National Defense Industrial Association

U.S. ARMY RDECOM
TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

U.S. Army Research, Development and Engineering Command

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

5.56mm High Pressure Test Cartridge Development

How to ruin a perfectly good weapon

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What is a Proof Cartridge?

- *Proof cartridges are used to stress test barrels and bolts for weapon acceptance.*

- *…develop pressures substantially exceeding those developed by normal service loads.*
  - ANSI/SAAMI Z299.4-1992, SAAMI Voluntary Performance Standards, Section IV Definitive Proof Loads Center Fire Rifle

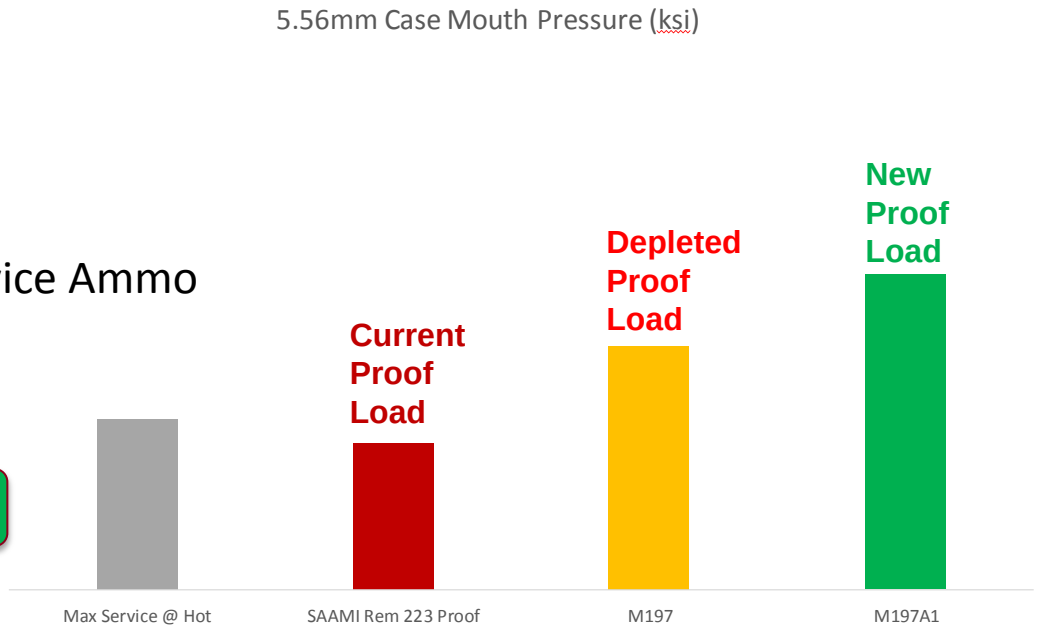
- *…(shall) produce pressures substantially in excess of the service round.*
  - TM 43-0001027, Technical Manual Army Ammunition Data Sheets , Small Caliber Ammunition

The Problem

- Depleted Proof Load Is Obsolete
  - Not Produced In 35+ Years
  - Material Unavailable
  - Design Not Optimized
  - Obsolete Test Methods

- Current Proof Load Is Inadequate
  - Different Pressure Standard
  - Pressure Too Low
  - Not Representative Of Army Service Ammo

How much pressure is too much?



What Should the New Pressure Be?

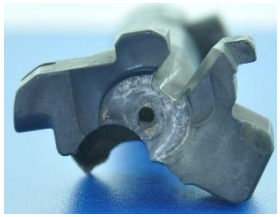
Pressure To Destroy Good Weapons

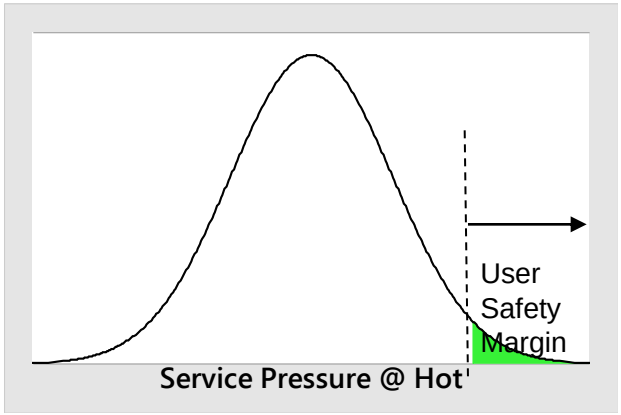
Supplier Safety Margin

M197A1 Design Pressure

User Safety Margin

Service Pressure @ Extreme Hot





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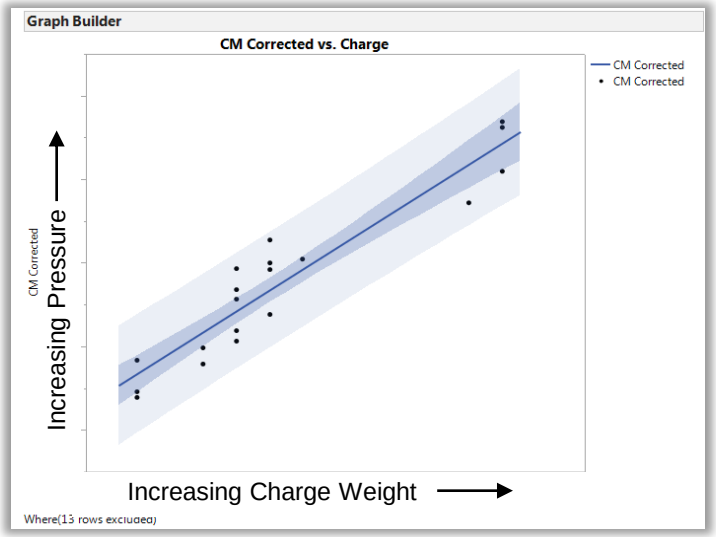
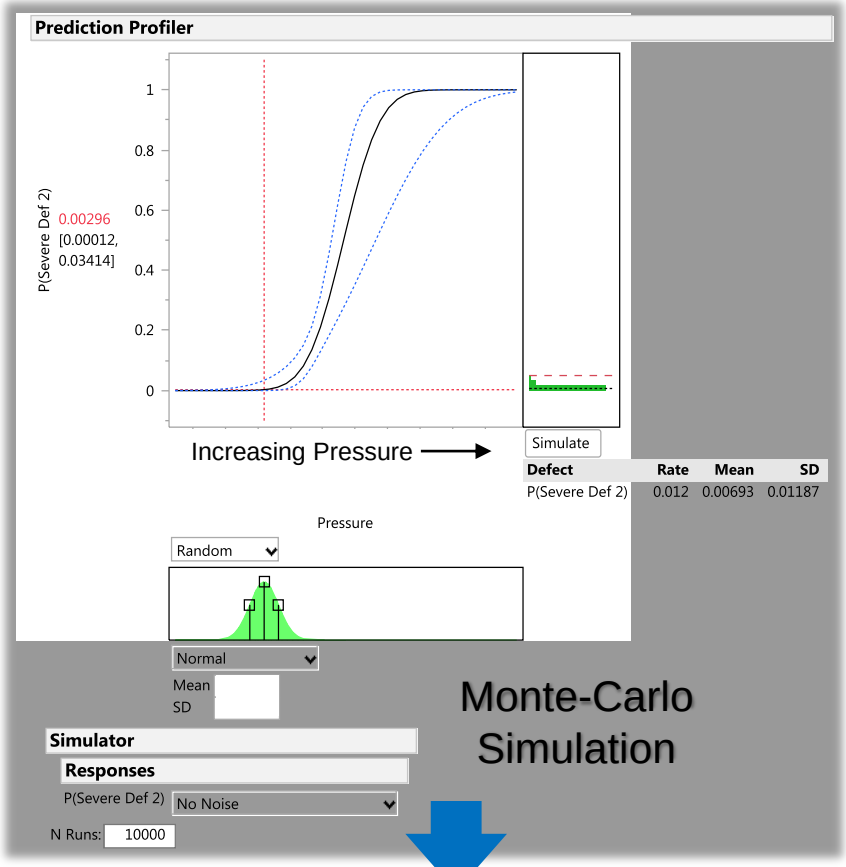
Analysis Approach

Charge Weight Establishment

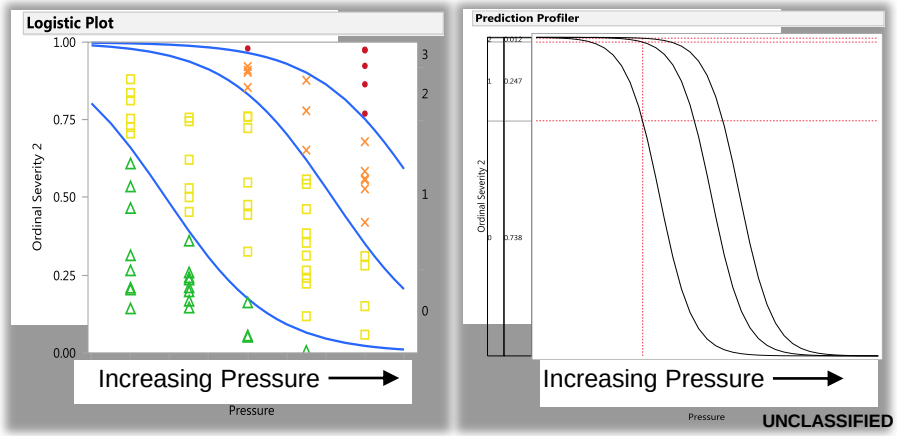


- Linear Regression used to establish relationship between Charge Weight & Pressure.
- Ordinal Logistic Regression used to determine a variety of defect probabilities given pressure
- Binary Logistic Regression used to determine a severe defect probability given pressure

Binary Logistic Regression Model



Ordinal Logistic Regression Model

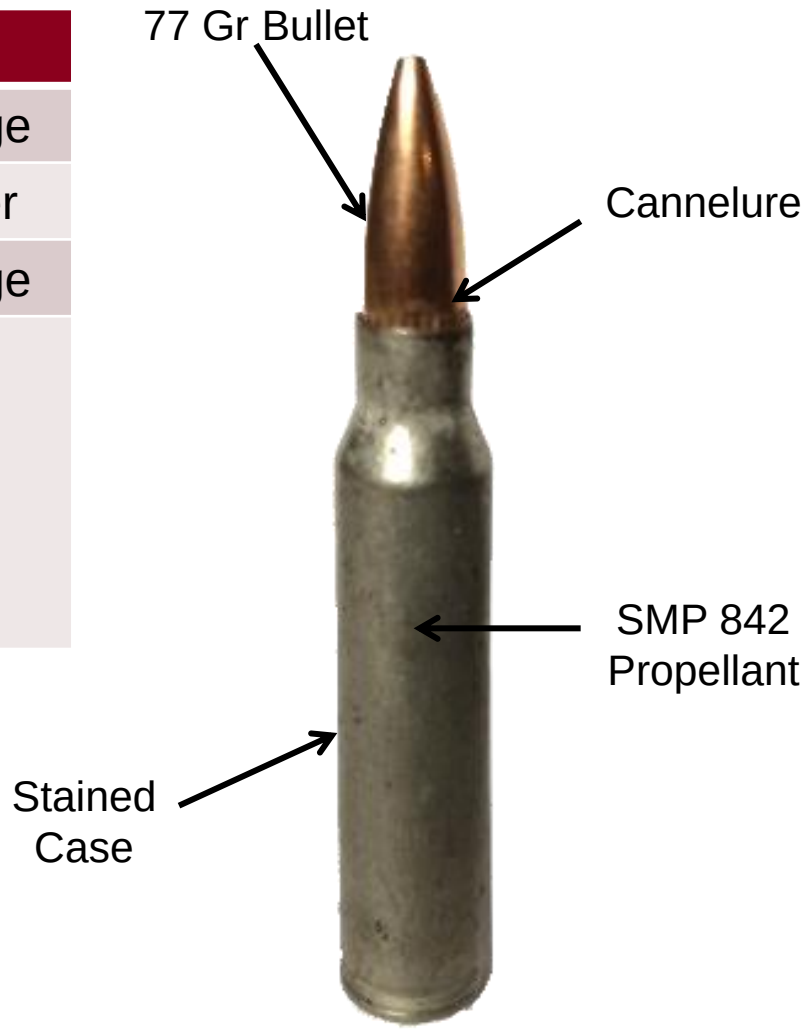


Monte-Carlo Simulation

- Identify Pressure That Corresponds to < ~ 1 in 1 Million Defects
- Include Pressure Limits Constrained By:
  - Service Pressure @ Extreme Hot
  - Manufacturing Process Capability

The Design Solution

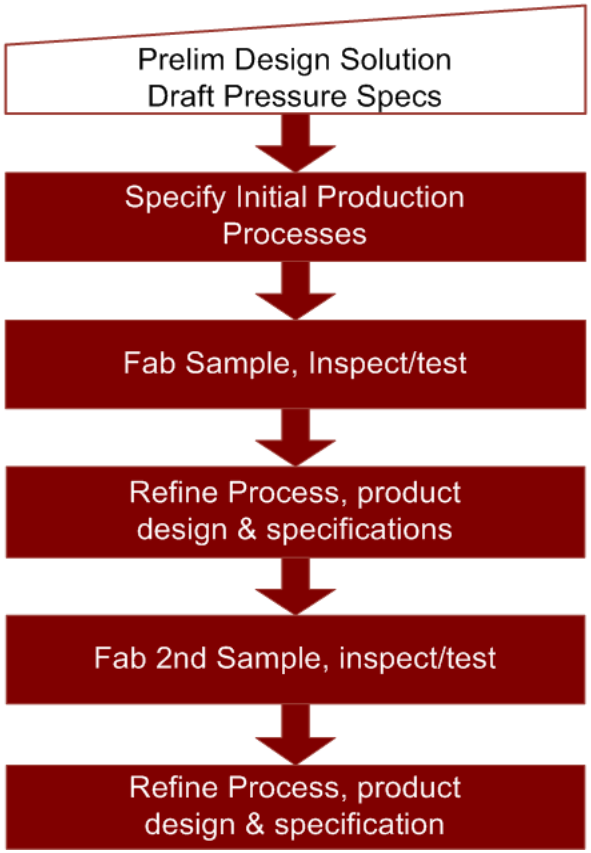
M197A1	Benefits
Case & Primer	Same As Service Cartridge
Case Stannic Stain	Low Cost Unique Identifier
SMP 842 Propellant	Same As Service Cartridge
77 Grain Projectile	Heavier Projectile: • Increases Pressure • Reduces Powder Placement Variability • Allows Use Of Service Cartridge Propellant



Engineering & Manufacturing Development

Product Refinements

- Design
  - Add bullet cannelure
  - Eliminate stain masking
- Specification
  - Add profile requirement
  - Eliminate:
    - Waterproof test
    - Dropped primer limits
    - Post-stain cartridge dims
  - Relax cartridge OAL tolerance



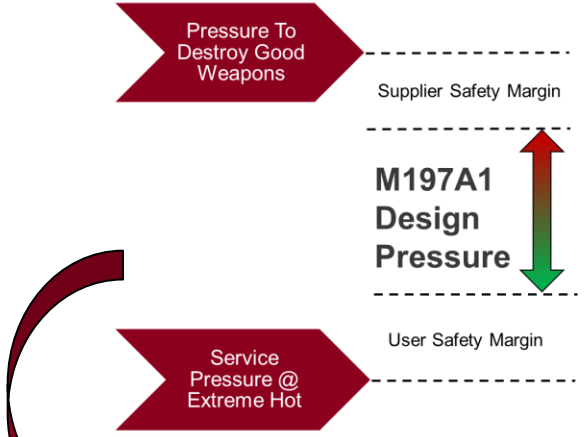
Process Development

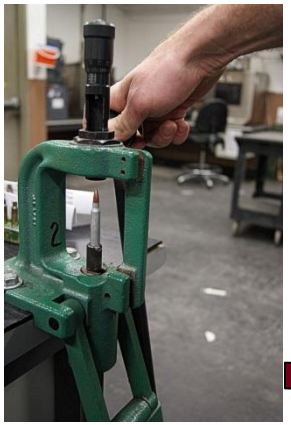
- Measured pressure using Piezo sensors not crusher gages
- Inserted bullet pushing on ogive not tip
- Established loading procedures to manage variability
- Developed plate process
- Sorted cartridges to achieve profile requirement

Enabled Path For Successful Product Transition Into Production At LCAAP

Results

- Outstanding collaborative effort
- Rapid evolution from requirements development to production validation
  - Provided pressure assessment consistent with Army small caliber ammunition test procedures
  - Utilized abundant materials
  - Sorted product to achieve optimized results
  - Ensured producible, cost-effective solution





M197A1 Drawings & Specifications Are Producible

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Special Thanks