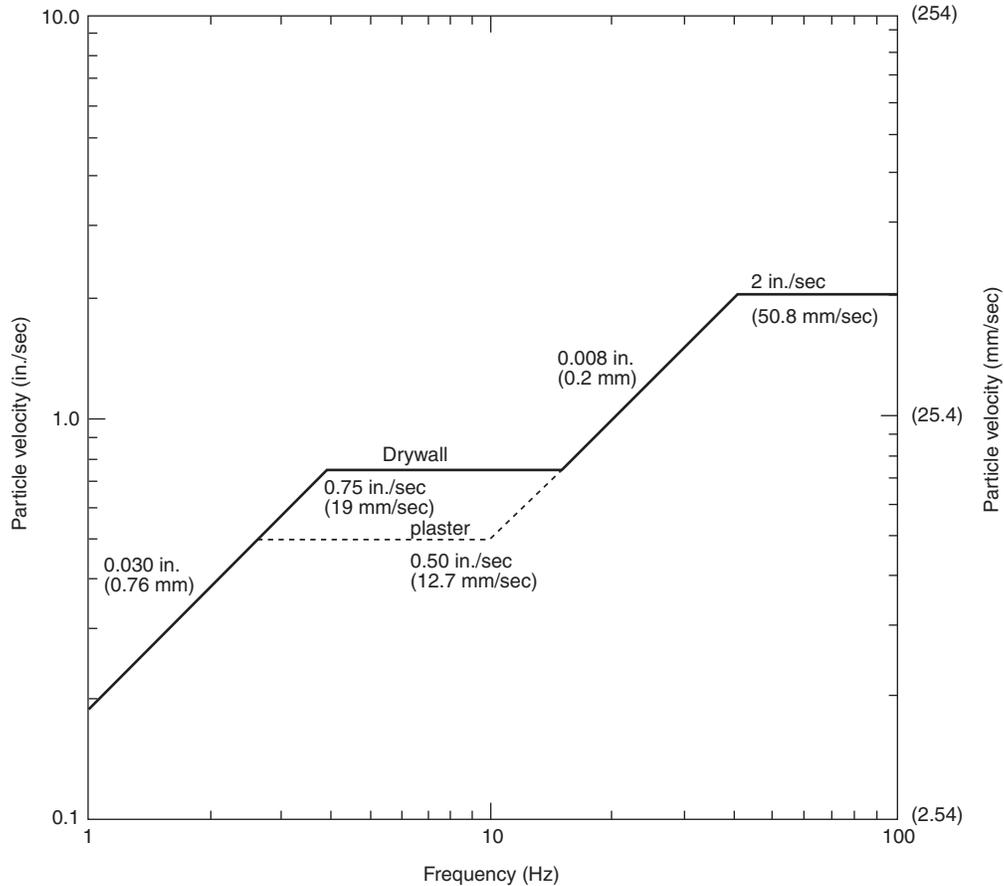


Figure 8-1.2(a) Frequency vs. particle velocity graph.

8-1.4 Where the blasting operation considers the scaled distance equations of Table 8-1.3 as being too restrictive, the operation shall have the right to petition the authority having jurisdiction to use a modified scaled distance equation. Such a petition shall demonstrate that the use of the modified scaled distance equation would not cause predicted ground vibration that exceeds the peak particle velocity limits specified in Table 8-1.1. Any petition for modification of the scaled distance equations of Table 8-1.3 shall be substantiated thoroughly by seismograph recordings to show that the limitations of Table 8-1.1 cannot be exceeded.

8-2 Airblast.

8-2.1 Airblast at the location of any dwelling, public building, school, church, or commercial or institutional building that is not owned, leased, or contracted by the blasting operation, or on property for which the owner has not provided a written waiver to the blasting operation, shall not exceed the maximum limits specified in Table 8-2.1.

Table 8-2.1 Airblast Limits

Lower Frequency of Measuring System [Hz (± 3 dcb)]	Measurement Level (dcb)
0.1 Hz or lower	flat response ¹ 134 peak
2 Hz or lower	flat response 133 peak
6 Hz or lower	flat response 129 peak
C-Weighted	slow response ¹ 105 peak

¹Only where approved by the authority having jurisdiction.

8-3 Flyrock.

8-3.1 Flyrock traveling in the air or along the ground shall not be cast from the blast site in an uncontrolled manner that could result in personal injury or property damage.

8-3.2 Flyrock shall not be propelled from the blast site onto property not contracted by the blasting operation or onto property for which the owner has not provided a written waiver to the blasting operation.

8-3.3 Where blasting operations do not conform to 8-3.1 and 8-3.2, the authority having jurisdiction shall require that special precautions be employed to reduce or control flyrock.

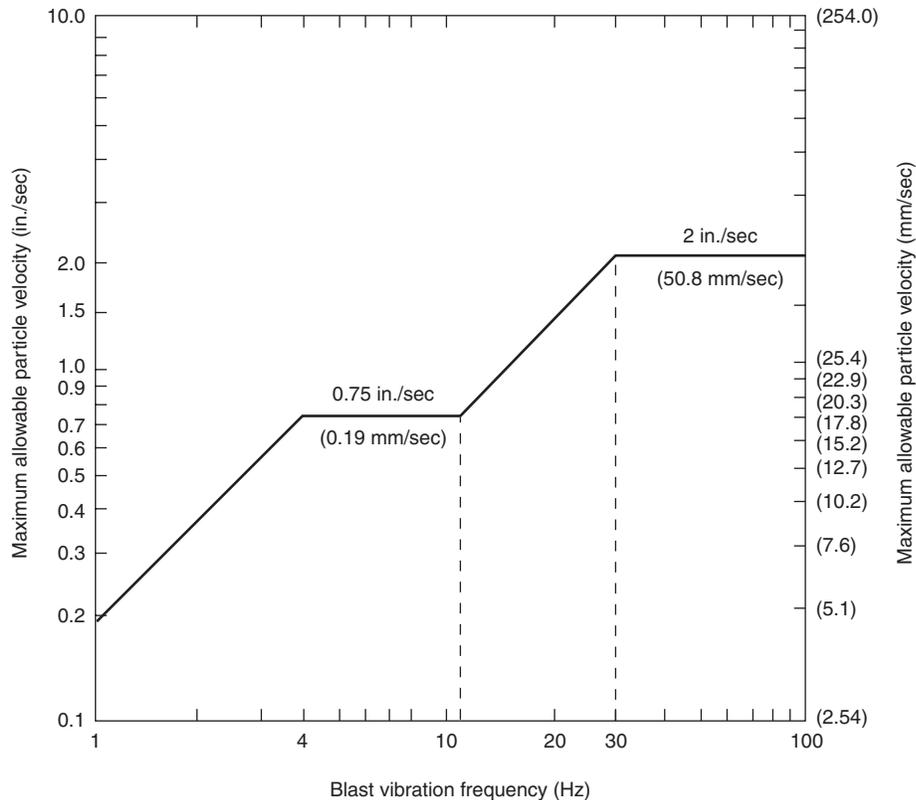


Figure 8-1.2(b) Frequency vs. particle velocity graph.

Chapter 9 Explosive Materials at Piers and Railway, Truck, and Air Terminals

9-1 Basic Requirements.

9-1.1 Explosive materials shall not be kept in a railway car unless the car, its contents, and methods of loading comply with the regulations of the U.S. Department of Transportation.

Exception: This requirement shall be permitted to be waived in an emergency with the approval of the authority having jurisdiction.

9-1.2 Explosive materials shall not be delivered to any carrier unless the explosives comply in all respects, including marking and packing, to the regulations of the U.S. Department of Transportation.

9-1.3 Every railway car containing explosive materials that has reached its destination, or has stopped in transit so it no longer is considered in interstate commerce, shall remain placarded in accordance with U.S. Department of Transportation regulations.

9-1.4 Any explosive materials at a railway facility, truck terminal, pier, wharf, harbor facility, or airport terminal, whether for delivery to a consignee or forwarded to some other destination, shall be kept in a safe place and isolated as far as practicable and in such a manner that they can be removed easily and quickly.

9-1.5 Truck terminals for explosives vehicles shall meet the requirements of NFPA 498, *Standard for Safe Havens and Interchange Lots for Vehicles Transporting Explosives*.

9-2 Notifications. A consignee, having been notified that a shipment of explosives is in the hands of any carrier, shall remove the explosives within 48 hours, excluding Saturdays, Sundays, and holidays, to a storage area meeting the requirements of this code.

9-3 Facilities for Trailer-on-Flatcar and Container-on-Flatcar. Rail shipments of explosives by trailer-on-flatcar (TOFC) or container-on-flatcar (COFC) shall meet the following requirements:

(a) Shipments by TOFC or COFC shall be unloaded at a nonagency station only where a consignee is present to receive them or where properly locked and secure storage facilities are available. If delivery cannot be made, the shipment shall be taken to the next or nearest agency station for delivery.

(b) * Carriers shall require the consignee to remove TOFC and COFC shipments from the carrier's property within 48 hours after notice of arrival, excluding Saturdays, Sundays, and holidays. If the trailers or containers are not so removed, the carrier shall dispose of the shipment immediately by means of storage, disposal, or, where necessary for safety, destruction under the supervision of a competent person.

(c) If storage is required to comply with 9-3(b), it shall be located in an interchange lot meeting the requirements of Chapters 2 and 3 of NFPA 498, *Standard for Safe Havens and Interchange Lots for Vehicles Transporting Explosives*, or in a location that provides equivalent safety to the public.

(d) Where local conditions make the acceptance, transportation, or delivery of explosive materials unusually hazardous, appropriate local restrictions shall be imposed by the carrier.

(e) All rail carriers shall report complete information on their restrictions regarding the acceptance, delivery, or transportation of explosive materials over any portion of their lines to the Bureau of Explosives of the Association of American Railroads for publication by the Bureau.

(f) Where shipping explosives, regularly scheduled days for receiving trailers and containers for shipment shall be assigned wherever it is practicable to do so.

(g) To enable the carrier to provide suitable flatcars for the shipment of Division 1.1 or Division 1.2 Explosives, the shipper shall give the carrier at least 24 hours notice of the shipments and their destinations.

Exception: Where a regularly scheduled day has been appointed for receipt of trailers and containers for shipment, this notice shall be permitted to be waived by the carrier. In such cases, the shipments shall be delivered on the assigned days in time to allow proper inspection, billing, and loading on that day.

(h) Carriers shall forward shipments promptly within 48 hours after acceptance at the originating point or after receipt at any yard transfer station or interchange point, excluding Saturdays, Sundays, and holidays.

Exception: Where biweekly or weekly service is provided, shipments shall be forwarded on the next train.

(i) The Bureau of Explosives of the Association of American Railroads shall be consulted by rail carriers to determine that the storage facility required by 9-3(b) is safe, adequate, and complies with Chapter 2 of NFPA 498, *Standard for Safe Havens and Interchange Lots for Vehicles Transporting Explosives*.

(j) Cars loaded with explosive materials shall be placed so that they are safe from all probable danger from fire. They shall not be placed under bridges or overhead highway crossings, or in or alongside passenger sheds or stations.

9-4 Designation of Facilities. The local authority having jurisdiction has the authority to designate the location for, and limit the quantity of, explosive materials that are loaded, unloaded, reloaded, or temporarily retained at any facility within the jurisdiction.

Chapter 10* Plosophoric Materials

10-1 Basic Requirements.

10-1.1 Mixed or combined plosophoric materials shall be transported, stored, and used in the same manner as explosive materials. (*See Chapters 2, 5, 6, and 7.*)

10-1.2 For transportation and storage, individual packages of each plosophoric component shall be packaged in separate shipping containers in compliance with the U.S. Department of Transportation, "Hazardous Materials Regulations," 49 CFR, Parts 100-199.

10-2 Storage.

10-2.1 Plosophoric components shall be stored in separate locked containers. If any component possesses a hazard classification, it shall be stored in a location and manner appropriate to its hazard class.

10-2.2 Plosophoric materials shall be permitted to be stored in the same magazine with explosive materials, provided their total weight is included in the weight of explosives permitted in the magazine in order to comply with the quantity-distance requirements of Table 6-4.1. Storage shall not introduce a hazard due to chemical incompatibility.

10-3 Use.

10-3.1 Where plosophoric materials are mixed or combined at the point of use, the procedures recommended by the manufacturer shall be followed strictly.

10-3.2 Since the mixing or combining of plosophoric components produces an explosive material, the number of packages combined at any one time shall be limited to the number needed for immediate use.

Exception: This requirement shall be permitted to be waived, provided the extra explosive material produced can be handled and stored as such.

10-4 Record Keeping and Reporting.

10-4.1 Dealers in plosophoric materials shall record all transactions on appropriate federal, state, and local forms, as required for transactions with explosive materials.

10-4.2 Thefts of plosophoric materials during transportation, storage, and use shall be reported to the authority having jurisdiction, as required for thefts of explosive materials.

10-4.3 Dealers in plosophoric materials shall require that all purchasers possess a license or permit to use explosive materials. The license or permit number shall be recorded with other records of the sale.

Chapter 11 Small Arms Ammunition and Primers, Smokeless Propellants, and Black Powder Propellants

11-1 Basic Requirements.

11-1.1 In addition to all other applicable requirements of this code, intrastate transportation of small arms ammunition, small arms primers, smokeless propellants, and black powder shall comply with the U.S. Department of Transportation, "Hazardous Materials Regulations," 49 CFR, Parts 100-199.

11-1.2 This chapter shall apply to the users and distribution channels of small arms ammunition, small arms primers, smokeless propellants, and black powder.

11-1.3 This chapter shall not apply to in-process storage and intraplant transportation during manufacture.

11-1.4 This chapter shall apply to the transportation and storage of small arms ammunition and components.

11-1.5 This chapter shall not apply to safety procedures in the use of small arms ammunition and components.

11-2 Small Arms Ammunition.

11-2.1 No restrictions shall be imposed on transportation of small arms ammunition other than those imposed by the U.S. Department of Transportation or by the presence of other hazardous materials.

11-2.2 No quantity limitations shall be imposed on the storage of small arms ammunition in warehouses, retail stores, and other occupancies other than those imposed by the limitations of the storage facility and by public safety regulations.

11-2.3 Small arms ammunition shall be separated from materials classified by the U.S. Department of Transportation as flammable liquids, flammable solids, and oxidizing materials by a distance of 15 ft (4.6 m) or by a fire partition having a fire resistance of at least 1 hour.

11-2.4 Small arms ammunition shall not be stored together with Division 1.1, Division 1.2, or Division 1.3 Explosives.

Exception: Where the storage facility is suitable for the storage of explosive materials.

11-2.5* Small arms ammunition that has been exposed to fire or has been damaged by exposure to water shall not be returned to commercial channels for reasons of consumer safety. The manufacturer shall be contacted to obtain recommendations for the disposal of damaged ammunition.

11-3 Smokeless Propellants.

11-3.1 Quantities of smokeless propellants not exceeding 25 lb (11.3 kg) in shipping containers approved by the U.S. Department of Transportation shall be permitted to be transported in a private vehicle.

11-3.2 Quantities of smokeless propellants exceeding 25 lb (11.3 kg), but not exceeding 50 lb (22.7 kg), transported in a private vehicle shall be transported in a portable magazine having wood walls of at least 1-in. (25.4-mm) nominal thickness.

11-3.3 Transportation of more than 50 lb (22.7 kg) of smokeless propellants in a private vehicle shall be prohibited.

11-3.4 Commercial shipments of smokeless propellants in quantities not exceeding 100 lb (45.4 kg) are classified for transportation purposes as flammable solids where packaged in accordance with the U.S. Department of Transportation, "Hazardous Materials Regulations," 49 CFR, Part 173.197, and shall be transported accordingly.

11-3.5 Commercial shipments of smokeless propellants exceeding 100 lb (45.4 kg) or not packaged in accordance with the regulations cited in 11-3.4 shall be transported in accordance with the U.S. Department of Transportation regulations for Class B propellant explosives.

11-3.6 Smokeless propellants shall be stored in shipping containers specified by U.S. Department of Transportation Hazardous Materials Regulations.

11-3.7 Smokeless propellants intended for personal use in quantities not exceeding 20 lb (9.1 kg) shall be permitted to be stored in original containers in residences. Quantities exceeding 20 lb (9.1 kg), but not exceeding 50 lb (22.7 kg), shall be permitted to be stored in residences where kept in a wooden box or cabinet having walls of at least 1 in. (25.4 mm) nominal thickness.

11-3.8 Not more than 20 lb (9.1 kg) of smokeless propellants, in containers of a 1-lb (0.45-kg) maximum capacity, shall be displayed in commercial establishments.

11-3.9 Commercial stocks of smokeless propellants shall be stored as follows:

(a) Quantities exceeding 20 lb (9.1 kg), but not exceeding 100 lb (45.4 kg), shall be stored in portable wooden boxes having walls of at least a 1-in. (25.4-mm) thickness.

(b) Quantities exceeding 100 lb (45.4 kg), but not exceeding 800 lb (363 kg), shall be stored in nonportable storage cabinets having walls of at least a 1-in. (25.4-mm) thickness. Not more than 400 lb (181 kg) shall be permitted to be stored in any one cabinet, and cabinets shall be separated by a distance of at least 25 ft (7.63 m) or by a fire partition having a fire resistance of at least 1 hour.

(c) Quantities exceeding 800 lb (363 kg), but not exceeding 5000 lb (2268 kg), shall be permitted to be stored in a building, provided the following requirements are met:

1. The warehouse or storage room shall not be accessible to unauthorized personnel.

2. Smokeless propellant shall be stored in nonportable storage cabinets having wood walls of at least 1 in. (25.4 mm) thickness and having shelves with no more than 3 ft (0.92 m) of separation between shelves.

3. No more than 400 lb (181 kg) shall be stored in any one cabinet.

4. Cabinets shall be located against the walls of the storage room or warehouse with at least 40 ft (12.2 m) between cabinets.

5. The separation between cabinets shall be permitted to be reduced to 20 ft (6.1 m) where barricades twice the height of the cabinets are attached to the wall, midway between each cabinet. The barricades shall extend at least 10 ft (3 m) outward, shall be firmly attached to the wall, and shall be constructed of $\frac{1}{4}$ -in. (6.4-mm) boiler plate, 2-in. (51-mm) thick wood, brick, or concrete block.

6. Smokeless propellant shall be separated from materials classified by the U.S. Department of Transportation as flammable liquids, flammable solids, and oxidizing materials by a distance of 25 ft (7.63 m) or by a fire partition having a fire resistance of at least 1 hour.

7. The building shall be protected by an automatic sprinkler system installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

(d) Smokeless propellants not stored in accordance with 11-3.9(a), (b), and (c) shall be stored in a Type 4 magazine constructed and located in accordance with Chapter 6.

11-4 Black Powder.

11-4.1 Black powder shall be transported in accordance with the U.S. Department of Transportation Regulations. (*See also Chapter 5.*)

11-4.2 Black powder shall be stored in shipping containers approved by the U.S. Department of Transportation.

11-4.3 Black powder intended for personal use in quantities not exceeding 20 lb (9.1 kg) shall be permitted to be stored in residences where kept in the original containers and stored in a wooden box or cabinet having walls of at least a 1-in. (25.4-mm) nominal thickness.

11-4.4 No more than 1 lb (0.45 kg) of black powder shall be displayed in commercial establishments.

11-4.5 Commercial stocks stored in buildings in quantities not exceeding 50 lb (22.7 kg) shall be stored in a Type 4 indoor magazine.

11-4.6 Commercial stocks in quantities exceeding 50 lb (22.7 kg) shall be stored in a Type 4 outdoor magazine.

11-4.7 Where smokeless propellants are stored in the same magazine with black powder, the total quantity shall not exceed that permitted for black powder.

11-4.8 Commercial shipments of black powder intended for personal use in small arms shall be permitted to be shipped in quantities not exceeding 50 lb (23 kg), subject to the requirements of the U.S. Department of Transportation, *Exemption Certificate E-8958*.

11-5 Small Arms Primers.

11-5.1 Small arms primers shall be transported or stored in containers approved by the U.S. Department of Transportation.

11-5.2 Transportation of small arms primers shall comply with U.S. Department of Transportation Regulations.

11-5.3 No more than 25,000 small arms primers shall be permitted to be transported in a private vehicle.

11-5.4 No more than 10,000 small arms primers shall be permitted to be stored in residences.

11-5.5 No more than 10,000 small arms primers shall be permitted to be displayed in commercial establishments.

11-5.6 Commercial stocks of small arms primers shall be stored as follows:

(a) Quantities not exceeding 750,000 shall be permitted to be stored in a building where not more than 100,000 are stored in any one pile and where piles are at least 15 ft (4.6 m) apart.

(b) Quantities exceeding 750,000 shall be permitted to be stored in a building, provided the following conditions are met:

1. The warehouse or storage room shall not be accessible to unauthorized personnel.

2. Primers shall be stored in cabinets. No more than 200,000 primers shall be stored in any one cabinet.

3. Shelves in cabinets shall have a vertical separation of at least 2 ft (0.6 m).

4. Cabinets shall be located against the walls of the warehouse or storage room with at least 40 ft (12.2 m) between cabinets.

5. The separation between cabinets shall be permitted to be reduced to 20 ft (6.1 m) where barricades twice the height of the cabinets are attached to the wall, midway between each cabinet. The barricades shall extend at least 10 ft (3 m) outward, shall be firmly attached to the wall, and shall be constructed of $\frac{1}{4}$ -in. (6.4-mm) boiler plate, 2-in. (51-mm) thick wood, brick, or concrete block.

6. Primers shall be separated from materials classified by the U.S. Department of Transportation as flammable liquids, flammable solids, and oxidizing materials by a distance of 25 ft (7.63 m) or by a fire partition having a fire resistance of at least 1 hour.

7. The building shall be protected by an automatic sprinkler system installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

(c) Small arms primers not stored in accordance with 11-5.6(a) or (b) shall be stored in a magazine meeting the requirements of Chapter 6.

Chapter 12 Referenced Publications

12-1 The following documents or portions thereof are referenced within this code and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

12-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 10, *Standard for Portable Fire Extinguishers*, 1994 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1996 edition.

NFPA 70, *National Electrical Code*, 1996 edition.

NFPA 430, *Code for the Storage of Liquid and Solid Oxidizers*, 1995 edition.

NFPA 498, *Standard for Safe Havens and Interchange Lots for Vehicles Transporting Explosives*, 1996 edition.

NFPA 1122, *Code for Model Rocketry*, 1994 edition.

NFPA 1123, *Code for Fireworks Display*, 1995 edition.

NFPA 1124, *Code for the Manufacture, Transportation, and Storage of Fireworks*, 1995 edition.

NFPA 1125, *Code for the Manufacture of Model Rocket and High Power Rocket Motors*, 1995 edition.

NFPA 1126, *Standard for the Use of Pyrotechnics before a Proximate Audience*, 1996 edition.

NFPA 1127, *Code for High Power Rocketry*, 1995 edition.

12-1.2 Other Publications.

12-1.2.1 IME Publications. Institute of Makers of Explosives, 1120 19th St. NW, Suite 310, Washington, DC 20036-3605.

“American Table of Distances for Storage of Explosives,” June 1991.

IME Safety Library Publication No. 20, *Safety Guide for the Prevention of Radio Frequency Radiation Hazards in the Use of Commercial Electric Detonators (Blasting Caps)*, December 1988.

12-1.2.2 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Title 18, *United States Code*, “Importation, Manufacture, Distribution and Storage of Explosive Materials,” in Chapter 40.

Title 18, *United States Code*, “Organized Crime Control Act of 1970,” in Chapter 40.

Title 18, *United States Code*, Chapter 44, “Gun Control Act of 1968.”

Title 27, *Code of Federal Regulations*, “Table of Distances for Low Explosives,” U.S. Bureau of Alcohol, Tobacco, and Firearms, Part 55.

Title 49, *Code of Federal Regulations*, “Federal Motor Carrier Safety Regulations,” U.S. Department of Transportation, Part 397.

Title 49, *Code of Federal Regulations*, “Hazardous Materials Regulations,” U.S. Department of Transportation, Parts 100-199.

U.S. Department of Transportation, *Exemption Certificate E-8958*.

Appendix A Explanatory Material

This Appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

A-1-4 Blasting Agent. Such materials or mixtures have been found to be so insensitive that there is little probability of accidental initiation of explosion or of transition from deflagration to detonation. Blasting agents are 1.5D materials, and tests required to classify these materials are specified in the U.S. Department of Transportation, "Hazardous Materials Regulations," Title 49, *Code of Federal Regulations*, Parts 173.56, 173.57, and 173.58.

A-1-4 Blast Site. The word "barrier" means an object or objects that separates, keeps apart, or demarcates in a conspicuous manner by means of cones, a warning sign, or tape.

A-1-4 Bullet-Resistant Construction. Tests to determine bullet-resistance are to be conducted on test panels or empty magazines. The panels or magazines are to resist penetration of 5 out of 5 shots placed independently of each other in an area at least 3 ft × 3 ft (0.9 m × 0.9 m). If hardwood or softwood is used, its water content is not to exceed 15 percent.

Where a magazine roof or ceiling is required to be bullet-resistant, it shall be constructed of materials comparable to the sidewalls or of other materials that can withstand the penetration of bullets fired at an angle of 45 degrees from perpendicular.

A-1-4 Cap-Sensitive Explosive Material. A No. 8 blasting cap contains 0.40 to 0.45 grams of PETN (pentaerythritol tetranitrate) base charge pressed into an aluminum shell having a bottom thickness not greater than 0.03 in. (0.8 mm) to a specific gravity of not less than 1.4 g/cc and primed with standard weights of primer, in accordance with the manufacturer's specifications.

A-1-4 Explosive. A list of explosives determined to be within the scope of Title 18, *United States Code*, Chapter 40, is published at least annually by the Bureau of Alcohol, Tobacco, and Firearms, U.S. Department of the Treasury.

The classification of explosives described in the "Hazardous Materials Regulations" of the U.S. Department of Transportation is provided in Appendix E. These regulations were revised in 1991.

A-1-4 Flash Point. See also NFPA 30, *Flammable and Combustible Liquids Code*.

A-1-4 Oxidizing Material. See NFPA 430, *Code for the Storage of Liquid and Solid Oxidizers*.

A-1-4 Special Industrial Explosive Material. The high explosives used include dynamite, TNT (trinitrotoluene), PETN (pentaerythritol tetranitrate), and RDX (cyclotrimethylene-trinitramine).

A-1-4 Water Gel. Water gels (or slurries) are manufactured with varying degrees of sensitivity to initiation and are classified as Division 1.1D or 1.5D Explosives, as appropriate. Water gels can be sensitized by a material that itself is classified as an explosive material, such as TNT or smokeless powder, or they might not contain any ingredient classified as an explosive.

Water gels in this latter category are sensitized using metals such as aluminum or using other fuels.

A-2-8.5 The toll-free telephone number for reporting incidents to the Bureau of Alcohol, Tobacco, and Firearms is 800-800-3855.

A-3-4.2 See NFPA 490, *Code for the Storage of Ammonium Nitrate*, for guidance in choosing compatible materials.

A-6-6.1(c) A bullet-resistant roof may be permitted to be constructed in accordance with any of the specifications in Appendix C. A bullet-resistant ceiling may be permitted to be constructed at the eave line, covering the entire area of the magazine, excluding the necessary ventilation space. Examples of bullet-resistant ceiling construction include:

(a) Any construction meeting the specifications in Appendix C.

(b) A sand tray having a sand depth of at least 4 in. (102 mm).

A-7-1.16(b) For further information, see IME Safety Library Publication No. 20, *Safety Guide for the Prevention of Radio Frequency Radiation Hazards in the Use of Commercial Electric Detonators (Blasting Caps)*.

A-7-6.4 The member companies of the Institute of Makers of Explosives have agreed to supply advice on or assistance in destroying commercial explosives to law enforcement agencies, fire departments, and inspection and regulatory officials, as well as to users of explosives. The manufacturer, if known, should be consulted for assistance. If the manufacturer is not known, a member company of the Institute of Makers of Explosives can provide advice or assistance.

A-9-3(b) The specific requirement is provided in the U.S. Department of Transportation, "Hazardous Materials Regulations," 49 CFR, Part 174.16.

A-10 Phosphoric materials, or phosphors, also are known as two-component or binary explosives.

A-11-2.5 A bulletin on this subject is available from the Sporting Arms and Ammunition Manufacturer's Institute, Inc., Flintlock Ridge Office Center, 11 Mile Hill Road, Newtown, CT 06470-2359.

Appendix B Recommended Separation Distances of Ammonium Nitrate and Blasting Agents from Explosives or Blasting Agents

This Appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

B-1 Derivation of Table.

B-1.1 The Table of Recommended Separation Distances of Ammonium Nitrate and Blasting Agents from Explosives or Blasting Agents is shown in Table 6-4.2.

B-1.2 A test program sponsored by the Chemical Manufacturers Association and the Institute of Makers of Explosives and conducted by the U.S. Bureau of Mines developed data on the relative sensitivity of ammonium nitrate (AN) and ammonium nitrate/fuel oil (ANFO) to sympathetic detonation.