XM1158 40mm PROXIMITY FUZE EXPLOSIVE TRAIN DESIGN

XM 1112 ANLM (Airburst Non-Lethal Munition)

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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INTRODUCTION

Airburst Non-Lethal Munition (ANLM) Project Overview

  Schedule

  Participating Organizations

Operational Parameters

ANLM Sequence of Operation

Fuze Design Approach

M550 S&A Background

Explosive Train Design

  Initial

  Current

Piston Acutator

Explosive Train Subassembly Testing & Results

Other Fuze Subassembly Tests

SUMMARY – QUESTIONS?

ANLM Demo Functioning Video
• The XM1112 Airburst Non-Lethal Munitions provides selective non-lethal area denial, crowd dispersion or individual/crowd behavior control capability. The system will provide consistent non-lethal effects & significantly increase range capabilities. Proximity fuze enables airburst delivery of NL payloads throughout operational ranges. It has user settable proximity delay mode for room clearing.

• The Joint Non-Lethal Weapons Directorate (JNLWD) is the executive agent for all NL capabilities within DOD and are the program sponsor. The ANLM is a joint program between the US Army, the lead service, and US Air Force. The US Navy and US Marine Corps have expressed program support.

• The XM1112 ANLM is the Tactical Non-Lethal Munition Increment I Capabilities Development Document material solution that was JROC approved on 14Jul08.

• The XM1112 is presently under PM Soldier Weapons management and executed by US Army, ARDEC. Upon approval of Milestone C the program will be transitioned to PM Close Combat Systems for production.
• Airburst Non-Lethal Munition (ANLM)
  – Type Designation XM1112
    • Fuze Type Designation XM1158

– Schedule
  • Concept Demo    July 2006
  • Milestone B     March 2009
  • Fuze Sub-assembly Testing  2008-09
  • Integration Testing  2009-2010
  • Qualification Testing  2010-2011
  • Joint Fuze Safety Board Cert.  2011
  • Milestone C        September 2011

Participating Organizations
JNLWD – Joint Non-Lethal Weapons Directorate
  Sponsor
US Army Infantry Center/DCD – Firepower Division
  Requirements Generation and User Proponent
Air Force Security Forces Center (AFSFC)
  User Proponent
PM-Soldier Weapons
  RDT&E Management
PM-Close Combat Systems
  Production Management
US Army, ARDEC
  Munition Lead and Fuze & Projectile Design
NSWC Dahlgren
  Payload Technical Lead
ATK Launch Systems
  Payload Design Improvements and Integration Support
HECOE
  Human Effects Analysis and Support
SAVIT Corp.
  Cartridge Design Improvements, Integration, and Development Hardware Support
Aberdeen Test Center – DTC&AEC / NSWC CRANE
  Test & Evaluation
Indiana Ordnance Inc.
  Developmental Testing
Kansas State University
  Environmental Assessment
XM1158 – 40mm Proximity Fuze – EXPLOSIVE TRAIN

Operational Parameters

• Operational Environment
  – M203 Ballistic environment
    • Compatible with M79, M320
    • 250 ft/s; 63 rps; 15,500 g’s
  – Temperature range: -25°F to +140°F
  – Ballistic Equivalent to M433 cartridge

• Operational Requirements
  – Minimum Engagement Range: 35m(T), 15m(O)
  – Shelf Life: 10yr(T), 20yr(O)
  – Engage targets in open terrain & confined spaces
  – Self Destruct/Self Neutralization
XM1158 – 40mm Proximity Fuze – EXPLOSIVE TRAIN

ANLM SEQUENCE OF OPERATION

Battery Activated (Setback) → Prox Circuit Active → Target Detected

Prox Mode

Impact collapses Fuze, Driving PA into Firing Pin, initiating M55 detonator (or jams rotor if OOL) (Mechanical Backup)

Fire Command Issued (Instant) → Igniter Mix Activated by M55 Output – NL Mix ejected forward → "All-Arm" = 28m

Piston Actuator drives Firing pin, which stabs and initiates M55 detonator

Fire Command Issued (Delay) → Igniter Mix Activated by M55 Output – NL Mix ejected forward

Piston Actuator drives Firing pin, which stabs and initiates M55 detonator

Electronic Timer issues fire command upon t = 30s (Electronic Backup)

Min. Target Engagement

"Flash Bang"

NL Mix Ignites on Air Contact – NL Mix ejected forward

Piston Actuator drives Firing pin, which stabs and initiates M55 detonator

IGNITER MIX

Activated by M55 Output – NL Mix ejected forward

"Flash Bang"

NL Mix Ignites on Air Contact – NL Effect

Gun Launch

Dud?

Battery Rise Time

Mech. Arming

t = 0

Piston Actuator drives Firing pin, which stabs and initiates M55 detonator

"All-Arm" = 28m

NL Mix Ignites on Air Contact – NL Mix ejected forward

Two Independent Modes of Self-Neutralization

"Flash Bang"

NL Mix Ignites on Air Contact – NL Effect

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.
FUZE DESIGN APPROACH

- Limited Funds Available for Fuze Development
  - Emphasis on leveraging existing technologies from other fuzes
    - Proximity technology for use in Direct-Fire scenario (EX433 & M734A1)
    - Existing mechanical S&A – M550
    - Small, fast-activating, reserve-cell battery (EX433)

- Utilizes existing mechanical S&A
  - Inexpensive & Reliable
  - Proven history (>20 million produced)

- Piston Actuator Used to Drive Firing Pin
  - Initiates M55 Stab Detonator in M550 S&A
  - Early design used M100 electric detonator

- Transitioned ARDEC Fuze Design to Savit Corp for design refinements

- Potential use on other 40mm low velocity cartridges
History

- The M550 Fuze was Type-Classified in 1971 for the low velocity (250 ft/sec) M433 High Explosive Dual Purpose application
  - Also used in M918 high velocity Target Practice cartridge
- In Production - Over 20 Million fuzes have been produced
- Two independent safety locks (setback pin & one spin detent)
- Excellent safety record
• Initial design used a M100 electric detonator input into the M55 stab detonator
  – M100 positioned 90° “sideways” above M55
    • Used because electric detonators are available, inexpensive, & reliable
    • Utilized MOFA detonator plug & contact clip assembly
  – M100 did not reliably initiated M55
    • Out of line safety barrier plate between M100 & M55 attenuated M100 output
• ARDEC redesigned explosive train to closely duplicate 40mm M550 fuze
  – Duplicated firing pin dimensions
  – Piston actuator pushes firing pin into M55
    • Positioned on centerline
    • Activates on command detonation from proximity circuit

• Design Details
  – Piston Actuator – Action Mfg
    • Directly connects to circuit card assembly using pin and socket connection
    • Piston has attached firing pin
    • Used in PD backup mode
  – M550 Safe & Arm Device - Amtec Corp.
    • Used on current 40mm HE & practice rounds
    • Contains the two independent MIL-STD-1316 compliant safety locks
**Piston Actuator – Action Mfg**

- Approximately 50 lbs force & 0.090” displacement
- ~5mg Spot Charge
- Bridgewire Resistance = 1.5 ± .5 ohms
- All Fire Energy = 22 microfarad capacitor at 2.5 volts
  
  = 687.5 erg = .06875 joules
- Explosive Train Subassembly Testing
  - Explosive Train Subassembly Tests – Successful Jan-May 2009
    - “In-Line” Explosive Component Output – MIL-STD-331, Test D4
    - Progressive Arming Test – planned 3Q FY09 - MIL-STD-331, Test D8
• Explosive Train Subassembly Testing (cont’d)
  
  – Point Detonation Backup Subassembly Tests

  • Head-on Impact Angle Test—Successful March 2009
  • Angle of Attack Impact Test—planned June 2009
    – Utilizing decision matrix to determine 50% functioning point
    – Use samples at operating temperature extremes
• Non Explosive Train Subassembly Testing
  – Battery Activation Mechanism Subassembly Test
    • Mechanism w/o battery – Successful July 2008
      • Drop Test non-activation per MIL-STD-331, Test A4.1
      • Ballistic Test activation – M203 Mann Barrel into foam soft catch
    • Actual battery – planned June 2009
      – Repeat drop and ballistic tests
  – Mode Select Subassembly Test/ Electronics Survivability - Planned July 2009
    – Ballistic Test – M203 Mann Barrel into foam soft catch

• Non-Lethal Warhead Testing
  – Fuze explosive train successfully ignited warhead energetic material
• SUMMARY
  – Explosive Train Tested Successfully
  – Created Command Initiated Stab Detonator
    • Maintains current explosive train
    • Utilizes proven mechanical S&A

• SHOW VIDEO – ANLM FUNCTIONING – Concept Demo July 2006
Initial Design

Manually Activated Battery Through Hole in Nose
On Side M100 Initial Firing Train Charge
Barrier Plate
Threaded Body to Fuze Interface
M550 S&A w/ Rotor Hole Filled

Current Design

Point Detonating Backup Feature
Piston Actuator Firing Mechanism
Dual Mode Setting Collar and Selector
Setback and Spin Initiated Reserve Battery
Firing Pin to Initiate M55 Stab Detonator
Standard Production M550 S&A no Modification