GENERAL DYNAMICS
Ordnance and Tactical Systems

Temperature Insensitive Propulsion for KE Tank Ammunition

Author: Neal Hylton - General Dynamics Ordnance & Tactical Systems: Large Caliber Ammunition

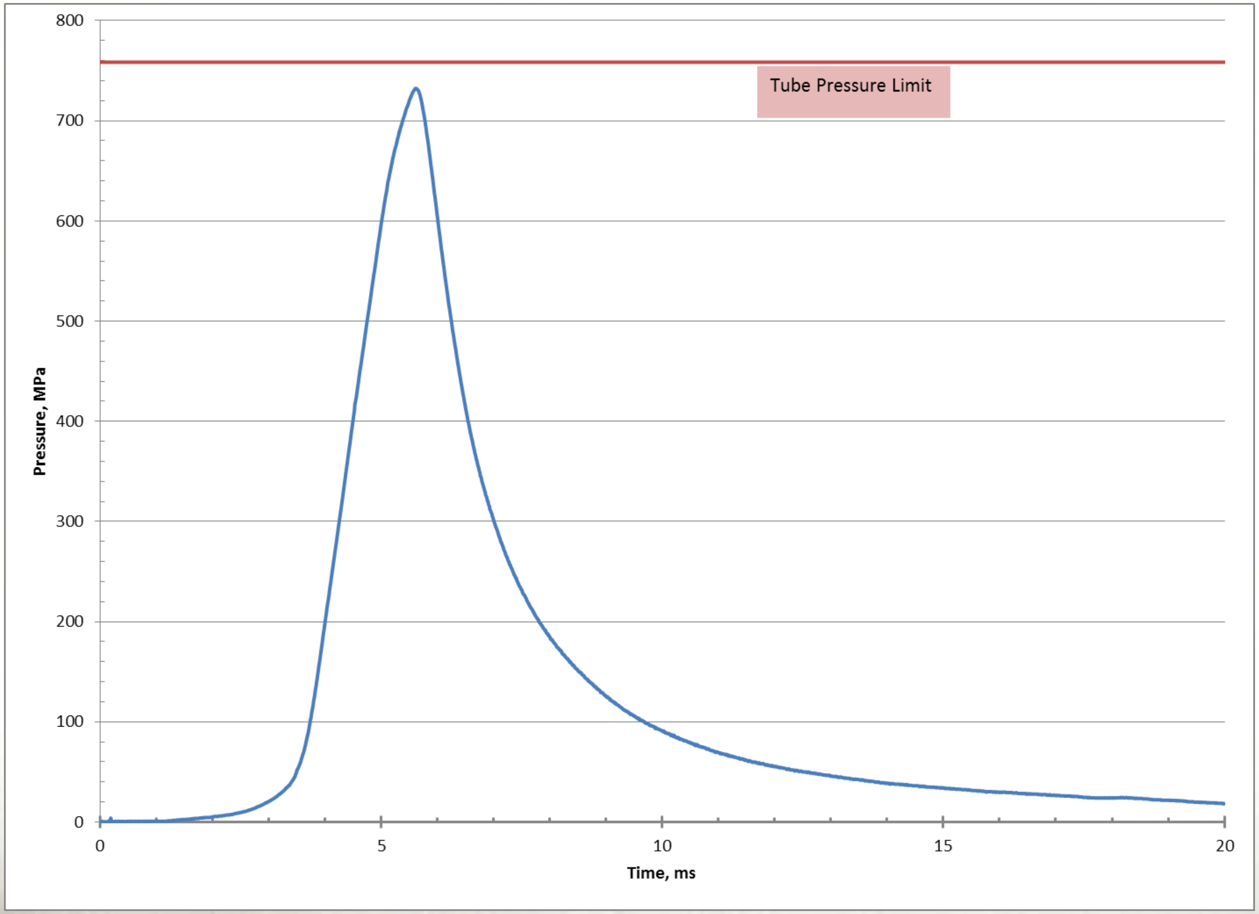
Co-author: Dr. Klaus-Achim Kratzsch – Rheinmetall Waffe Munition

KE Performance Limitations

- $KE = \frac{1}{2}mv^2$
- Improved performance is achieved via increased velocity at target
- Therefore, the main goal is increased muzzle velocity
- Higher velocity is typically obtained through increased operating pressures
- *But* – Cannon pressure limits are established to ensure safety
- Problem – current systems already operate at the maximum safe limit of the cannon (rules out increased velocity via higher operating pressure)

Typical Pressure Curve for KE

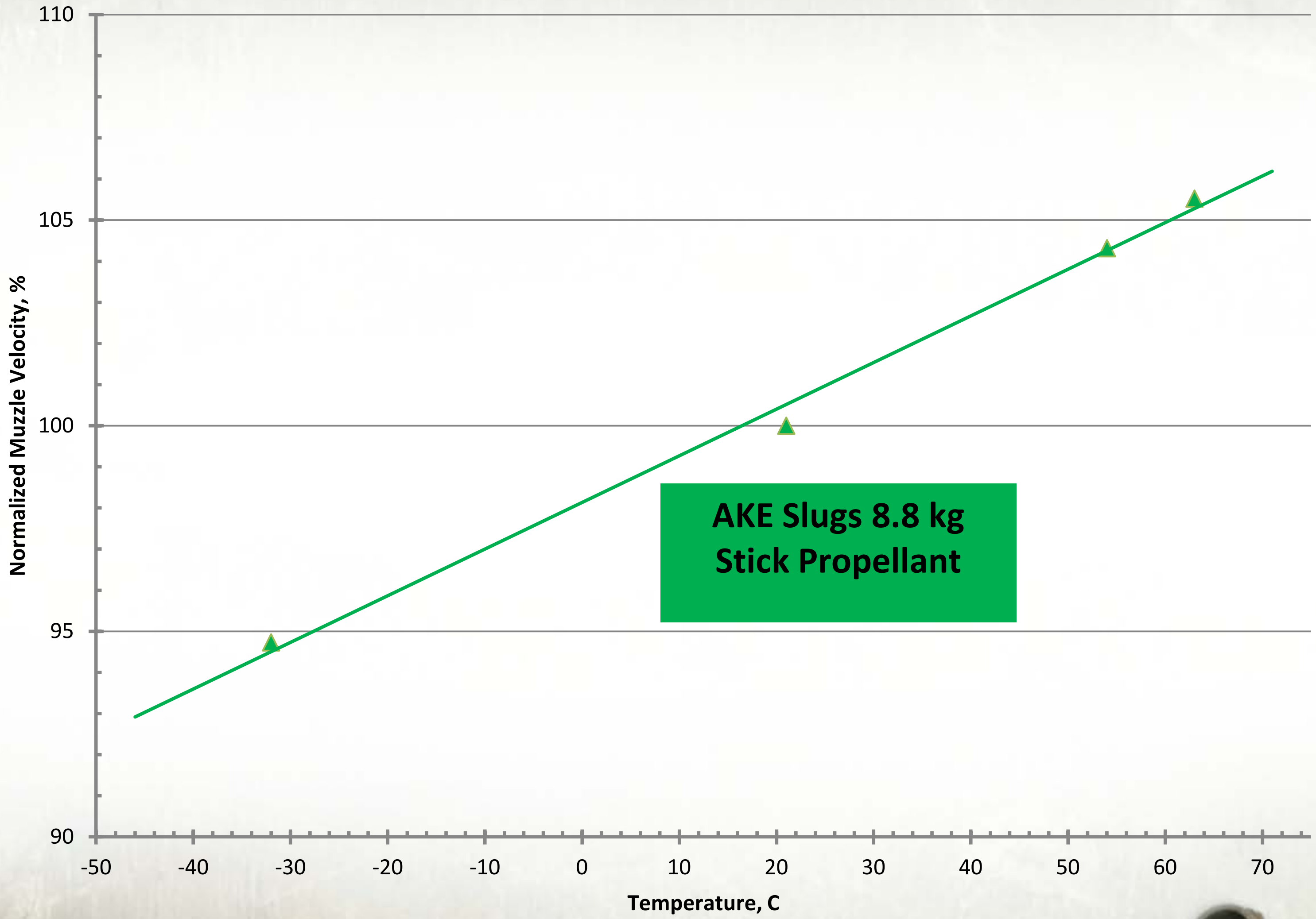
- Total energy imparted to the projectile is equivalent to the integrated area under the pressure time curve



How to Increase Performance

- Many ideas to increase the area without increasing P-max have been limited in successes
  - Programmed Splitting Slotted Stick
  - Multi-layered Propellants
  - Deterred Propellants
- Some successful tests have been performed but not yet fielded due to various issues of safety, producibility, and aging

Typical Propellant Temperature Profile



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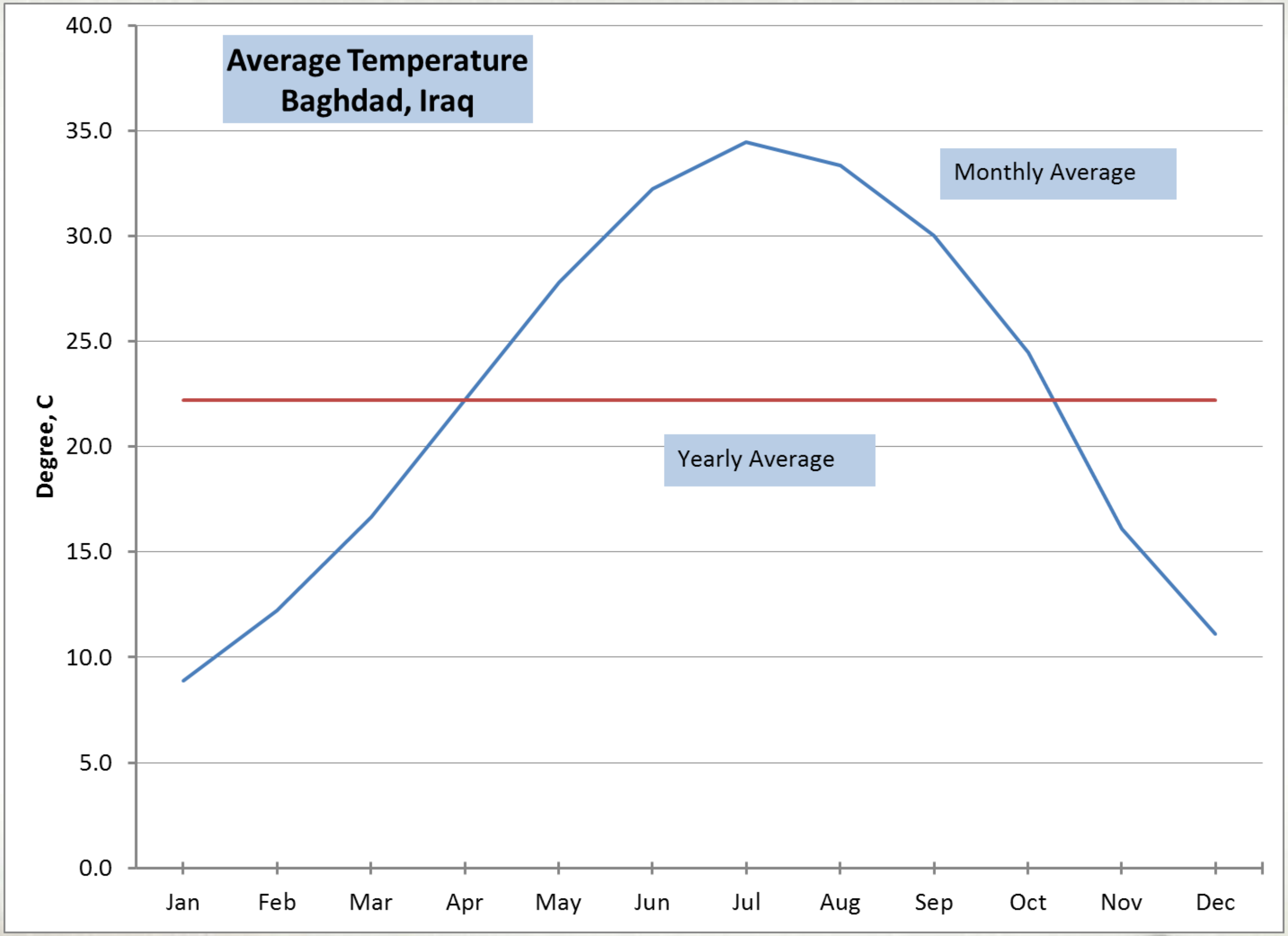
Increase Performance by Altering Temperature Profile

- Every fielded round needs to be capable of firing across the operational temperature range, including extremes
- But – Majority of firing engagements are more normal “ambient” temperatures
- Temperature Insensitive Propulsion System (TIPS®) breaks the normal increased temperature – increased pressure correlation
- This allows for an increase in performance at those temperatures most commonly encountered

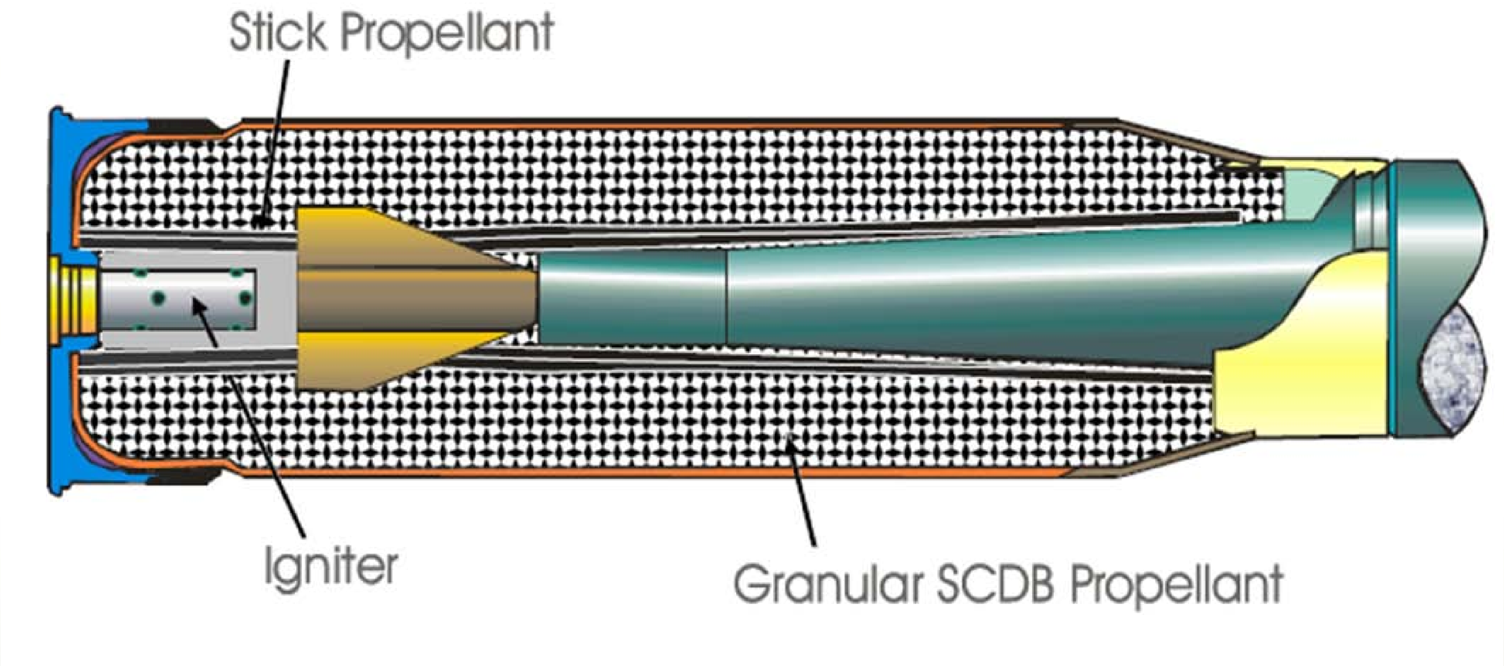
Typical Average Temperature



Advanced Propulsion Work

- Ballistic testing was performed using a notional KE slug with a mass of 8.800 kg
- This work built on previous efforts
  - DM63 Development by Rheinmetall
  - SCDB Propellant Evaluation by PM-MAS
  - GD-OTS IRAD
- This work involved every component of the propulsion system including:
  - Combustible Cartridge Case
  - Primer
  - Propellant

Slug Cartridge



Propulsion System Components

SCDB Granular Propellant

Stick Propellant

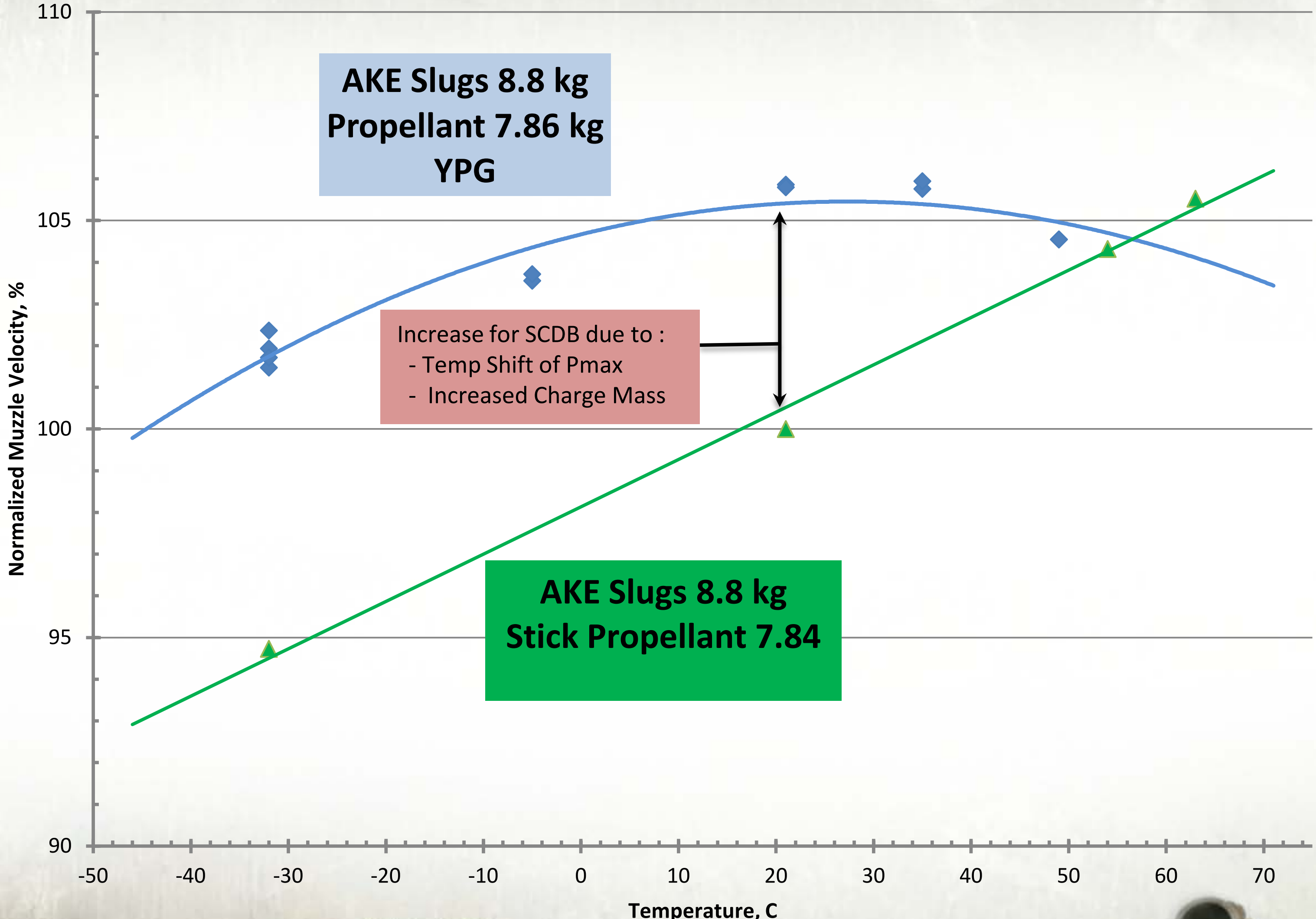
M123 Primer (used with stick propellant in M830/M831 rounds)

M35L70 Primer (used in this work)

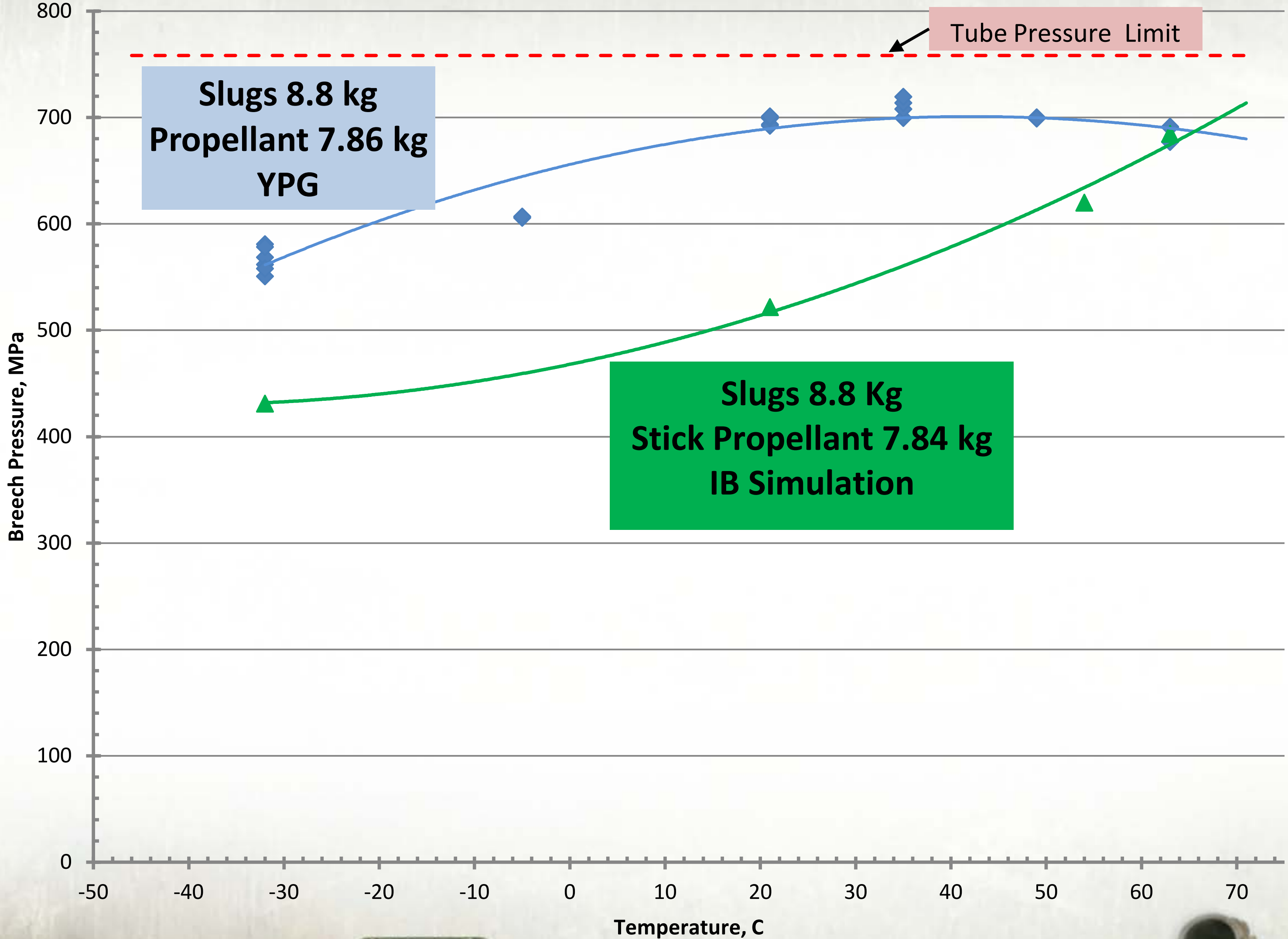
Problems Encountered

- SCDB Propellant Coating Strength
  - Dependent on loading density
  - Dependent on strength of ignition
- Ignition Issues due to the long aft boom intrusion and short primer
  - High Negative Delta Pressure
  - Flareback at cold temperature
- Ignition Issues solved by:
  - Changing primer configuration
  - Method of affixing propellant sticks
  - Integration of cartridge components

Final CV Test – Velocity Data



Final CV Test – Pressure Data



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LEADING THE WAY

Summary

- This program successfully demonstrated a Thermally Insensitive Propulsion System (TIPS®) with a KE slug in 120mm Tank Gun application
- The outcome was demonstration of a propulsion system that only varied 65 m/s across temperature range from cold to hot
- Demonstrated a significant increase in velocity at all temperatures below 35°C
- All of this was achieved within the safety pressure limits of the current 120mm cannon