Caseless Ammunition & Advances in the Characterization of High Ignition Temperature Propellant

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- Objective
  - To re-establish, develop, and demonstrate a capability to manufacture Caseless Ammunition prototypes and characterize the High Ignition Temperature Propellant
  - In support of the Lightweight Machine Gun and Ammunition Science & Technology Objective, deliver Caseless Ammunition for a ballistic demonstration
  - Transfer technology to industry

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- *Why Caseless Ammunition?*
  - Lightweight
  - Force Multiplier
  - Decreased Logistics Burden
  - High Ignition Temperature Propellant(HITP) Provides Improved Propellant Characteristics & Energetic Behavior
  - The State of the Art

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Overall Program Requirements

Threshold requirements (“must haves”)

- 35% Decrease in ammunition weight
- Same lethality as the 5.56mm M855 cartridge
- Environmentally friendly ammunition and process
- Low life-cycle costs

Extra requirements (“nice to haves”)

- 40% decrease in ammunition weight
- Increased lethality over the 5.56mm M855 cartridge
- Same cost/round as current 5.56mm M855 ammunition

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Why Use an HITP?

- Brass is a heat sink that is discharged with each round fired and provides structural strength
- Caseless ammo will not have a heat sink through mass discharge
  - HITP will need to provide significantly more insulation and thermal stability than typical ball powders
  - HITP will also need high degree of structural stability and maintain tolerances over operational temperature ranges
- Integration of this technology requires a system approach to be successful

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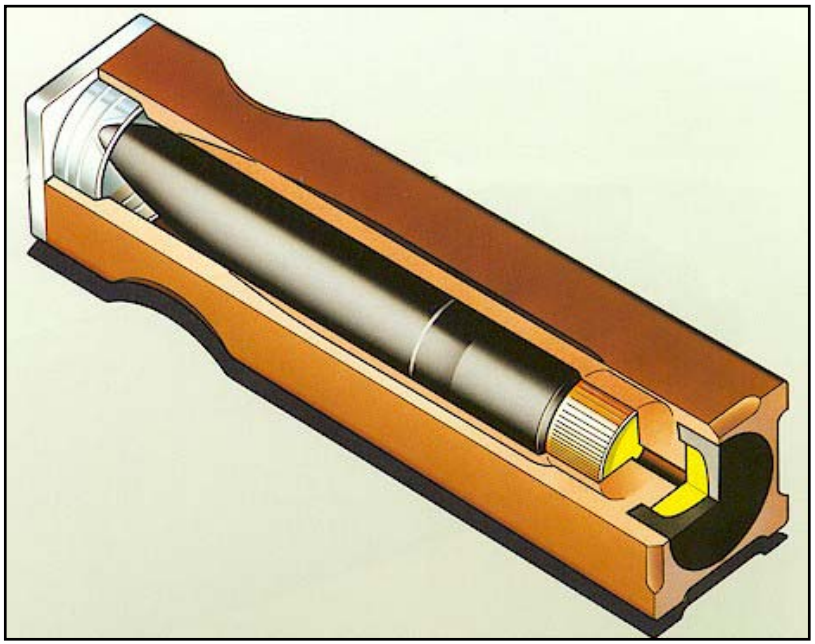
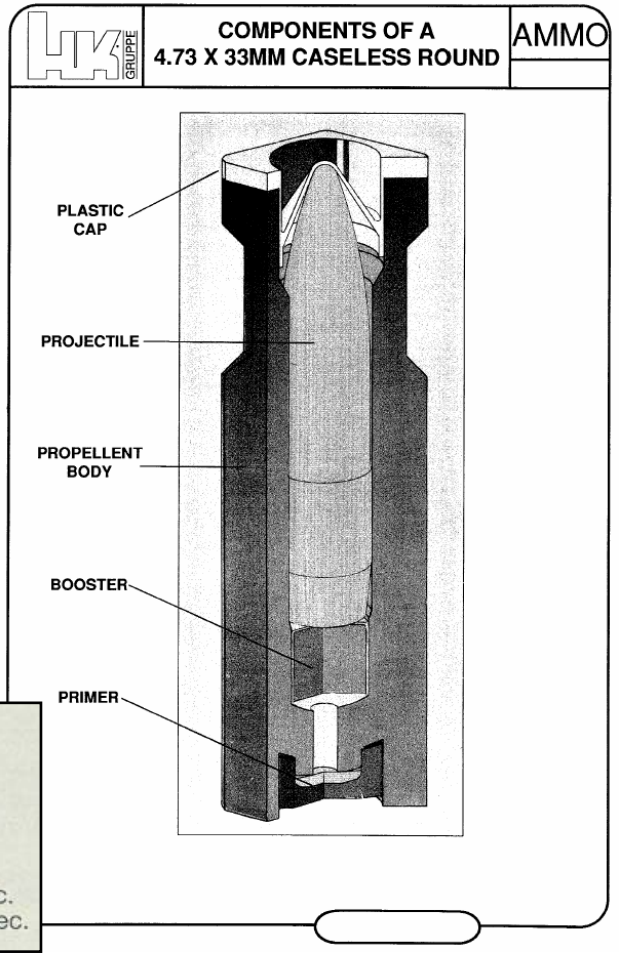
- Background
  - Previous work performed under the Advanced Combat Rifle (ACR) Program
  - Technology Development funded by US (ARDEC) and Germany to Heckler & Koch(H&K)/Dynamit Nobel(DNAG)
  - Successful Demonstration of a Caseless Ammunition Rifle System
  - Technology Licensed & Transferred to the US at ARDEC

G11 Open Source Data





Caseless ammunition

Length	33 mm/1.29 in.	Ignition	mechanical
Cross-section	8 × 8 mm/0.32 in.	Mean gas pressure	3850 bar
Total weight	5.20 g/0.18 oz.	Muzzle velocity V_o	approx. 930 m/sec.
Projectile weight	3.25 g/0.12 oz.		3051 ft./sec.

AAI

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J·S·S·A·P JOINT SERVICE SMALL ARMS PROGRAM

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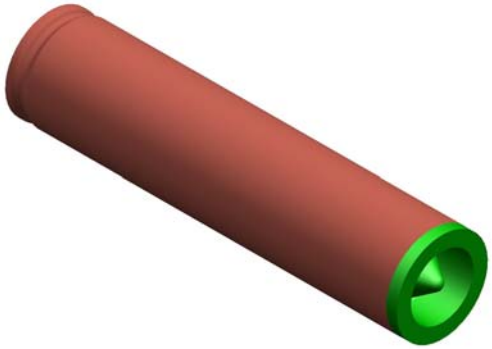
5.56mm Caseless Prototypes

Original Caseless Ammunition



5.56 mm LMGA Concept

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- Technical Approach
  - Determine Feasibility
    - Identify and address technical challenges/potential risk areas
      - Near term & long term
    - Material needs and source suppliers - availability
    - Assess equipment condition
    - Costs
      - Determined viability → Organizational Commitment
  - Re-establish capability and prototyping process utilizing existing technology
    - *Validation of In-house Caseless Ammunition capability in a 5.56mm cartridge configuration in support of the Lightweight Machine Gun and Ammunition STO*

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- Characterization of HITP
  - Original Caseless HITP and ARDEC HITP
    - Chemical analysis of original caseless HITP (NMR, HPLC & GPC)
    - Propellant density
    - Thermal stability
    - Heat of Explosion
    - Hazards analysis – friction, impact and ESD
- Demonstrate Producibility
  - Several hundred rounds have been produced from lab-scale propellant mixes
- Deliver Ammunition for testing
  - Conducted three ballistic firings in Mann Barrel @ ATF
- Transfer Technology to Industry
  - CRADA established with AAI

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Caseless Firings

- Test Firing I
  - Five Shots
  - Chamber Pressure (8190-11314 psi)
  - Muzzle Velocity (589-1204 fps)
- Test Firing II (Addition of Booster Charge)
  - 12 Shots
  - Chamber Pressure (14372-62225 psi)
  - Muzzle Velocity (1489-2795 fps)
- Test Firing III
  - 14 Shots
  - Chamber Pressure (15992-24579 psi)
  - Muzzle Velocity (1000-1686 fps)

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- Status of Progress
  - Next Steps
    - Continuing Characterization
    - Continue to manufacture qty of prototypes
      - Implementation of any processing improvements/fixes
    - Continue ballistic testing
    - Deliver prototypes for ballistic demonstration

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- Technical Challenges being addressed as technology is transitioned:
  - Long term availability and identification of source suppliers
  - Material replacements
  - Environmentally friendly alternatives/ manufacturing processes for constituents
  - Manufacturing process

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- Summary
  - Three Ballistic Test Firings
  - Validation of the in-house capability proceeding
  - Efforts focused to bring Caseless Ammunition Capability/Technology to a sufficient maturation level for transfer to industry
  - Potential applications in other caliber ammunition as the propulsion charge

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Status of JHU/APL Modeling

- IBHVG2 Model developed
  - HITP burn data
  - Single perf grain
  - ACR/G11 IB sequence recreated
- Reasonable results given limited data
  - Pressure & velocity close
  - Sensitivity analysis generally consistent
- Model will be updated as better data becomes available

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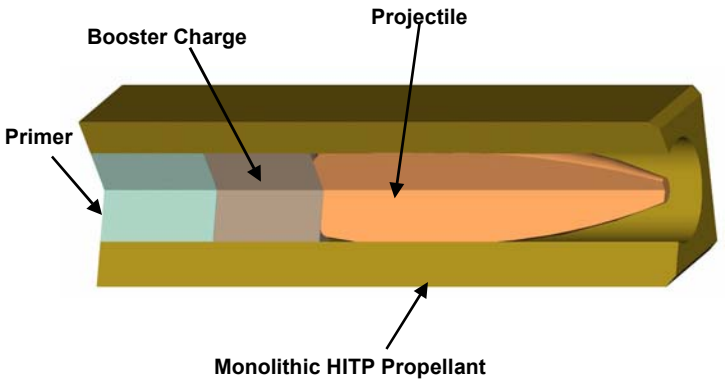
ATK – Phase II Contractor for CL Propellant

- H&K's propellant used as a foundation
- ATK Thiokol's energetic thermoplastic elastomer (ETPE) gun propellant experience will provide processing and modeling experience
- Propellant options
  - HITP recreation of DNAG propellant
  - HITP development of new binder and combination of energetic ingredients
  - ETPE with insulating layer
  - LOVA with insulating layer
  - Consolidated ball powder with insulating layer

H&K Ammunition Design



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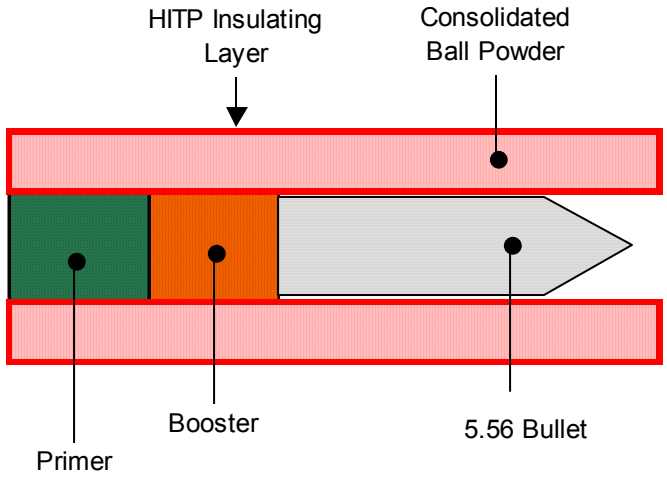
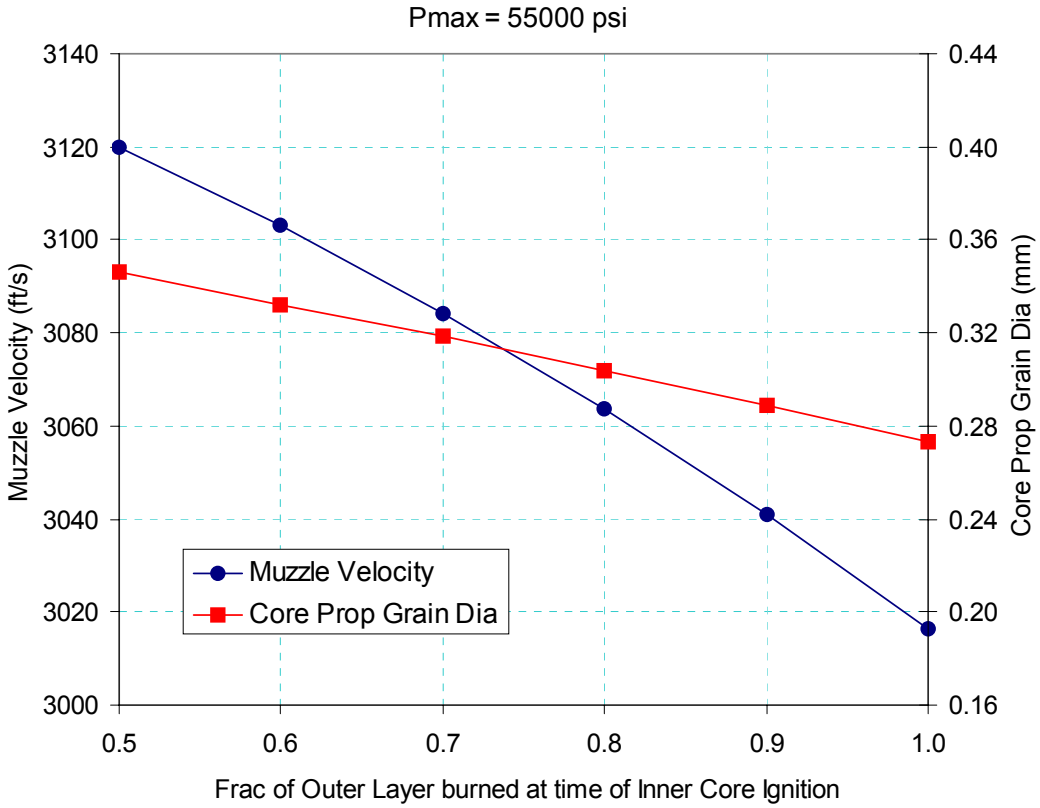
Concept Model

- Critical Assumptions:
  - Surface area of consolidated ball powder
  - Burning rate of HITP insulating layer
- The system was modeled as shown here:



Preliminary IB Modeling



Future Work

- Determine optimum propellant formulation
- Develop process for low-rate production of caseless rounds
- Deliver ammunition for testing and evaluation
- Scale-up process for pilot-scale ammunition production