



GD-OTS Propellant Program
HIGH DENSITY, MULTI-GRANULATION,
PROPELLING CHARGE DESIGN

April 7, 2009

Daniel Lepage - Valleyfield

Bob Pulver – St. Marks Powder

GD-OTS Propellant Capabilities



GD-OTS
St. Marks Powder
Producing Propellant
Since 1970
1974 Acres,
of Buildings - 137
of Employees - 350



GD-OTS Canada
Valleyfield
Producing Propellant
Since 1941
1112 Acres,
of Buildings - 180
of Employees - 420



St. Marks Powder



Valleyfield

**High Loading Density
+ Ballistic Efficiency**

= High Performance

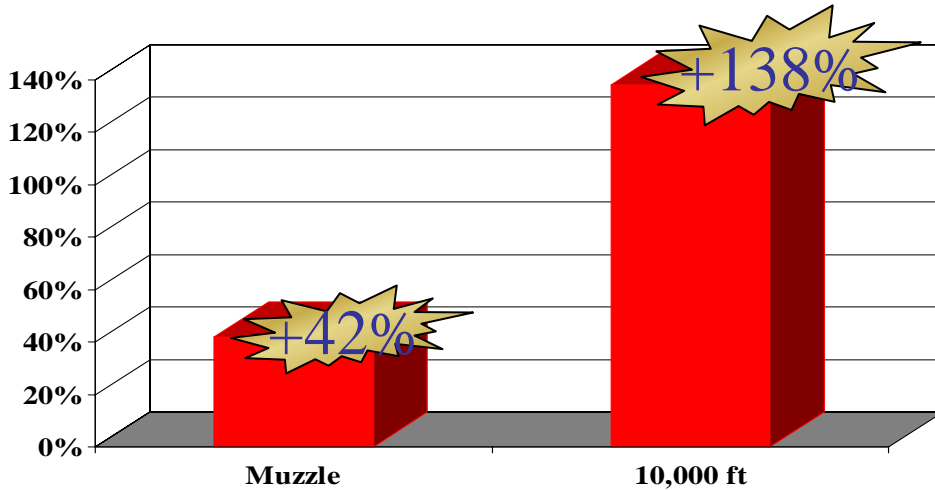
The ability to achieve higher charge weights combined with the appropriate burn progressivity (ballistic efficiency) will yield higher performance capabilities

High Performance Propellant Technology

High Loading Density Performance Improvements *Demonstrated in 20mm Mk-244*

- Increased Kinetic energy with heavier projectiles
- Reduced Time of Flight
- Flat Temperature Sensitivity
- Improved Ballistic Stability
- **Low Flame Temperature for Longer Barrel Life**

High Loading Density Charge – Proven Technology



Maximum Kinetic Energy

Example:

20mm Phalanx Ammunition

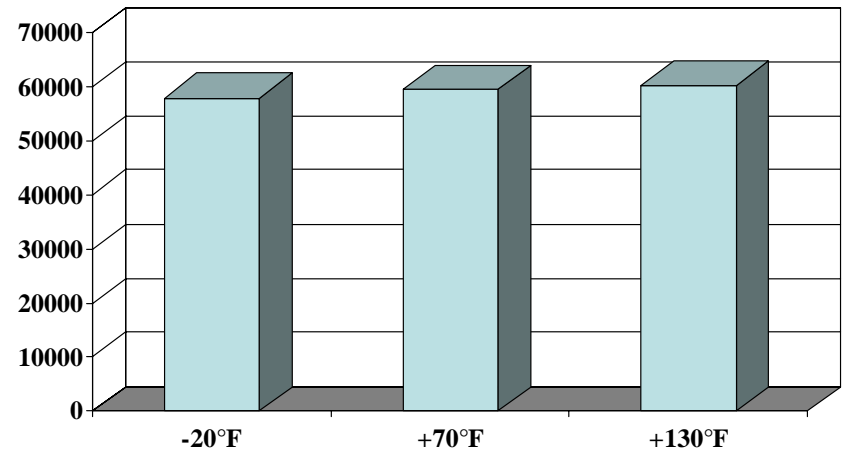
Mk-149 Loose Loaded Charge

Mk-244 Compacted Loaded Charge

(+ 25% in Propellant Charge Weight)

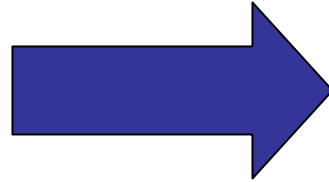


Excellent Temperature Sensitivity



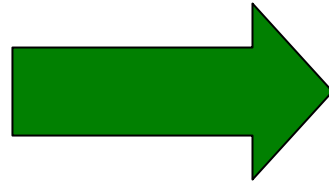
High Performance Propellant Technology

Compacted
Propellant Charge



Excellent for minimal
projectile case
intrusion

Mixed Propellant
Charge



Excellent for applications
with significant projectile
case intrusion such as KE
rounds

Mixed Charge Propellant Concept

High Density, High Performance Charge provides up to **25%*** higher charge weights than typical Loose Loaded charge

** In laboratory studies*



Mixed Propellant Charge - Objective

- Objective: Demonstrate this concept in ammunition to achieve improved ballistic performance
 - Chose 30mm GAU-8/A PGU-15 /B TP ammunition as a Baseline
 - Valleyfield started with a 7-Perf, surface deterred, extruded propellant
 - Blended in a small diameter, surface deterred, BALL POWDER® propellant
 - Loaded with vibration

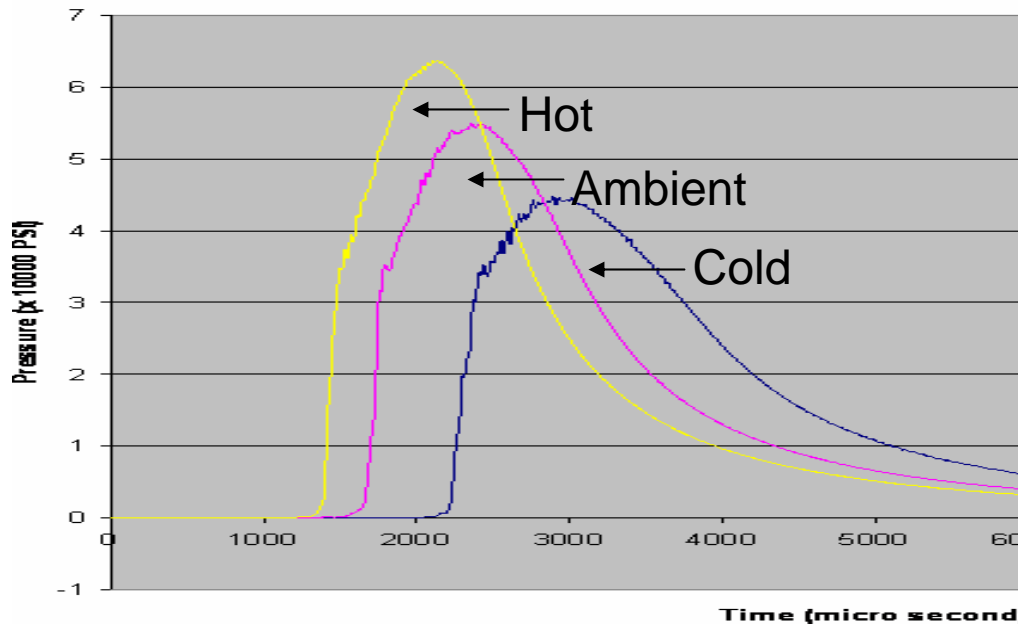
***Achieved 17% charge weight
increase with excellent ballistic
efficiency***

30mm Ballistic Results

Baseline @ 145 grams = 3,340 fps 50,000 psi

Mixed Charge @ 170 grams = 3,623 fps 56,000 psi

Represents a 18% increase in Kinetic Energy with low flame temperature propellant charge



Typical temperature sensitivity with very good standard deviations

Bottom Line: Excellent combustion dynamics with the mixed charge

30mm Ballistic Results - Projected

Baseline @ 145 grams = 3,340 fps

1st Iteration Mixed Charge @ 170 grams = 3,623 fps

Planned Iteration Mixed Charge @ 188 grams = 3,730 fps

Represents a 25% increase in Kinetic Energy



Mixed Propellant Charge – Future Work

Future Work

- Maximize Charge Weights
 - *Geometry and Loading Studies*
- Maximize ballistic efficiency with deterrent technology
- Optimize Standard Deviations and Temperature Sensitivity
 - *Propellant chemistry (Compatibility)*
 - *Ignition system*
- Ensure excellent long-term, hot temperature ballistic storage
- Ensure excellent IM properties

Mixed Charge Propellant Concept - Summary

Large Multi-Perf, Deterred,
Extruded Propellant

+

Small Deterred BALL
POWDER® Propellant

=

High Density, High
Performance Mixed Charge

***GD-OTS Valleyfield and St. Marks Powder
have the technical know-how to develop
high performance, high propellant density
charges for maximum performance***



Development Team

St. Marks Powder

- Bill O'Meara, Manager, Product Development
- Tim Ulrey, R&D Development Engineer

GD OTS-Canada Valleyfield

- Mathieu Racette, R&D Project Officer, Small and Medium Calibre Ammunition
- Frederick Paquet, R&D Project Officer, Large Calibre Internal Ballistics
- Pierre-Yves Paradis, R&D Coordinator