

**Densified BALL POWDER®
Cased Telescoped Propelling Charge
LSAT Success**

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St. Marks Powder Inc.**

Acknowledgments

LSAT Team



ARES, Inc.



Battelle
The Business of Innovation



St. Marks Powder
A GENERAL DYNAMICS COMPANY

Propellant & Cartridge Development

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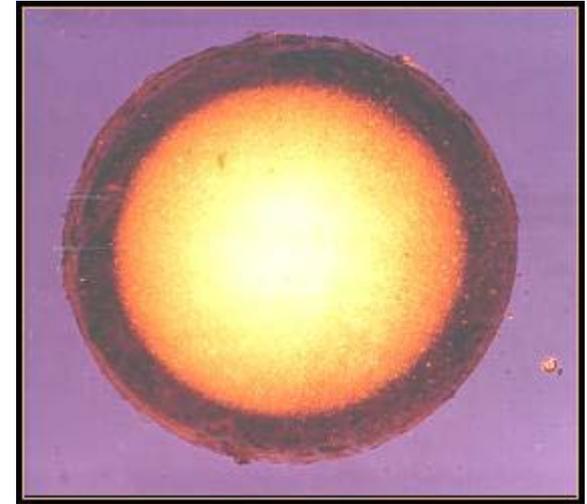
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Contents

- 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

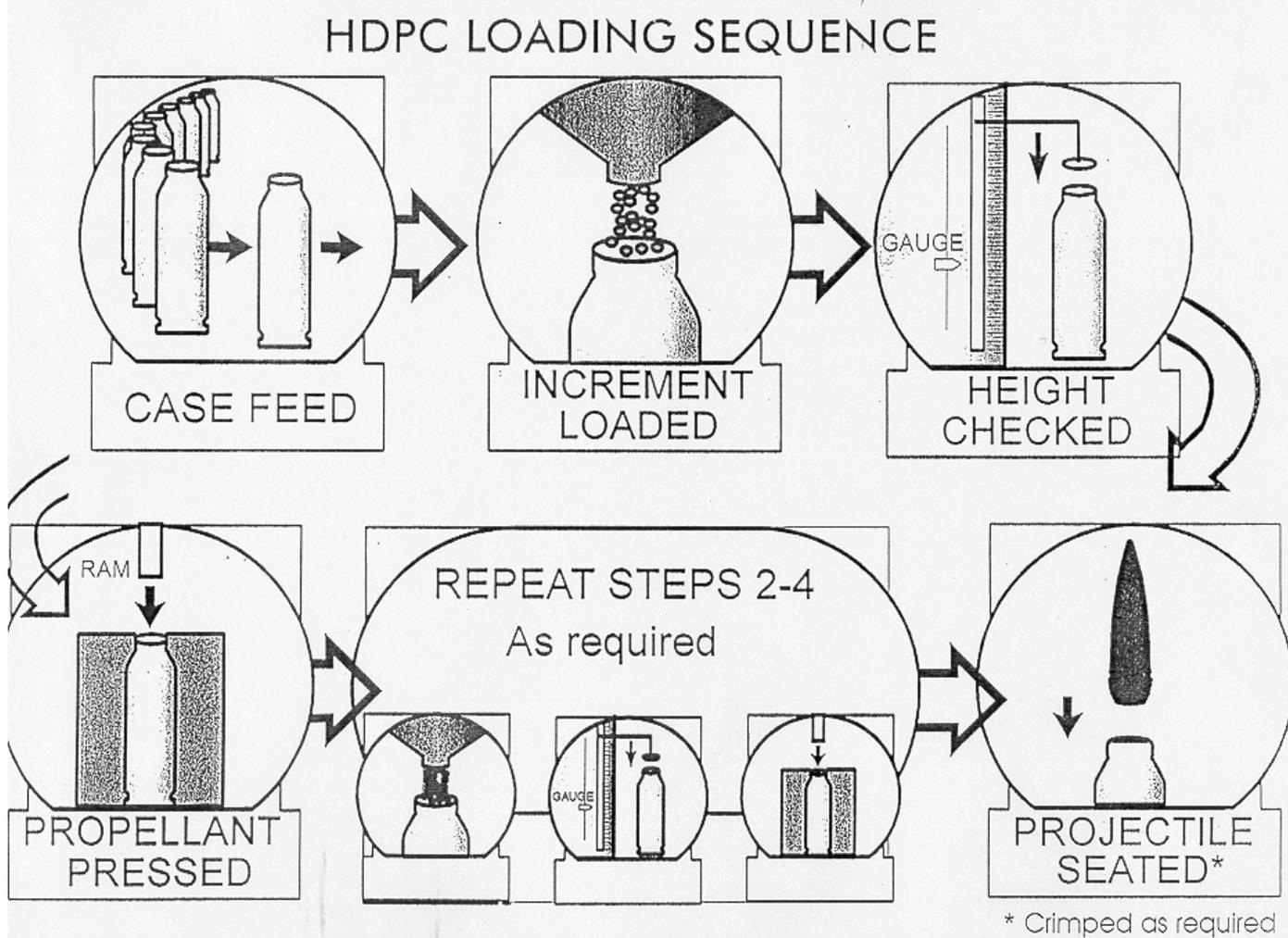
LSAT Program Initial Concerns

- 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

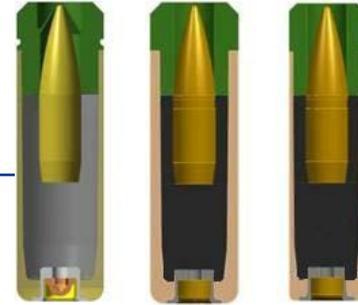
In Case Powder Compaction High Density Propulsion Charge

- 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)



LSAT CT Evolution



Lessons Learned

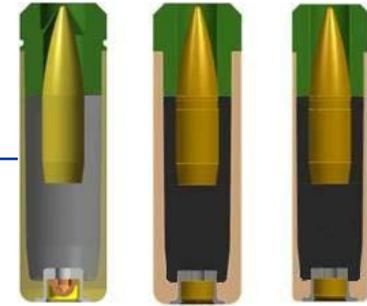
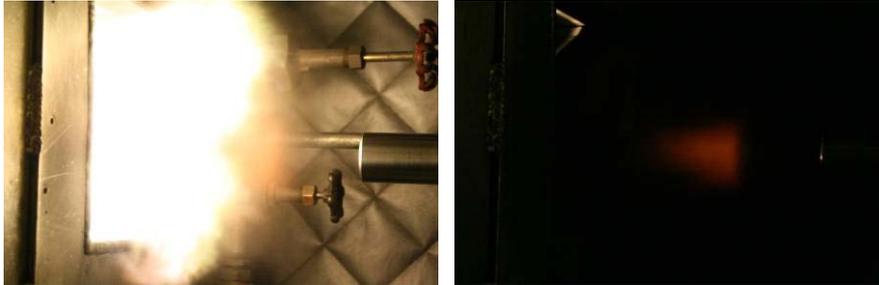
Spiral 1 - Loose Load with Std. 5.56mm M855 Case Volume

- 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 1 Charge / Full Case

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

LSAT CTA Evolution cont.



Comparison of
Unsuppressed and
Suppressed Propellant
in the LSAT Cartridge

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

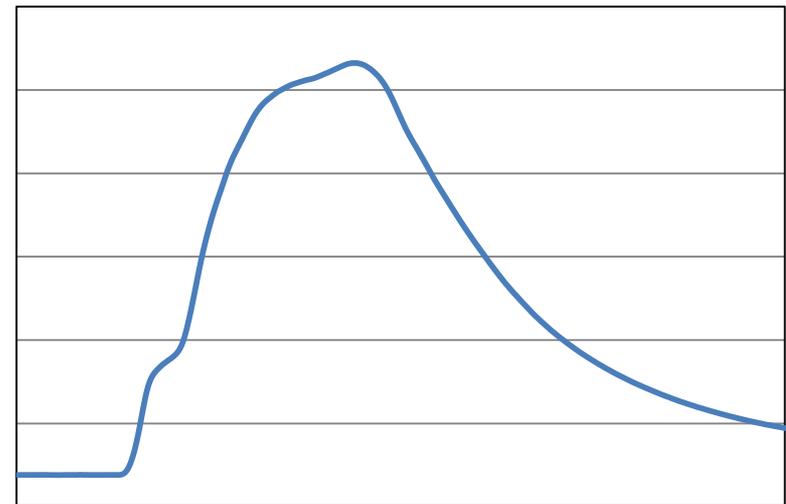
FIRING	Charge Wt	Chamber	Velocity	Velocity
TEMP °F	grains	PSI	ft/s @ 78 ft	% Change
70	23.4	Meets M855 Spec	3019	-
125	23.4	+ 7%	3064	+ 1.5
-65	23.4	- 14%	2864	- 5.1
160	23.4	+ 12%	3099	+ 2.7
140	23.4	+ 10%	3084	+ 2.1

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**

LSAT Pressure Plot



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?

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