Bursting Munition Fuzing for Individual and Crew Served Systems

15 August 2001
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<tr>
<td><strong>Author(s)</strong></td>
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**Abstract**

**Subject Terms**

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| **Number of Pages** | 28 |

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**Notes**

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<thead>
<tr>
<th>Name</th>
<th>Company</th>
<th>Position</th>
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<tr>
<td>Dave Broden</td>
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<td>System Analyst</td>
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</table>
Objective: Confirm Bursting Munition Capability Readiness for Individual and Crew Served Weapon Systems

- System effectiveness
- Requirement assessment
- System integration
- Technology
- Performance
- Safety
- Training
- Commonality
- Affordability
“Bursting Munition” Applications

Bursting Munition Systems

M203 40mm
MK19 40mm
• Striker
• H&K

OICW 20mm

30mm AAAV Bushmaster II
35mm Bushmaster III

40mm ALACV Conventional

40mm Cased Telescoped

25mm M792 Bradley Bushmaster
30mm LW-30 M789 Up-gun

Establishing a Commonality of Systems
• Integration
• Technology
• Performance

Ensure Affordability
Bursting Munitions Fuzing Applications/Commonality

- OICW — 20mm → Design focus ensures application to other calibers
  → Maximizes warhead capability
  → Establishes commonality
  → Address producibility/affordability

Cannon Caliber System
- 30mm AAAV
- 25mm M790 family
- 35mm
- 40mm high velocity — cannon application(s)

Individual and Crew Systems
- 40mm grenade
  - Low velocity → M203  M406/M433
  - High velocity → MK19  M383, M385, M430, M918
  - Improved low and high velocity ammunition
Bursting Munition System

Bursting Munition Capability is an Integrated System

- Operational capability
- Weapon system integration
- Fire control system
  - Aiming
  - Adjusted aim point/ballistic computer
  - Ranging
  - Fuze setter
- Setter interface
- Ammunition
  - Ballistics
  - Warhead
- Fuzing
- Training
- Supportability

Leveraging OICW Total System Approach Ensures Integration
Bursting Munition System Drivers

- System effectiveness
- Ergonomics
- Error budget management
- Weight
- Compact profile
- Adaptable/modular
- Long operational life/low power
- Ruggedness
- Reliability
- Safety
- Supportability
- Affordability

System Characteristics
Critical to Individual and Crew Served Systems

OICW Evolution Address Technology Readiness
System Integration

• System physical integration
• Fire control system
  – Laser range finder
  – Adjusted aimpoint
    - Optical
    - Alignment indicator
  – Ballistic computer
  – Setter
• System setter
  – Weapon interface
  – Inductive
  – Contact

Bursting Munition Fuze Integration is Adaptable to Multiple Weapon System Applications
ATK Bursting Munitions Fuzing Elements

- System error budget management
- System effectiveness
- Ballistic solution/algorithm
- Fuze design and performance
- Fuze setter design and integration
  - Inductive
  - Contact (alternate)
- Functions
  - Air burst
  - Point detonating — super quick
  - Point detonating — delay
  - Window
  - Point detonating — backup
  - Self destruct
  - Self neutralize
- Safing and arming — meet MIL-STD-1316E

Requirements Established to Meet Specific Application
Objective: Enhance Individual and Crew Served Capability with Precision Delivery of Lethality to Target

- Extend battlefield
- Battlefield safety
- Defilade target(s)
- Functional alternatives
  - Air burst
  - Point detonating
  - Window
- Achieving capability through rigorous error budget management

Fuze Precision Requirement Dictates Fuze Range Precision Algorithm
Systems Effectiveness / Error Budget
System Performance Model

CASRED Output
- Pk Grids
- Lethal Area

System Errors
- Environment: Temperature, Pressure, Wind
- Weapon / Fire Control: Site Angle, Cant Angle, Boresight, Aimpoint Accuracy
- Ammunition: Muzzle Velocity, Drag Coefficient, Spin Damping Coeff., Cm_alpha, Cn_alpha, Mass, Ixx, Dref, Muzzle Twist, Dispersion

Man-in-the-Loop
- Aiming Errors
- Laser Accuracy
- Laser Ranging

FBAR Inputs
- Occasion-to-Occasion Errors: Down Range, Cross Range
- Random Errors: Down Range, Cross Range
- Terminal Velocity
- Angle of Fall
- Fuze Timing Error

Aeroballistic / Turns Count Fuze Model

Integrated Approach to Requirements Assessment Ensures Priority
OICW (Typical System)
Miss Distance from Ideal Burst Point
Error Budget Levels

Miss Distance (m)

Note: Component Levels Represent % Contribution to Total Variance ($\sigma^2$)

- Man-in-the-Loop (Aiming Error)
- Ammo
- Fire Control
- Environment

Range (m)
**Fuze Type Algorithm Assessment**

**Turns Count System Minimizes Miss Distance**

**Graph:**
- **Time Fuze**
- **Turns Fuze**

**Axes:**
- **Target Range (m)**
- **Miss Distance (m)**

**Legend:**
- Time Fuze
- Turns Fuze
2–3 pages on 40mm
Aeroballistics/Miss Distance
and
Turns vs. Time
to be added
on Friday a.m.
Bursting Munition Fuze Algorithm Alternatives

Alternatives
- Time
- Closed loop time compensation
- Turns
- Turns/time hybrid
- Above with accelerometer compensation

Selection Criteria
- Muzzle velocity
- Aeroballistics
- System integration
- Precision
- Application range

Preferred Approach: Turns or turns/time provides assured precision without compensation link
Bursting Munition Fuzing Capability

- Focus on system integration ensuring enhanced effectiveness
  - Error Budget Management

- Ensure repeatable and precise fuze function
  - Fuze Compensation Addressing Error Parameters

- Safety compliance
  - MIL-STD-1316E and System Integration Interface

- Affordability
  - Technology Selection, Technology Insertion, Commonality, Adoptability
Miniaturization

• Design focus to 20mm OICW: Volume $\leq 0.45 \text{ in}^3$
  – Reduction in volume evolving

• Adaptable to MEMs S&A as MEM matures
  – Fuze integration
  – Mechanical configuration
  – Explosive train

• Electronic packaging
  – Alternatives addressed
    - Power
    - Packaging

• Power source
  – Application dependent
  – Power source affordability addressed
Safing and Arming (S&A) Mechanism

- Volume ≤ 0.1 in³
- Command arm system
  - Arming distance options
    - Normal
    - MOUT
  - Overhead safety (option)
- MIL-STD-1316E compliant
- Weapon launch compatible to over 100K g’s
- Adaptable to multiple caliber and launch conditions
- Explosive train component compatible and rugged
- Tailor to initiation direction
  - Dual: Forward and rearward
  - Single: Rearward
- Demonstrated to meet MIL-STD-331 selected criteria
- Reviewed by Fuze Safety Board
- Ruggedization in process
Bursting Munition Demonstrated Performance

• High fuze setter reliability
• Command arm S&A function dual environment demonstrated
• Repeatable burst point precision
• Integrated compensation — reduces error
• Turns count precision
• Turns/time hybrid precision enhancement
• Functional modes
  – Air burst
  – Point detonating
  – Point detonating delay
  – Point detonating — backup
  – Window
  – Self destruct

Key Operational Feature Confirmed — Adaptable to Other Applications
## Demonstrated Performance

<table>
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<tr>
<th></th>
<th>20mm</th>
<th>40mm</th>
<th>30mm Cannon Caliber</th>
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<tr>
<td>System Integration</td>
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<td>In process</td>
<td>In process</td>
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<tr>
<td>Fire Control Interface</td>
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<td>Fuze Setter</td>
<td>√</td>
<td>In process</td>
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<td>Power Source</td>
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<td>Applies</td>
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<td>Safing and Arming</td>
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<td>Function</td>
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<td>• Self destruct</td>
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<td>Self Neutralized</td>
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• Turns data is repeatable from round to round

![Graph showing fuze turns data and tacticals with a line demonstrating precision turns/time hybrid. The graph includes data points for SN11 (2), SN8, and SN15. The barrel twist is 9.84°.]

**Turns/Time Hybrid Demonstrated Precision**
OICW Fuze Commonality

- OICW Base Fuze
- Multiple Integrated Fuze Applications
- Modules
- S&A
- Battery
- Electronics
- Component X
- Component Y

Commonality Applications
- Flexible Integrated Fuze Assembly

Flexible Component Manufacturing

Achieving Economies Through Commonality
ATK Bursting Munition Highlights

- Bursting munition technology and applications 1985 Present
- OICW applications and demonstrations 1995 Present
  - 1998 system demonstration confirmed integration and performance
- Safety and ruggedness enhancement 1999 Present
- 30mm cannon caliber integration 1999 Present
- 40mm applications — designs, performance, and integration 1998 Present
  - Integration 2001 – 2005

Individual and Crew Served Bursting Munition Systems Offer Near Term Capability Enhancements
Bursting Munition System Evolution


Bursting Munition Fuzing Technology
- First Generation
- Second Generation
- Third Generation

Electronic Packaging

OICW
- System Demonstration
- PDRE Updates

30mm AAAV
- Demonstration

Individual Weapons
- Concept/Analysis
- Applications
- Interfaces
- System Integration
- Demonstration

Crew Served Weapons

40mm

Expanded Applications
Bursting Munition Capability – Realizing the Benefits

Requirements
• Enhanced system effectiveness
• System integration
• Affordability

Integration and Technology
• Established and demonstrated
• Application from related systems
  – Weight
  – Power
  – Volume
  \{ Reductions realized
• Technology is available

Affordability
• Achieved through commonality and flexibility
Aiming at Affordability Through Commonality and Modularity

40mm Low Velocity or Alternate

40mm Crew Served System

Ammunition and Fuzing Commonality and Uniqueness

Target Acquisition and Fire Control Commonality and Uniqueness
- Integration
- Modularity

Weapon Elements

Total System Integration

Extend Legacy System Life Through Leveraging and Commonality
Conclusion

- Bursting munition fuzing utilizing turns and/or turns/time algorithm offer unique capability
  - Simplicity
  - Precision
  - Functional variations
  - Commonality/adoptability

- Total system approach ensures system interface capability
  - Setter
  - Fire control
  - Weapon integration

- Leveraging OICW system and fuzing technology and integration provides efficiency
  - Development
  - Commonality in technology
  - Training uniformity
  - Affordability
Individual and Crew Served Weapon Bursting Munition Benefits

- Enhances system effectiveness
- Extends life of Legacy Systems
- Provides for modular block mod changes
- Affordable

Provides Affordable and Effective Link to Objective Force Capability