Densified BALL POWDER®
Cased Telescoped Propelling Charge
LSAT Success

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St. Marks Powder Inc.
Acknowledgments

LSAT Team

Propellant & Cartridge Development

St. Marks Powder
Jean Brooks
Wade Colvin
Hayes Green
Lex Shea

ARDEC/JSSAP
Mark Leng
Sam Moy

AAI
Bo Engel
Ben Cole
Lynn Pierson

ATK
Jeff Marshall
Contents

- LSAT – What Makes it Go
  BALL POWDER® Propellant
- Cased Telescoped Ammunition
  ↗ Interior Ballistics & Charge Design
  Theoretically it’s better than you think
- In Case Compaction
  ↗ Low Cost, Low Risk, Proven Performance
- Putting it All together
  ↗ LSAT Evolution & Ballistic Results
BALL POWDER® Propellant

- Primary ingredients
  - Nitrocellulose
  - Nitroglycerin for energy
  - Deterrents – Burn Rate Modifiers

  For Ballistic Efficiency

- Spherical geometry for ease of loading
- Compressible for 20% to 40% increased charge weight over loose loaded ammunition
CT Ammunition

● Cased Telescoped – *Bullet in a Beer Can*
  ↗ Size and Shape Convenience – Long History
  ↗ Traditionally Energy and Volume Inefficient
    ■ Poor propellant choices – no charge development
      “What do you have - off the shelf”
    ■ Limited system understanding

● LSAT CT Spiral Development
  ↗ Plan for System Evolution
  ↗ Propellant & Charge evolved along with Cartridge (and Weapon)
Small Caliber CT Interior Ballistics
LSAT Program Initial Concerns

- Energy Efficiency?
  Historically up to 30% more propellant required than standard ammo for CT ammo

- Can the system be modeled (simply)?
  Lumped parameter codes assume simultaneous ignition

- Do we need translation/barrier hardware?
  Goal is to minimize volume & simplify system

- What is the best approach for propellant densification?
  KISS principal applies
In Case Powder Compaction
High Density Propulsion Charge

- Achieves higher loading densities via compression of the propellant bed
- Uses no heat or binders
- Does not affect the propellant burn characteristics for BALL POWDER® Propellant
- Muzzle energy increases from 20-40% can be obtained over loose loaded charges
- Commercially produced for over 10 years in over a dozen different cartridges (rifle) and military medium caliber
In Case Powder Compaction (HDPC)
Lessons Learned

Spiral 1 - Loose Load with Std. 5.56mm M855 Case Volume

- Needs higher gas generation rate
- System models as if chamber was much larger than actual
- ARL 5.56mm ignition studies (Horst, Conway, Williams, Brandt, etc.) suggest mechanical stress is transferred to bullet before full ignition
- Propellant design based on an effective chamber volume that was larger by bullet displacement

Spiral 2 – Loose Loaded Spiral 1Charge / Full Case

- Reduced volume & optimization allowed charge weight reduction
- No compaction required – actual density < 1.0
- Incorporated flash suppression
- Primer & Case variations impact performance
Lessons Learned cont.

Spiral 3 – Compacted Propellant Allows Further Volume Reduction

- Propellant still designed for larger chamber volume
- Optimization & CT characteristics reduce charge weight ~10% from M855
- Control of compaction variables critical for optimization
- AAI/ATK have successfully scaled up LSAT CT to produce 85,000 rounds
- BALL POWDER® Propellant is ideal for an in case compacted charge
**LSAT Ballistics**

**LIGHTWEIGHT SMALL ARMS TECHNOLOGIES (LSAT)**

**FIRING RECORD**

<table>
<thead>
<tr>
<th>FIRING</th>
<th>Charge Wt</th>
<th>Chamber</th>
<th>Velocity ft/s @ 78 ft</th>
<th>% Change</th>
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<tr>
<td>TEMP °F</td>
<td>grains</td>
<td>PSI</td>
<td></td>
<td></td>
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<tr>
<td>70</td>
<td>23.4</td>
<td>Meets M855 Spec</td>
<td>3019</td>
<td>-</td>
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<tr>
<td>125</td>
<td>23.4</td>
<td>+ 7%</td>
<td>3064</td>
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<td>23.4</td>
<td>+ 10%</td>
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</table>

**10 Round Group Averages**

| M855 Velocity Spec | 3020 ± 40 |

**•** Reliable performance across the full temperature range

**•** Velocity Standard Deviations <<20 f/s

**•** Consistent Action Times <2 ms

**•** Initial tests indicate BALL POWDER® Propellant meets specification for the M855A1 bullet in the LSAT system
Conclusions

- BALL POWDER® Propellant is optimal for LSAT due to its excellent loading and compaction properties
- Co-development of the LSAT CT cartridge and propellant has allowed system optimization
- CT LSAT ammunition provides an ideal platform for propellant compaction due to bullet translation on primer function
- St. Marks Powder Inc. has the capability to produce LSAT propellant for well over 1 billion rounds per year.

Questions?
Speaker Information

Jim Drummond
850-577-2222
St. Marks Powder
A General Dynamics Company
james.drummond@gd-ots.com