Always a Step Ahead

ARDEC ARMAMENTS

Conventional Fuze Improvements

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UNPARALLELED COMMITMENT & SOLUTIONS

Act like someone's life depends on what we do.

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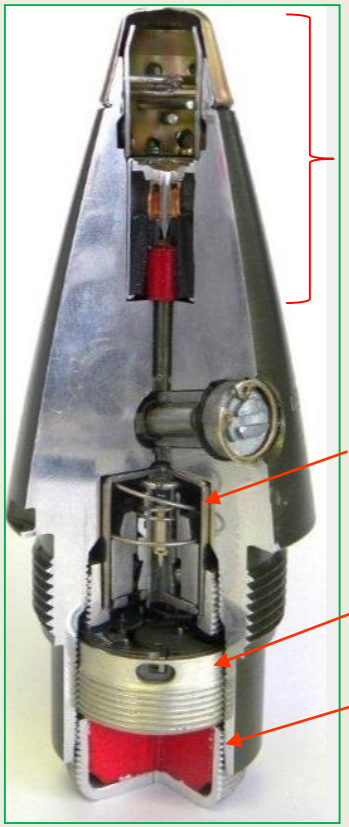
AGENDA

- Background
- Fuze improvements:
  - Artillery
    - M739A1 Plunger spring
  - Mortars
    - M734A1 / M783 Delay primer
    - M734A1 Electronics
    - M734A1 / M783 Impact switch

BACKGROUND

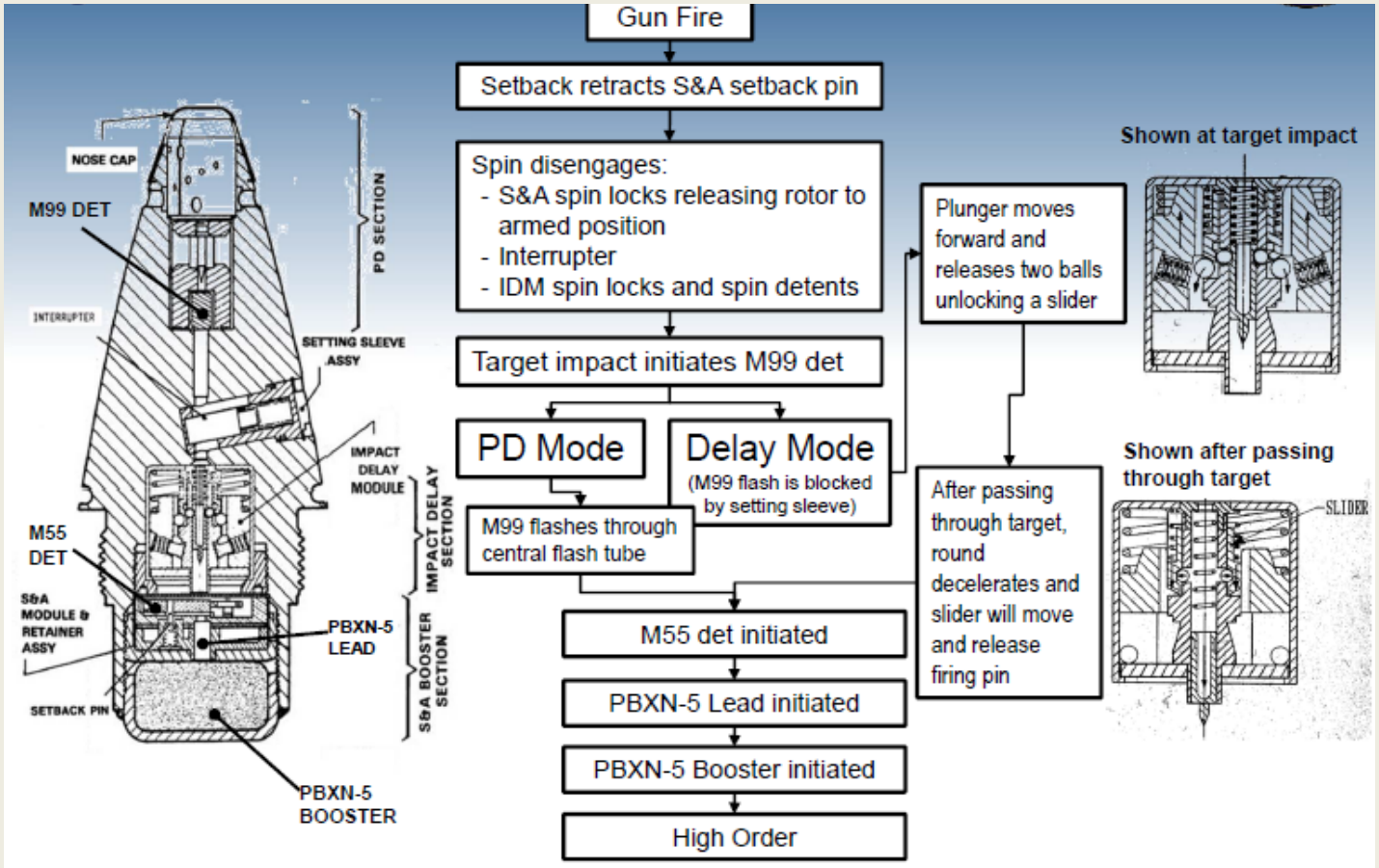
- Conventional mechanical and electro-mechanical fuzes
- Fielded and in current production
- Traditionally used in cannon-launched indirect fire systems
  - Artillery projectiles (105mm & 155mm)
  - Mortar cartridges (60mm, 81mm, & 120mm)
- Why the changes?
  - To enhance producibility, reliability, and safety while maintaining quality product for our Warfighter and cost effectiveness for the taxpayer
  - Continuous improvements

M739A1 PD/DELAY ARTILLERY FUZE



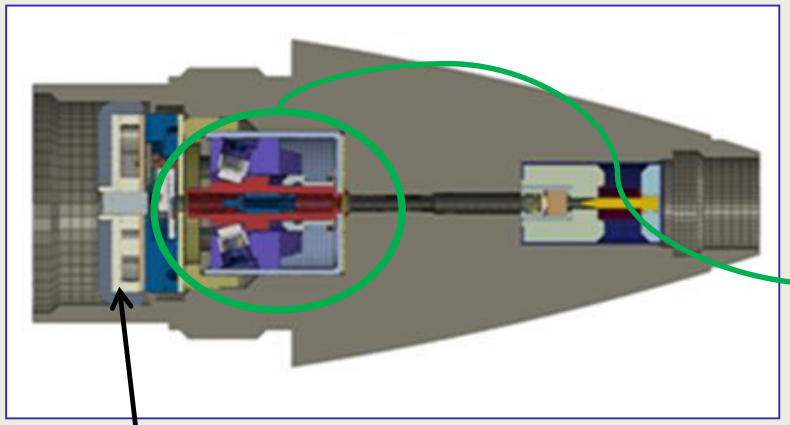
- The Army's preferred, primary fuze for 105mm and 155mm projectiles to address point detonating/delay artillery functions
- PD/Delay mode hand set capability
- 99% reliability
- Prime Contractor: Action Mfg
- Contains an Impact Delay Module (IDM)
  - Provides fuze initiation delay based upon the completion of mechanical actions caused by projectile deceleration and will function immediately after passing through the target

M739A1 FUZE OPERATION



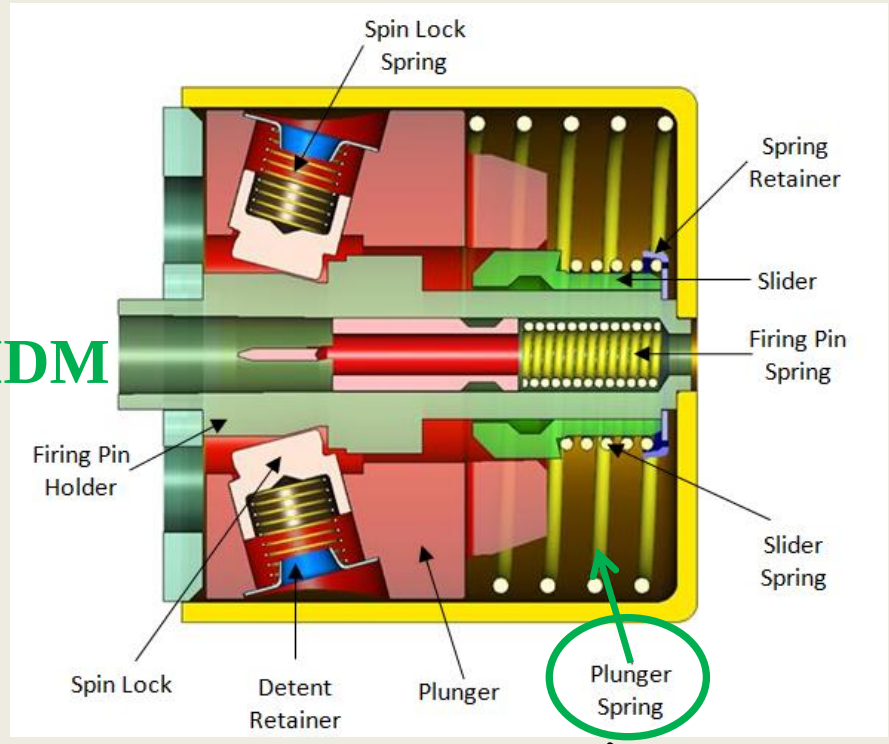
M739A1 Plunger Spring Improvement

Opportunity for Improvement	Objective	Analysis
Unstable flight pattern can create high set-forward forces which can activate the Impact Delay Module (IDM).	Prevent fuze function due to high set-forward forces.	Modeling & Simulation showed the required set-forward force can be increased from 26 Gs to 75 Gs by increasing the plunger spring wire diameter. The spring rate will increase from 0.74 lb/in to 3 lb/in. This will increase the required set-forward force to activate the IDM.

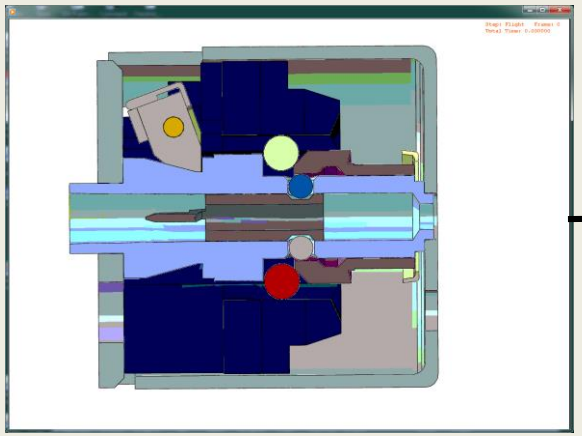


S&A

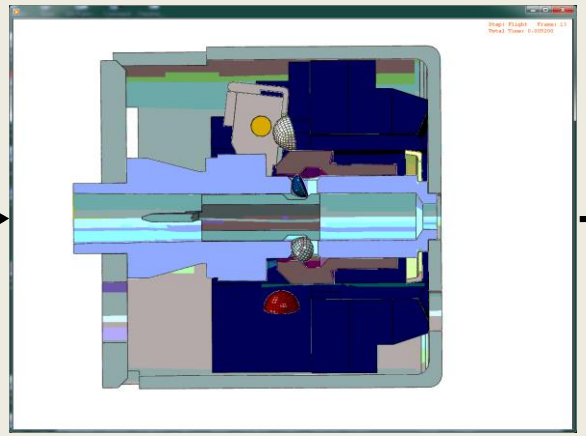
IDM



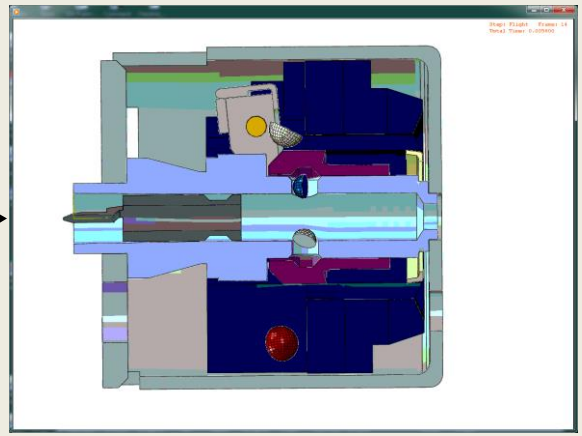
M739A1 Impact Delay Module Animation



During flight



At target impact



Firing pin released after target impact

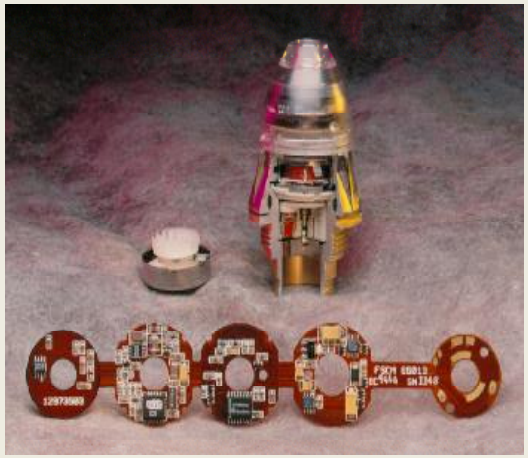
Direction of Flight

M739A1 PLUNGER SPRING TESTING

- Completed bench testing that included dimensional checks, load tests, arming/non-arming IDM spin tests, drop tests, environmental tests, and propagation tests. All units passed successfully.
- Performed ballistic testing at Yuma Proving Ground, Jan 2017
  - Over 130 total projectiles fired, 105mm & 155mm
  - Indirect (ground impact) & direct fire (plywood targets)
  - Test array included control fuzes, test fuzes, temp extremes, tactical vibration, “unbalanced” rounds

- Redesigned fuzes performed similar to control fuzes and maintained a high reliability against target impact

M734A1/M783 Mortar Fuzes



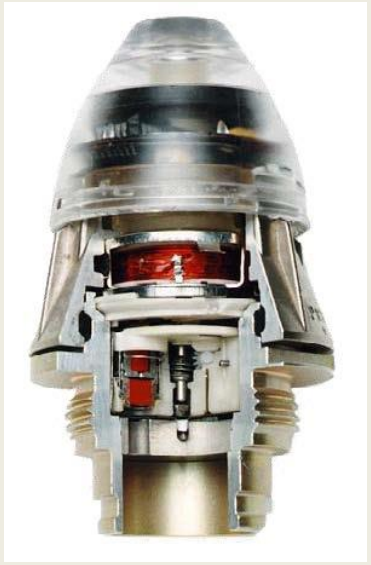
- M783 is the US Army's tactical trainer for the M734A1
- 4 settings: 60/81 Proximity, 120 Proximity, Impact, and Delay
  - For M783, a setting on Proximity results in Impact function
- Used on 60/81/120mm High Explosive (HE) mortar cartridges and 120mm White Phosphorus (WP) cartridges.
- Prime Contractor: L3-FOS

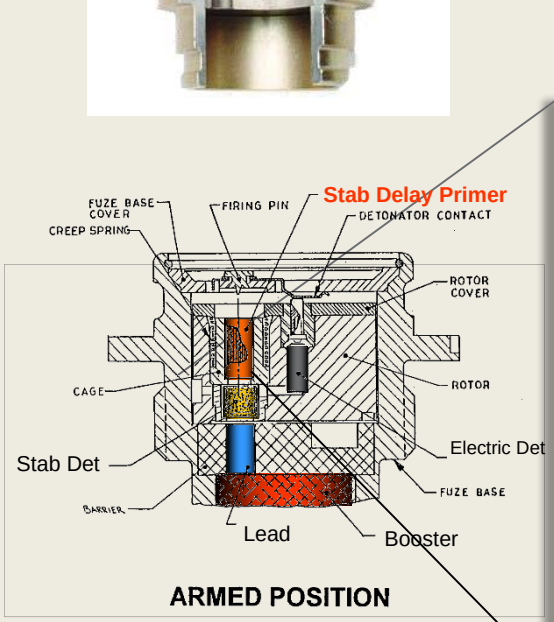
81mm HE Cartridge

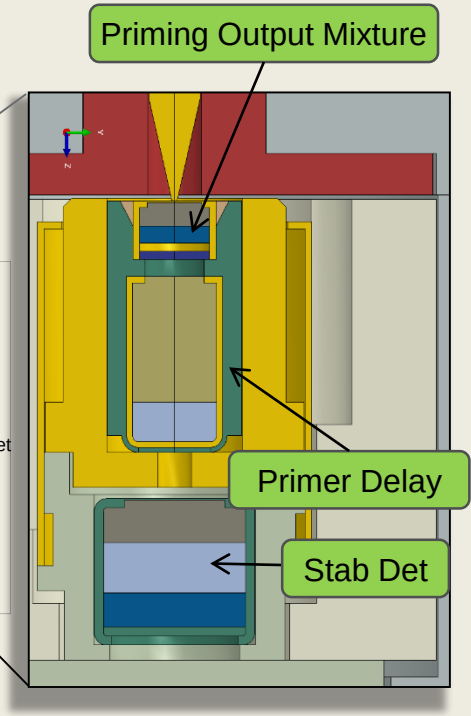
- **Opportunity for improvement**
  - The M734A1/M783 Delay Primer instantaneous function (no delay) occurrences during component and fuze lot acceptance tests have increased.
- **Objective**
  - Study and incorporate improvements to the explosive mix for the delay primer to reduce the occurrence of instantaneous functions.
- **Program Benefits**
  - Increase M734A1/M783 Delay Mode fuze reliability
  - Prevents fuze cost escalation due to high scrap rates, investigation, and additional testing cost.

DELAY PRIMER BACKGROUND

- The Delay Primer is a mechanical energetic device which provides Delay mode capability for the M734A1/M783 fuzes.
- Initial engineering tests showed that modifying the ratios in the Priming Output Mixture of the delay primer input cup assembly may significantly reduce instantaneous fire occurrences for delay primer Lot Acceptance Test (LAT).
- Conducted a Design of Experiments followed by ballistic lot acceptance testing IAW the detail specification.
- Test data for the design change shows improved reliability to the current production design.







M734A1 Electronics Upgrades

- **Opportunity for improvement**
  - Modernization
  - Compatibility with additional mortar cartridges
- **Objective**
  - Identify potentially obsolescent components
  - Perform engineering analysis, board layout, and lab testing
- **Program Benefits**
  - Improved producibility
  - Improved performance margins
  - Lower program costs
  - Expanded mortar applications

M734A1 Electronic Changes

- Improved fuze electronics power needs for other applications, i.e. slower velocity rounds
  - Powered supplied by ram air turbine
- Replacement of obsolete custom integrated circuit devices
  - Replacement Monolithic Microwave Integrated Circuit (MMIC) developed by another project
- Firing circuit improvement
  - Increased firing capacitor voltage to optimize fuze function time
- Updated board layout to suit new impact sensor

Opportunity for Improvement

The M734A1/M783 fuze impact switch is a fairly large spring-mass inertial switch, one of the largest components in fuze electronics.

Objective

Replace the current switch with a smaller switch optimized for mortar environments. Evaluate an “encapsulated” version of smaller switch to facilitate pick and place assembly process.

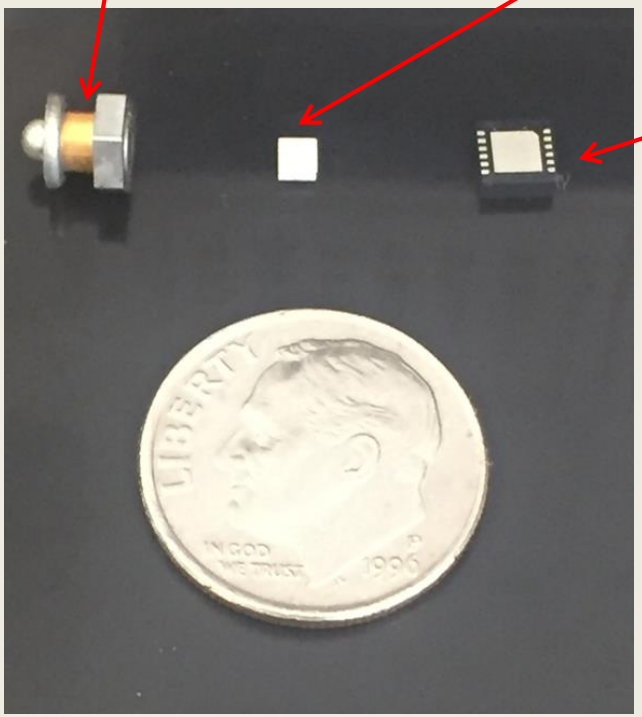
Tasks:

- Evaluate feasibility of incorporating new switch.
- Optimize and evaluate switch for equivalent target sensing capability.
- Update M734A1/M783 fuze electronic designs to use switch.
- Award contract to fuze producer for final switch integration tasks, M783 fuze prototype build & evaluation, and verification fuze build.

IMPACT SWITCH SIZE COMPARISONS

M783

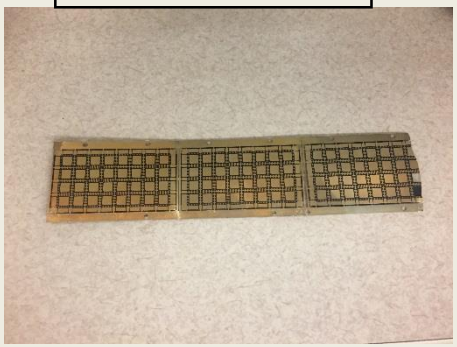
M734A1



SWITCH ENCAPSULATION PROCESS

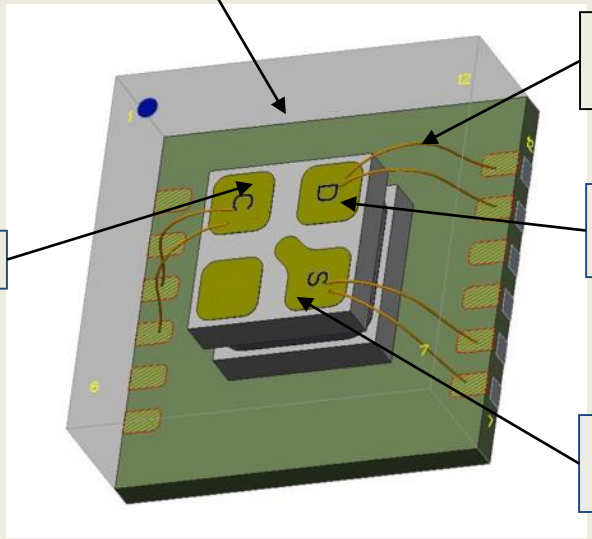
- Switch is die-attached to Lead Frame in 4 groups of 32
- Wirebonds are attached from Switch contacts to Lead Frame pad
- Encapsulant is molded over Switch and Lead Frame
- Parts are diced to final size

Lead Frame (bottom)



Standard Mold Compound (Encapsulant)

Wirebonding doubled on each pad



Common

Bottom Contact: Setback/Impact

Side Contact: Spin Sensing

Final Product

SWITCH ENVIRONMENTAL TESTING

A total of 180 units were environmentally tested after encapsulation

All units were centrifuge tested before and after environmental testing

Tests performed were:

- Vibration Test
- Thermal Shock
- Temperature Cycling
- Highly accelerated Life Test with Humidity
- Subscale gun testing up to 13,000 G in ARDEC air gun

SUMMARY

- M739A1 Plunger spring
  - Testing complete
  - Results under evaluation for Engineering Change Proposal (ECP)
- M734A1 / M783 Delay primer
  - Testing complete
  - Results under evaluation for ECP
- M734A1 Electronics
  - Continuing lab testing
- M734A1 / M783 Impact switch
  - Encapsulated switch test program complete
  - Moving forward with un-encapsulated version & lab testing

Questions?