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	Engineering and Design  EXPLOSIVES STORAGE MAGAZINES	
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CEMP-ET

DEPARTMENT OF THE ARMY  
U.S. Army Corps of Engineers  
Washington, D.C. 20314-1000

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No. 1110-345-102

31 August 1995

Engineering and Design  
EXPLOSIVES STORAGE MAGAZINES

1. Purpose. Appendix A provides a ready reference of explosives storage magazine information such as shape, size, explosive limits, and operational features. It is intended to provide planners and designers sufficient information to select the most suitable standard magazine design to satisfy the user's requirements.

2. Applicability. This pamphlet is applicable to all HQUSACE elements, major subordinate commands, districts, and field operating activities (FOA) having military design and construction responsibilities.

3. References.

- a. DoD 6055.9-STD
- b. AR 385-60
- c. AR 385-64
- d. AR 415-17
- e. TM 5-1300

4. Discussion. Military installations use magazines, sometimes referred to as igloos, for the storage of ammunition and explosives. Selecting the correct storage capacity, siting, and type of magazine has been a problem to military planners, and especially to those responsible for assuring safety compliance. Investigational work with earth-covered magazines has been concerned with intra relationships within magazine complexes for siting purposes. Numerous full-scale tests performed over a period of several years have established magazine separation criteria that will prevent magazine-to-magazine explosion propagation. These tests formed the basis for the explosive safety standards in AR 385-64 which implements DOD 6055.9-STD requirements. The primary objective of standard magazines is to provide designers and installation planners pre-approved magazines meeting the Department of Defense Explosives Safety Board (DDESB) safety criteria. This pamphlet is structured to

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This pamphlet supersedes DG 1110-3-170, dated June 1986.

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provide complete guidance to Army. It does not address those magazines listed in references a and c that were developed by the Naval Facilities Engineering Command.

FOR THE COMMANDER:

A handwritten signature in black ink, appearing to read "R. Griffin".

1 Appendix  
APP A - Explosives  
Storage Magazines

ROBERT H. GRIFFIN  
Colonel, Corps of Engineers  
Chief of Staff

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This pamphlet supersedes DG 1110-3-170, dated June 1986.

APPENDIX A  
EXPLOSIVES STORAGE MAGAZINES

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## CHAPTER I

### INTRODUCTION

1-1. General. An important element in selecting storage magazines for construction is determining the type of magazine to be used and the siting requirements. AR 385-64 provides clear guidance in this regard. An earth-covered magazine is not designed to resist the damaging effects of its own exploding contents. It is accepted that the donor magazine will be demolished if an internal explosion occurs. Earth-covered magazines are utilized primarily to prevent propagation of an explosion within an adjacent (receiver) magazine. During the design phase, and prior to construction, site plans and non-standard magazine drawings must be submitted to the DDESB for review in accordance with AR 385-60 to assure that the proposed project meets explosives safety standards. Only the drawing numbers of standard magazines need be submitted with the site plan since the construction of such magazines are preapproved by the DDESB.

#### 1-2. Definitions.

a. Magazine: Any building or structure, except an operating building, used for the storage of ammunitions and explosives.

b. Standard Magazine: A preapproved magazine of the designation listed in AR 385-64. It is a magazine approved for the storage of 500,000 pounds net explosive weight (NEW) at the separation distances listed in AR 385-64.

c. Non-Standard Magazine: An earth-covered magazine that is not listed in AR 385-64 as being approved by the DDESB. These magazines are limited to a maximum 250,000 pounds NEW at the separation distances listed in AR 385-64.

d. Hybrid Magazine: A magazine that uses components and/or modifications from more than one magazine.

e. Intermagazine Distance: This is the minimum permissible distance between storage magazines. For earth-covered magazines, this distance is intended to provide reasonable protection against the propagation of an accidental explosion by airblast and by fragments.

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f. Quantity-Distance: The quantity of explosive material and distance separation relationship that provide defined types of protection.

g. Donor Magazine: Is a magazine which produces the damaging output.

h. Receiver Magazine: Is the magazine away from the donor source which requires protection.

i. Barricaded: Magazines with intervening barrier, natural or artificial, of such type, size, and construction as to limit in a prescribed manner the effect of an explosion on a nearby magazine.

j. Unbarricaded: Magazines without an intervening barrier.

1-3. Separation Distances of Magazines. Separation distance from magazines, commonly referred to as quantity-distance (Q-D), governs many aspects of a project. Stated simply, the more explosive material concentrated at one place, the farther that place has to be from a potential target. AR 385-64 contains tables equating amounts of explosives to the distance that they must be separated from other magazines, other ammunition and explosives handling facilities, public roads, and inhabited buildings. Orientation effects on intermagazine distance can also be found in AR 385-64. The following table and Figure 1 show the Q-D requirements between standard magazines:

<u>Orientation</u>	<u>Minimum Separation for Standard Magazines</u>	<u>Separation for W=500,000 pounds</u>
Side-to-Side	1.25 $W^{1/3}$	100 feet
Rear-to-Front	2.00 $W^{1/3}$	160 feet
Side-to-Front	2.75 $W^{1/3}$	220 feet
Front-to-Front (barricaded)	6.00 $W^{1/3}$	480 feet
Front-to-Front (unbarricaded)	11.00 $W_{1/3}$	880 feet

W = largest net explosive weight (NEW)

1-4. Magazine Grouping Concepts. Magazine grouping concepts are provided in Figures 2 and 3. These concepts are typical layouts found on most Army installations. Magazines may be placed in one row or multiple rows. Siting is generally side-to-side and

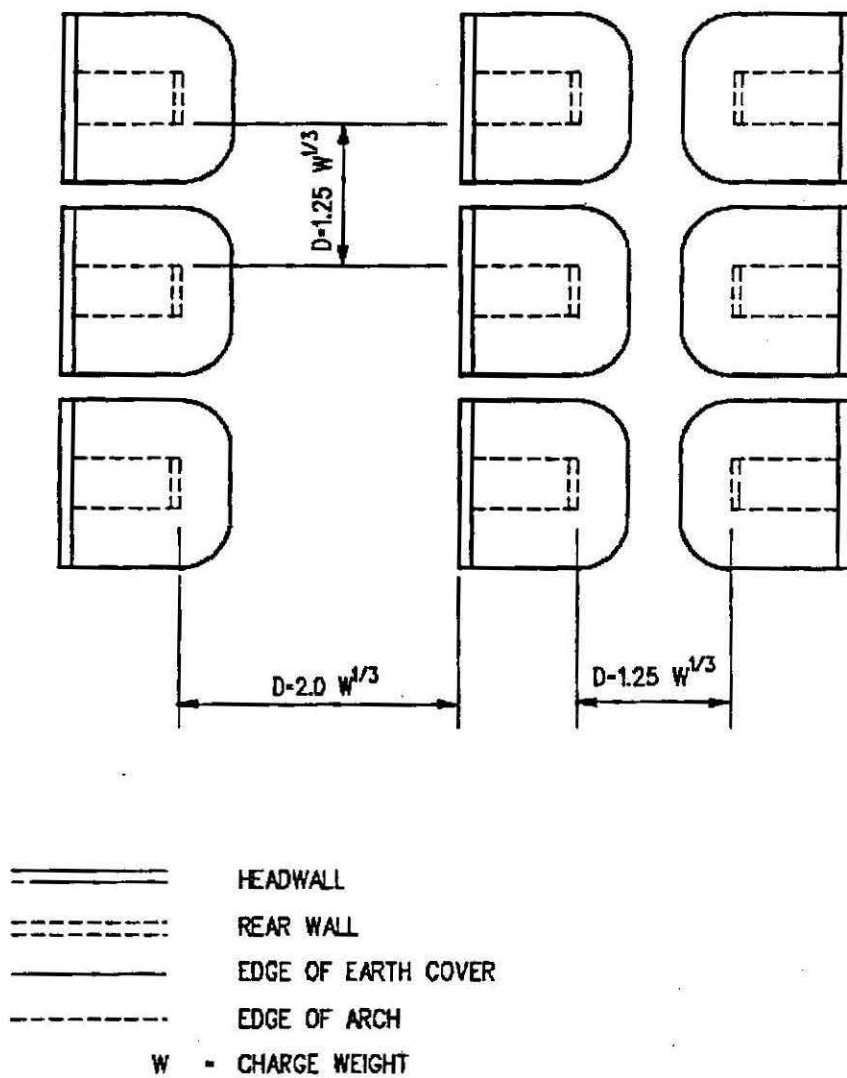


FIGURE 1. MINIMUM SEPARATION DISTANCES OF STANDARD MAGAZINES



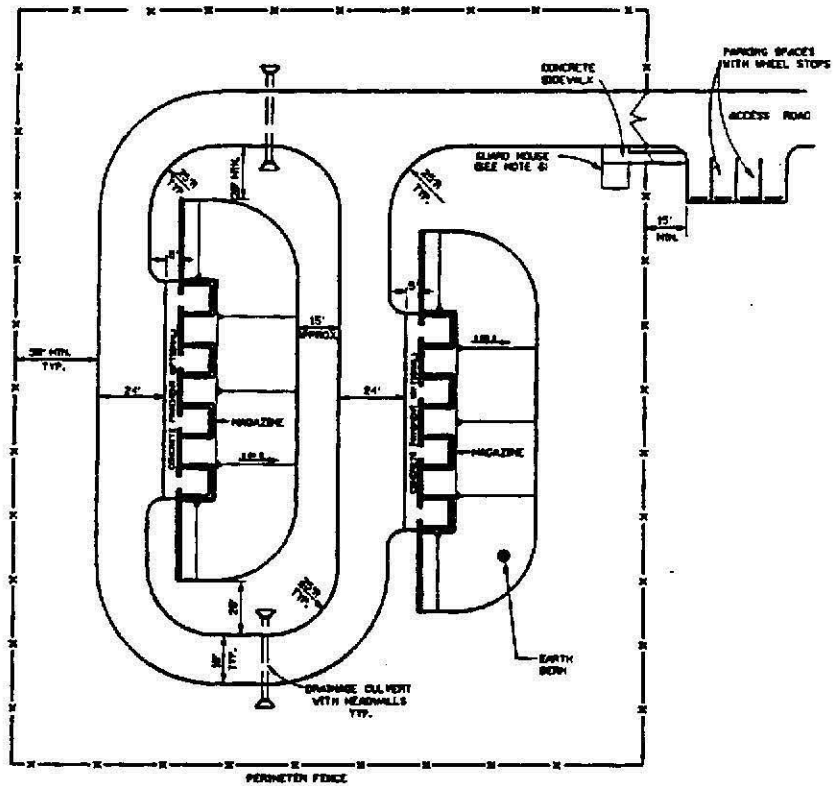


FIGURE 2 - SITING PLAN

REAR TO FRONT

MAGOLDON

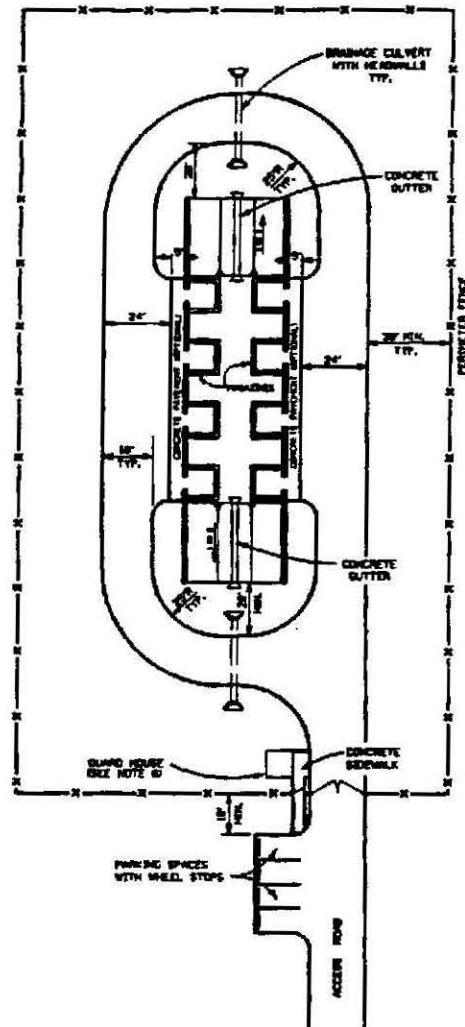


FIGURE 3 - SITING PLAN  
BACK TO BACK

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rear-to-front. Front-to-front orientation is seldom used because of the excessive intermagazine separation distance required.

1-5. Storage and Outloading Drawings. Storage and outloading drawings for ammunition are provided in U.S. Army Materiel Command drawings 19-48-75-5 published and distributed by the U.S. Army Ammunition Center and School (USADACS). These drawings will assist Army activities and contractors in the effective use of storage to ensure safe, economic and standardized procedures for storing and transporting ammunition commodities. Its Index lists the drawings that depict storage configurations (stacking patterns) of ammunition and components in various types of magazines.

1-6. Cost of Magazines. Construction cost estimates of magazines for programming purposes can be found in AR 415-17.

1-7. Waivers and Exemptions. Waivers, exemptions, and site general construction plan requests pertaining to Army owned facilities will be processed in accordance with AR 385-64. They are, however, discouraged since these waivers permit temporary deviation from the standards.

1-8. Technical Assistance. Users of this pamphlet are encouraged to communicate with the following organizations for technical assistance:

a. Planning Ammunition Facilities:

U.S. Army Defense Ammunition Center and School (USADACS)  
ATTN: SMCAC-AV  
Savanna, IL 61074-9639  
Telephone: DSN 585-8921.

b. Facilities-Related Explosive Safety Matters:

U.S. Army Technical Center for Explosives Safety (USATECS)  
ATTN: SMCAC-ES  
Savanna, IL 61074-9639  
Telephone: DSN 585-8919, commercial (815) 273-8919.

c. Magazine Designs and Criteria:

Headquarters, U.S. Army Corps of Engineers  
ATTN: CEMP-ET  
20 Massachusetts Avenue, NW  
Washington, D.C. 20314-1000  
Telephone: 202-761-1436

U.S. Army Engineer Division, Huntsville  
ATTN: CEHND-ED-CS  
4820 University Drive  
Huntsville, AL 35816-1822  
Telephone: 205-895-1650.

d. Protective Design Technical Assistance:

U.S. Army Engineer District, Omaha  
ATTN: CEMRO-ED-SH  
215 North 17th Street  
Omaha, NE 68102-4978  
Telephone: 402-221-3177

e. Distribution of Magazines (drawings and specifications):

U.S. Army Engineer Division, Huntsville  
ATTN: CEHND-ED-ES (Service Section)  
106 Wynn Drive  
Huntsville, AL 35805-1957  
Telephone: 205-955-4782

## CHAPTER II

### STANDARD MAGAZINES

2-1. General. Standard magazines are preapproved for construction and are mandatory for use within the Department of Defense unless circumstances, such as less storage capacity, require a non-standard design. The advantages of standard designs are:

- a. Design costs are saved.
- b. obtaining approval from The DDESB is simplified.
- c. Less real estate may be required because of certain decreased intermagazine separations permitted when standard magazines are used.
- d. The user has confidence in the end product.
- e. Flexibility of storage situations exists because magazines can be designed to varying lengths.
- f. Because of certain reduced separation distances, less roads, fences, utilities, etc., may be required.

2-2. Description of Earth-Covered Magazines. A typical earth-covered magazine has the following features:

- a. A semicircular arch, oval arch, or a rectangular box constructed of reinforced concrete or steel or a combination thereof.
- b. A reinforced concrete floor slab, sloped for drainage.
- c. A reinforced concrete rear wall.
- d. A reinforced concrete headwall that extends at least 2-1/2 feet above the top of the magazine.
- e. Reinforced concrete wingwalls on either side of the headwall. The wingwalls may slope to the ground or may adjoin wingwalls from adjacent magazines. The wingwalls may be either monolithic or separated by expansion joints from the headwall.
- f. Heavy steel doors in the headwall (either manually operated or motorized).

- g. An optional gravity ventilation system.
- h. Earth cover over the top, sides and rear of the magazine.
- i. Lightning protection and grounding systems.

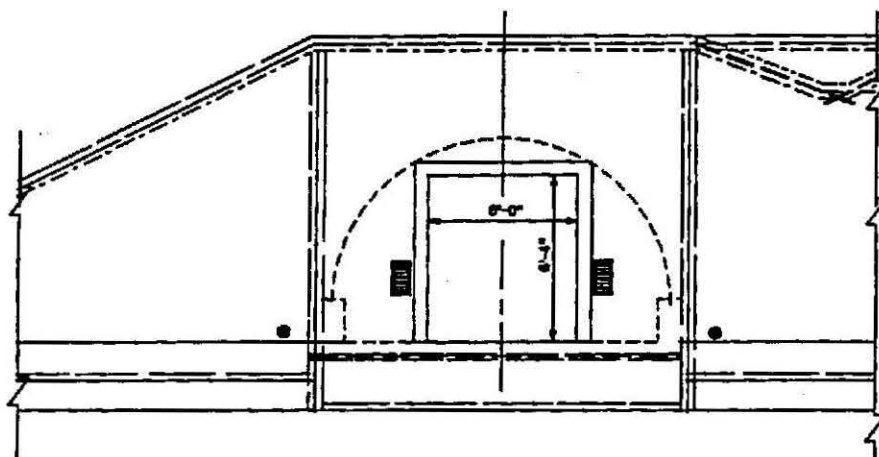
2-3. Standard Magazines. Standard magazine designs have been developed in coordination with the Department of Defense Explosive Safety Board (DDESB) so that designs would be considered preapproved when called for in construction. The largest sizes are about 25 feet wide. The length can vary, but is usually 80 feet. Smaller magazines have widths ranging from approximately 8 feet to 14 feet, with the length also varying.

a. Drawings approved for new construction. These standard magazines, are for the most part, a complete set of construction drawings with accompanying specifications. The magazines must, however, be site-adapted for local conditions. These magazines designs are approved for storing 500,000 pounds and may be ordered from the U.S. Army Engineer Division, Huntsville.

- (1) Semicircular steel arch - 33-15-65 (Figure 4)
- (2) Reinforced concrete arch - 33-15-74 (Figure 5)
- (3) Semicircular steel arch - 421-80-01 (Figure 6)
- (4) Steel and concrete large box - 421-80-02 (Figure 7)
- (5) Steel oval arch - 421-80-03 (Figure 8)

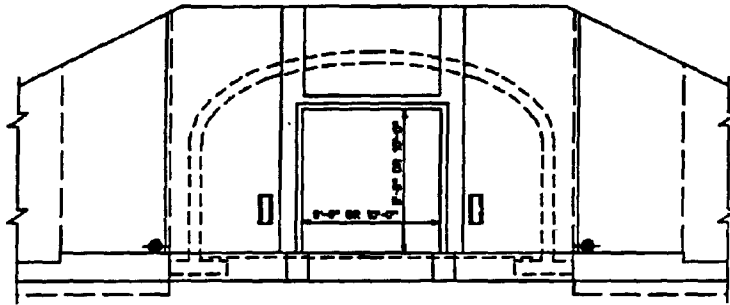
b. Older magazines found on Army installations:

- (1) Mounded concrete - 33-15-06 (Figure 9)
- (2) Atomic blast resistant - 33-15-58
- (3) Stradley - 33-15-61 (Figure 10)
- (4) Steel arch - AW 33-15-63
- (5) Steel arch - AW 33-15-64 (Figure 11)
- (6) Steel oval arch - 33-15-73
- (7) Semicircular mounded concrete - 652 series



**FIGURE 4. EARTH COVERED STEEL ARCH MAGAZINE**

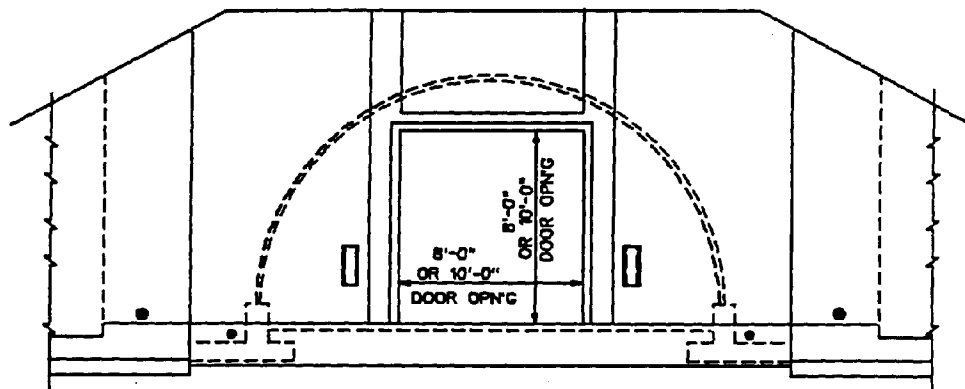
DRAWING NUMBER	33-15-65
ISSUE DATE	MARCH 1963
DIMENSIONS	WIDTHS: 8'-0", 10'-0", 12'-0" AND 14'-0" VARIABLE LENGTH TO 27' MAX
DOOR	HINGED, DOUBLE-LEAF 6'-0" x 6'-4"
EXPLOSIVE LIMIT	500,000 LBS. (NEW)
PHYSICAL SECURITY	HIGH SECURITY HASP (MIL-H-29181)
GENERAL FEATURES	1. HEADWALL - 1'-0" THICK REINFORCED CONCRETE 2. BACKWALL - 1'-0" THICK REINFORCED CONCRETE 3. ARCH - 8 GAUGE CORRUGATED STEEL
COMMENT	HEADWALL NOT EQUIVALENT IN STRENGTH TO 33-15-74 OR LATER DEVELOPED STANDARD MAGAZINE
DDESB APPROVAL DATE	15 MARCH 1965



**FIGURE 5. MAGAZINE, CONCRETE, OVAL-ARCH, EARTH-COVERED**

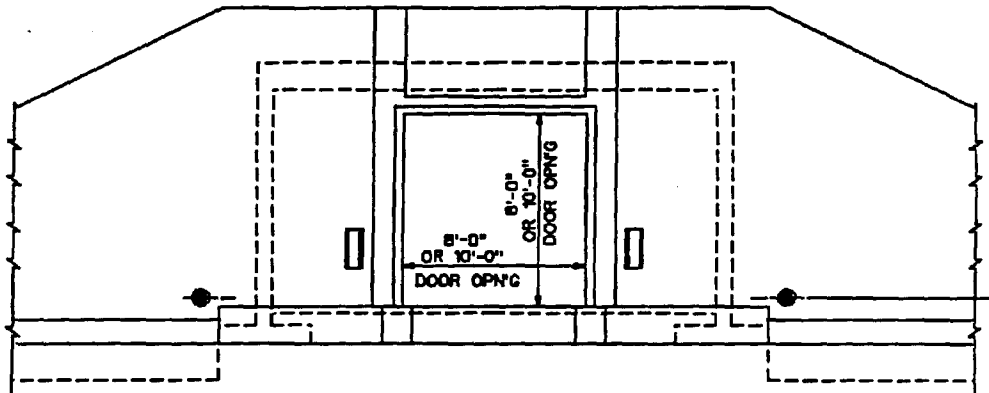
DRAWING NUMBER	33-15-74
ISSUE DATE	APRIL 1979
DIMENSIONS	25'-0"Wx14'-0"H LENGTH VARIES: 60'-0" TO 90'-0"
DOOR	SLIDING, 8'-0"x8'-0" OR 10'-0"x10'-0"
EXPLOSIVE LIMIT	500,000 LBS. (NEW)
PHYSICAL SECURITY	HIGH SECURITY HASP NOT SPECIFIED
GENERAL FEATURES	1. WALLS - 1'-0" THICK REINFORCED CONCRETE 2. ARCH - 1'-0" THICK REINFORCED CONCRETE 3. PILASTERS - 2'-6"x1'-10" AT DOOR JAMBS
COMMENT	RECOMMENDED FOR NEW CONSTRUCTION. THE 8' VERTICAL WALL PROVIDES EFFICIENT AMMUNITION STORAGE
DDESB APPROVAL DATE	22 JULY 1980





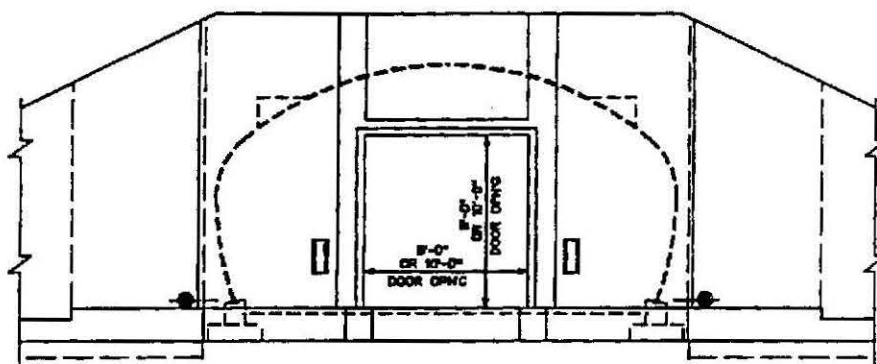
**FIGURE 6. MAGAZINE, STEEL, SEMICIRCULAR-ARCH, EARTH-COVERED**

DRAWING CODE	421-B0-01
ISSUE DATE	MARCH 1963
DIMENSIONS	25'-0"W x 14'-0"H LENGTH VARIES: MAX. 89'-0"
DOOR	SLIDING, 8'-0" x 8'-0" OR 10'-0" x 10'-0"
EXPLOSIVE LIMIT	500,000 LBS. (NEW)
PHYSICAL SECURITY	HIGH SECURITY HASP (MIL-H-29181)
GENERAL FEATURES	<ol style="list-style-type: none"> <li>1. HEADWALL - 1'-0" THICK REINFORCED CONCRETE</li> <li>2. REARWALL - 1'-0" THICK REINFORCED CONCRETE</li> <li>3. ARCH - 1 GAUGE CORRUGATED STEEL FOR 2" DEEP OR 5½" DEEP ARCHES</li> <li>4. PILASTERS- 1'-10" x 2'-6" AT DOOR JAMBS</li> </ol>
DDESB APPROVAL DATE	02 OCTOBER 1987



**FIGURE 7. STEEL AND CONCRETE BOX MAGAZINE, EARTH-COVERED**

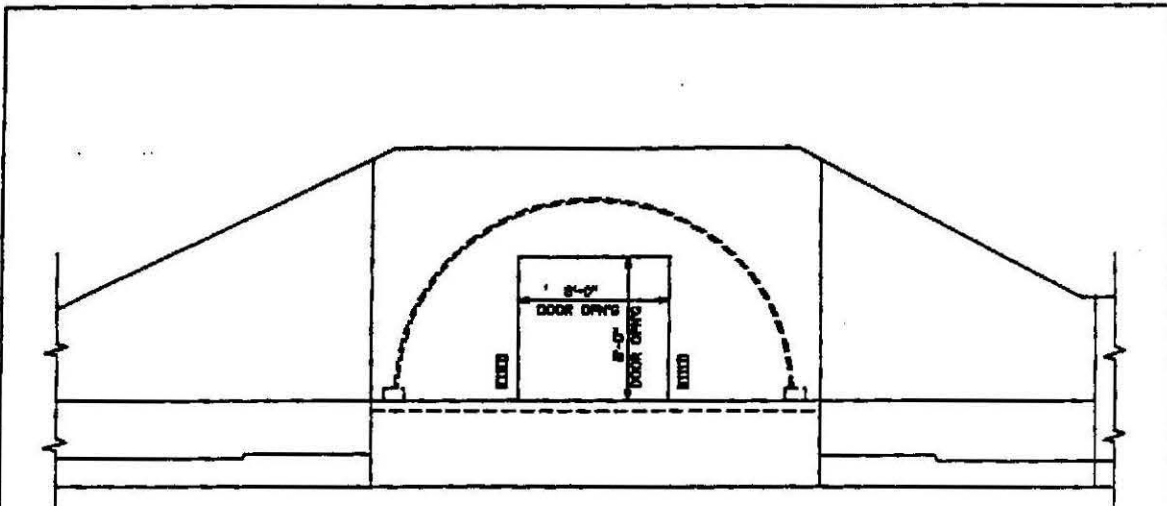
DRAWING CODE	STD 421-80-02
ISSUE DATE	JUNE 1993
DIMENSIONS	24'-0"Wx11'-2"H LENGTH VARIES: MAX. 90'-0"
DOOR	SLIDING, 8'-0"x8'-0" OR 10'-0"x10'-0"
EXPLOSIVE LIMIT	500,000 LBS. (NEW)
PHYSICAL SECURITY	HIGH SECURITY HASP (MIL-H-29181).
GENERAL FEATURES	1. ROOF - 1'-6" THICK REINFORCED CONCRETE 2. WALLS - 10" THICK BFR PANELS 3. HEADWALL - 10" THICK BFR PANELS 4. PILASTERS - 2'-0"x2'-6" REINFORCED CONCRETE 5. WINGWALLS - BFR PANELS
COMMENT	BFR (BLAST AND FRAGMENT RESISTANT) PANELS ARE PATENTED
DDESB APPROVAL DATE	22 FEBRUARY 1993



**FIGURE 8. MAGAZINE, STEEL, OVAL-ARCH, EARTH-COVERED**

DRAWING CODE	STD 421-80-03
ISSUE DATE	APRIL 1993
DIMENSIONS	25'Wx14'-5"H , LENGTH VARIES 21'-0" TO 89'-0"
DOOR	SLIDING, 8'x8' OR 10'x10'
EXPLOSIVE LIMIT	500,000 LBS. (NEW)
PHYSICAL SECURITY	HIGH SECURITY HASP (MIL-H-291B1)
GENERAL FEATURES	<ol style="list-style-type: none"> <li>1. HEADWALL - 1'-0" THICK REINFORCED CONCRETE</li> <li>2. BACKWALL - 1'-0" THICK REINFORCED CONCRETE</li> <li>3. ARCH - 1 GA. CORRUGATED PLATE</li> <li>4. PILASTERS - 2'-6"x1'-10" AT DOOR JAMBS</li> </ol>
COMMENT	THIS MAGAZINE REPLACES 33-15-73
DDESB APPROVAL DATE	28 DECEMBER 1992

MA00352.DGN

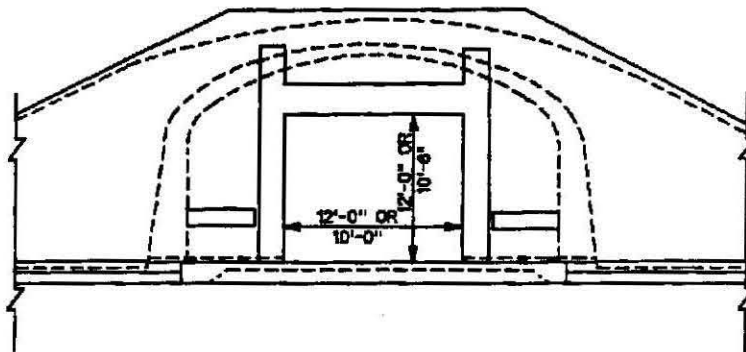


**FIGURE 9. MAGAZINE, MOUNDED CONCRETE IGLOO**

STANDARD MAGAZINE	33-15-06
ISSUE DATE	AUGUST 1951
DIMENSIONS	26'-6"Wx12'-9"H LENGTH VARIES: 81'-0" MAXIMUM
DOOR	HINGED, DOUBLE-LEAF 8'-0" x 8'-0"
EXPLOSIVE LIMIT	500,000 LBS. (NEW)
PHYSICAL SECURITY	NONE
GENERAL FEATURES	1. HEADWALL- 1'-0" THICK REINFORCED CONCRETE 2. REARWALL - 8" THICK REINFORCED CONCRETE 3. ARCH-THICKNESS VARIES, 6" @ CROWN 1'-4" @ BASE 4. PILASTERS- 1'-6" x 3'-4 <sup>3</sup> / <sub>4</sub> " AT DOOR JAMBS
COMMENT	THIS MAGAZINE SUPERSEDED DWGS 652-686 THRU 652-692 & 33-15-01
DDES B APPROVAL DATE	29 JULY 1955

MAGCJLON

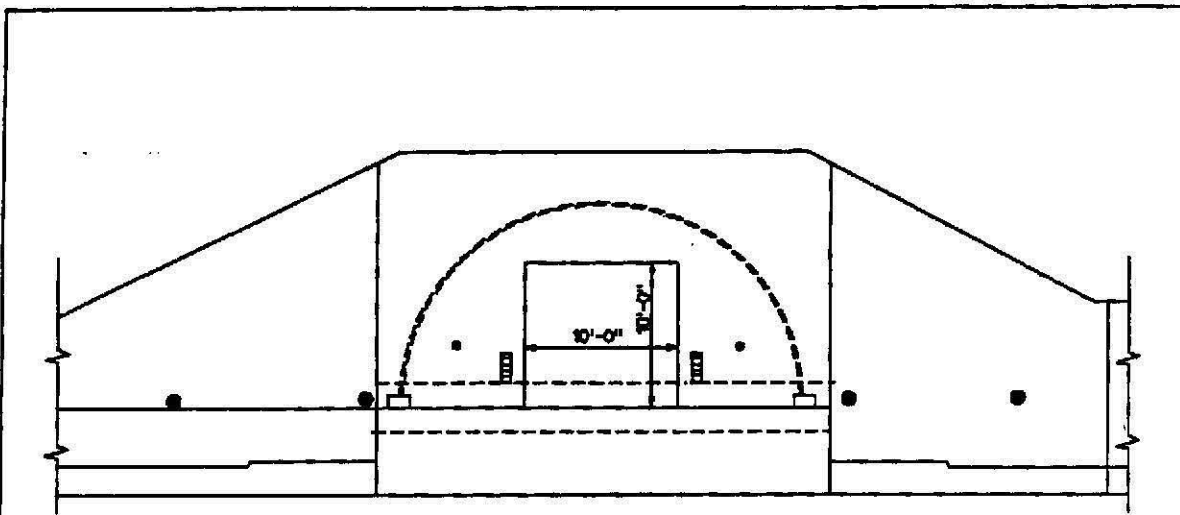
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**FIGURE 10. MAGAZINE, STRADLEY TYPE, EARTH-COVERED**

DRAWING NUMBER	33-15-61
ISSUE DATE	DECEMBER 1959
DIMENSIONS	25'-0"Wx14'-0"Hx80'-0"L
DOOR	SLIDING, 10'-0"x10'-6" OR 12'-0"x12'-0"
EXPLOSIVE LIMIT	500,000 LBS. (NEW)
PHYSICAL SECURITY	NONE
GENERAL FEATURES	1. HEADWALL - 1'-0" THICK REINFORCED CONCRETE 2. REARWALL - 10" THICK REINFORCED CONCRETE 3. PILASTERS - 2'-4"x1'-8" AT DOOR JAMBS
COMMENT	THIS MAGAZINE REPLACES "YURT" MAGAZINE YT-106 THRU YT-111
DDES APPROVAL DATE	30 DECEMBER 1959

MAG003.DGN



**FIGURE 11. IGLOO, STORAGE, STEEL ARCH - EARTH MOUNDED**

DRAWING NUMBER	AW 33-15-64
ISSUE DATE	MAY 1963
DIMENSIONS	25' x 14'-4"H x 59'L
DOOR	HINGED, DOUBLE-LEAF 10'x10'
EXPLOSIVE LIMIT	500,000 LBS (NEW)
PHYSICAL SECURITY	NONE
GENERAL FEATURES	<ol style="list-style-type: none"><li>1. REAR WALL- 1'-0" THICK REINFORCED CONCRETE</li><li>2. ARCH- 1 GA CORRUGATED STEEL</li><li>3. HEADWALL- 1'-0" THICK REINFORCED CONCRETE</li><li>4. PILASTERS- NONE</li></ol>
COMMENTS	<ol style="list-style-type: none"><li>1. HEADWALL NOT EQUIVALENT IN STRENGTH TO 33-15-74 OR LATER DEVELOPED STANDARD MAGAZINES</li></ol>
DDESB APPROVAL DATE	11 MARCH 1966

1064.DGN

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2-4. Site-Adaptation. Standard magazines are meant to be site-adapted, that is, tailored to the peculiarities at each particular location. For magazines, this tailoring mainly involves the foundation and the drainage system. For instance, if the soil bearing pressures at the construction location is below the design value, then an increase in the footing width is necessary. Also, a deep versus a shallow foundation is influenced by the frost penetration depth at the particular site. Site-adaptation also includes determining magazine length and deciding whether ventilators are required. The protective construction of the magazine (arch, headwall and door) must remain unchanged. The 2-foot minimum earth cover must also be maintained.

2-5. Changes to Standard Designs. changes to standard designs, other than site adaptation, should not be made without coordination with the DDESB. Any change will invalidate the DDESB's approval and result in the magazine being considered non-standard. This may require greater Q-D separations for those magazines in certain situations.

2-6. DDESB Approval. Site plans for construction projects containing magazines must be submitted in accordance with AR 385-60 for review and approval by the DDESB for:

- a. New construction.
- b. Changes in utilization of facilities or mission affecting Q-D requirements.
- c. Major modification to facilities.

2-7. Specifications. Specifications have been developed for each standard design, and are available with the drawings. Users can obtain a set of these specifications for the construction project with a request for the drawings. Deviations from these specifications may compromise the quality of the constructed project, and therefore must not be made. Design analyses may be requested if required.

## CHAPTER III

### MISCELLANEOUS CONSIDERATIONS

3-1. Earth Cover. Material for earth cover over magazines should be reasonably cohesive (solid or wet clay, or similar types of soil may not be used as they are too cohesive), free from deleterious organic matter, trash, debris, and stones heavier than 10 pounds or larger than 6 inches in diameter. The larger stones should be limited to the lower center of fills and will not be used for earth cover over magazines. Compaction and surface preparation should be provided, as necessary, to maintain structural integrity and avoid erosion. When it is impossible to use a cohesive material, for example, in sandy soil, the earth cover over magazines should be finished with a suitable material to ensure structural integrity. The minimum earth cover over the top of the magazine should be 2 feet, with a slope of 2 horizontal and 1 vertical. periodic maintenance must be performed to ensure restoration of erosion of cover below the 2-foot depth requirement. The earth-cover over and around the magazine is a critical element of the standard design. It provides some confinement and tends to directionalize the explosive force both upward and outward from the door end of the donor magazine. The cover over receiver magazines resists fragment penetrations and provides mass to the arch to resist the blast pressure. Where practical, earth cover should be seeded to prevent soil erosion. Where rainfall is insufficient to maintain grass cover, soil stabilization methods should be used.

3-2. Waterproofing. provisions are made in the standard magazine designs to ensure watertightness of the magazine. The type of magazine (steel or concrete) generally dictates the type of waterproofing used. An elastomeric membrane is most suitable on concrete arches, and a bituminous waterproofing is suitable on steel magazines. Moisture proofing difficulty is increased with steel-arch magazines because of the many lineal feet of joints.

3-3. Drainage Systems. Drainage systems are provided around the magazines to channel the water away from the structure. For concrete magazines, the drainage composite system is recommended. The older sand-gravel filter system is more costly and should be avoided, except for the steel arch where it is recommended due to the corrugated configuration.

3-4. Doors. Magazine doors are either of the swinging or the sliding type. Sliding doors are generally specified on large magazines, and swinging doors on smaller magazines. Doors are



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designed to withstand the dynamic forces from an explosion in an adjacent magazine and, therefore, are a critical element of the magazine design. These doors do not provide resistance to the effects of an explosion within the magazine.

3-5. Utilities and Power. The only utility usually required at a magazine site is electricity. This power is needed for lights at individual magazines, for perimeter lighting, and possibly for operation of electronic security equipment.

3-6. Road Network. The road network is not part of the standard design. The user must provide service to each magazine as part of the site adaptation process. vehicle size and wheel loads should be stated in the project development documentation. Forklift loads are usually the most critical. Two-lane roads are seldom required, except at the site entrance.

3-7. Aprons. Each magazine has an apron in front of its door to allow for loading and unloading. The aprons slope away from the door for drainage. Changes to the apron configuration to suit user needs will not compromise the pre-approved status of the standard design.

3-8. Retaining Walls (Wing walls). Retaining walls are for the sole purpose of retaining the earth fill away from the magazine doors. Construction type may vary from reinforced concrete, precast concrete to reinforced-earth systems. The slope of these walls should be 2 horizontal to 1 vertical.

3-9. Ventilation. Standard magazine designs usually include provisions for ventilation. Ventilation is provided by louvered openings in the headwall and ventilator stacks at the rear walls. Magazines intended for weapons storage containing certain active materials must be ventilated. Otherwise, louvers and ventilators are optional. Their necessity and size should be determined during the site adaptation based on material to be stored and geographical location.

3-10. Security. The security at a magazine complex is an integration of physical measures, equipment, and operational procedures. procedures are left to the using agency, since they are beyond the control of the designer. Limited security features included in the standard designs are high security hasp requirements at magazine doors (MIL-H-29181), steel bars at openings, shrouded ventilators, and basic provisions, i.e., steel conduit for electronic security equipment.

3-11. Cathodic protection. Cathodic protection may be required for steel-arch magazines and should be considered in areas where

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galvanic action in some types of soils is likely to occur.

3-12. Lightning protection. Standard magazine designs include an integral system of lightning protection. The system consists of air terminals, roof conductors, down conductors, ground connections, and ground, electrically interconnected to form the shortest distance to ground. Lightning protection requirements are clearly described in each magazine specifications.

3-13. Mixing of Standard and Non-Standard Magazines. Mixing of standard and non-standard magazines is not cost effective and, therefore, is discouraged. The element that greatly influence the magazine classification (standard or non-standard) is the headwall and its door. Since the headwall and door cost is a small portion of the overall cost of the magazine, a greater benefit is realized from the increased storage capacity in standard magazines.

## CHAPTER IV

### NON-STANDARD MAGAZINES

4-1. General. Non-standard earth covered magazines are those not listed in AR 385-64. Non-standard magazines are approved for all quantities of explosives up to 250,000 pounds. Earth cover over the top of these magazines should be equal to or greater than that required for standard magazines.

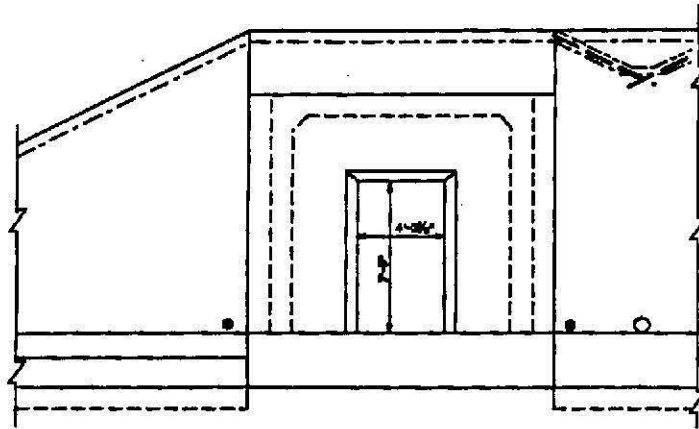
4-2. Evaluating Non-Standard Magazines. TM 5-1300 should be used to design or evaluate the blast resistance of non-standard magazines. Headwalls and doors of standard magazines are designed for 100 psi overpressure and 22 millisecond load duration (equivalent impulse of 1,100 psi-millisecond). Magazines not classified as standard must be analyzed for this loading to determine whether storage capacity can be increased to 500,000 pounds. A guide prepared by the U.S. Army Engineer Division, Huntsville provides procedures for determining the adequacy of the non-standard headwalls and doors to withstand blast effects from a donor explosive source.<sup>1</sup> The guide is based on TM 5-1300 criteria and magazine tests.

4-3. Hybrid Magazines. Hybrid magazines have been developed and used by installations to meet specific needs. As stated above, these magazines use components from more than one standard magazine. This type of magazine is not considered preapproved for construction and, therefore, requires DDESB approval if it is to be sited as a standard magazine. This magazine type offers no real advantage over standard magazines and their use is discouraged.

4-4. Preapproved Non-Standard Magazine. Magazine 422-15-01 (Figure 12) is a reinforced concrete cubicle magazine which is preapproved for a limited storage of 425 pounds. This magazine is approved for siting at the intermagazine separation distance of standard magazines.

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<sup>1</sup>U.S. Army Engineer Division, Huntsville, HNDED-CS-93-4, "Guide for evaluating Blast Resistance of Non-Standard Magazines", December 1994.



**FIGURE 12. MAGAZINE, CONCRETE CUBICLE, EARTH-COVERED**

DRAWING CODE	STD 422-15-01
ISSUE DATE	JUNE 1987
DIMENSIONS	10'W x 10'L x 10'H
DOOR	HINGED, SINGLE-LEAF 4'-3 1/2"x7'-3"
EXPLOSIVE LIMIT	425 LBS (NEW)
PHYSICAL SECURITY	HIGH SECURITY HASP (MIL-H-29181)
GENERAL FEATURES	1. WALLS: 1'-0" THICK REINFORCED CONCRETE 2. ROOF: 1'-0" THICK REINFORCED CONCRETE
DDESB APPROVAL DATE	03 MARCH 1988

MAG004.DGN