



PDHonline Course G506 (2 PDH)

A Guide to the Safe Storage of Explosive Materials

Instructor: D. Allen Hughes, PE

2020

PDH Online | PDH Center

5272 Meadow Estates Drive
Fairfax, VA 22030-6658
Phone: 703-988-0088
www.PDHonline.com

An Approved Continuing Education Provider



A Guide to the Safe Storage of Explosive Materials



N.C. Department of Labor
Occupational Safety and Health Division
1101 Mail Service Center
Raleigh, NC 27699-1101

Cherie Berry
Commissioner of Labor

**N.C. Department of Labor
Occupational Safety and Health Program**

Cherie Berry
Commissioner of Labor
OSHA State Plan Designee

Allen McNeely
Deputy Commissioner for Safety and Health

Kevin Beauregard
Assistant Deputy Commissioner for Safety and Health

Bobby Davis
Reviewer

Acknowledgments

A Guide to the Safe Storage of Explosive Materials was prepared prepared by Harold D. Megredy and Douglas K. Wortham of the Mine and Quarry Bureau, N.C. Department of Labor. The guide includes OSHA standards for blasting (Subpart U) as amended by 13 NCAC 7F.0201(5) to include state-specific requirements. This guide was updated in 2009.

This guide is intended to be consistent with all existing OSHA standards; therefore, if an area is considered by the reader to be inconsistent with a standard, then the OSHA standard should be followed.

To obtain additional copies of this guide, or if you have questions about N.C. occupational safety and health standards or rules, please contact:

**N.C. Department of Labor
Education, Training and Technical Assistance Bureau
1101 Mail Service Center
Raleigh, NC 27699-1101**

Phone: (919) 807-2875 or 1-800-NC-LABOR (1-800-625-2267)

Additional sources of information are listed on the inside back cover of this guide.

The projected cost of the NCDOL OSH program for federal fiscal year 2008–2009 is \$17,042,662. Federal funding provides approximately 30 percent (\$4,090,400) of this total.



Contents

Foreword	iv
Storage	1
Regulations Governing the Storage of Explosive Materials	1
Classes of Explosive Materials	1
Types of Magazines	2
Storage of Classes of Explosive Materials	2
Storage Within Magazines, Types 1, 2, 3 and 4	2
Quantity and Storage	3
Construction of Magazines	3
Construction Specifications for Types of Magazines	3
Type 1 Magazine	3
Type 2 Magazine	5
Type 2 Indoor Magazine	5
Type 3 Magazine	6
Type 4 Magazine	6
Type 4 Indoor Magazine	7
Type 5 Magazine	8
Specifications for Bullet Resistant Construction	15
Exterior of Steel	15
Exterior of Any Type	15
Masonry Construction	15
Use of Magazines	16
Lighting	16
Repairs	16
Housekeeping	16
Smoking and Open Flames	16
Posting	16
Inspection	17
Location of Magazines	17
Notes	23
North Carolina Occupational Safety and Health Standards in Construction for	
Blasting and Use of Explosives	24
Glossary	37
References	38

Foreword

North Carolina employers and employees who store and handle explosives accept a great responsibility. They must guard against the theft or loss of materials that if mishandled could lead to tragedy for the American people. Such tragedies can be avoided by building proper storage magazines and by following good safety and security procedures.

This guide provides information on how to store different types and amounts of explosive materials safely. Several charts included in this guide can help the reader find information relating directly to specific situations.

In North Carolina, the N.C. Department of Labor enforces the federal Occupational Safety and Health Act through a state plan approved by the U.S. Department of Labor. NCDOL offers many educational programs to the public and produces publications to help inform people about their rights and responsibilities regarding occupational safety and health.

When reading this guide, please remember the mission of the N.C. Department of Labor is greater than just regulatory enforcement. An equally important goal is to help citizens find ways to create safe and healthy workplaces. Everyone profits when managers and employees work together for safety. This booklet, like the other educational materials produced by the N.C. Department of Labor, can help.

Cherie Berry
Commissioner of Labor

Storage

Proper storage prevents unauthorized access to explosive materials and reduces their deterioration. All explosive materials, including blasting agents, detonators, detonating cord, boosters, blasting caps, and electric and nonelectric detonators should be stored in magazines. The magazines should be properly designed and located to comply with all applicable federal, state and local laws, rules and regulations.

Regulations Governing the Storage of Explosive Materials

The storage of explosive materials is regulated by the N.C. Department of Labor, U.S. Department of Justice, U.S. Department of Labor and U.S. Department of the Treasury. Table 1 offers more details about the various government agencies that regulate the storage of explosive materials.

Table 1

Federal and State Control of Explosive Materials

Agency	Responsibility	Regulations	Subject of Regulations
N.C. Department of Labor Occupational Safety and Health Division	Health and safety of general industry and construction employees.	29 CFR 1910 and 29 CFR 1926	Use of explosives in general industry and in construction.
N.C. Department of Labor Mine and Quarry Bureau	Health and safety of surface and underground miners.	30 CFR 56, 30 CFR 57; and Sections .0525, .0526*	Use of explosives in surface and underground metal and nonmetal mines.
U.S. Department of Interior Office of Surface Mining Reclamation and Enforcement	Protects general public and the environment from the effects of coal mining.	30 CFR 715	The environmental effects of blasting such as ground vibration, air blast, flyrock, etc., and the safety of the general public in the surrounding area.
U.S. Department of Labor Mine Safety and Health Administration	Health and safety of surface and underground miners.	30 CFR 56 and 30 CFR 57	Use of explosives in surface and underground metal and nonmetal mines.
U.S. Department of Justice Bureau of Alcohol, Tobacco and Firearms	Issues licenses to manufacture, import, distribute and use explosive materials. Storage of explosive materials to prevent their illegal use.	27 CFR 555	Licensing, recordkeeping and storage.

*Health and Safety Standards for Metal and Nonmetal Mines, N.C. Gen. Stat. Chapter 74, Article 2A.

Classes of Explosive Materials

Explosive materials may be divided into three classes:

- *High explosives* are explosive materials that, when unconfined, can be caused to detonate by means of a blasting cap. An example is dynamite.
- *Low explosives* are explosive materials that, when confined, can be caused to deflagrate. Black powder, safety fuses, igniters, igniter cords and fuse lighters are examples.
- *Blasting agents* are substances classified by the U.S. Department of Transportation in 49 CFR 173.50 as blasting agents. These are substances that have a mass explosion hazard but are so insensitive that there is very little probability of initiation or of transition from burning to detonation under normal conditions of transport. Ammonium nitrate, fuel oil and particular water gels are examples.

Familiarity with the classes of explosive materials is essential to an understanding of the type of magazine in which they may be stored.

Types of Magazines

There are five types of magazines for the storage of explosive materials:

- *Type 1 magazines* are permanent magazines for the storage of high explosives. Other classes of explosive materials may also be stored in Type 1 magazines.
- *Type 2 magazines* are mobile or portable indoor and outdoor magazines for the storage of high explosives.
- *Type 3 magazines* are portable outdoor magazines for the temporary storage of high explosives while attended (a day box, for example).
- *Type 4 magazines* are for the storage of low explosives. Blasting agents, Class C detonators, safety fuses, squibs, igniters and igniter cords may also be stored in Type 4 magazines.
- *Type 5 magazines* are for the storage of blasting agents.

Storage of Classes of Explosive Materials

In Table 2, the classes of explosive materials are paired with types of magazines.

Table 2

Storage of Classes of Explosive Materials by Magazine Type¹

Class of Explosive Materials	Magazine Type				
	1	2	3	4	5
High Explosives (dynamite; cap sensitive water gels; slurries; emulsions; cast boosters)	•	•	•		
Low Explosives (black powder)	•	•	•	•	
Class A Detonators	•	•	•		
Detonating Cords	•	•	•		
Class C Detonators*	•	•	•	•	
Safety Fuses, Electric Squibs, Igniters and Igniter Cords**	•	•	•	•	
Blasting Agents	•	•	•	•	•

Note: Detonators must not be stored in the same magazine with other explosives.

*Includes electric detonators with leg wires 4 feet long or longer or detonators with empty plastic tubing 12 feet long or longer that contain not more than 1 gram explosives (excluding ignition and delay charges).

**Detonators are not to be stored in the same magazine with other explosive materials, except that Class C detonators and those described above may be stored with safety fuses, electric squibs, igniters or igniter cords in Type 1, 2, 3 or 4 magazines.

Storage Within Magazines, Types 1, 2, 3 and 4

When explosive materials are stored within Type 1, 2, 3 and 4 magazines, the following rules should be observed:

- Explosive materials must not be placed directly against interior walls and must be placed so as not to interfere with ventilation.
- Containers of explosive materials must be stored so that marks are visible.
- Except with respect to fiberboard or other nonmetal containers, containers of explosive materials must not be unpacked or repacked inside a magazine or within 50 feet of a magazine.
- Tools used to open or close containers of explosive materials must be of a nonsparking material, except that metal slitters may be used for opening fiberboard containers. A wood wedge and a fiber, rubber or wooden mallet must be

used for opening or closing wood containers of explosive materials. Metal tools other than nonsparking transfer conveyors must not be stored in any magazine containing high explosives.

Quantity and Storage

Detonators must not be stored in the same magazine with other explosive materials, except under the following circumstances:

- In a Type 4 magazine, detonators that will not mass detonate may be stored with electric squibs, safety fuses, igniters and igniter cords.
- In a Type 1 or 2 magazine, detonators may be stored with delay devices and stored with electric squibs, safety fuses, igniters and igniter cords.

Unless approved, explosive materials in excess of 300,000 pounds or detonators in excess of 20 million must not be stored in one magazine.

Construction of Magazines

In Table 3, the types of magazines are paired with applicable construction features.

Table 3

Construction Features of Types of Magazines

Construction Features	Magazine Type				
	1	2	3	4	5
Permanent	•			•	•
Portable		•	•	•	•
Bullet Resistant	•	•			
Fire Resistant	•	•	•	•*	•*
Theft Resistant	•	•	•	•	•**
Weather Resistant	•	•	•	•	•
Ventilated	•	•	•	•*	•*

*Over-the-road trucks or semitrailers used for temporary storage as Type 4 or 5 magazines need not be fire resistant or ventilated.

**Each door of a mobile Type 5 magazine should be equipped with at least one five-tumbler padlock having a 3/8-inch case-hardened shackle. The lock need not be hooded.

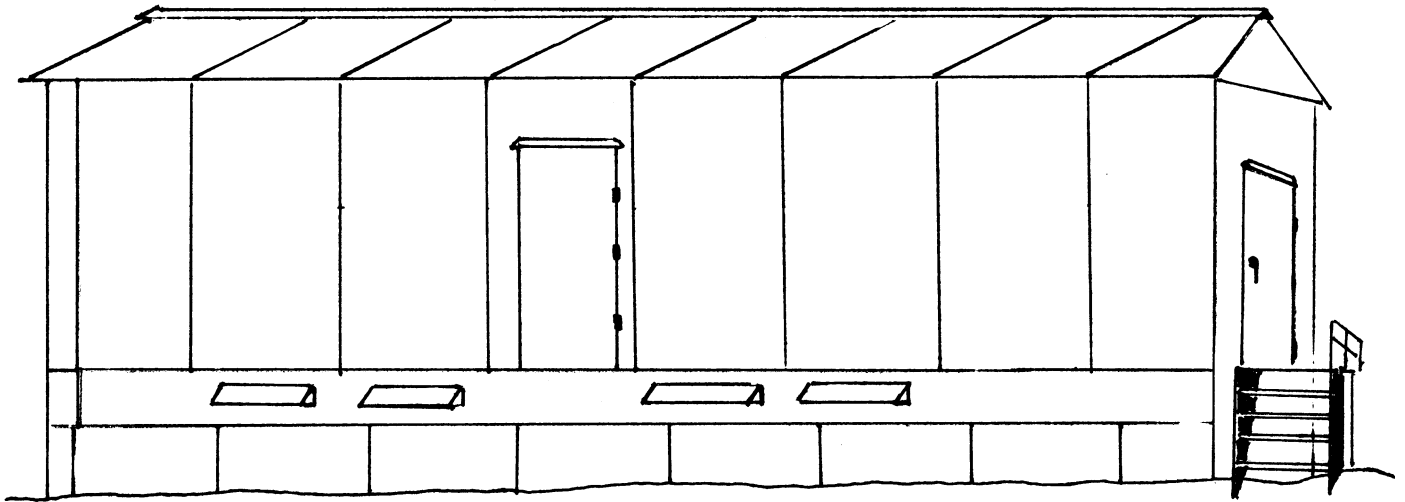
Construction Specifications for Types of Magazines

This section discusses construction specifications for various aspects (walls, floors, roofs, doors and locks, ventilation, bonding and grounding) of the types of magazines. The discussion frequently refers to plates or drawings that appear at the end of this section.

Type 1 Magazine

A Type 1 magazine is a permanent structure such as a building, igloo, tunnel or dugout. Figure 1 depicts a Type 1 magazine.

Figure 1
Type 1 Magazine



Type 1 magazine, constructed of 1/4-inch steel and 3-inch hardwood

The Type 1 magazine must be bullet resistant, fire resistant, weather resistant, theft resistant and ventilated. It should conform to the following specifications:²

Walls. Walls must be constructed of a combination of steel, masonry or other materials that are fire resistant and structurally sound (see Plates 1, 2 and 6). Any wood on the exterior of the magazine must be covered with a fire-resistant material. Voids in standard concrete blocks must be filled with well-tamped dry sand or well-tamped sand and cement mixture. Lattice lining must be installed to aid in ventilation (see Plates 1 and 2).

Floor. The floor must be constructed of wood or other suitable materials. Plates 1, 2 and 3 show a masonry magazine with a foundation, ventilation and wood flooring.

Roof or Ceiling. The roof or ceiling may be constructed of any type of structurally sound material that is or has been made fire resistant on its exterior. When the natural terrain around the magazine makes it possible to shoot a bullet through the ceiling or roof that could hit the explosive material, the roof or ceiling must be of bullet-resistant construction. A bullet-resistant roof can be constructed according to any of the specifications for wan sections shown in Plate 6.

Other verified bulletproof construction for ceilings includes that with 20 gauge steel with 4 inches of hardwood or 18 gauge aluminum with 7 inches of hardwood.

Doors and Locks. The doors and locks must be constructed according to any of the wall sections shown in Plate 6. Commonly used door construction and details are shown in Plates 7 and 8.

Doors must be tightly fitted. Hinges, hasps and all locking hardware must be rigidly secured and fastened by welding or by through bolts that cannot be removed when the door is locked. Methods of locking are:

- Two mortise locks.
- Two padlocks fastened in separate hasps and staples. Padlocks must be steel, have at least five tumblers, and be at least 3/8-inch diameter case-hardened shackle. All padlocks must be protected by steel hoods made from 1/4-inch minimum thickness steel and installed so as to discourage the insertion of bolt cutters, saws, files or levering devices.
- A combination of a mortise lock and a hooded padlock.
- A mortise lock that requires two keys to open.
- A three-point lock that secures the door to the frame at more than one point.

Ventilation. The generally accepted minimum ventilation area is 0.2 square inches per cubic foot of magazine space. Recommended ventilation is as follows:

- Wall and foundation—4×8 inches opening on 6-foot centers.

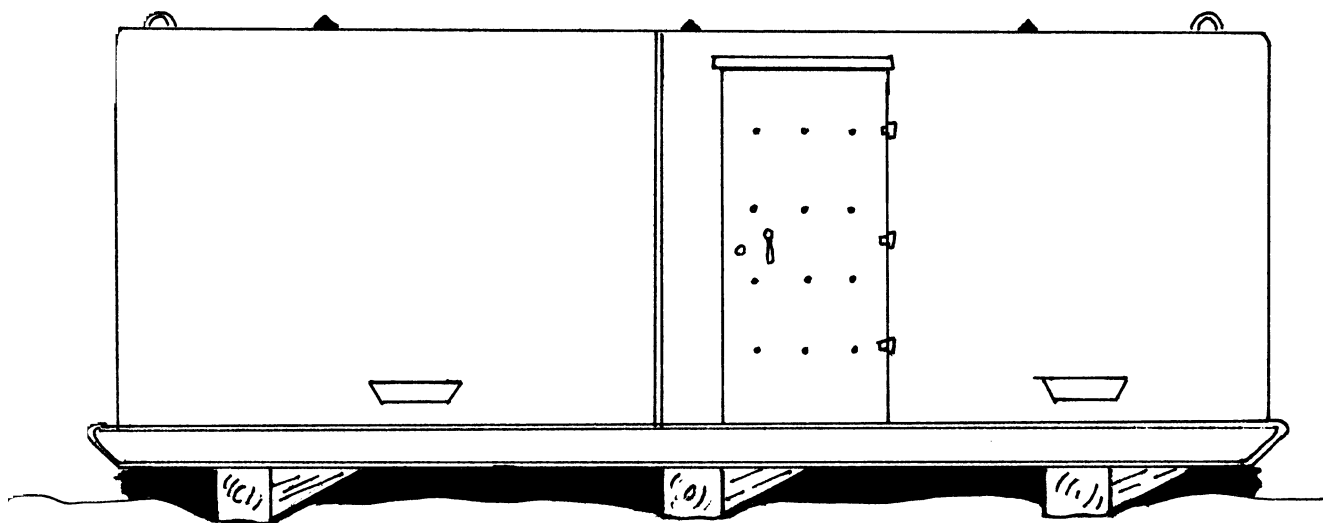
- Roof—(Globe type ventilation)—one 12-inch diameter per each 12 feet of magazine length or one 10-inch diameter per 10 feet of magazine length.
- Ventilating openings must be screened as shown in Plate 4 to prevent entrance of sparks and rodents.
- Ventilation openings must be offset or shielded for bullet resistant purposes.
- For security, ventilating openings should not be larger than 6×12 inches or 12 inches in diameter.

Bonding and Grounding. Experience over the years indicates that electrical bonding and grounding of field commercial explosives magazines is not needed. The Bureau of Alcohol, Tobacco and Firearms; the National Fire Protection Association (NFPA); and the Institute of Makers of Explosives (IME) do not require the bonding or grounding of magazines. However, one Mine Safety and Health Administration standard requires that magazines made of metal be electrically bonded and grounded.

Type 2 Magazine

A Type 2 magazine,³ depicted in Figure 2, is a portable or mobile structure such as a skid magazine, tractor or semi-trailer.

Figure 2
Type 2 Magazine



Type 2 magazine, constructed of 1/4-inch steel and 3-inch hardwood

Any of the details for the requirements shown for a Type 1 magazine are acceptable for the Type 2 outdoor magazine. A magazine of less than 1 cubic yard in size must be fastened to a fixed object to prevent theft of the entire magazine.

Hinges, hasps, locks and locking hardware must conform to provisions for Type 1 magazines. Vehicular magazines must be immobilized by removing the wheels, by locking with a king pin locking device or by other approved means.

Type 2 Indoor Magazine

Type 2 indoor magazines must be fire resistant and theft resistant. They need not be bullet resistant. No indoor magazine is to be located in a residence or dwelling. Indoor storage of high explosives must not exceed 50 pounds. Detonators must be stored separately and must not exceed 5,000 in number.

Wood indoor magazines must have the sides, bottom and doors constructed with at least 2 inches of hardwood and be covered with sheetrmetal not less than 26 gauge (.0179 inches). Metal doors must have sides, bottoms, and doors constructed of not less than number 12 gauge (.1046 inches) metal and be lined with a nonsparking material. Hinges and hasps must be attached to doors by welding, riveting or bolting. Each door must be equipped with two mortise locks or two padlocks. Padlocks must have at least five tumblers and a case-hardened 3/8-inch shackle.

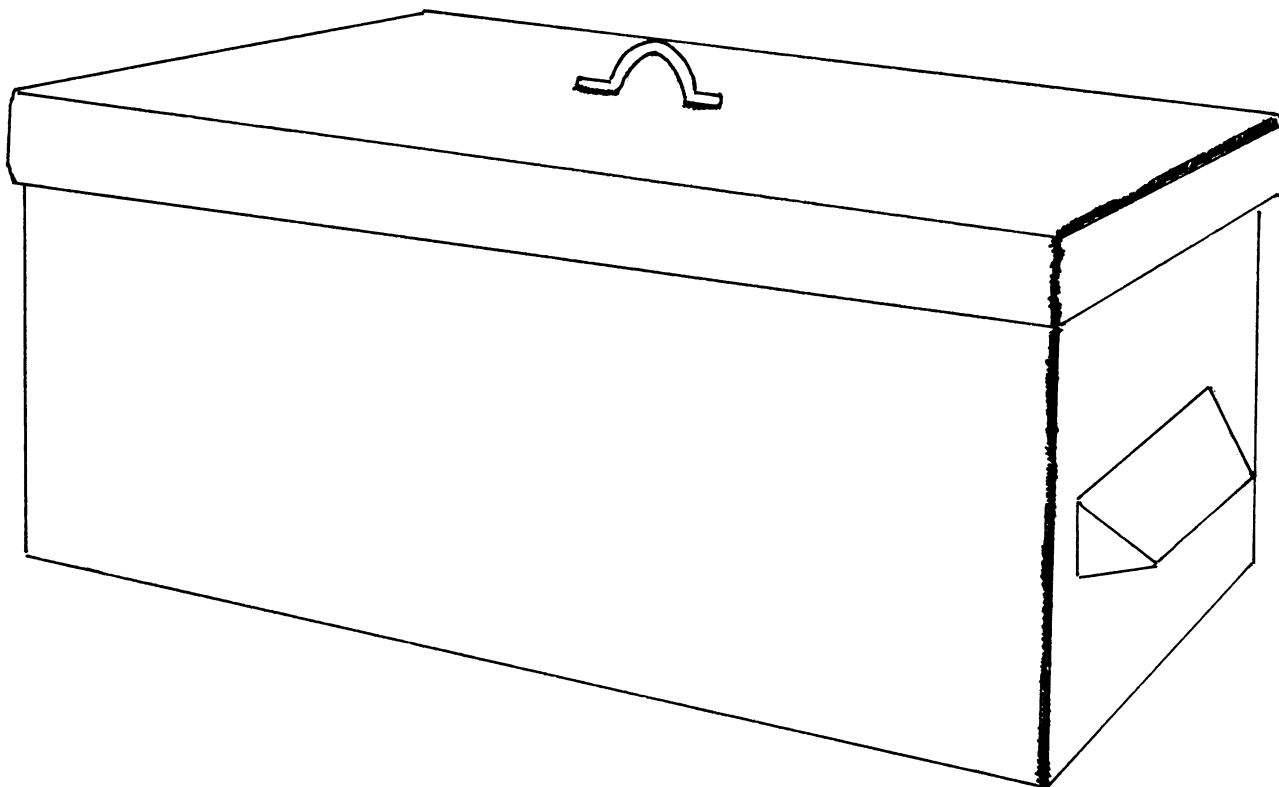
Type 2 indoor magazines for detonators in quantities of 100 or less must be constructed of not less than number 12 gauge (0.1046 inches) metal and lined with a nonsparking material. One padlock is required, having at least five tumblers and a 3/8-inch case-hardened shackle. No steel hood is required for protection of the padlock.

Type 3 Magazine

A Type 3 magazine⁴ is a “day box” or other portable magazine. It must be theft resistant, fire resistant, and weather resistant, but not necessarily bullet resistant. Figure 3 depicts a Type 3 magazine.

Figure 3

Type 3 Magazine



Type 3 magazine, constructed of 1/4-inch steel and 3-inch hardwood

The lock for the Type 3 magazine must be at least a five tumbler steel padlock with at least a 3/8-inch case-hardened shackle. The lock need not be protected by a hood. Explosive materials must not be left unattended in a Type 3 magazine. They must be removed to a Type 1 or Type 2 magazine.

Type 4 Magazine

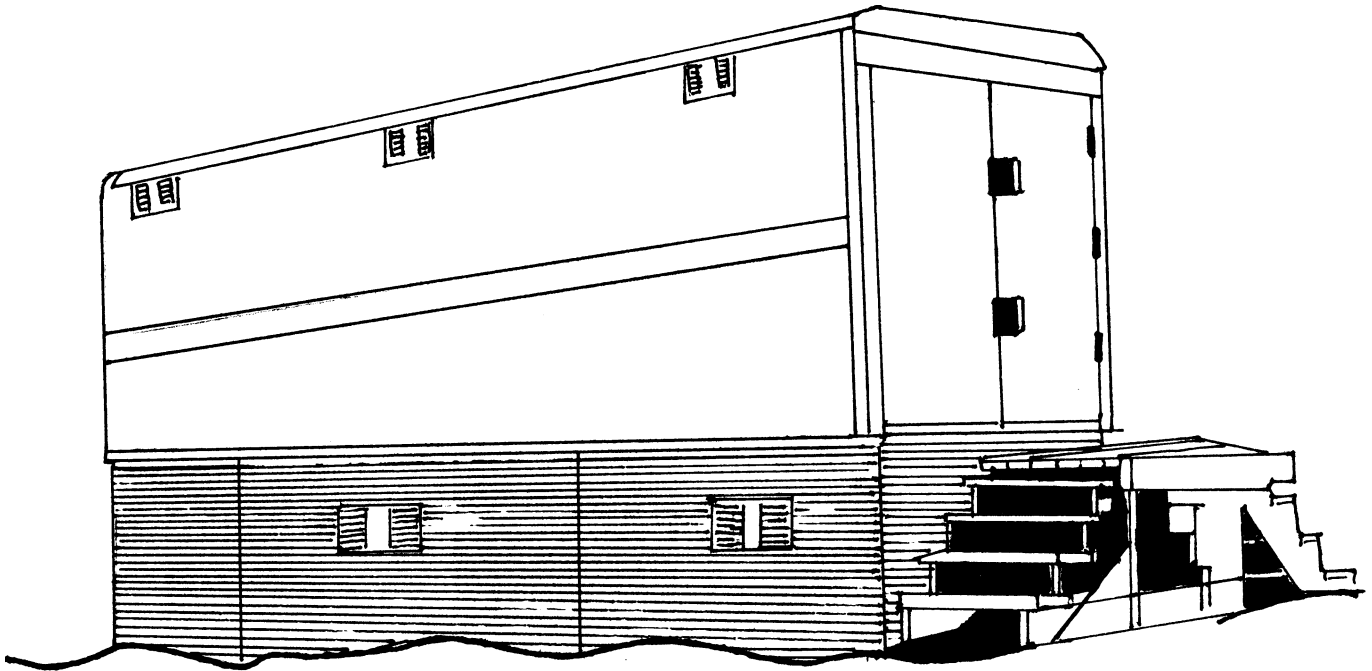
A Type 4 magazine⁵ is a permanent, portable or mobile structure such as a building. It need not be bullet resistant. Figure 4 depicts Type 4 magazines.

Construction must be of wood covered with metal, masonry, fabricated metal or a combination of these materials. The doors must be of metal or wood covered with metal.

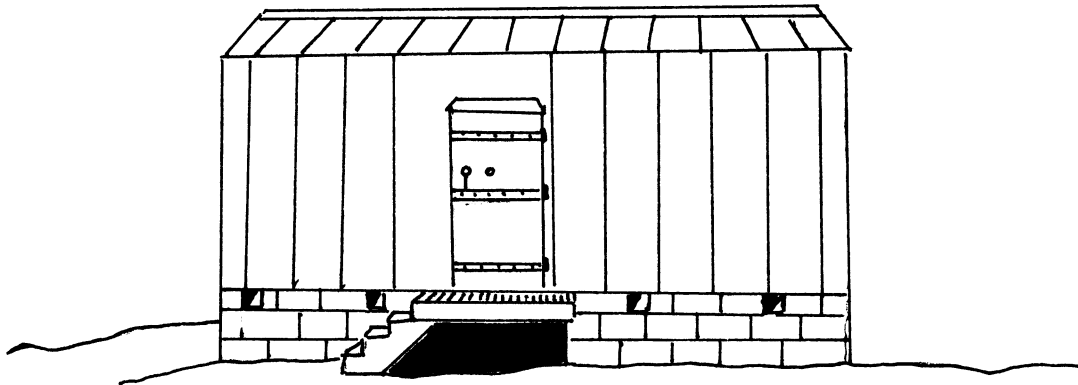
Door locks must be two mortise locks or two padlocks. Padlocks must have at least five tumblers and 3/8-inch case-hardened shackles. Padlocks must be protected by steel hoods of not less than 1/4-inch metal.

When unattended, vehicular magazines must be immobilized, as described for Type 2 magazines.

Figure 4
Type 4 Magazines



Type 4 portable magazine; Fire resistant exterior, nonsparking interior



Type 4 permanent magazine; Fire resistant exterior, nonsparking interior

Type 4 Indoor Magazine

Type 4 indoor magazines must be fire resistant and theft resistant. They need not be weather resistant if the building in which they are stored provides protection from the weather.

No indoor magazine may be located within a residence or dwelling. Storage for low explosives must not exceed 50 pounds. Detonators must be stored in a separate magazine, and the total number may not exceed 5,000.

Type 4 indoor magazines must be constructed of masonry, metal covered wood, fabricated metal or a combination of these materials. The walls and floors must be constructed of or covered with a nonsparking material. The door must be metal or solid wood covered with metal. Hinges and hasps must be attached to doors by welding, riveting or bolting (with nuts on the inside of the door).

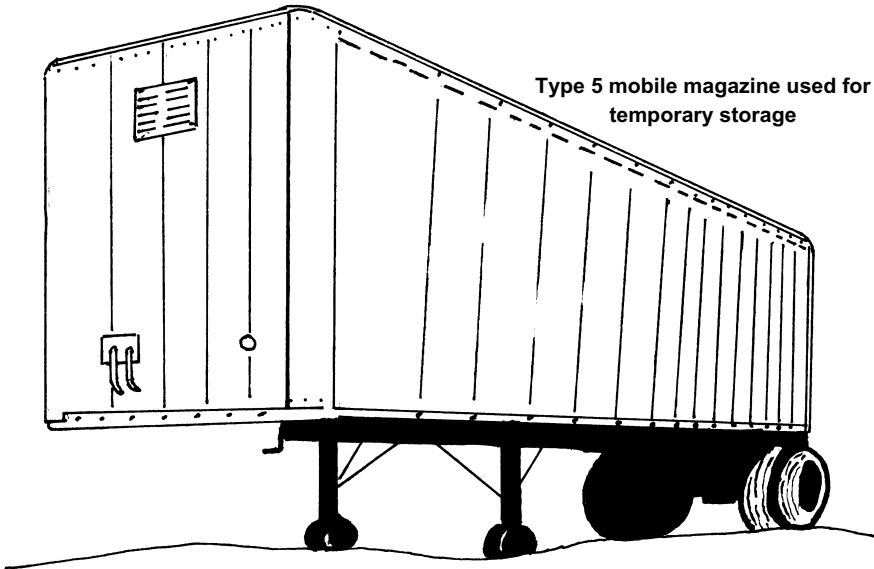
Each door must be equipped with two mortise locks or two padlocks fastened in separate hasps and staples. Padlocks must have at least five tumblers and $\frac{3}{8}$ -inch case-hardened shackles. Padlocks must be protected by $\frac{1}{4}$ -inch metal steel hoods.

Type 5 Magazine

A Type 5 magazine⁶ is 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. It need not be bullet resistant. Figure 5 depicts Type 5 magazines.

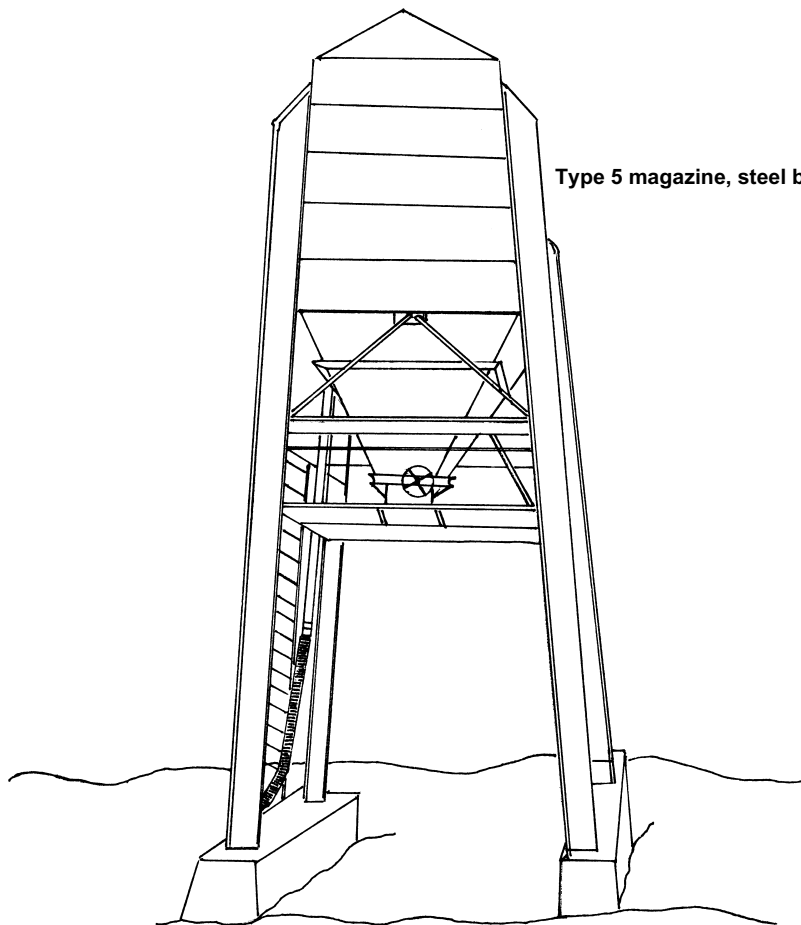
Figure 5

Type 5 Magazines

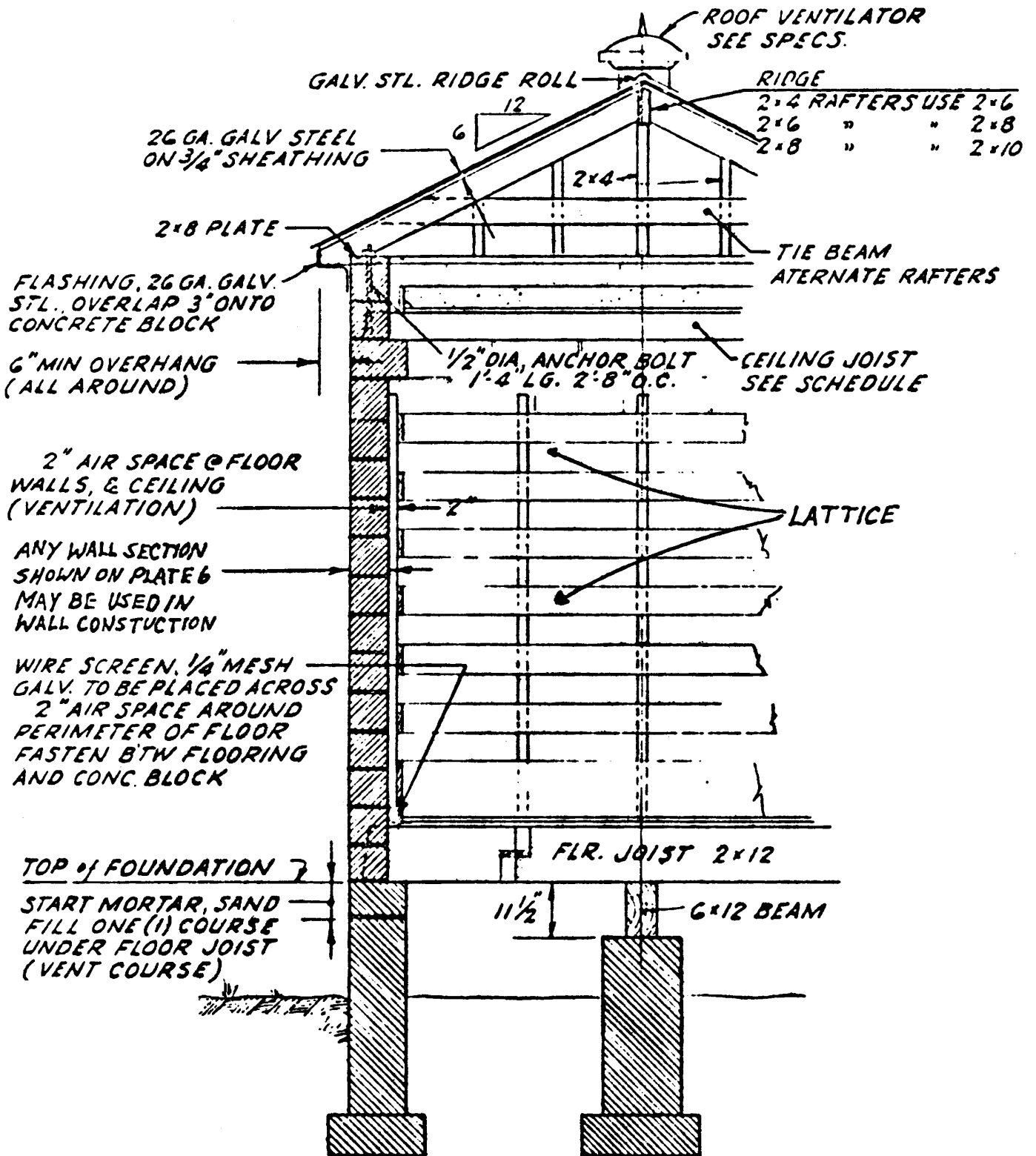


Construction of a Type 5 magazine must be of masonry, wood covered with metal, fabricated metal or a combination of these materials. The doors must be constructed of solid wood or metal.

Permanent Type 5 magazines must be constructed according to Type I magazine detail with respect to the foundation, floors, ventilation and locking devices. When unattended, vehicular magazines must be immobilized, as described for Type 2 vehicular magazines.



Half Cross Section⁷



Half Longitudinal Section⁸

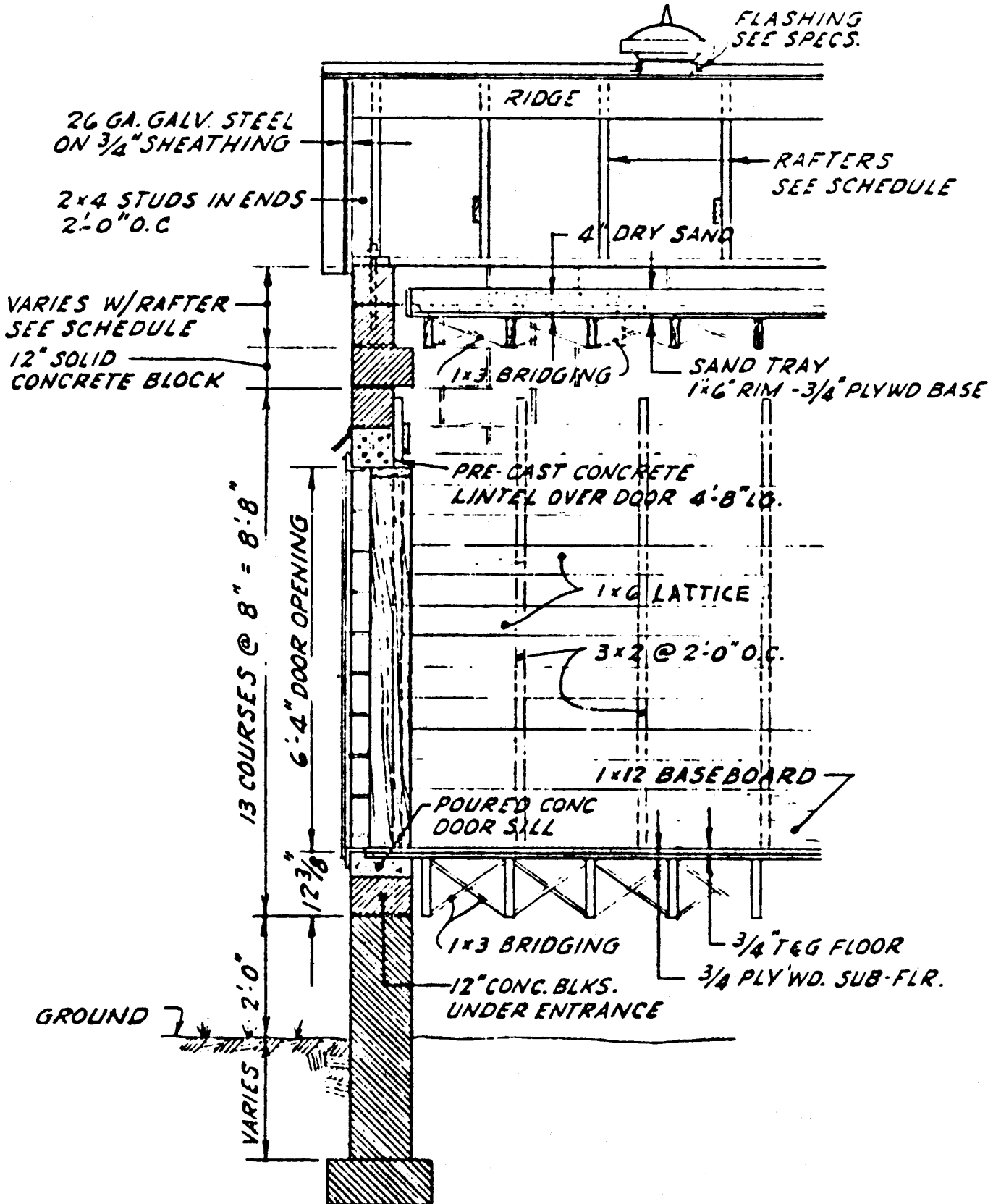
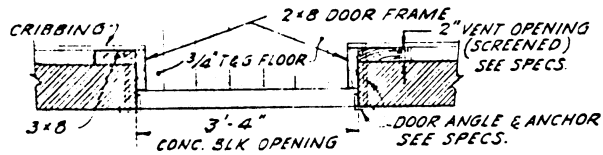
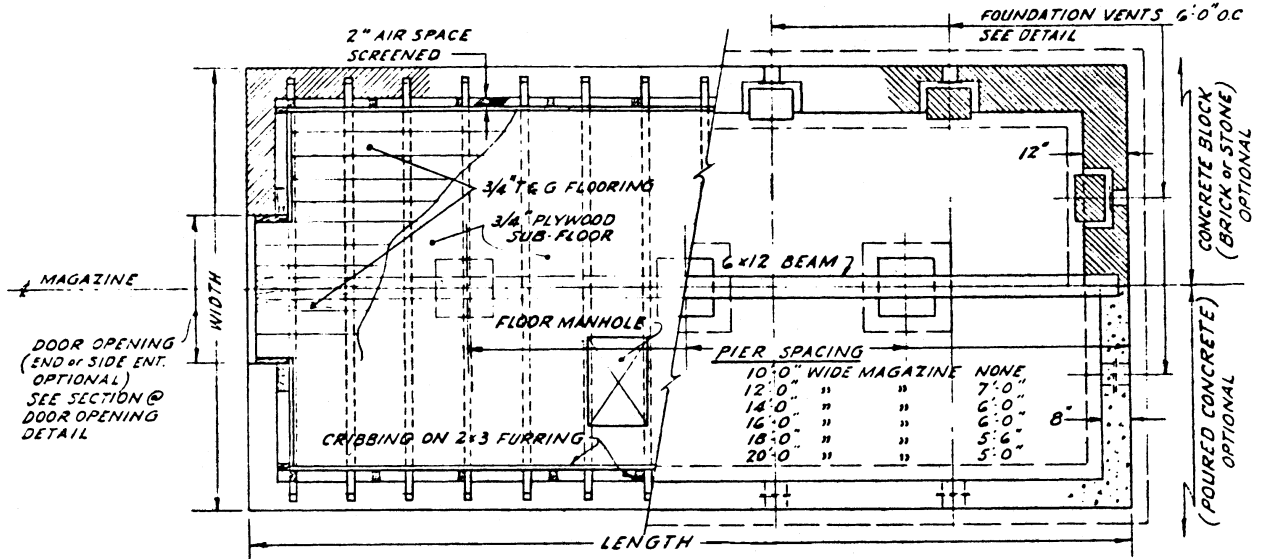


Plate 3

Door Opening Plan Section; Floor and Foundation Plan⁹



DOOR OPENING PLAN SECTION

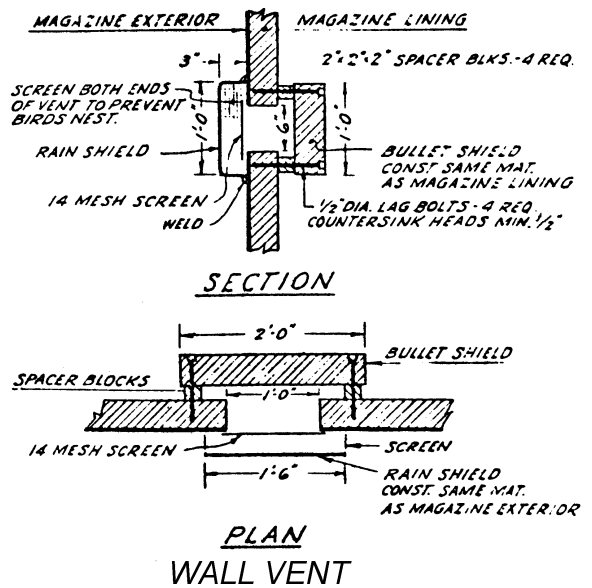
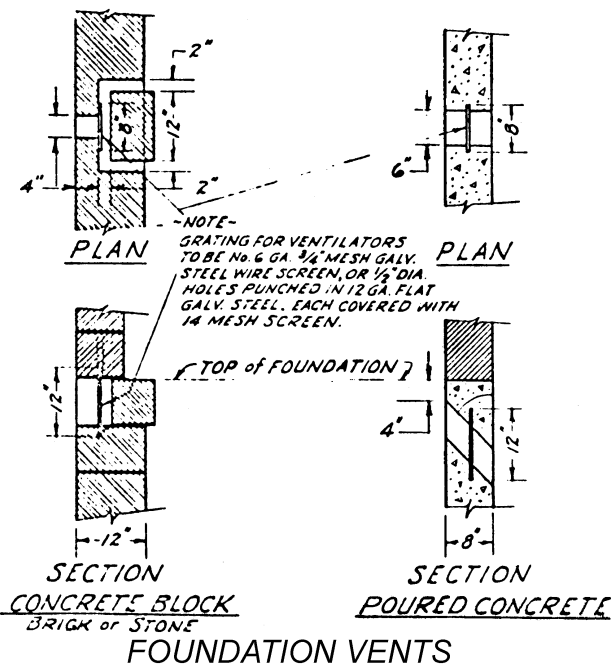
NOTE:

OTHER TYPES OF FOUNDATIONS MAY BE USED FOR PERMANENT MAGAZINES, SUCH AS A CONCRETE SLAB OR PIERS.

FLOOR & FOUNDATION PLAN

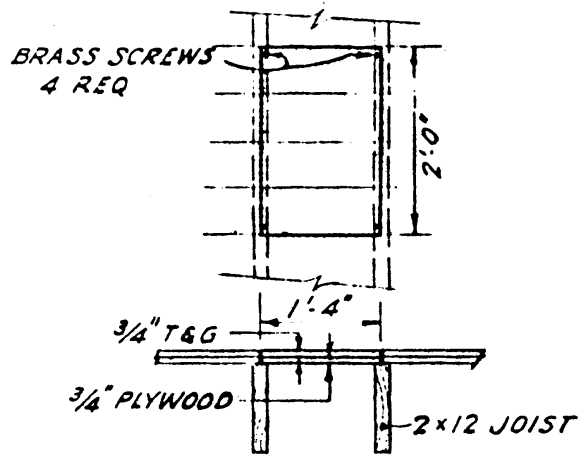
Plate 4

Vent Details—Foundation Vents; Wall Vent¹⁰

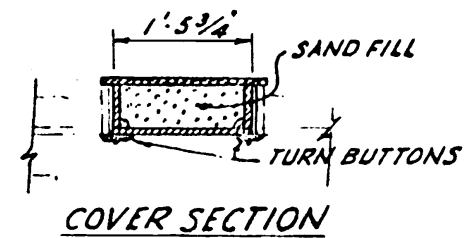
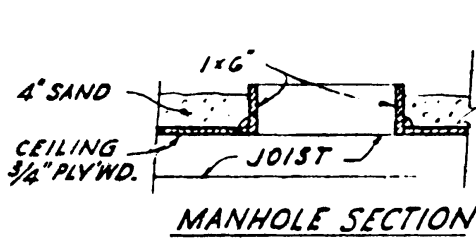
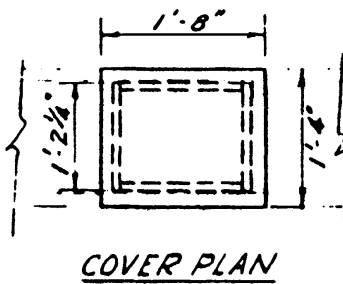
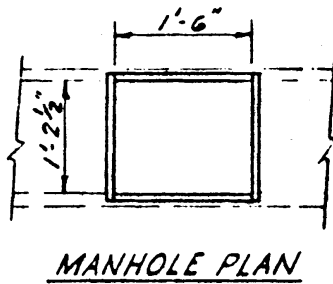


*Bullet shield not required when rain shield is constructed of 5/8" steel.

Floor Manhole; Ceiling Manhole¹¹



FLOOR MANHOLE
PLAN & SECTION

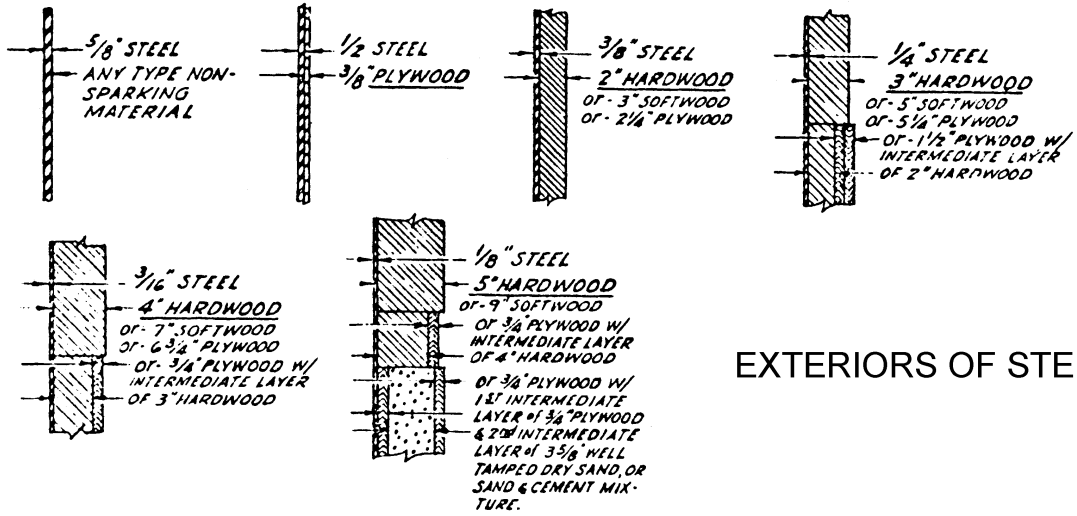


CEILING MANHOLE

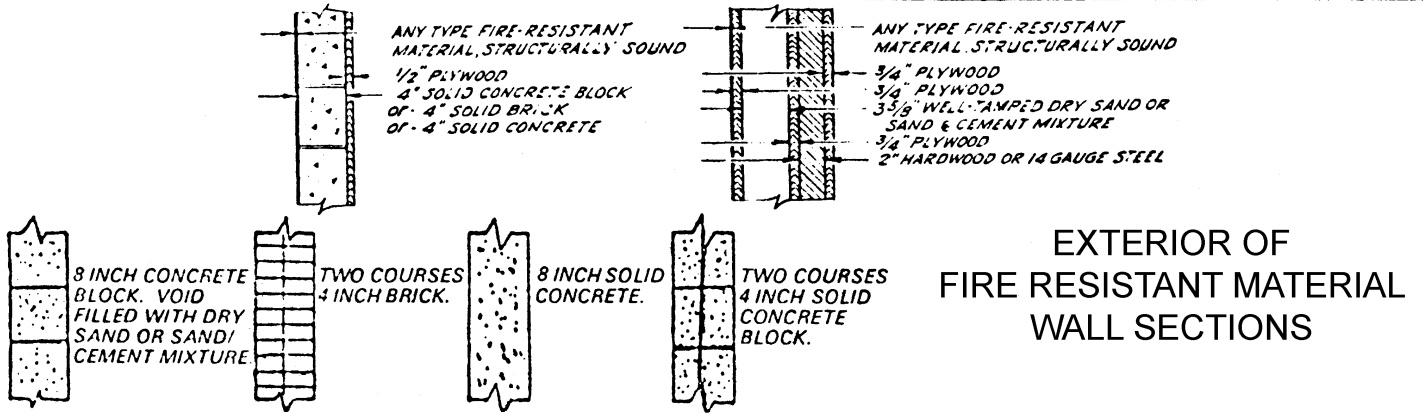
SCHEDULE				
JOIST, RAFTERS, TIE BEAMS				
MAGAZINE WIDTH	FLOOR JOIST 16" O.C.	CEILING JOIST 16" O.C.	RAFTERS 24" O.C.	TIE BEAMS
10'-0"	2x12	2x6	2x4	2x4
12'-0"	2x12	2x8	2x6	2x4
14'-0"	2x12	2x8	2x6	2x4
16'-0"	2x12	2x10	2x6	2x4
18'-0"	2x12	2x10	2x8	2x6
20'-0"	2x12	2x12	2x8	2x6

MANHOLE DETAILS & JOIST - RAFTER SCHEDULE

Exterior of Fire Resistant Material Wall Sections¹²



EXTERIORS OF STEEL



EXTERIOR OF FIRE RESISTANT MATERIAL WALL SECTIONS

Plate 7

Door—Frame; Door on Frame¹³

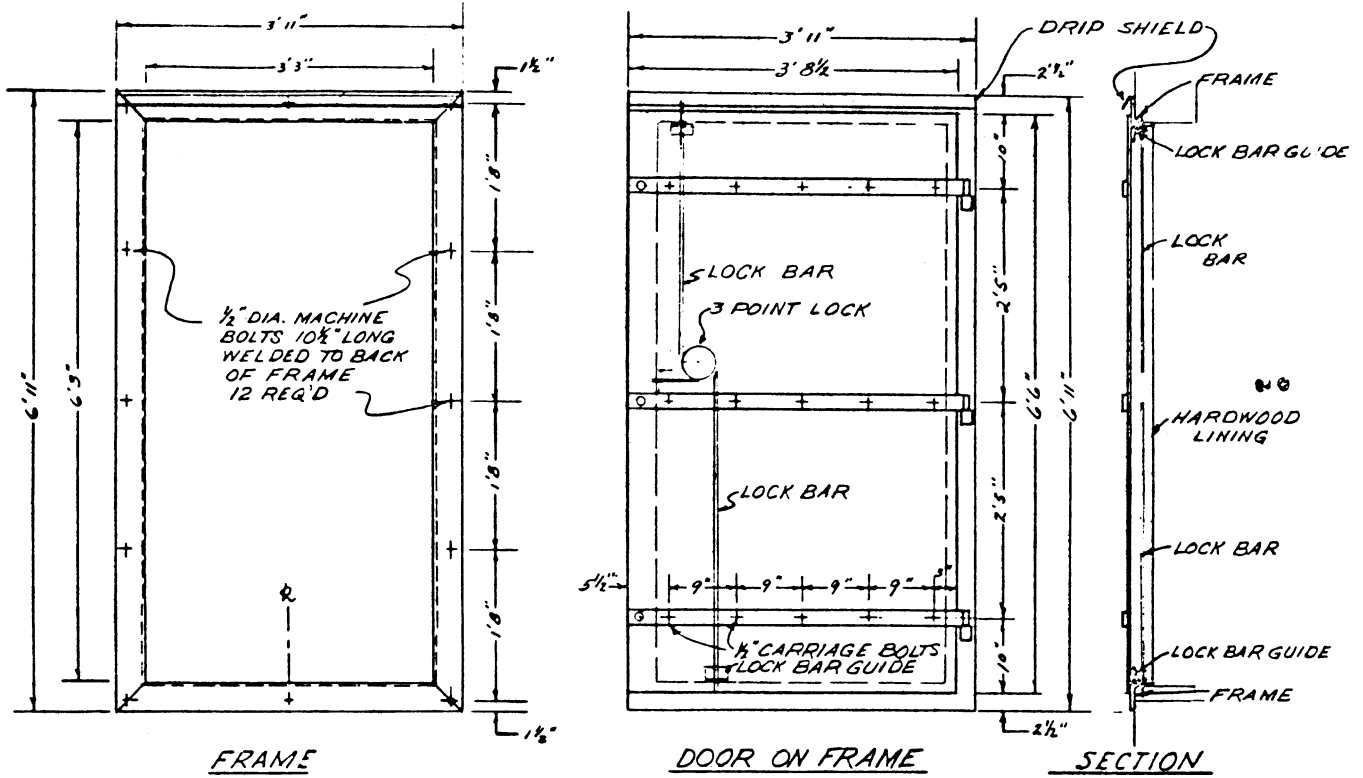
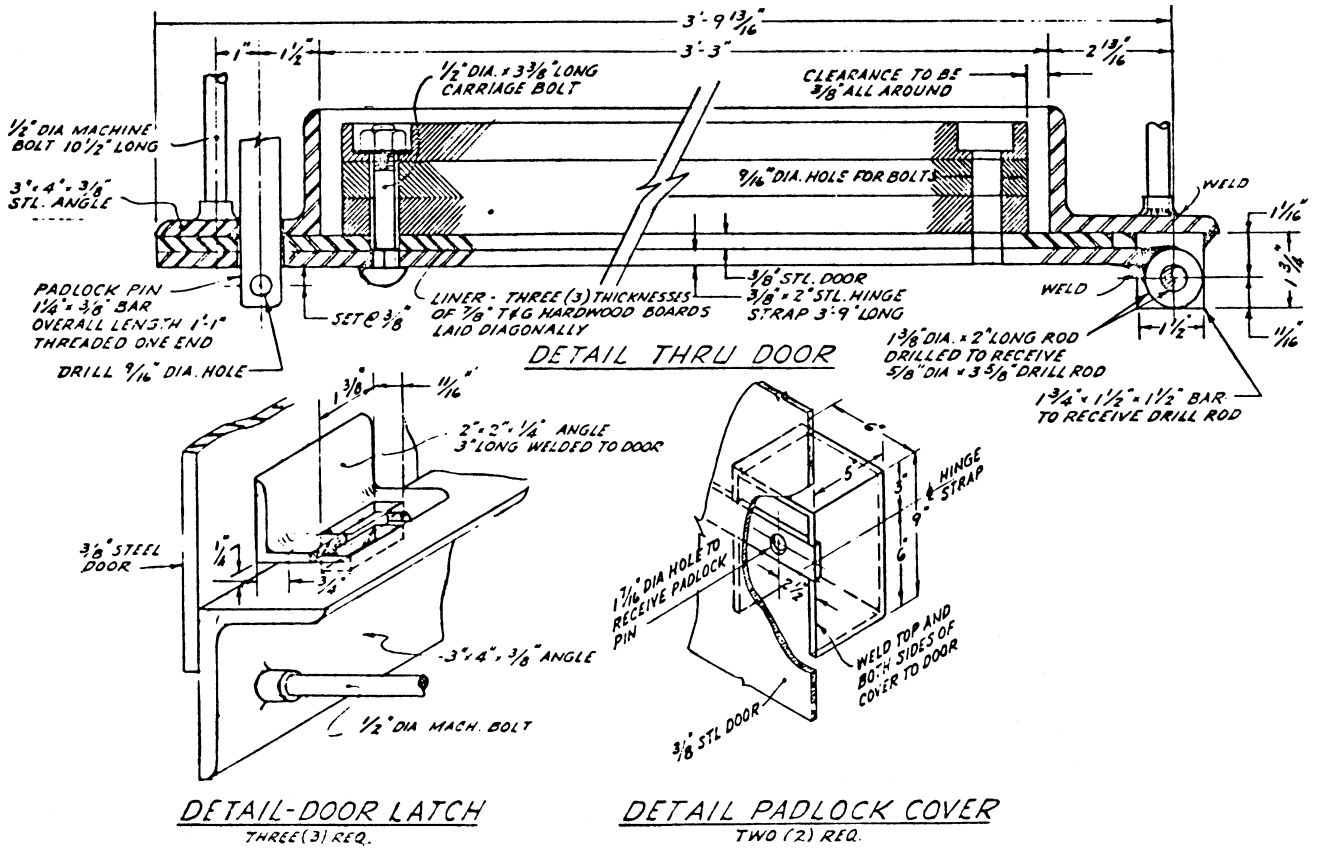


Plate 8

Door Details—Door Latch; Padlock Cover¹⁴



Specifications for Bullet-Resistant Construction

Magazines constructed to the specifications listed below have been tested and determined to be bullet resistant.

Exterior of Steel

A magazine with a steel exterior will be bullet resistant if composed of:

- $\frac{5}{8}$ -inch steel with an interior lining of any type of nonsparking material.
- $\frac{1}{2}$ -inch steel with an interior lining of not less than $\frac{3}{8}$ -inch plywood
- $\frac{3}{8}$ -inch steel with an interior lining of
 - 2 inches of hardwood, or
 - 3 inches of softwood, or
 - $2\frac{1}{4}$ inches of plywood.
- $\frac{1}{4}$ -inch steel with an interior lining of
 - 3 inches of hardwood, or
 - 5 inches of softwood, or
 - $5\frac{1}{4}$ inches of plywood, or
 - $1\frac{1}{2}$ inches of plywood with an intermediate layer of 2 inches of hardwood, or
 - $5\frac{1}{4}$ inches of particle board.
- $\frac{3}{16}$ -inch steel with an interior lining of
 - 4 inches of hardwood, or
 - 7 inches of softwood, or
 - $6\frac{3}{4}$ inches of plywood, or
 - $\frac{3}{4}$ inches of plywood with an intermediate layer of 3 inches of hardwood, or
 - $6\frac{3}{4}$ inches of particle board.
- $\frac{1}{8}$ -inch steel with interior lining of
 - 5 inches of hardwood, or
 - 9 inches of softwood, or
 - $\frac{3}{4}$ inches of plywood with an intermediate layer of 4 inches of hardwood, or
 - $\frac{3}{4}$ inches of plywood with the first intermediate layer of $\frac{3}{4}$ inch plywood and a second intermediate layer of $3\frac{5}{8}$ inches of well-tamped dry sand or sand/cement mixture.

Exterior of Any Type

A magazine with any type of exterior will be bullet resistant if composed of fire-resistant material that is structurally sound and if it includes:

- An interior lining of $\frac{1}{2}$ -inch plywood placed securely against an intermediate layer of
 - 4 inches of solid concrete block, or
 - 4 inches of solid brick, or
 - 4 inches of solid concrete.
- An interior lining of $\frac{3}{4}$ inches of plywood and a first intermediate layer of $\frac{3}{4}$ inches of plywood, a second intermediate layer of $3\frac{5}{8}$ inches of well-tamped dry sand or sand/cement mixture, a third intermediate layer of $\frac{3}{4}$ -inch plywood, and a fourth intermediate layer of 2 inches of hardwood or 14 gauge steel.
- An intermediate 6-inch space filled with well-tamped dry sand or well-tamped sand/cement mixture.

Masonry Construction

A magazine of masonry construction will be bullet resistant if composed of:

- Standard 8-inch concrete block with the void filled with well-tamped dry sand or well-tamped sand/cement mixture, or
- Standard 8-inch solid block or
- 8-inch thickness of solid concrete, or
- Two 4-inch thick blocks of solid concrete.

Use of Magazines

Lighting

Battery-activated safety lights or battery-activated safety lanterns may be used in magazines for the storage of explosive materials. Electric lighting used in any explosives storage magazine must meet the standards prescribed by the National Electrical Code (NFTA 70-81) for the condition present in the magazine at any time. All electrical switches must be located outside of the magazine and must meet the standards prescribed by the National Electrical Code. Copies of invoices, work orders or similar documents indicating that the lighting complies with the National Electrical Code must be available.

Repairs

Before one repairs the interior of a magazine, all explosive materials must be removed. Before one repairs the exterior of a magazine, all explosive materials must be removed if there exists any possibility that repairs may produce sparks or flame. Explosive materials removed from magazines under repair must be:

- Placed in other magazines appropriate for the storage of explosive materials.
- Placed a safe distance from the magazines under repair where the materials are properly guarded and protected until repairs have been completed.

Housekeeping

Magazines must be kept clean, dry, and free of grit, paper, empty packages, containers and rubbish. Floors must be swept regularly. Brooms and other utensils used in cleaning and maintenance of magazines may be kept in magazines, but the utensils must not have spark producing metal parts.

When explosive materials have deteriorated, they must be destroyed in accordance with the advice or instruction of the manufacturer. The area around magazines must be kept clear of rubbish, brush, dry grass and trees (except live trees more than 10 feet tall) for not less than 25 feet in all directions. Volatile materials must be kept a distance of 50 feet from outdoor magazines. Living foliage that is used to stabilize the earthen covering of a magazine need not be removed.

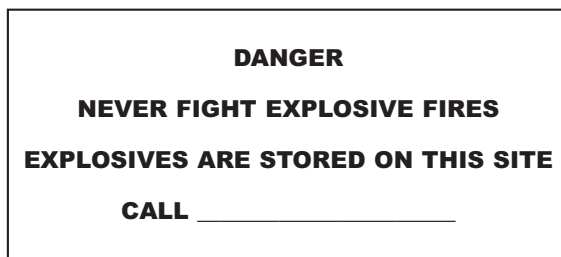
Smoking and Open Flames

Smoking, matches, open flames and spark-producing devices are not permitted:

- In any magazine.
- Within 50 feet of any outdoor magazines.
- Within any room containing an indoor magazine.

Posting

The Mine Safety and Health Administration standard on posting requires a suitable danger sign so located that a bullet passing through the face of the sign will not strike the magazine. The Institute of Makers of Explosives recommends a sign on all normal access routes to explosives storage buildings. The sign should be weather resistant with a reflective surface, and lettering should be at least 2 inches high. The first two lines should be printed with red lettering, and the remaining lines should be printed in black lettering. The sign should read:



Inspection

Magazines must be inspected at least every seven days to determine whether there has been unauthorized entry or attempted entry into the magazines, or unauthorized removal of the contents of the magazines.

Location of Magazines

Outdoor magazines in which high explosives are stored must be located no closer to inhabited buildings, passenger railways, public highways or other magazines in which high explosives are stored than the minimum distance specified in Table 4.

Table 4

Distances for Storage of Explosive Materials^{15*}

Quantity of Explosive Materials ^{1,2,3,4,5}		Distances in Feet							
		Inhabited Buildings ⁹		Public Highways Class A to D ¹¹		Passenger Railways—Public Highways with Traffic Volume of more than 3,000 Vehicles/Day ^{10,11}		Separation of Magazines ¹²	
Pounds Over	Pounds Not Over	Barri-caded ^{6,7,8}	Unbarri-caded	Barri-caded ^{6,7,8}	Unbarri-caded	Barri-caded ^{6,7,8}	Unbarri-caded	Barri-caded ^{6,7,8}	Unbarri-caded
2	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	1,000	400	800	160	320	300	600	36	72
1,000	1,200	425	850	165	330	318	636	39	78
1,200	1,400	450	900	170	340	336	672	41	82
1,400	1,600	470	940	175	350	351	702	43	86
1,600	1,800	490	980	180	360	366	732	44	88
1,800	2,000	505	1,010	185	370	378	756	45	90
2,000	2,500	545	1,090	190	380	408	816	49	98
2,500	3,000	580	1,160	195	390	432	864	52	104
3,000	4,000	635	1,270	210	420	474	948	58	116
4,000	5,000	685	1,370	225	450	513	1,026	61	122
5,000	6,000	730	1,460	235	470	546	1,092	65	130
6,000	7,000	770	1,540	245	490	573	1,146	68	136
7,000	8,000	800	1,600	250	500	600	1,200	72	144
8,000	9,000	835	1,670	255	510	624	1,248	75	150
9,000	10,000	865	1,730	260	520	645	1,290	78	156
10,000	12,000	875	1,750	270	540	687	1,374	82	164
12,000	14,000	885	1,770	275	550	723	1,446	87	174
14,000	16,000	900	1,800	280	560	756	1,512	90	180
16,000	18,000	940	1,880	285	570	786	1,572	94	188
18,000	20,000	975	1,950	290	580	813	1,626	98	196
20,000	25,000	1,055	2,000	315	630	876	1,752	105	210
25,000	30,000	1,130	2,000	340	680	933	1,866	112	224
30,000	35,000	1,205	2,000	360	720	981	1,962	119	238
35,000	40,000	1,275	2,000	380	760	1,026	2,000	124	248
40,000	45,000	1,340	2,000	400	800	1,068	2,000	129	256
45,000	50,000	1,400	2,000	420	840	1,104	2,000	135	270
50,000	55,000	1,460	2,000	440	880	1,140	2,000	140	280
55,000	60,000	1,515	2,000	455	910	1,173	2,000	145	290
60,000	65,000	1,565	2,000	470	940	1,206	2,000	150	300
65,000	70,000	1,610	2,000	485	970	1,236	2,000	155	310
70,000	75,000	1,655	2,000	500	1,000	1,263	2,000	160	320
75,000	80,000	1,695	2,000	510	1,020	1,293	2,000	165	330
80,000	85,000	1,730	2,000	520	1,040	1,317	2,000	170	340
85,000	90,000	1,760	2,000	530	1,060	1,344	2,000	175	350
90,000	95,000	1,790	2,000	540	1,080	1,368	2,000	180	360
95,000	100,000	1,815	2,000	545	1,090	1,392	2,000	185	370
100,000	110,000	1,835	2,000	550	1,100	1,437	2,000	195	390
110,000	120,000	1,855	2,000	555	1,110	1,479	2,000	205	410
120,000	130,000	1,875	2,000	560	1,120	1,521	2,000	215	430
130,000	140,000	1,890	2,000	565	1,130	1,557	2,000	225	450
140,000	150,000	1,900	2,000	570	1,140	1,593	2,000	235	470
150,000	160,000	1,935	2,000	580	1,160	1,629	2,000	245	490
160,000	170,000	1,965	2,000	590	1,180	1,662	2,000	255	510
170,000	180,000	1,990	2,000	600	1,200	1,695	2,000	265	530
180,000	190,000	2,010	2,010	605	1,210	1,725	2,000	275	550
190,000	200,000	2,030	2,030	610	1,220	1,755	2,000	285	570
200,000	210,000	2,055	2,055	620	1,240	1,782	2,000	295	590
210,000	230,000	2,100	2,100	635	1,270	1,836	2,000	315	630
230,000	250,000	2,155	2,155	650	1,300	1,890	2,000	335	670
250,000	275,000	2,215	2,215	670	1,340	1,950	2,000	360	720
275,000	300,000	2,275	2,275	690	1,380	2,000	2,000	385	770

*Approved by the Institute of Makers of Explosives, February 1986.

Table 4 Notes

1. *Explosive materials* means explosives, blasting agents and detonators.

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 "18 U.S.C. Chapter 40, Importation, Manufacturer, 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 pounds of high explosives per 1,000 feet. Heavier or lighter core loads should be rated proportionately.

3. *Blasting agents* means any material or mixture, consisting of fuel and oxidizer, intended for blasting, not otherwise defined as an explosive: Provided that the finished product, as mixed for use or shipment, cannot be detonated by means of a No. 8 test blasting cap when unconfined.

4. *Detonator* means any device containing any initiating or primary explosive that is used for initiating detonation. A detonator may not contain more than 10 grams 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 non-electric instantaneous and delay blasting caps which 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 pounds of explosives per 1,000 caps. For strengths higher than No. 8 cap, consult the manufacturer.

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

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

7. *Artificial barricade* means an artificial mound or revetted wall of earth of a minimum thickness of 3 feet.

8. *Barricaded* means the effective screening of a building containing explosive materials from the magazine or other building, railway or highway by a natural or an artificial barrier. A straight line from the top of any sidewall of the building containing explosive materials to the eave line of any magazine or other building or to a point 12 feet above the center of a railway or highway must pass through such barrier.

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, except any building or structure occupied in connection with the manufacture, transportation, storage or use of explosive materials.

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

11. *Highway* means any public street, public alley or public road. "Public Highways Class A to D" are highways with average traffic volume of 3,000 or less vehicles per day as specified in "American Civil Engineering Practice" (Abbett, Vol. 1, Table 46, Sec. 3-74, 1956 Edition, John Wiley and Sons).

12. When two or more storage magazines are located on the same property, each magazine must 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 must govern in 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, then such two or more magazines, as a group, must be considered as one magazine, and the total quantity of explosive materials stored in such group must be treated as if stored in a single magazine located on the site of any magazine of the group and must comply with the minimum of distances specified from other magazines, inhabited buildings, railways and highways.

13. Storage in excess of 300,000 pounds of explosive materials in one magazine is generally not required for commercial enterprises.

14. This table applies only to the manufacture and permanent storage of commercial explosive materials. It is not applicable to 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.

If you have enjoyed this course, you may want to try our course series "A Guide to Rock Blasting and Overbreak Control"

Outdoor magazines in which low explosives are stored must be located no closer to inhabited buildings, passenger rail-ways, public highways or other magazines in which explosive material is stored than the minimum distances specified in Table 5. No reduction of the distance is allowed for barricades.

Table 5
Distances for Storage of Low Explosives

Pounds		Distance in Feet		
		From Inhabited Building	From Public Railroad and Highway	From Above Ground Magazine
Over	Not Over			
0	1,000	75	75	50
1,000	5,000	115	115	75
5,000	10,000	150	150	100
10,000	20,000	190	190	125
20,000	30,000	215	215	145
30,000	40,000	235	235	155
40,000	50,000	250	250	165
50,000	60,000	260	260	175
60,000	70,000	270	270	185
70,000	80,000	280	280	190
80,000	90,000	295	295	195
90,000	100,000	300	300	200
100,000	200,000	375	375	250
200,000	300,000	450	450	300

For the separation of stores of ammonium nitrate and blasting agents from nearby stores of high explosives or blasting agents, use the distances specified in Table 6.

Table 6

Distances^{1,6} of Ammonium Nitrate and Blasting Agents From Explosives or Blasting Agents¹⁶

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	1,000	6	22	12
1,000	1,600	7	25	12
1,600	2,000	8	29	12
2,000	3,000	9	32	16
3,000	4,000	10	36	15
4,000	6,000	11	40	15
6,000	8,000	12	43	20
8,000	10,000	13	47	20
10,000	12,000	14	50	20
12,000	16,000	15	54	26
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

Table 6 Notes

1. Recommended separation distances 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 when 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, one-half the mass of the ammonium nitrate should be included in the mass of the donor.

2. When the ammonium nitrate and/or blasting agent is not barricaded, the distances shown in the table shall be multiplied by six. 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 may enclose the "donor." Where storage is in bullet-resistant magazines 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.

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; and ammonium nitrate failing to pass said test shall be stored at separation distances determined by competent persons and approved by the authority having jurisdiction.

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.

5. Earth, or sand dikes, or enclosures filled with the prescribed minimum thickness of earth or sand are acceptable artificial barricades. Natural barricades, such as hills or timber of sufficient density that the surrounding exposures which require protection cannot be seen from the "donor" when the trees are bare of leaves, are also acceptable.

6. For determining the distances to be maintained from inhabited buildings, passenger railways and public highways, use the Table of Distances for Storage of Explosives in table 6-4b of NFPA 495-1985, *Code for the Manufacture, Transportation, Storage, and Use of Explosive Materials*.

Notes

1. Institute of Makers of Explosives. *Construction Guide for Storage Magazines*. Safety Library Publication No. 1, p. I (hereinafter, for example, IME No. 1, p. 1).
2. IME No. 1, p. 3.
3. IME No. 1, p. 5.
4. IME No. 1, p. 5.
5. IME No. 1, p. 5.
6. IME No. 1, p. 5.
7. IME No. 1, pp. 8, 9.
8. IME No. 1, pp. 8, 9.
9. IME No. 1, pp. 10, 11.
10. IME No. 1, pp. 10, 11.
11. IME No. 1, p. 12.
12. IME No. 1, p. 13.
13. IME No. 1, p. 14.
14. IME No. 1, p. 15.
15. Institute of Makers of Explosives. *The American Table of Distances*. Safety Library Publication No. 2, pp. 4, 5.
16. IME No. 2, p. 10.