2012 NDIA
Joint Armaments Conference
May 14-17, 2012

Integration of a 40x46mm Grenade Proximity Fuze into a 30x113mm M789 (HEDP)

Chris Sande
Mechanical Design Engineer
ATK Armament Systems
763-744-5267
Christopher.Sande@atk.com

Effort sponsored by the U.S. Government under Other Transaction number W15QKN-09-9-1001 between the National Warheads and Energetics Consortium and the Government. The US Government is authorized to reproduce and distribute reprints for Governmental purposes notwithstanding any copyright notation thereon.

Approved for Public Release 22 CFR 125.4(b)(13) Applicable. PAO Log# 491-12 Dated 05/10/2012

Outline

- Applications & Requirements
- Design Challenges
- Initial Design
- Design Analysis
- Final Prototype Design
- Testing & Results
- Summary and Future Plans


Medium Caliber Cannon Rifling

Application & Requirements

Application:

- M230 Gun on the Apache Helicopter
  - Increased Lethality Against Targets on Sand/Soft Earth

Requirements:

- Utilize a Current Low Velocity 40mm Grenade Circuit
- Flight Characteristics
  - Ballistic Match to M789 HEDP
- Fuze Requirements
  - Height of Burst (HOB)
  - Retain M759 Mechanical Safe & Arm
  - Maintain M759 All/No-Arm Distances

LW30 M789 HEDP

Direct Drop-in Addition to the LW30 Ammunition Family with HOB Capabilities

Design Challenges

More Strenuous Firing Environment:

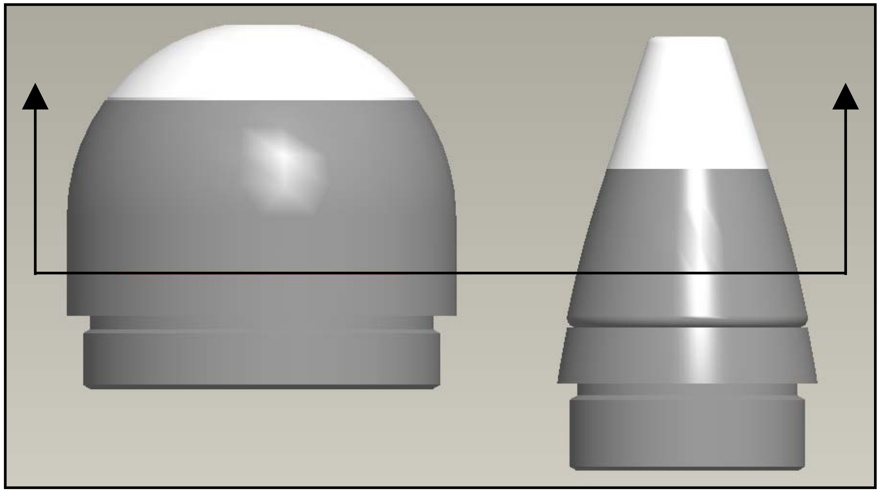
- Higher Muzzle Velocity
- Higher Spin Rate
- Higher Setback Forces

40x46mm Grenade	30x113mm Proximity
76 mps	805 mps
60 rps	975 rps
14,000 G	100,000 G

http://www.inetres.com/gp/military/infantry/grenade/40mm_ammo.html
http://www.inetres.com/gp/military/infantry/grenade/M203.html

Smaller Packaging Volume:

- Proximity Fuze Components Located Above the Line

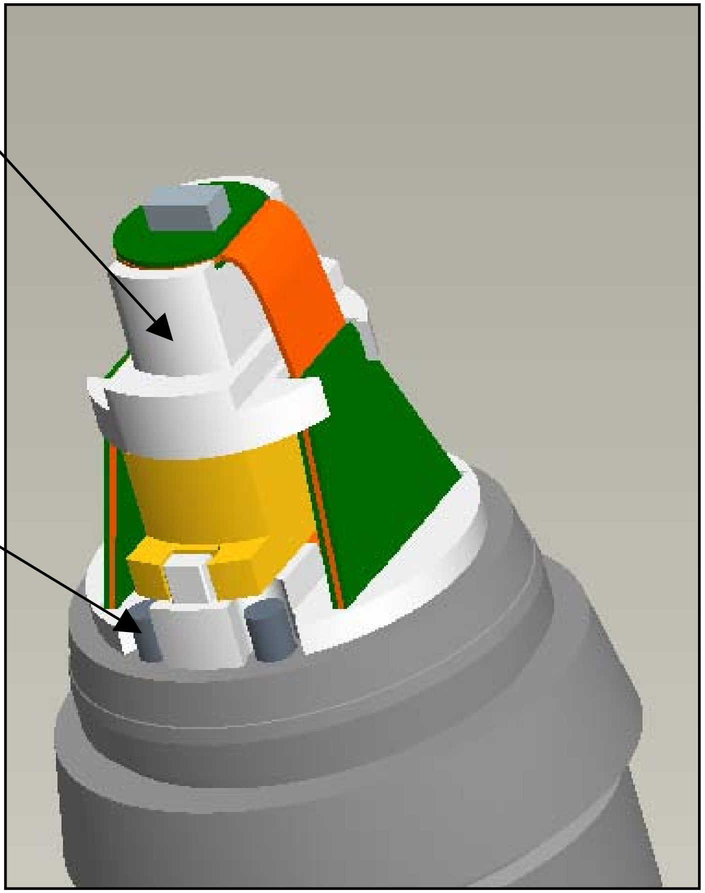


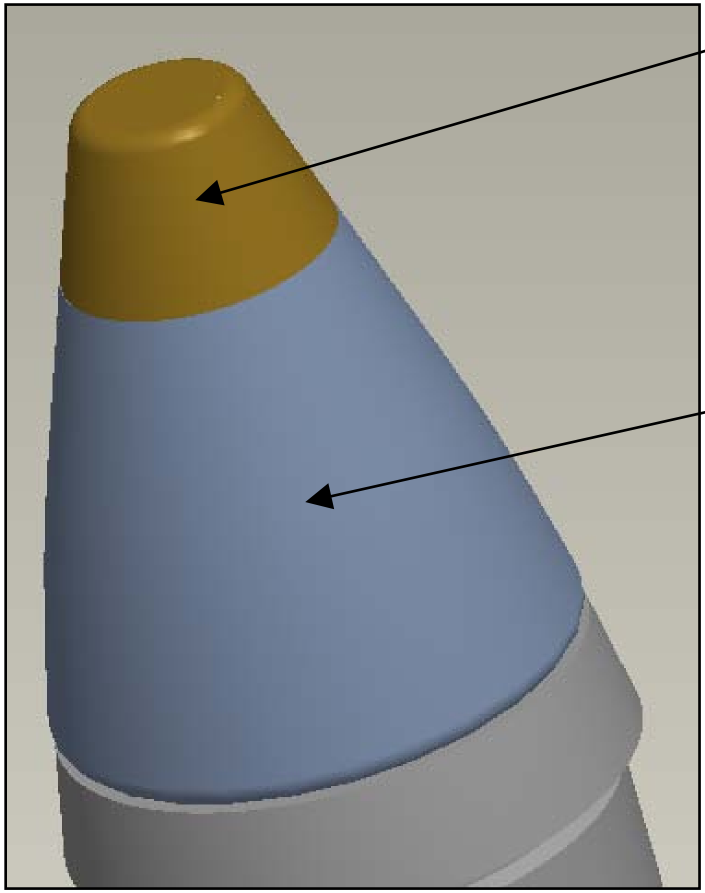
Explosive Train Initiation Method:

- Electronic Initiation of a Mechanical Explosive Train

More Strenuous Operating Environment.

Initial Design





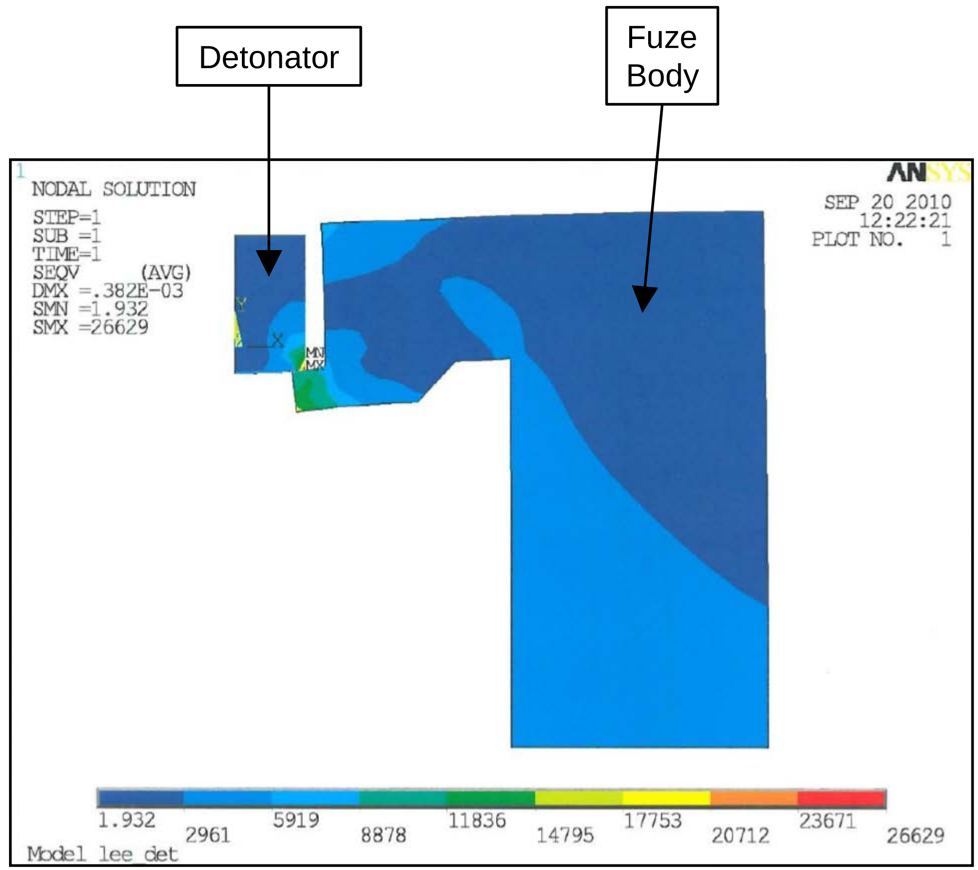
Original Integration of a LW30 Proximity Fuze.

Design Analysis - Setback

ANSYS Finite Element Analysis at Setback.

Inputs:

- <u>Material:</u> Minimum High Strength Aluminum Properties
- <u>Detonator Mass:</u> Twice the Expected Mass
- <u>Acceleration:</u> 100,000 G



Results:

- Fracture not Anticipated
- Safety Factor of Greater Than 2

Analysis Indicated Initial Design Would Survive LW30 Setback Force.

ABAQUS Finite Element Analysis of Spin

Inputs:

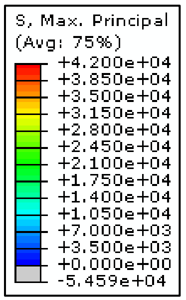
- Fuze Component Mass: Worst Case Mass From Drawing Requirements
- Spin: M230 Spin vs. Time Profile
- Loading: Frictionless, so the Pins Take the Entire Spin Load
- Initial Pin Diameter: 0.050 inches

Results:

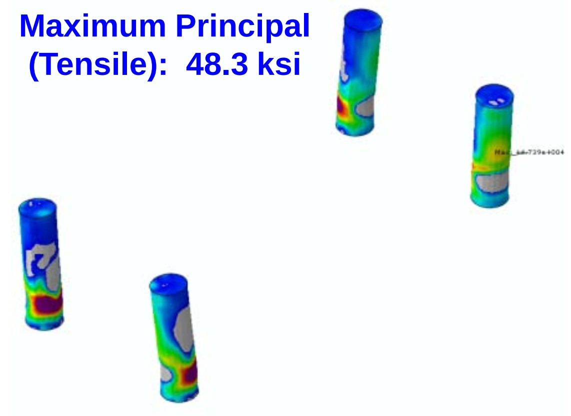
- Aluminum Pins Would Fail
- Steel Pins Borderline Survive
  - Safety Factor of About 1.5

Aluminum Pins

Scaled to UTS

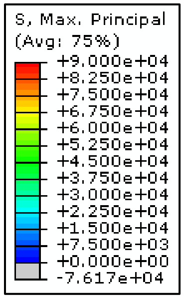


Maximum Principal (Tensile): 48.3 ksi



Steel Pins

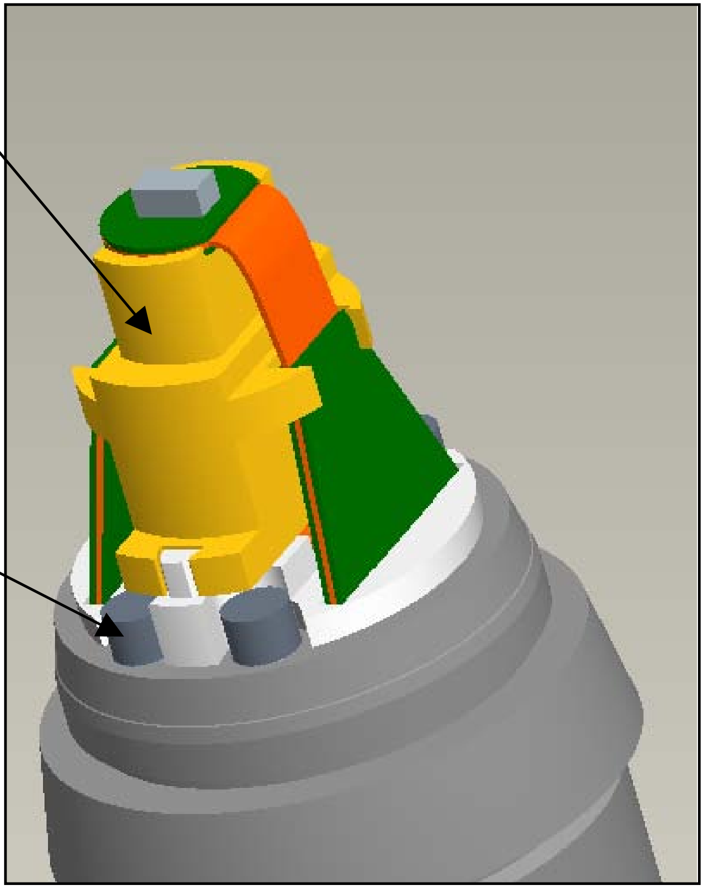
Scaled to UTS

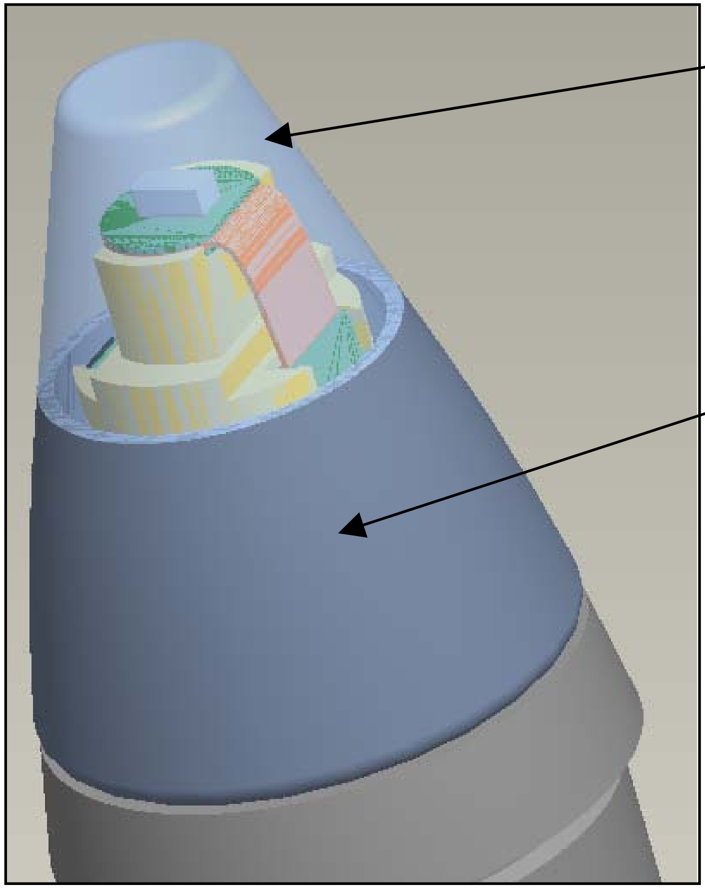


Maximum Principal (Tensile): 59.0 ksi

Analysis Indicated Ø0.050 in Steel Pins were Marginal for Surviving Spin.

Final Prototype Design





Improved Producibillity and Survivability.

Testing - Electric Detonator Selection

Electric Detonator Test 1:

- Tested Four Different Detonator Configurations.
  - 3 Manufacturers
  - 3 Different Output Strengths
- All Configurations Passed In-Line Function and Out-of-Line Safe Testing.

Electric Detonator Test 2:

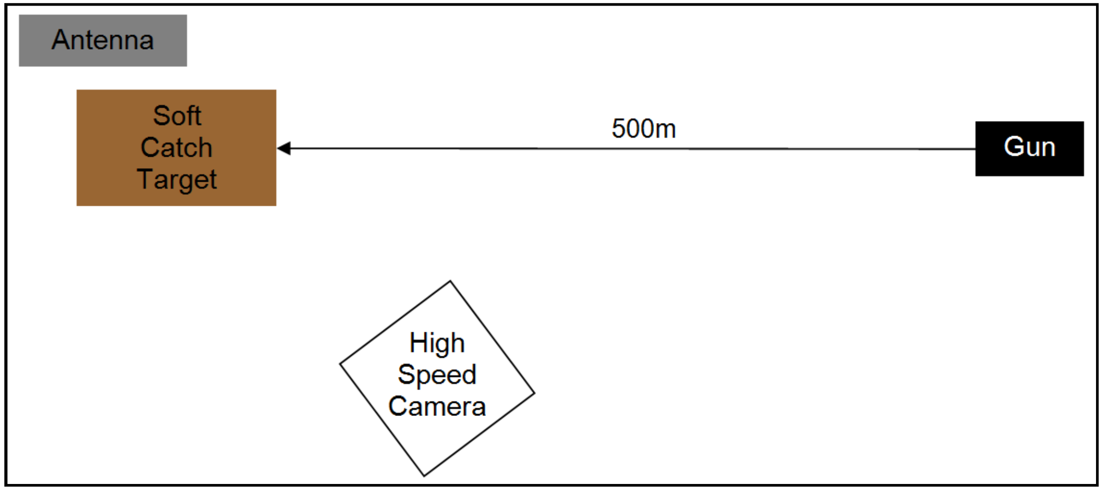
- Tested a Single Optimized Detonator Configuration.
  - Smallest Size
  - Middle Output Strength
    - Provides Margin
      - Safety
      - Function
- Passed In-Line Function and Out-of-Line Safe Testing.

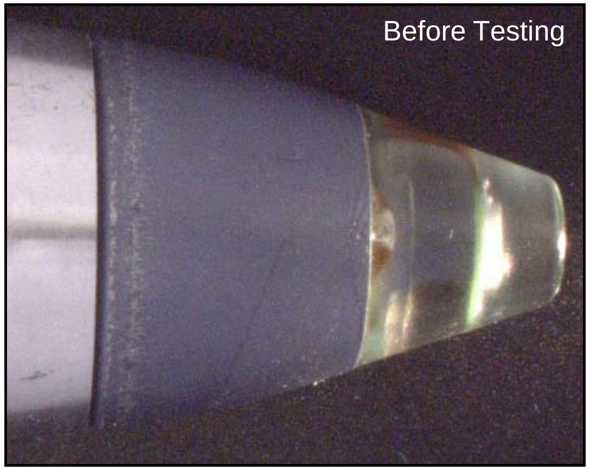
Optimized Firing Explosive Train Initiation.

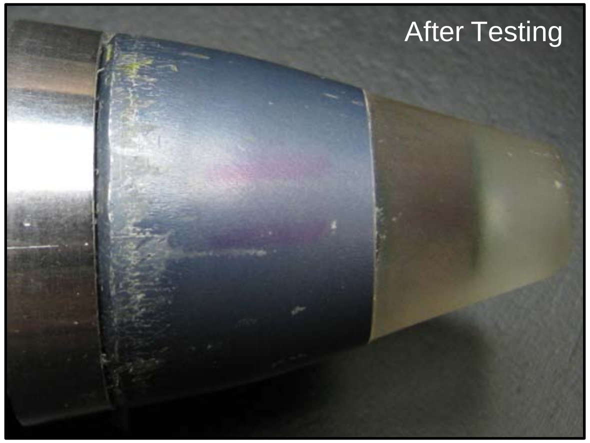
Testing - Fuze Survivability and Function

Soft Catch Testing:

- Inert Test Fuzes
- 500m Test from a MANN Barrel
- All Fuzes Survived Ballistic Environment
- Most were Powered up by 500m Target







Verified Fuze Survivability.

Summary and Future Plans

Summary:

- Successfully Packaged a 40mm Prox Fuze Circuit into a LW30 Fuze
- Improved the Design to Survive Ballistic Environment
  - Successfully Shown the Electronics Survive the Ballistic Environment and the Circuits Function in Flight
- Identified an Electric Initiation Method for the Explosive Train

Future Plans:

- Decreasing Battery Ramp Up Time
- Improving the Antenna Pattern
- Modifying the Design for Producibility
- Continuing in the Next Series of Testing
  - Live Fire HOB Testing
  - Environment and Drop Testing

Proof Of Concept Demonstrated with Room for Improvement.

Contact Information

Dick Bottenberg

- ATK Program Manager
- (763) 744-5129
- Richard.Bottenberg@ATK.com

Lee Olson

- ATK Medium Caliber Ammunition and Mechanical Fuzing Engineer
- (763) 744-5721
- Lee.Olson@ATK.com

Chris Sande

- ATK Medium Caliber Mechanical Fuzing Engineer
- (763) 744-5267
- Christopher.Sande@ATK.com

Brent Beauseigneur

- ARDEC Fuze Electronics Engineer
- (973) 724-7965
- Brent.Beauseigneur@us.army.mil

Daniel Kelly

- ARDEC Fuze Mechanical Engineer
- (973) 724-5996
- Daniel.g.Kelly@us.army.mil