

HIGH PERFORMANCE MAGAZINE: PERFORMANCE GOALS, CONCEPTUAL DESIGN, BENEFITS, AND DEVELOPMENT PLAN

by

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ABSTRACT

A new magazine design, named the High Performance (HP) Magazine, is being developed by the Naval Facilities Engineering Service Center (NFESC). The HP magazine provides a better balance between operational requirements, explosives safety regulations, and economic considerations. The magazine is designed to meet explosives safety regulations within the many constraints imposed by public encroachment, shrinking supply of buildable land, especially near the waterfront, rising cost of land to accommodate ESQD distances, and reduced operating budgets to handle the many types, sizes, and classes of ordnance in today's Navy inventory. This paper presents the performance goals, conceptual design, operating procedure, benefits and development plan for the HP magazine.

1.0 INTRODUCTION

1.1 Problem

Ordnance storage magazines comprise the largest investment of real property inventory at shore activities supporting the Naval ammunition logistics system. This stems, in part, from the fact that existing magazine designs encumber large areas of land to meet the explosives safety quantity distance (ESQD) required to limit the risk of injuries and damage from an accidental explosion in a magazine. Also, the labor and equipment costs are becoming prohibitive to store and retrieve ordnance in today's magazines, especially for today's broad spectrum of ordnance types (containerized missiles and palletized conventional ordnance), and hazard classes of Navy ordnance. Further, the number of magazines required simply to segregate noncompatible weapon systems is driving up the acquisition cost of magazines needed to deploy new weapon systems.

A new magazine design is needed that provides a better balance between operational requirements, explosives safety regulations and economic considerations. In light of the

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growing inventory of ordnance, shrinking supply of buildable land (especially near the waterfront), and rising cost of land, labor and materials, it is important to develop a new magazine design. The new magazine must meet explosives safety regulations within the many constraints imposed by operational requirements, public encroachment, availability and cost of land to accommodate ESQD distances, construction budgets for acquisition of new magazines, and operating budgets to handle the many types, sizes and classes of ordnance in today's inventory.

1.2 Solution

The High Performance (HP) Magazine is a new magazine design being developed by the Naval Facilities Engineering Service Center (NFESC) to solve the operational, safety, and economic problems associated with the storage of ordnance, as described above.

1.3 Performance Goals

The performance goals in development of the HP magazine are as follows:

- Improve the land use by reducing the land area encumbered by ESQD arcs designed to limit the risk of injuries and damage from accidental explosions in the HP magazine. The goal is to reduce the encumbered land area by at least 80 percent, thereby increasing by at least 500 percent the quantity of stored explosives per acre of land.
- Improve the efficiency of storage operations by reducing the time and manpower needed to inspect stored ordnance, to load and unload conveyance vehicles, and to store and retrieve ordnance in magazines.
- Achieve the above performance goals within the many constraints imposed by explosives safety regulations designed to limit the risk of injuries and damage from accidental explosions and fires.

2.0 CONCEPTUAL DESIGN

The HP magazine is an earth-covered box structure. The conceptual design of the HP magazine is described in Figures 1 through 14. The HP magazine consists of two Weapons Storage Areas (Areas 100 and 200), a Shipping and Receiving Area (SRA) (Area 300), an Entrance (Area 400), and a Material Handling System that includes a Bridge Crane, Universal Straddle Carrier, and Forklift. Each of these components is described below.

2.1 Weapons Storage Area (Areas 100 and 200)

A weapons storage area is located at both ends of the earth-covered box structure. Each storage area consists of two storage pits, each 82'-0" L x 20'-0" W x 15'-6" H. These pits provide protected space for storage of containerized and palletized ordnance. The two pits are separated by a transfer aisle (Areas 102 and 202), 82'-0" L x 5'-0" W, for unobstructed transport of ordnance between the storage pits (Areas 101, 103, 201, 203), and the Shipping and Receiving Areas (Areas 301 through 307). Relocatable, modular, cell walls, as shown in Figure 9, can be added to a storage pit, as shown in Figure 7, to subdivide a storage pit into two or more storage cells.

Each storage pit has a cover, consisting of eight sliding pit covers, shown in Figures 2, 3, 7, and 8. By sliding the pit covers horizontally on their tracks, an opening of any size up to a maximum opening of 40'-0" L x 20'-0" W can be made to store and retrieve ordnance in any storage cell. An elevated, relocatable platform supported above one of the sliding pit covers, as illustrated in Figure 8, provides a space for temporary storage of ordnance during storage or retrieval operations in a storage cell.

The transfer aisle, relocatable cell wall, and pit covers are designed to prevent a sympathetic reaction resulting in a detonation in more than one storage cell.

The design of storage cells allows each cell to be treated as a separate magazine. Consequently, noncompatible ordnance can be stored in the same HP magazine, provided each noncompatible storage group is segregated into a different storage cell.

A relocatable, sliding, stow-away, cell ladder is used for personnel to gain access to any storage cell. The ladder is moved manually in a horizontal position above the pit covers on a track as shown in Figure 7. By sliding the ladder in its stow-away configuration on its track, personnel can gain access to any storage cell at any point along the length of the storage pit. The ladder is deployed by rotating the hinged ladder in a vertical plane, as illustrated in Figures 7 and 8. This allows personnel to gain access to the floor of any storage cell.

2.2 Shipping and Receiving Area (Area 300)

The SRA is located at mid-length of the earth-covered box structure, as shown in Figure 1. The SRA is used to load and unload conveyance vehicles. The vehicle is parked in the vehicle pit (Area 301), which accommodates both rail and truck vehicles. Open conveyance vehicles, such as a flatbed truck, are loaded and unloaded using the overhead bridge crane, as illustrated in Figure 14. A side-loading dock (Area 302) and rear-loading dock (Area 304) allow storage and retrieval of ordnance for side-loaded and rear-loaded covered conveyance vehicles, using a forklift located on the loading dock, as illustrated in Figure 13. Also, the side- and rear-loading docks plus the staging dock (Area 303) allow prestaging of ordnance before arrival of the transport vehicle.

The SRA transfer aisles (Areas 305, 306, and 307) provide an unobstructed path for transfer

of ordnance and personnel between the weapons storage pits, loading docks and parked conveyance vehicles. Two of these transfer aisles (Areas 305 and 306) also serve as nonpropagation walls that prevent a sympathetic reaction resulting in a detonation in the SRA and any weapons storage cell.

2.3 Entrance (Area 400)

The entrance provides the path for vehicle access (Area 401) and personnel access (Area 402) to the SRA, as shown in Figures 1 and 6. The vehicle entrance accommodates both rail and truck. Personnel enter the SRA through the personnel entrance (Area 402), climb the stairs located in Area 302, and walk along the transfer aisles (Areas 102, 202, 305, 306, and 307) to reach any storage cell.

2.4 Soil Cover

The box structure is covered with a blanket of soil, as shown in Figures 2 through 5. The depth of soil cover is designed to limit the maximum launch velocity of debris, and thus the maximum strike range of box-structure debris and weapon fragments from MCEs inside the HP magazine. The soil cover over the box-structure will be about 2'-0" to limit the ESQD distance to about 1250 ft. maximum, based on the 1250-ft safe debris distance allowed by explosives safety regulations for standard earth-covered magazines.

2.5 Material Handling System

The Primary Material Handling System consists of two overhead bridge cranes, two universal straddle carriers (USCs), and one forklift, as shown in Figure 10. The Backup Material Handling System consists of one overhead bridge crane, one universal straddle carrier (USC), and one forklift as shown in Figure 11. The bridge crane travels the full length (230'-0") of the HP magazine and is used to store, retrieve and transport ordnance in the storage cells, on the loading docks, and on the conveyance vehicle parked in the SRA. The crane hoist has a capacity of 6 tons to lift the heaviest ordnance package in the USN inventory (TOMAHAWK UGM-109-C (Tactical) missile weighing 8,963 lbs) or a stack of containers, canisters, or pallets, provided the stack is 12,000 lb maximum stack weight, 7'-0" maximum stack height, and 2,000 lbs maximum stack explosive weight. The bridge spans the width of the magazine (49'-0") and the trolley has a twin hook hoist equipped to rotate a suspended stack of pallets or containers 90 degrees in a horizontal plane. The forklift is dedicated to the loading dock area for side- and rear-loading covered conveyance vehicles.

3.0 ORDNANCE OPERATIONS

3.1 Operating Procedure

The following procedure is used to store, retrieve and transport ordnance in the HP magazine. The procedure applies to a storage operation. The procedure is reversed to retrieve ordnance from a storage cell and to transfer it to either an uncovered transport vehicle parked in the

SRA or to one of the loading docks in the SRA.

Step 1: The ordnance arrives on a flatbed truck or railcar and the vehicle is parked in the vehicle pit in the SRA, as shown in Figure 14.

Step 2: The pit covers over the appropriate storage cell are slid horizontally to the sides to open up access to the appropriate storage cell, leaving pit covers in their closed position over all other storage cells, as illustrated in Figures 7 and 8.

Step 3: The bridge crane and its hoist trolley are moved into position directly over the ordnance package or stack to be removed from the vehicle.

Step 4: The universal straddle carrier (USC) is connected to the twin hoist hooks and the USC is lowered over the ordnance stack (containers or pallets). The operator inserts the appropriate pins to couple the ordnance stack with the bridge crane, as illustrated in Figure 10.

Step 5: The hoist trolley lifts the ordnance stack vertically to an elevation about 1'-0" above the elevation of the pit covers, rotates the stack 90 degrees, if required, so that the length of the stack is parallel to the length of the storage transfer aisle, and moves the stack along the bridge to a point directly in line with the storage transfer aisle.

Step 6: The ordnance stack is moved horizontally by the bridge along a path directly above (1'-0") the transfer aisle floor to the point directly adjacent to the appropriate stack in the appropriate storage cell.

Step 7: The ordnance stack is moved by the trolley along the bridge to the point directly above the appropriate stack in the storage cell.

Step 8: The hoist is used to lower the stack onto the existing stack or pit floor. The USC is removed from the stack by releasing pins in the USC and raised from the storage cell. The pit covers are then slid into their closed position over the storage cell.

3.2 Explosive Limits

The explosives storage capacities of the HP magazine are as follows:

- Left Storage Area (Area 100) = 120,000 lb NEW (maximum of 60,000 lb NEW per storage pit; maximum of 30,000 lb NEW per storage cell)
- Right Storage Area (Area 200) = 120,000 lb NEW (maximum 60,000 lb NEW per storage pit; maximum of 30,000 lb NEW per storage cell)
- Shipping and Receiving Area (Area 300) = 55,000 lb NEW (conveyance vehicle plus loading docks)

- HP Magazine (Areas 100, 200, and 300) = 295,000 lb NEW Total

3.3 Storage Plans

Typical stowage plans for storing various containerized and palletized ordnance in the storage pits (Areas 101, 103, 201 and 203) of the HP magazine are presented in Figures 16 through 19. The stowage plans are based on the following stowage requirements.

- 0'-6" minimum air space between any ordnance and an exterior pit wall.
- 1'-0" minimum space between the sides of adjacent stacks of containers or pallets in order to deploy the universal straddle carrier to lift any stack in the storage cell.
- 3'-0" minimum air space from face of interior pit walls and relocatable cell walls to the face of bombs and other ordnance having a high explosive density per cubic foot of ordnance.
- 3'-0" minimum air space between the pit floor and bottom of bomb stacks and other ordnance stacks having a high explosive density per cubic foot of ordnance.
- 2'-6" minimum aisle space along width of storage cell (20'-0"), somewhere along the length of each storage cell for deployment of the stow-away cell ladder.
- 1'-4" minimum aisle space along length of each storage cell (parallel to transfer aisle) for personnel to inspect ends of any container.
- Total NEW in a storage cell must not exceed the NEW limit specified by the curve shown in Figure 15.
- The stack height shall not exceed 15'-0" or the safe maximum number of containers or pallets allowed in a stack, whichever is less.
- All weapons in the same storage cell shall be compatible for storage, as defined by NAVSEA OP-5 explosives safety regulations.

4.0 PERFORMANCE

4.1 Maximum Credible Events

The HP magazine reduces, by more than 80 percent, the land area encumbered by ESQD arcs designed to limit the risk of injuries and damage from accidental explosions. This reduction in encumbered land area is achieved by limiting the maximum credible event (MCE) in the HP magazine to a small fraction of the total net explosive weight (NEW) capacity (295,000 lb. NEW) of the magazine. For example, the storage cells, transfer aisles and SRA are designed to prevent a mishap from resulting in detonations in two or more storage cells and in

SRA plus any storage cell, considering all possible mechanisms of a sympathetic reaction, as described in Figure 19. Consequently, the MCEs for the HP magazine are inadvertent detonation of the maximum NEW stored in any storage cell (30,000 lb. NEW), the maximum NEW stored in the SRA (about 55,000 lb. NEW), and the maximum NEW transported along a storage transfer aisle (2,000 lb. NEW). The reduced MCEs, in combination with the 2 feet of soil cover over the box structure, reduce the ESQD distance to no more than 1250 feet (safe distance from debris and fragments) beyond the magazine wall in the rear direction, and 1330 feet (safe distance from the blast overpressure, $35W^{1/3}$ where $W = 55,000$ lb NEW) beyond the magazine wall in the side and front directions. These ESQD distances will protect people and property outside the magazine from the blast, fragment and debris hazards resulting from the MCEs inside the magazine.

4.2 Maximum Credible Hazard Scenarios

The maximum credible hazard scenarios have been defined for the HP magazine. The hazard scenarios consider all credible mishaps that could lead to a detonation, explosion, or fire resulting in a detonation exceeding the design MCEs for the HP magazine, including the design MCE for storage cells, transfer aisles, loading docks, and shipping and receiving area.

4.3 Land Efficiency

The HP magazine reduces, by at least 84 percent, the land area encumbered by ESQD arcs designed to limit injuries and damage from an accidental explosion inside the magazine. The basis for the 84 percent reduction is shown below.

Magazine	Total NEW (lb)	ESQD Distance (ft)			Encumbered Land (acres)
		Front	Side	Rear	
Standard Earth-Covered Box	295,000	3328 ^a	3328 ^a	3328 ^a	842
HP Magazine	295,000	1331 ^b	1331 ^b	1250 ^c	137

^aESQD = $50W^{1/3}$ for $W > 250,000$ lb NEW.

^bESQD = $35W^{1/3}$ for $W < 100,000$ lb NEW, but not less than 1250 ft.

^cESQD = $25W^{1/3}$ for $W < 100,000$ lb NEW, but not less than 1250 ft.

4.4 Construction Cost Efficiency

The HP magazine will cost more to build than a conventional type magazine. The exact increase in the construction cost, compared to a standard earth-covered box magazine, is not known at this time. However, this extra investment will surely yield a major payback when the reduced costs of land and operations are included in the cost benefit analysis. And the higher the value of land, the greater the benefit derived from the HP magazine.

5.0 BENEFITS

The High Performance Magazine offers the following benefits:

- Reduce by at least 84% the land area encumbered by explosives safety (ESQD) arcs designed to protect people and property from effects of an accidental explosion.
- Reduce by at least 61% the safe standoff distance required from inhabited facilities and property lines.
- Allows noncompatible ordnance to be stored in the same magazine, thereby reducing the number of magazines needed to store a fixed inventory of ordnance.
- Offers the potential of utilizing sites located closer to platforms (e.g. homeports) that previously could not be used as storage sites because of a limited supply of land or public encroachment.
- Capability to store ordnance close-in to platforms (aircraft and ships) because of smaller ESQD distances required for safety of people and property.
- Fewer work crews and less equipment and time needed for storage and retrieval of ordnance.
- Allows more efficient use of land in an era of downsizing, consolidation, and base closures.
- Reduces operating costs in an era of less manpower.
- Provides weather protected shipping and receiving area.
- Barricaded siding (Area 301) for temporary storage of ordnance loaded vehicles.
- Lower total acquisition cost (land plus facility) in an era of reduced construction budgets.
- Improves storage efficiency, selectability and versatility.
- Capability to HVAC only individual pits storing those weapons requiring temperature and humidity control, thereby reducing operating costs.
- Avoids land acquisition costs and provides a scheme to free-up land for other uses.
- Means to accommodate public encroachment without reducing ordnance

operations or forcing base closures.

- Provides capability to pre-stage ship's ordnance load near waterfront.
- Major increase in survivability of ordnance in a combat environment.
- Reduce physical security costs by increasing the denial time to forced entry and by reducing perimeter around magazines.

6.0 DEVELOPMENT PLAN

NFESC is the principal development activity for the HP magazine. The HPM project was initiated in FY91 with 6.2 funding from the Office of Naval Research (ONR). The Development Plan for the demonstration (6.3A) and certification (6.3B) phases of the HP magazine project are summarized in Table 1. The development status of the HP magazine is summarized below.

6.1 Design Definition

The conceptual design of the HP magazine has evolved with the technology base developed by the HPM project. Major changes resulted from definition of the maximum credible hazard scenarios associated with ordnance operations, and the risk mitigation strategies needed to cope with possible mishaps that could lead to a detonation or explosion involving more than a small fraction of the total ordnance inside the HP magazine. Further conceptual design changes resulted from the new technology base generated by the HPM project on the performance of composite storage-cell walls required to prevent a sympathetic detonation from all possible mechanisms of a sympathetic reaction (see Figure 20) resulting from the MCEs in HPM storage cells, transfer aisles, loading docks, and conveyance vehicles. Evidence of the benefit derived from new technology for the design of nonpropagation cell walls is shown in Figure 21. Also, other conceptual design changes resulted from HPM generated technology base on the performance of an earth-covered box with a tunnel entrance (a box with restricted venting from a partially confined internal explosion) to limit the safe distance outside the HP magazine from the blast, fragment and debris hazards resulting from the MCEs in storage cells, transfer aisles, loading docks and conveyance vehicles.

The current conceptual design of the HP magazine is described in Figures 1 through 14. More changes may occur in the project certification phase but any changes are not expected to alter the basic design features shown in Figures 1 through 14.

6.2 Feasibility

NFESC has completed the 6.2 feasibility phase of the project in which it was concluded that the HP magazine concept is feasible, based on results from computer code analysis of MCE detonations and fires inside the HP magazine, and from explosive tests involving MCE detonations in small-scale structures. Some explosive tests involved detonations inside an

earth-covered box structure with a tunnel entrance to evaluate the safe distance from blast pressures and facility debris. Other explosive tests involved detonations near one face of various cell-wall designs to evaluate the capacity of hi-tech walls to prevent an MCE detonation near one face of the wall from causing sympathetic reaction of acceptor ordnance located behind the wall. Another study involved a thermal analysis of the HP magazine to evaluate if the MCE fire in a conveyance vehicle (or in a storage cell) would cause thermal cook-off of ordnance located in any storage cell.

6.3 Demonstration

NFESC has completed the 6.3A demonstration phase of the project in which NFESC conducted two full-scale and one 1/4-scale explosive tests (Table 1) that demonstrated explosives safety performance of the HP magazine. The test structure was a full-scale storage cell. The tests involved detonating 10,000 lb. NEW of MK82 bombs inside the storage cell with pit covers in their closed position over the top of the donor storage cell (the confining effects of the pit covers were simulated by a layer of soil). Acceptor pallets of MK82 bombs and 155 projectiles were located behind three of the cell walls to simulate ordnance stored in adjacent storage cells. Two cell walls were relocatable, nonpropagation walls. The third cell wall was a stationary transfer-aisle wall. The fourth wall was a dummy wall designed to simulate the confining effects of the exterior walls of the HP magazine on the blast environment inside a storage cell.

The first test involved acceptor pallets of inert MK82 bombs and 155 projectiles. Measured acceptor accelerations (from combined effects of air shock waves, debris impact and fragment impact) and post test inspection of acceptor ordnance showed that the acceptor environment was less than the threshold environment required to cause a sympathetic detonation, explosion, or fire from direct shock stress in the explosive, primary fragment impact on acceptor casing, and deformation of the acceptor case (see Figures 20 and 21). The second explosive test involved live acceptor ordnance and was executed on 19 August 1993 at Naval Weapons Station, China Lake, California. This second explosive test did not cause sympathetic reaction of any live acceptor ordnance. In fact, all acceptor ordnance survived effects from the 10,000 lb NEW detonation with almost no damage, as shown in Figure 21b.

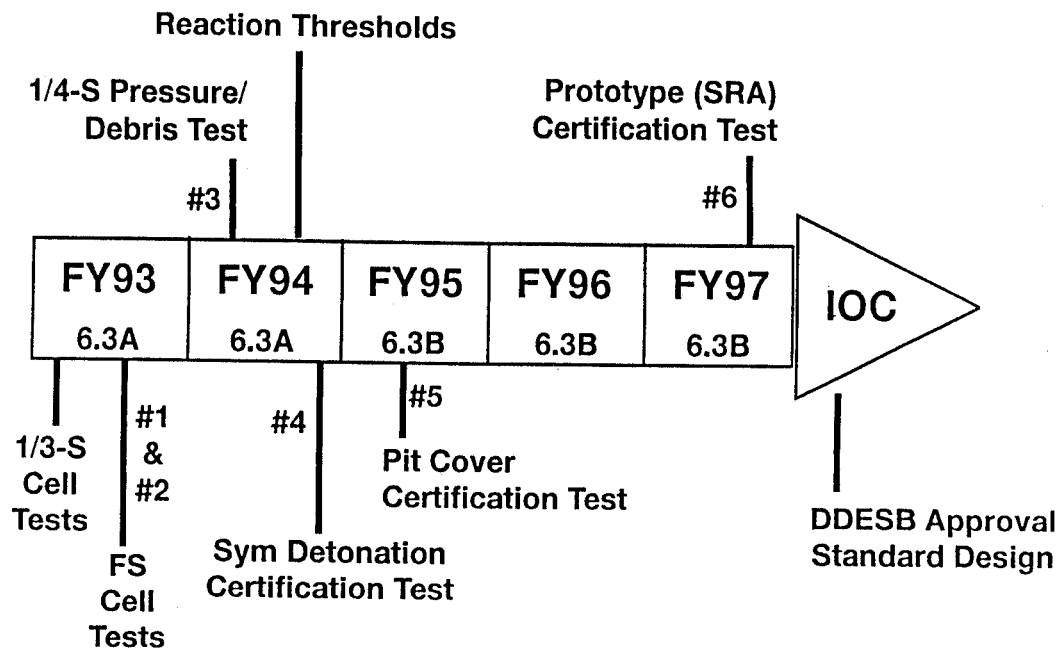
6.4 Certification

Three full-scale explosive tests (Tests 4, 5, and 6 in Table 1) are scheduled for FY95 through FY97 to certify explosives safety of the prototype design for the HP magazine. These tests are designed to certify explosives safety of the nonpropagation relocatable storage cell walls, pit covers over the storage cells, nonpropagation transfer aisle walls in the storage area and SRA, and the blast, fragment and debris hazards produced outside the magazine from the MCE in a storage cell (Test 4), in a transfer aisle (Test 5), and in the SRA (Test 6). These tests will be conducted at the Naval Weapons Station, China Lake, California.

6.5 Standard Design

The Standard Design for the HP magazine is scheduled to be developed by NFESC in 1996, approved by the Department of Defense Explosives Safety Board, and issued by the Naval Facilities Engineering Command as a Standard Design in 1997.

Table 1. Development plan for demonstration phase (6.3A) and certification phase (6.3B) of HP magazine project.



Project Phase	Sympathetic Detonation Tests				Pressure/Debris Tests		Oper. Tests
	Relocat. Wall	Aisle Wall	SRA Wall	Pit Covers	Storage Area Soil Cover	SRA Soil Cover	
Demonstration FY93 (6.3A)	X X Tests #1 & #2				X X Test #3		
Certification FY94 (6.3A)	X X Test #4				X Test #4		
Certification FY95 (6.3B)				X Test #5			
Certification FY97 (6.3B)			X Test #6	X Test #6		X Test #6	X Test #6

Test Description

#1 & #2 - Full Scale Cell	#5 - Full Scale HPM Aisle & Adjoining Cells
#3 - 1/4 Scale HPM	#6 - Prototype HPM
#4 - Full Scale Half HPM	

Table 1. Development plan for demonstration phase (6.3A) and certification phase (6.3B) of HP magazine project.

Figure 1. High Performance Magazine, Type 2: Floor plan.

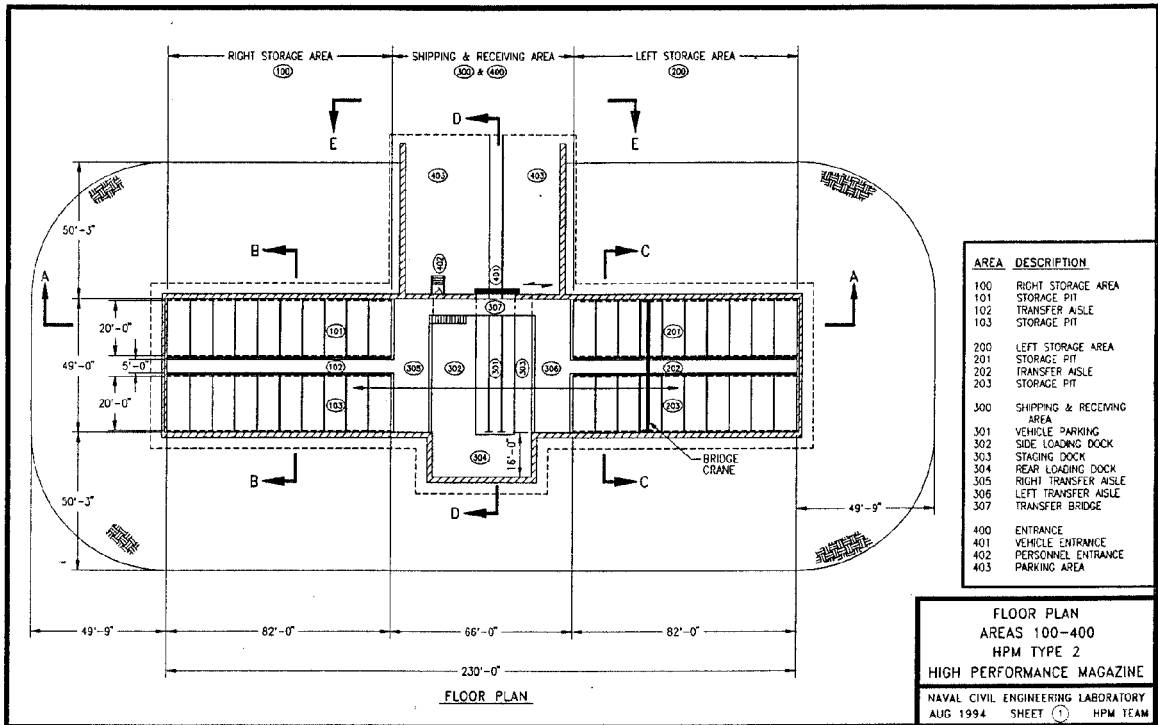


Figure 1. High Performance Magazine, Type 2: Floor plan.

Figure 2. High Performance Magazine, Type 2: Section A-A, elevation view of storage areas and shipping and receiving area.

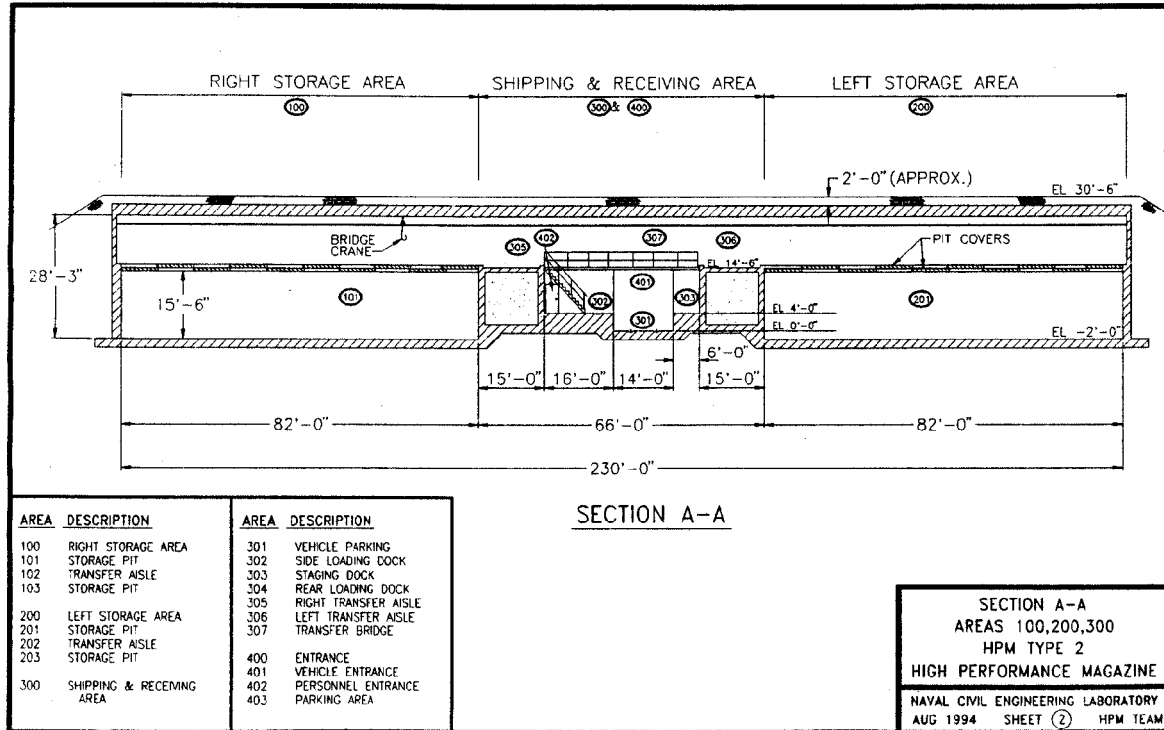


Figure 2. High Performance Magazine, Type 2: Section A-A, elevation view of storage areas and shipping and receiving area.

Figure 3. High Performance Magazine, Type 2: Section B-B, elevation view of right storage area.

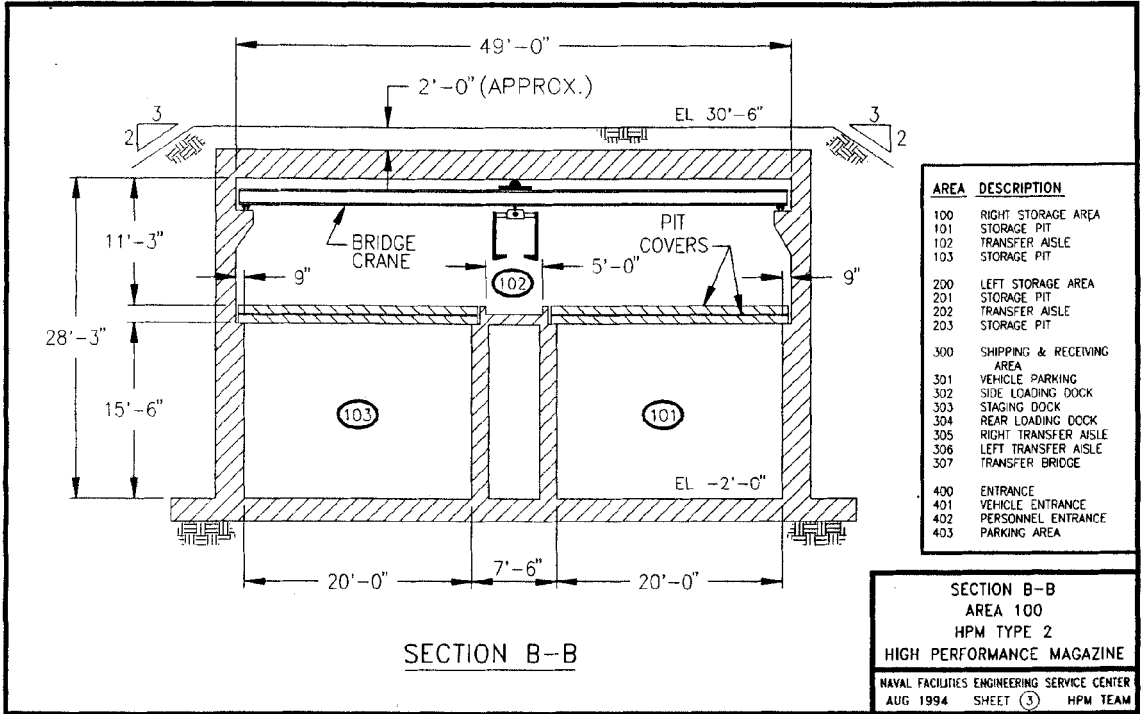


Figure 3. High Performance Magazine, Type 2: Section B-B, elevation view of right storage area.

Figure 4. High Performance Magazine, Type 2: Section C-C, elevation view of left storage area.

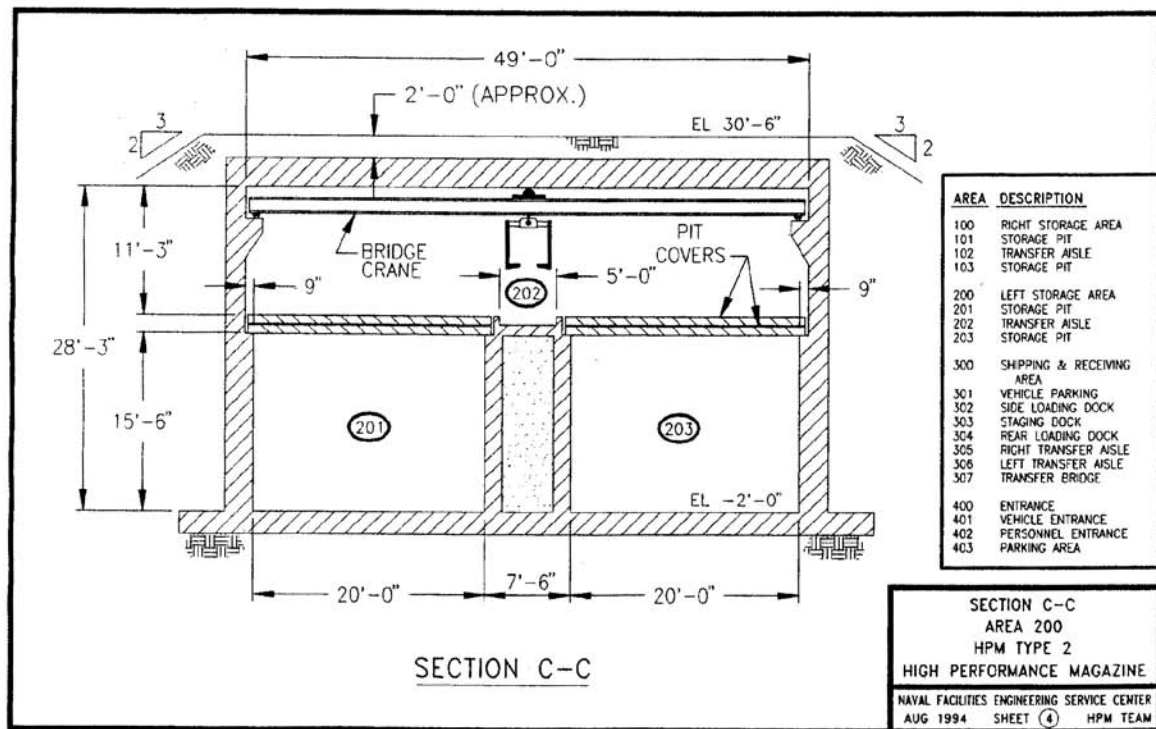


Figure 4. High Performance Magazine, Type 2: Section C-C, elevation view of left storage area.

Figure 5. High Performance Magazine, Type 2: Section D-D, elevation view of shipping and receiving area and entrance.

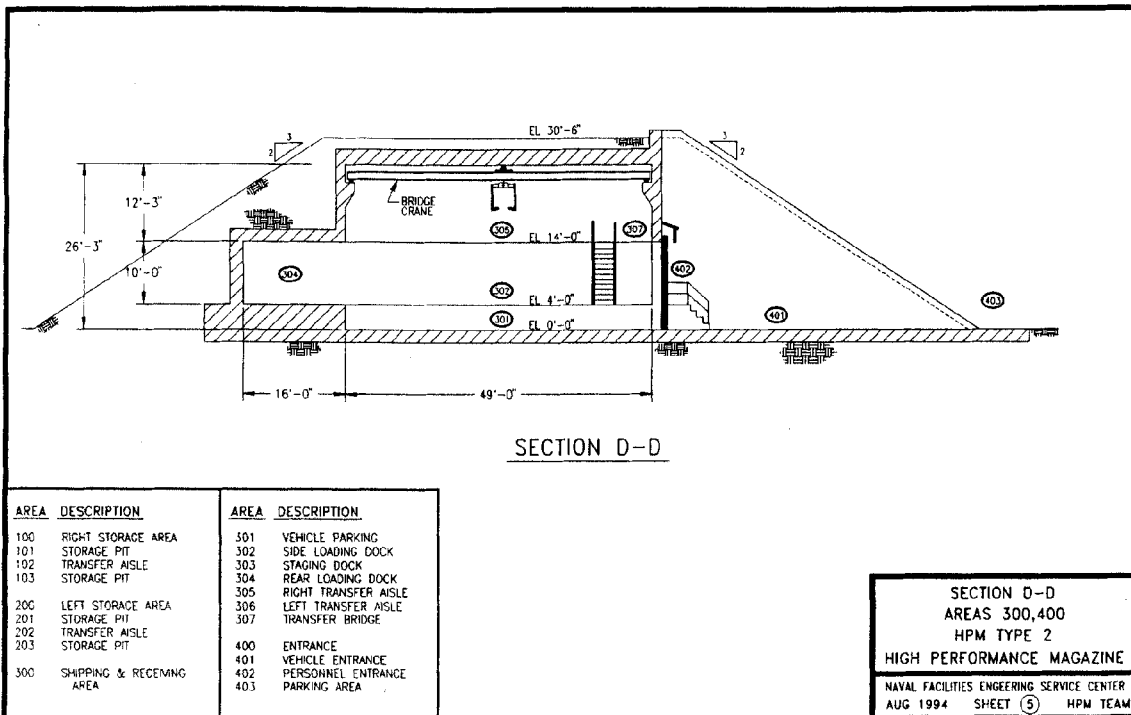


Figure 5. High Performance Magazine, Type 2: Section D-D, elevation view of shipping and receiving area and entrance.

Figure 6. High Performance Magazine, Type 2: Section E-E, front elevation view of magazine entrance.

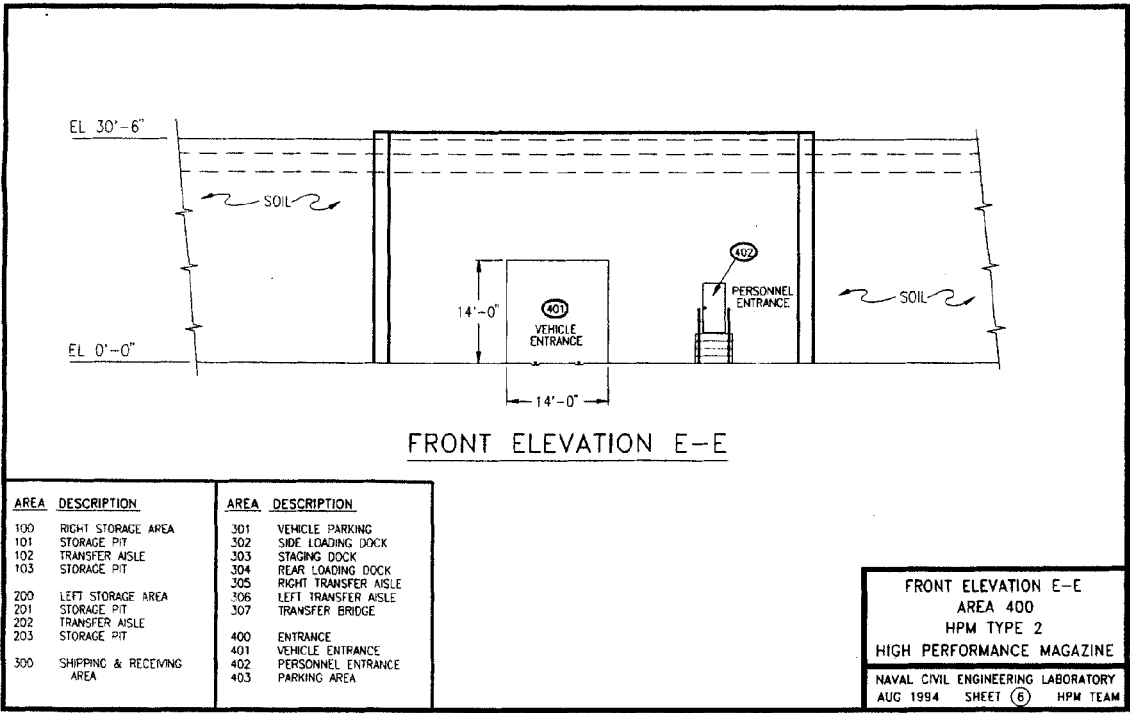


Figure 6. High Performance Magazine, Type 2: Section E-E, front elevation view of magazine entrance.

Figure 7. High Performance Magazine, Type 2: Sliding pit cover, relocatable nonpropagation cell wall, and sliding cell ladder.

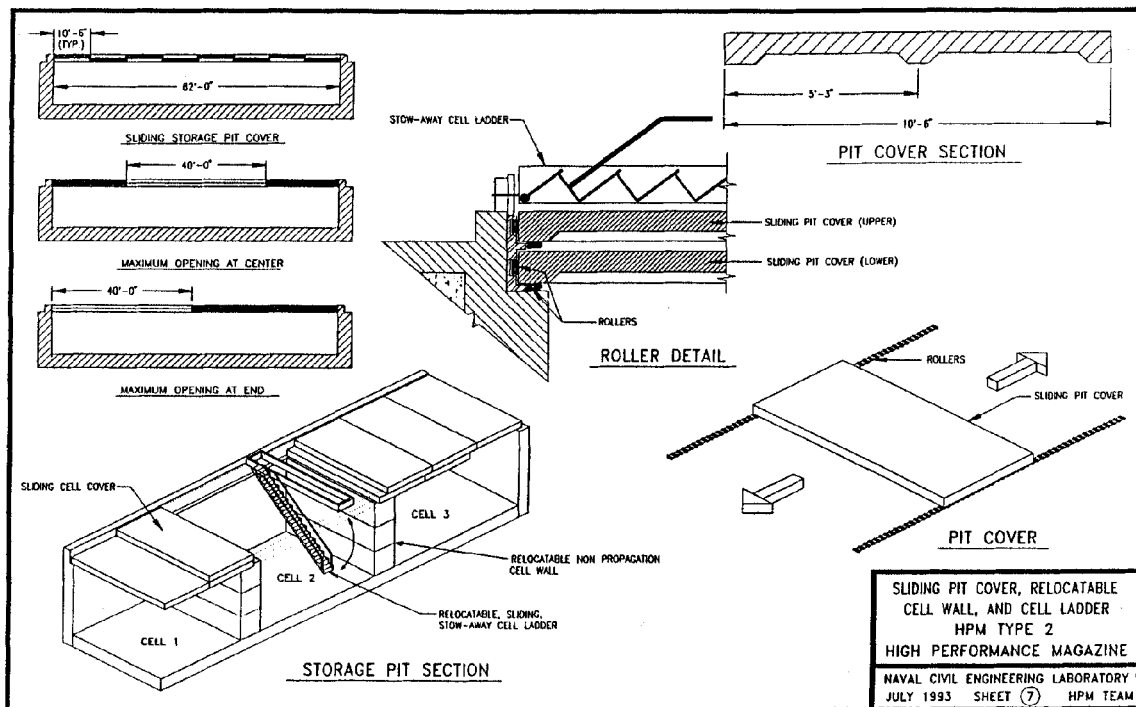


Figure 7. High Performance Magazine, Type 2: Sliding pit cover, relocatable nonpropagation cell wall, and sliding cell ladder.

Figure 8.
Elevated platform above pit cover for temporary storage of ordnance.

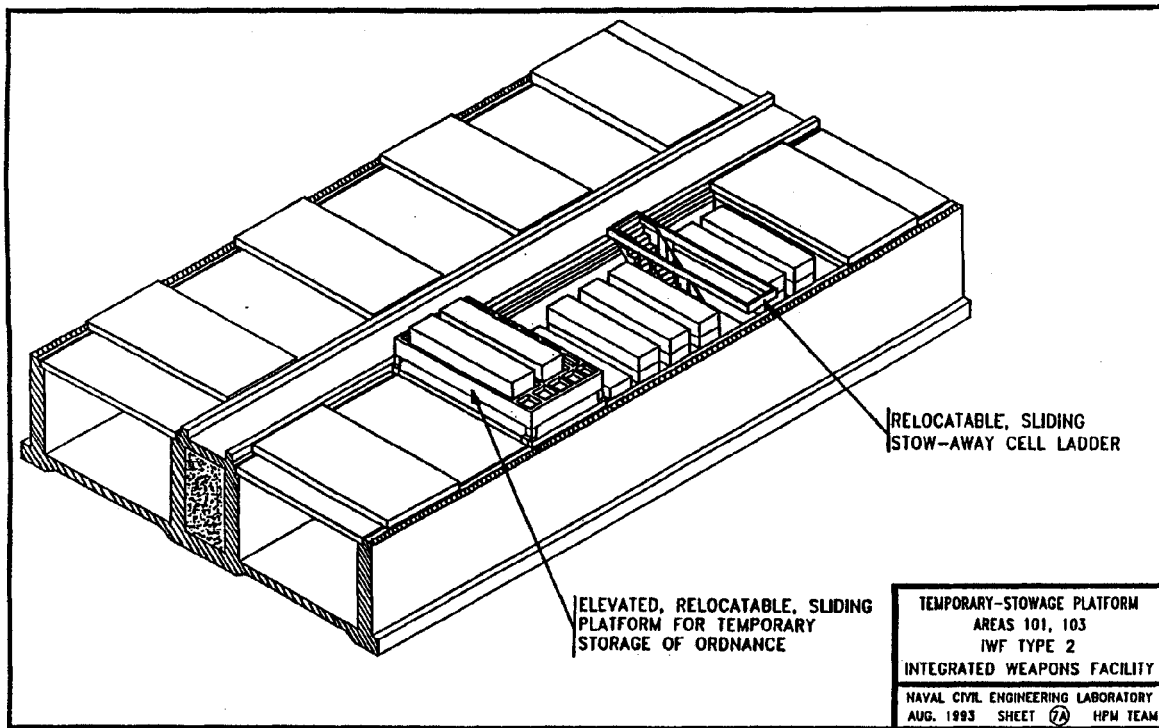


Figure 8. Elevated platform above pit cover for temporary storage of ordnance.

Figure 9. High Performance Magazine, Type 2: Nonpropagation, relocatable cell wall in storage pits.

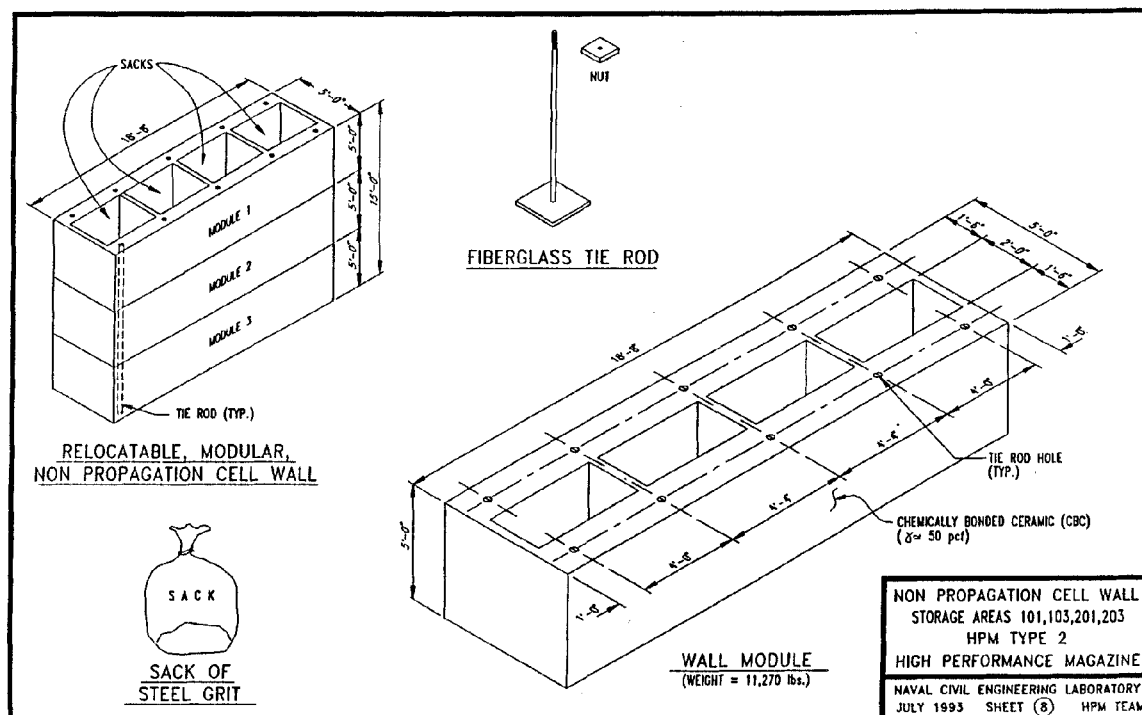


Figure 9. High Performance Magazine, Type 2: Nonpropagation, relocatable cell wall in storage pits.

Figure 10.
High Performance Magazine, Type 2: Primary material handling system.

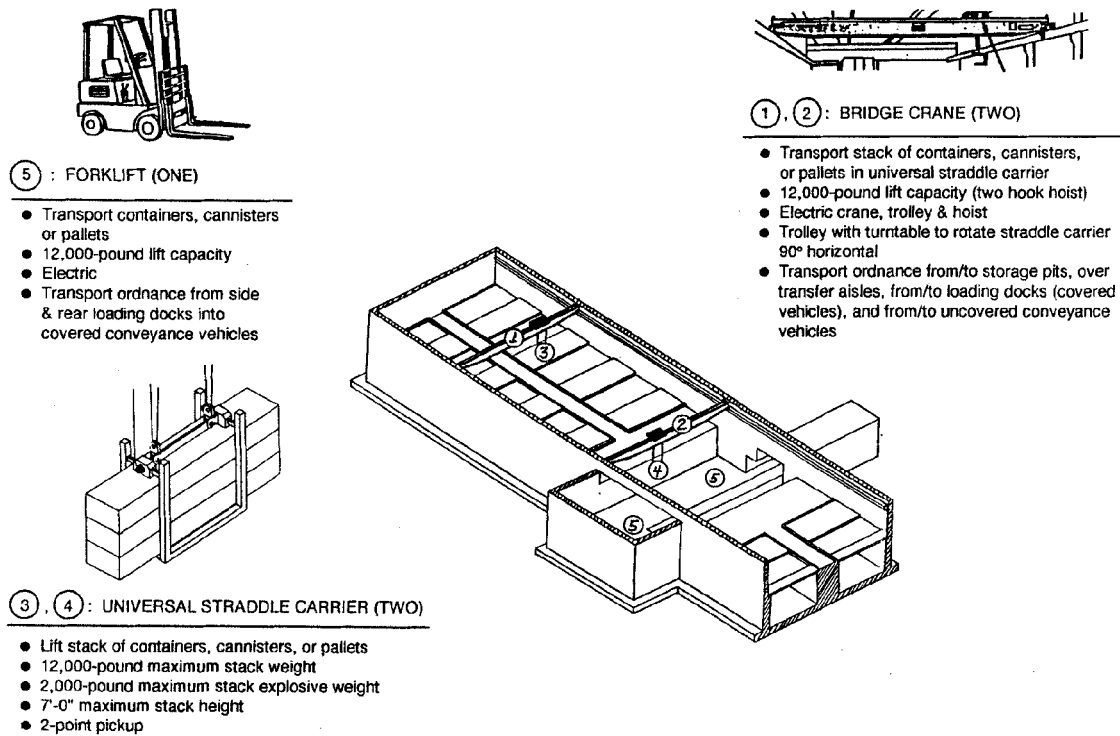


Figure 10. High Performance Magazine, Type 2: Primary material handling system.

Figure 11.
High Performance Magazine, Type 2: Backup material handling system.

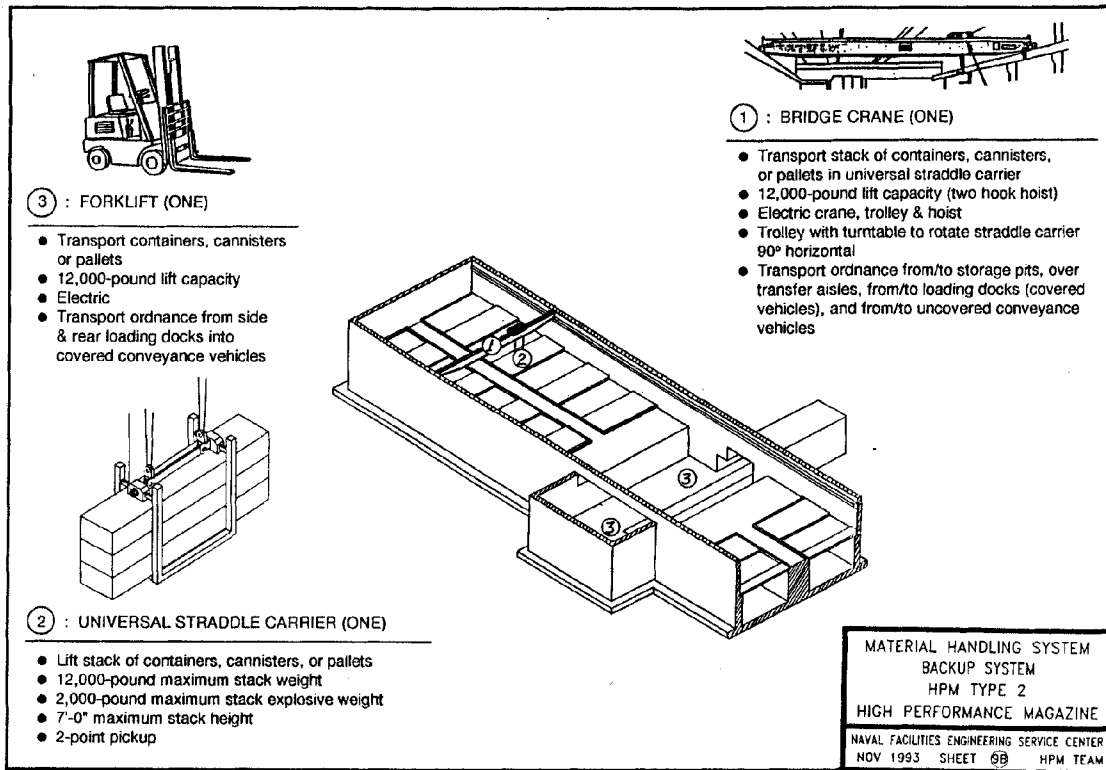


Figure 11. High Performance Magazine, Type 2: Backup material handling system.

Figure 12. High Performance Magazine, Type 2: Material handling system for handling a stack of containers, cannisters, or pallets.

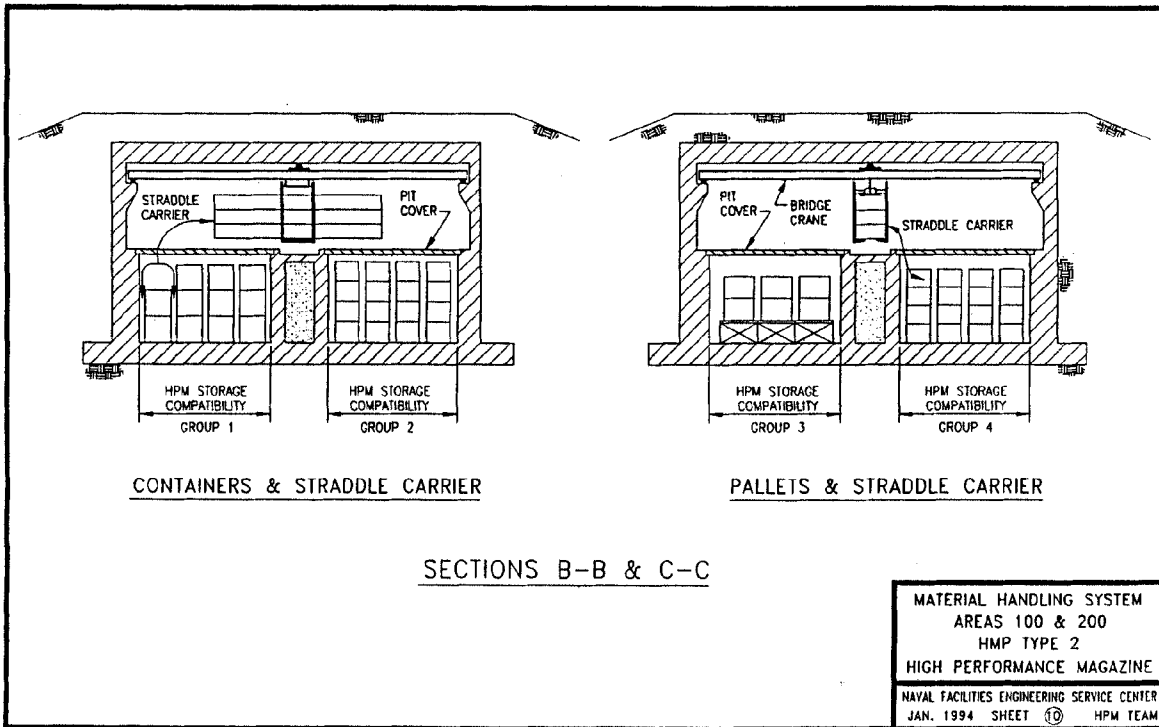


Figure 12. High Performance Magazine, Type 2: Material handling system for handling a stack of containers, cannisters, or pallets.

Figure 13. High Performance Magazine, Type 2: Material handling system for transferring palletized ordnance to/from covered conveyance vehicles.

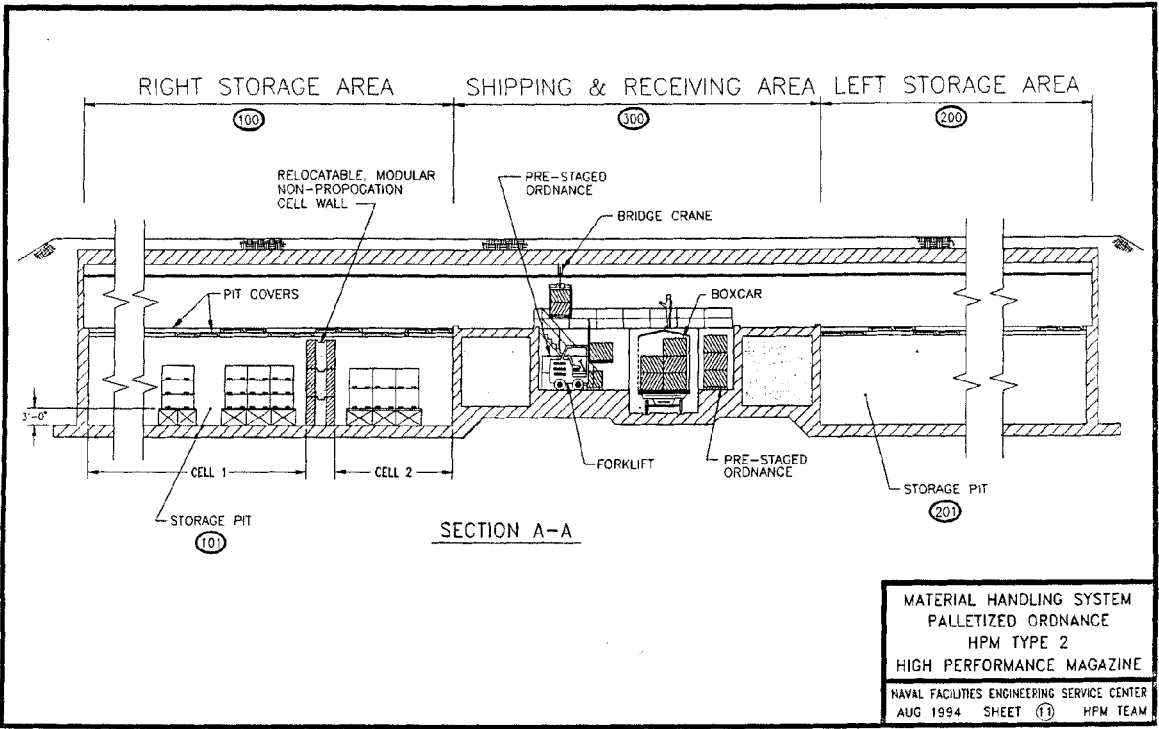


Figure 13. High Performance Magazine, Type 2: Material handling system for transferring palletized ordnance to/from covered conveyance vehicles.

Figure 14. High Performance Magazine, Type 2: Material handling system for transferring containers to/from flatbed trucks.

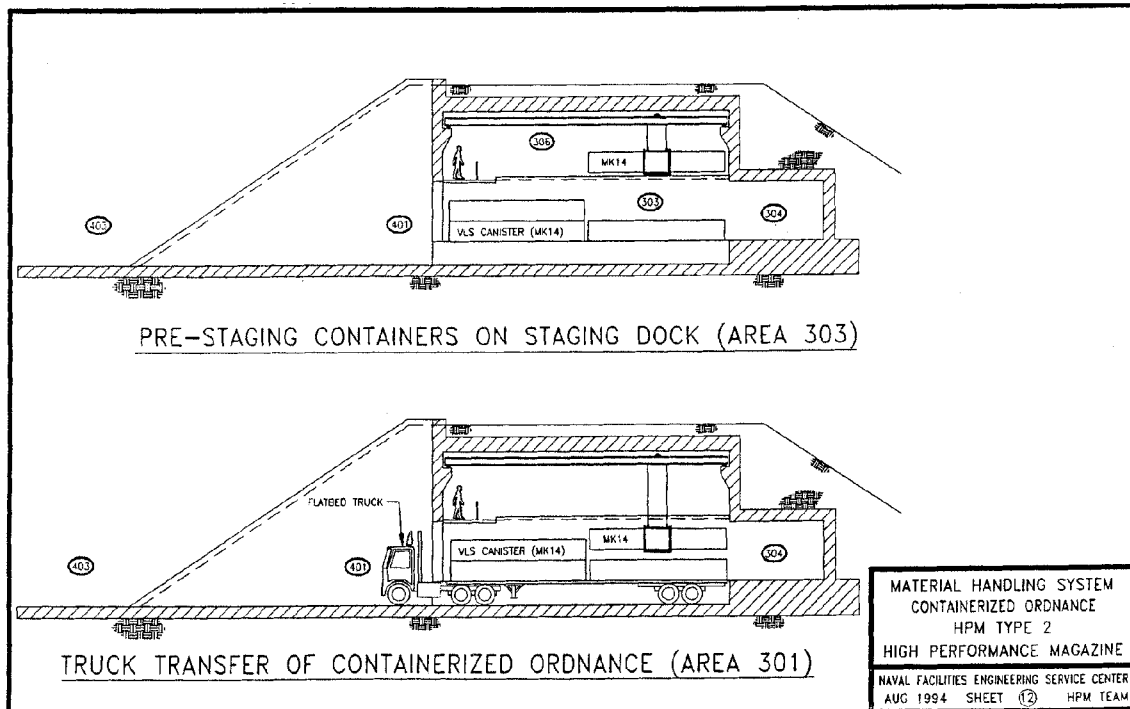


Figure 14. High Performance Magazine, Type 2: Material handling system for transferring containers to/from flatbed trucks.

Figure 15. Explosives storage capacity of storage cells in the High Performance Magazine.

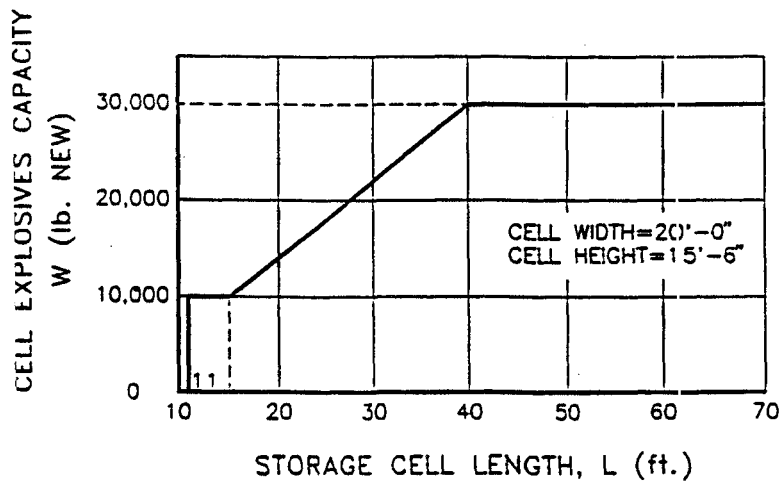
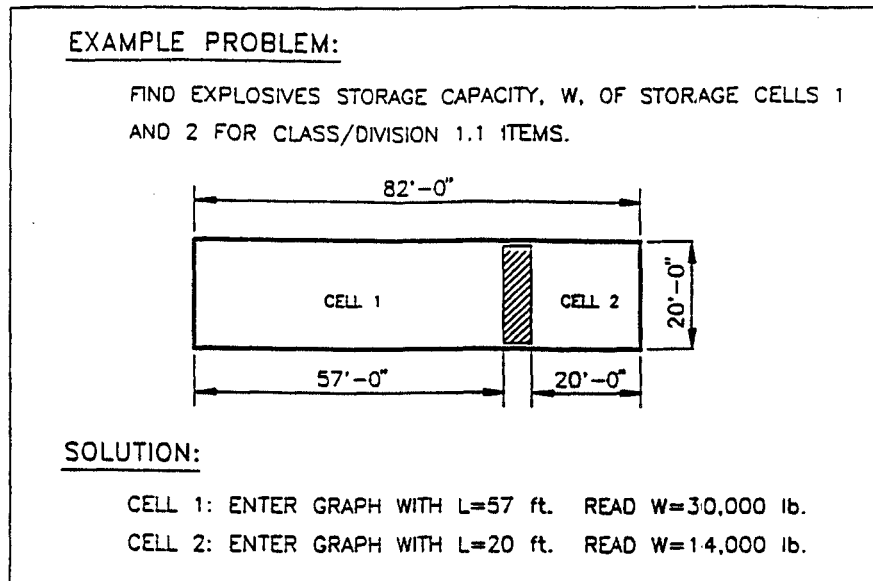


Figure 15. Explosives storage capacity of storage cells in the High Performance Magazine.

Figure 16. HPM stowage plans: Tomahawk (VLS-SUB), Standard (VL), Harpoon (RGM), and Harpoon (UGM).

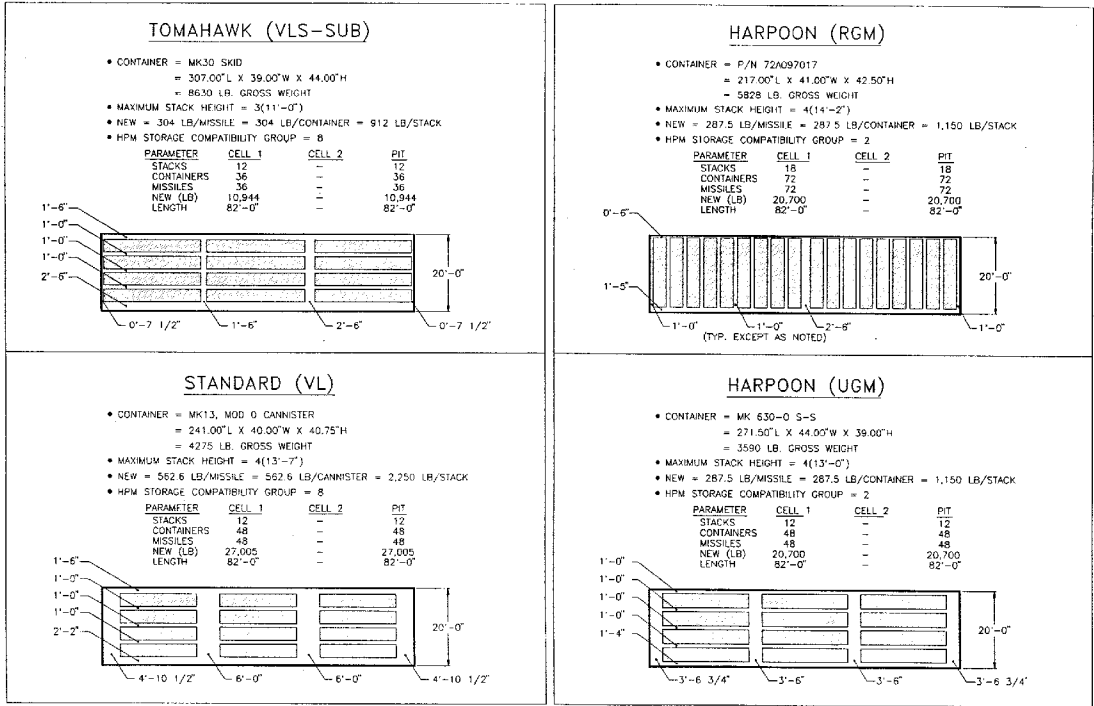


Figure 16. HPM stowage plans: Tomahawk (VLS-SUB), Standard (VL), Harpoon (RGM), and Harpoon (UGM).

Figure 17. HPM stowage plans: Torpedo (MK48), Walleye II (MK37-3), Bomb (MK84). And Bomb (MK82).

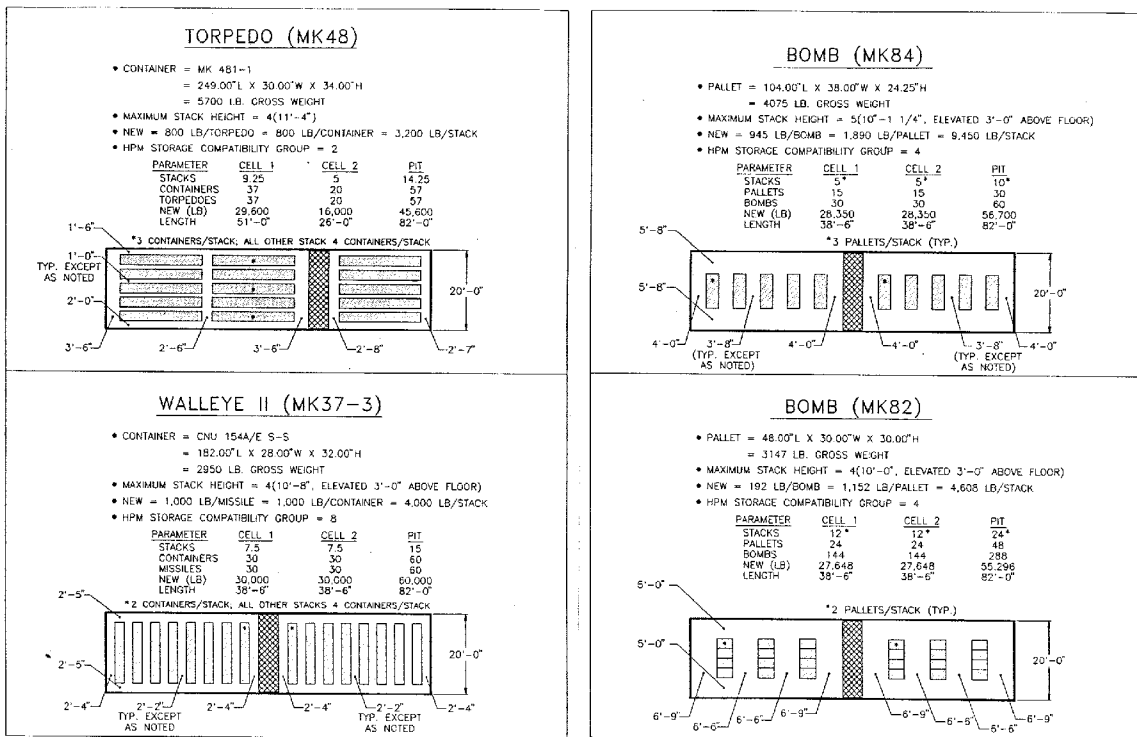


Figure 17. HPM stowage plans: Torpedo (MK48), Walleye II (MK37-3), Bomb (MK84), and Bomb (MK82).

Figure 18. HPM stowage plans: Shrike (AGM-45B), (AGM-84E), 5"/54 Projectile, and Sidewinder (AIM-9).

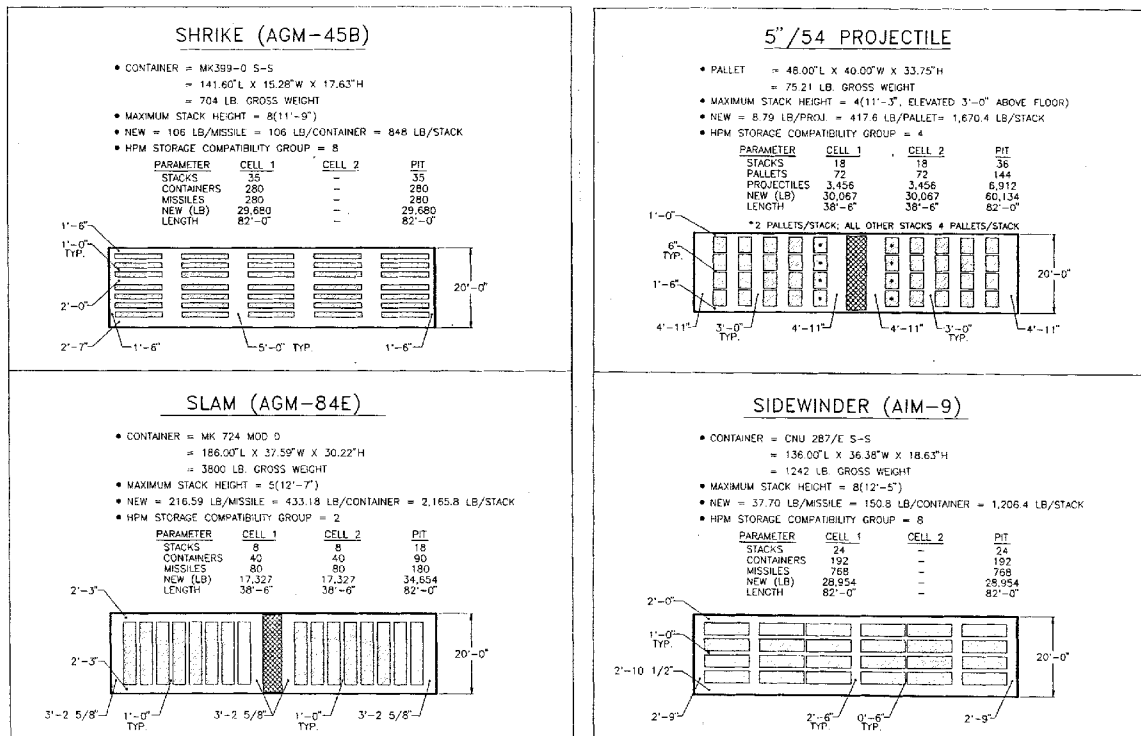


Figure 18. HPM stowage plans: Shrike (AGM-45B), Slam (AGM-84E), 5"/54 Projectile, and Sidewinder (AIM-9).

Figure 19. HPM stowage plans: Stinger (FIM-92), Tow (BGM-71A), Air Sparrow (AIM-7), and Hawk (MIM-23B).

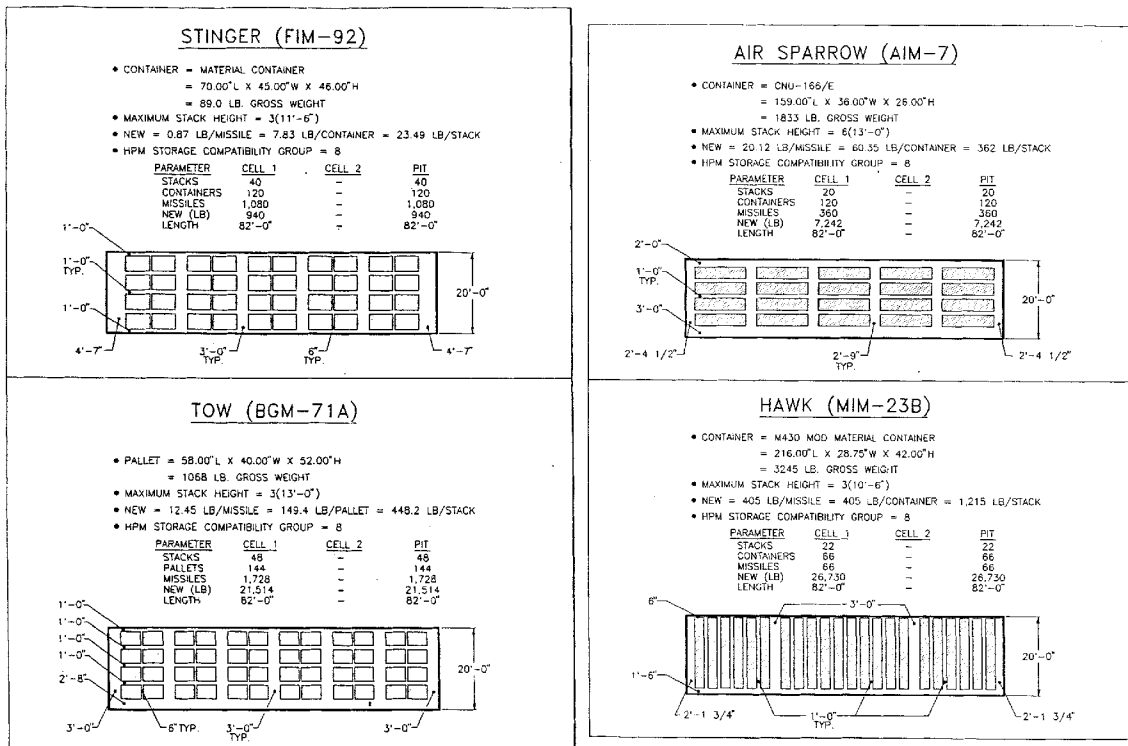


Figure 19. HPM stowage plans: Stinger (FIM-92), Tow (BGM-71A), Air Sparrow (AIM-7), and Hawk (MIM-23B).

Figure 20.
Possible mechanisms for unacceptable reaction of acceptor ordnance.

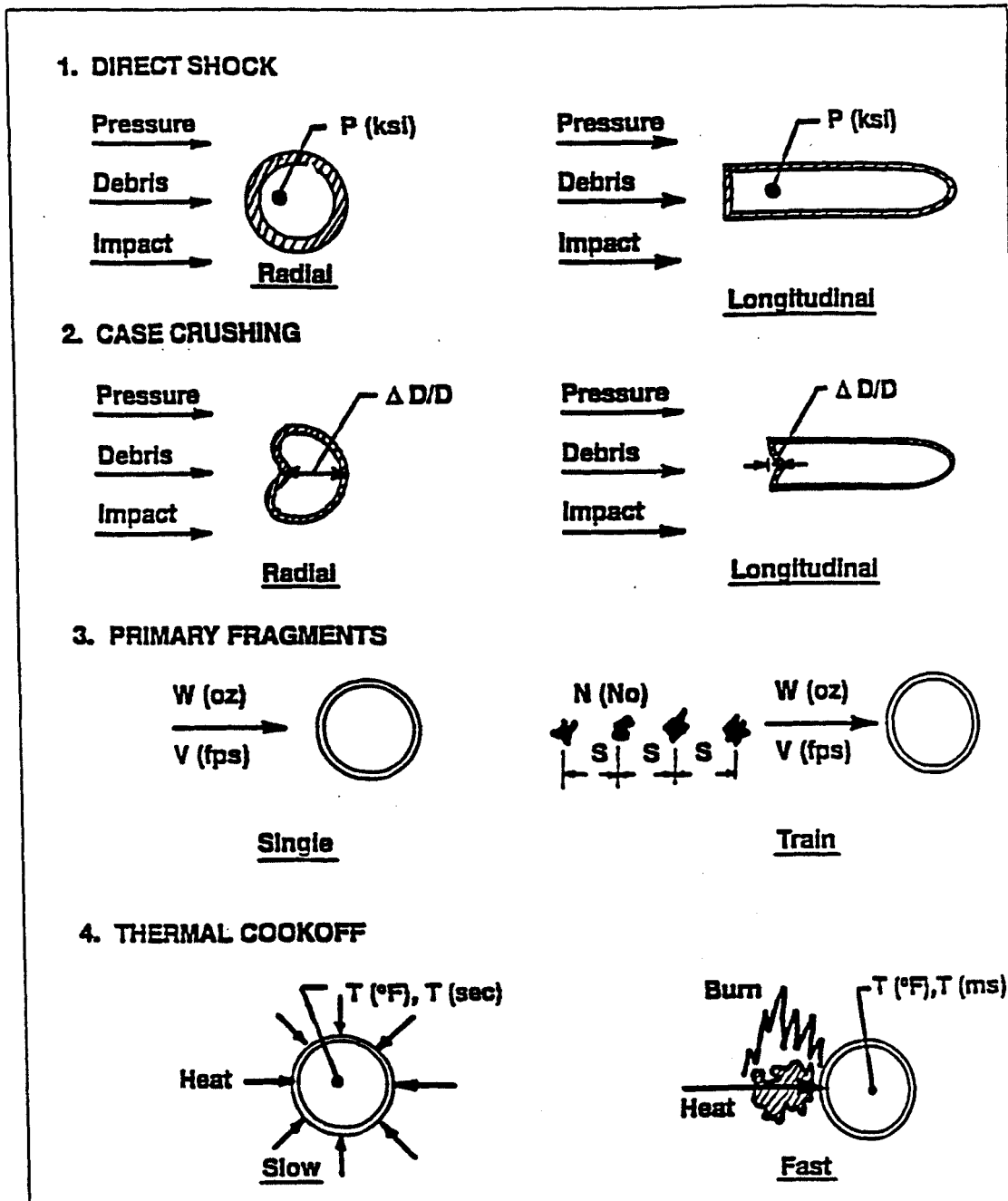
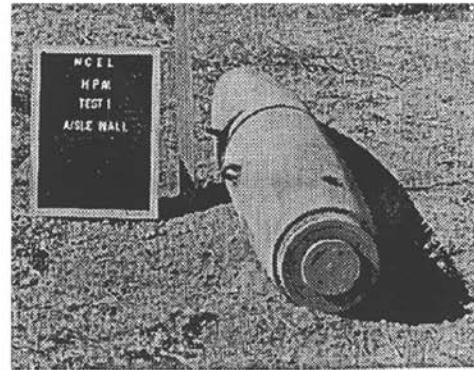
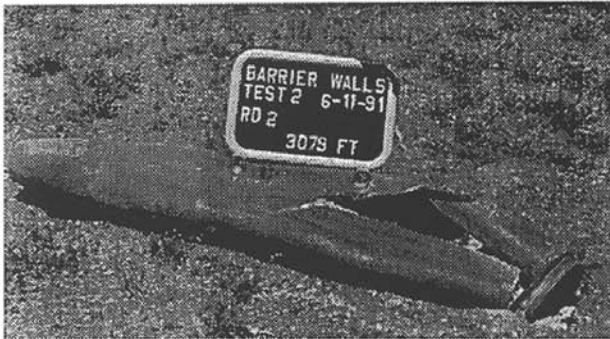
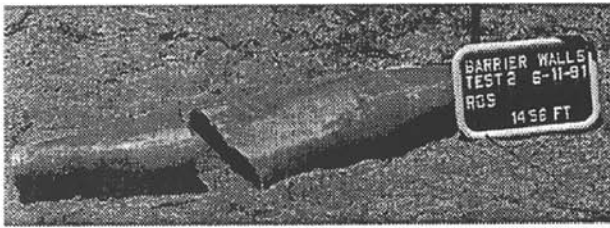


Figure 20. Possible mechanisms for unacceptable reaction of acceptor ordnance.

Figure 21. Reduction in acceptor environment resulting from nonpropagation wall technology. Developed by NFESC in HP Magazine project.



- a. Acceptor damage using old technology:
MK82 acceptor bombs after FY91
Exploratory Development Test 2.

- b. Acceptor damage using new technology:
MK82 acceptor bombs after FY93
Demonstration Test 1.

Figure 21. Reduction in acceptor environment resulting from nonpropagation wall technology
Developed by NFESC in HP Magazine project.