



Lightweight Composite Monopack for 120mm Mortar Ammunition

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Outline



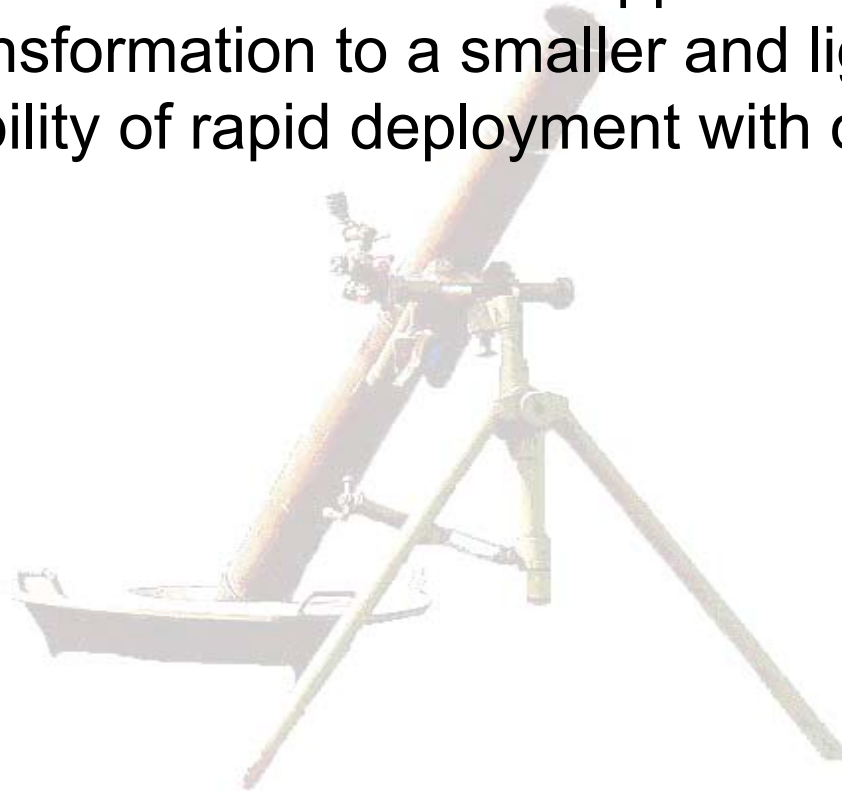
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Objective



To develop a lightweight packing system for the 120mm mortar ammunition in support of the Army's goal of transformation to a smaller and lighter force with the ability of rapid deployment with overwhelming power.





Existing Packaging System



- Packaging system design is marginal in meeting tactical/operational test requirements
- Consists of two 120mm mortar rounds (each round packed in one fiber container and over-packed inside a metal container)
- Slow access time to ammunition.
- Considerable amounts of packaging materials
 - Complicated packing operations at loading facilities
 - Difficult to repacking at the field due to loss of packing components
- Heavy – the package (with 2 rounds of ammunition) weighs 102 lbs.
- Requires two people to handle.



Monopack System Benefits



- Single man-portable (existing system requires two soldiers)
- Eliminates unnecessary packaging layer
- 62% reduction in packaging weight (7 lbs of packaging per round vs. 18.5 lbs for the current system)
- 100% compatible with existing and future tactical mortar vehicle storage and transportation platforms
- Provides quicker and easier access to ammunition
- Simplify field repacking - Reduce burden to soldier
- Enhanced Insensitive Munitions (IM) compliance performance
- Minimizes disposal costs as the Monopack is reusable
- Simplified packaging reduces the packing operation costs at ammunition loading facilities



Container Requirements



- Container design must be capable of surviving 20 years indoor storage conditions and 2 years of outdoor storage environments:
 - Loose cargo: Simulates container in back of truck vehicle
 - Stacking: Simulates a 16 ft high pallet stack weight that one container would support during storage
 - 3 ft Drop Test: Simulate accidental drop from soldier handling
 - 7 ft Drop Test: Simulate accidental drop from a pallet stack or from a truck.
 - 40 ft Drop Test: Simulate accidental drop from helicopter and shipdock loading/unloading.
 - Low surface-gloss for camouflage advantage



Materials Requirements



- The Material of the Monopack must meet the following requirements:
 - Retain dimensional stability over lifecycle of container
 - Resistance to creep
 - Smoke density: Container must demonstrate smoke density less than 200
 - Flame spread index: 25 or less
 - Toxicity: Toxic by products while burning is below levels harmful to humans.
- The container material must have high structural integrity through the temperature range of -65°F and $+160^{\circ}\text{F}$ and demonstrate all previously discussed properties.



Monopack Packaging System

Patent No. US 6,772,877 B1



- Packages one 120mm mortar cartridge
- One layer packaging design allows for quick and easy access to ammunition.
- Lightweight container – only weighs 7 lbs!
- Formed from commercially available fire retardant polyester (thermoset resin) with fiberglass for superior structural integrity.
- Heavy duty latching system for easy open and closure operations.
- Equipped with molded rubber gasket system that provides airtight seal for up to 3 psi pressure differential for adverse battlefield and long-term storage & transportation environments.
- Easy-carry handle for short-distance maneuver.



Technical Challenges

Nylon Carrying Handle

(Patent Pending)



- **CHALLENGE:** Difficulty in meeting design requirements for a two-hand pull test per US Army Human Factors Engineering test standards. Failure occurred at boss closure area.
- **SOLUTION:**
 - Several design iterations from using bonded closure mechanism proved unsuccessful. Deficient design and adhesives were not able to maintain uniform performance.
 - Final design: Robust strap bosses and improved design layout without use of adhesive led to successful results that exceeded the two-hand pull test requirement throughout the -65°F and +160°F temperature range.



Technical Challenges

Latches



Two latches at 180° apart are riveted to the cap.

- Ensure container closure security.
- Used as handles cap removal.
- Ensure maintaining 3 psi seal ability (with specially designed gasket seal system).



- **CHALLENGES:** 3 failure modes were observed during developmental testing:

- J-spring Lever
- Security Secondary Catch
- Latch Pull Force



Technical Challenges

Latches (continued)



- **CHALLENGE 1: J-spring Lever Deformation:**

Following temperature conditioning of containers at -65°F and $+160^{\circ}\text{F}$, the containers were dropped from 3ft in six orientations. The J-spring lever of the off-the-shelf latch deformed/broke, resulting in loss of container seal.

SOLUTION:

- Design improvements made on the J-spring lever significantly improved strength and reduce stress concentration.
- Stringent manufacturing process quality control significantly improved the performance and durability of the latches throughout the duration of the test sequence.



Technical Challenges

Latches (continued)



- **CHALLENGE 2: Security Secondary-catch:** Based on Soldier feedback, a security feature was added on the latch system to prevent accidental opening. However, the feature would often shear off during drop testing sessions. Consequently, the seal of the container was compromised.

SOLUTION: Improved material that could withstand applied loads at extreme high and low temperatures of -65°F and $+160^{\circ}\text{F}$.

- **CHALLENGE 3: Inconsistent Latch Pull Force:** During Engineering developmental testing, it was observed that the latch pull force to engage/disengage latches varied considerably.

SOLUTION: With accurate control of latch system position, optimum pull force was obtained. Moreover, this action led to improved latch performance throughout the Engineering development test sequence.



Technical Challenges

Seal Interface

(Patent Pending)



To maintain seal, the current configuration consists of a robust seal interface design that maximizes the amount of sealing surface area and allows for optimal compression force. With the aid of the latches and mate-positioning of the gaskets, the container is equipped with a good tight seal.

- **CHALLENGES:** The nature of the container does not assist to provide a large seal interface area . Consequently, it is very difficult to maintain seal capability following drop testing.

SOLUTION: Special design to maximizing sealing surface area and compression that is capable of maintaining a high quality seal system, which consistently provides 3 psi seal capability after vigorous series of tests.



Technical Challenges Insensitive Munitions Capabilities



(Patent Pending)

- Monopack does not generate fragmentations. It demonstrates superior capability of meeting Insensitive Munitions Slow Cook-Off and Fast Cook-Off requirements.
- In combination with the use of barriers on pallets, Monopack successfully passed Sympathetic Detonation test requirement. No Propagations on adjacent rounds.



Cost Savings



- Reduction in packaging costs as the Monopack simplifies the packaging operation. Estimated labor cost savings of 50% to package 2 rounds when compared to current configuration
 - Monopack allows one worker to load a container rather than a typical two person process
- Container is reusable (estimated for 3 times)
- Lower shipping costs –
 - For HE, pallet weight is reduced from 2,500 lbs to 2,100 lbs – 16% reduction
 - For Illum and Smoke, palletization efficiency would be increased by 17% from 48 to 56 rounds per pallet.



Program Schedule



- Monopack development contract award (Jul 03)
- Prototype Evaluation Tests (Nov 04)
- Design Verification Tests (Feb 05)
- Container Deliverables (Apr 05)
- Proving Ground Qualification Tests (Aug 05)
- Container Production (Jan 06)
- Container Fielding (Mar 06)



Conclusion



- Reduces logistics footprint, eliminates unnecessary packaging layers and provides quicker access to ammo for the soldiers.
- Revolutionary technology breakthrough listed in ARDEC Center Strategic Plan FY2005-2009. Provides both operational performance (lightweight structure and Human Factors Engineering design) with Insensitive Munitions performance.
- Easy to use and is fully compatible with the existing ammunition storage racks of mortar carrier.
- This technology has been quickly adapted to be the benchmark for future military packaging.
- PGMM will be using the Monopack technology. Novice packaging technology can be integrated to other families of ammunition utilizing cylindrical container packaging.