



Contributions of Variables to Velocity Deviations in Small Caliber Ammunition

Abstract #20209

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Test Samples



**5.56mm Reference
Cartridge**
M855 Ball



**7.62mm Reference
Cartridge**
M80 Ball



**Caliber .50
Reference Cartridge**
M33 Ball



Reference Round Observations



Reference Ammunition



Manufacturing:

- Produced to minimize variation
- Single lots of subcomponents
- Single flow path through manufacturing
- Tightened manufacturing and qualification requirements

Use:

- Used to verify weapon setup
- Shot on every weapon throughout its useful life
- Fired every day before testing
- Experiences varied seasonal/environmental conditions
- Typically lasts 3 to 5 years



Barrel-to-Barrel Differences



- Lake City Ballistics Testing consumes hundreds of test barrels each year.
- Since the same lot of reference is shot through various barrels on each caliber, it is possible to evaluate barrel-to-barrel differences.

Method of Evaluation:

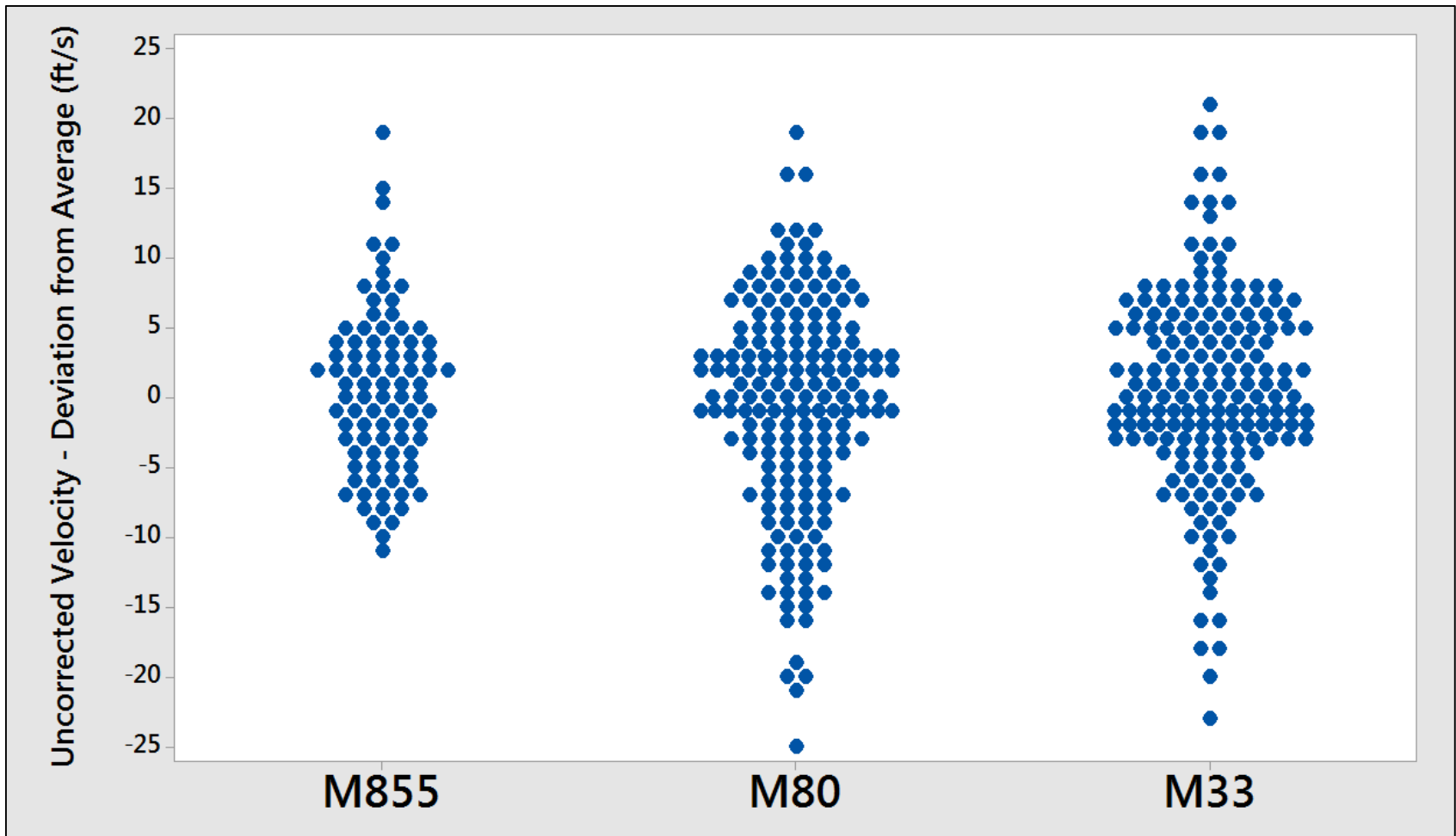
- Average uncorrected velocities were calculated for reference rounds fired on barrels containing between 100 and 300 rounds (cumulative).

Conclusion:

- The following barrel-to-barrel variations were observed:
 - 5.56mm (M855) = 30 ft/s
 - 7.62mm (M80) = 45 ft/s
 - Caliber .50 (M33) = 45 ft/s



Barrel-to-Barrel Velocity Deltas (100 to 300 ROB)



Barrel to Barrel Differences: M855 = 30 ft/s; M80 = 45 ft/s; M33 = 45 ft/s



Rounds on Barrel



- EPVAT test barrels at LCAAP are retired after 1,500 rounds fired.
- Since the same lot of reference is shot prior to testing each day throughout a barrel's life, it is possible to evaluate trends based on barrel influence.

Method of Evaluation:

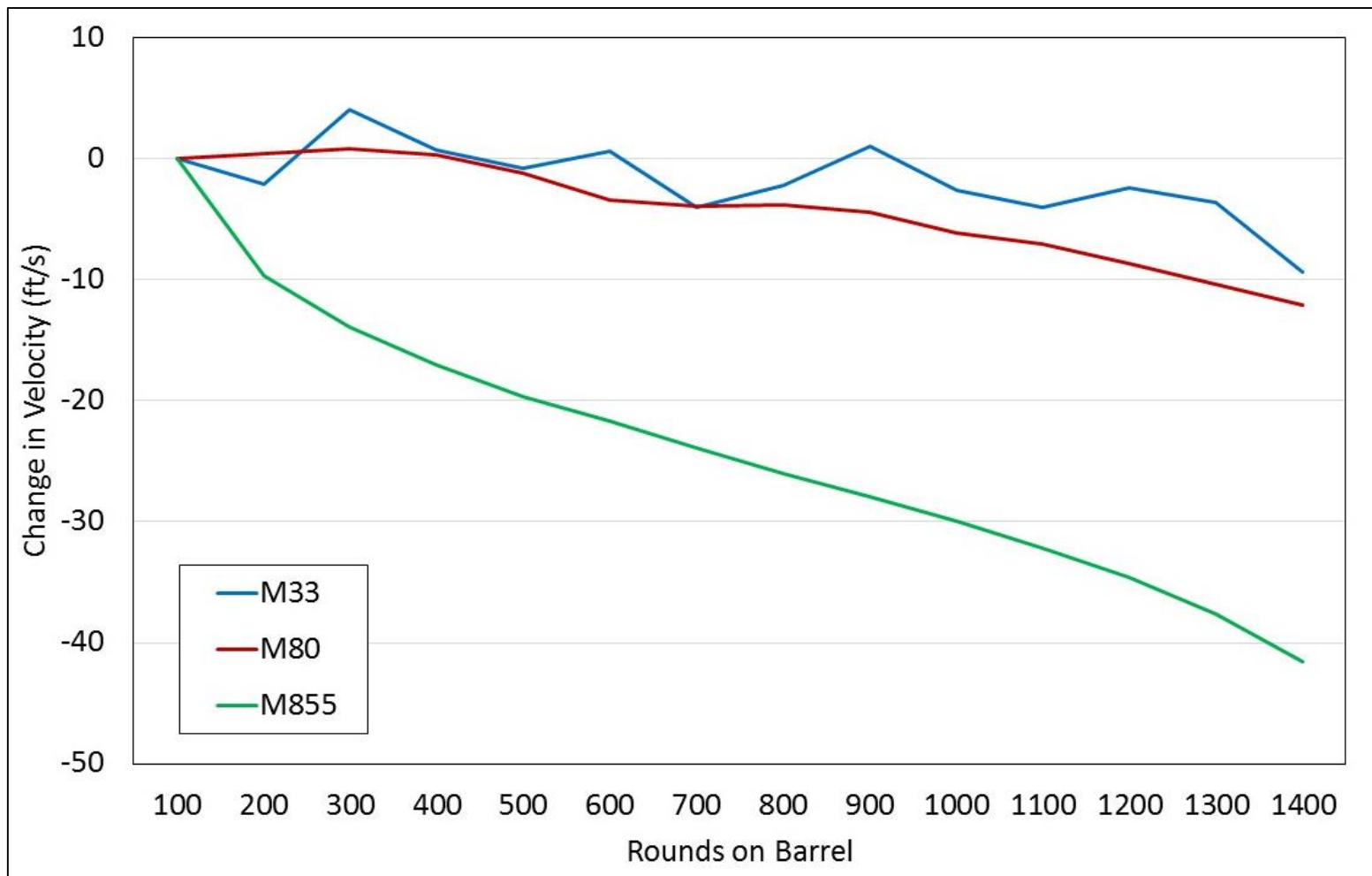
- Calculate the average reference round uncorrected velocity for each 100 rounds on barrel.

Conclusion:

- The following rounds-on-barrel variations were observed:
 - 5.56mm (M855) = 40 ft/s
 - 7.62mm (M80) = 10 ft/s
 - Caliber .50 (M33) = 10 ft/s



Uncorrected Velocity vs. Rounds on Barrel



M33 & M80 Average Velocity drops by 10 ft/s over the life of an EPVAT barrel
 M855 Average Velocity drops by 40 ft/s over the life of an EPVAT barrel



Shot-to-Shot Differences



- Generally, reference rounds are conditioned to ambient prior to validating a test setup.
 - Rounds are taken by the gunner in small quantities from the temperature chamber to the weapon using an insulated container.
- The consistency of reference ammunition provides an excellent opportunity to evaluate shot-to-shot influences during testing.

Method of Evaluation:

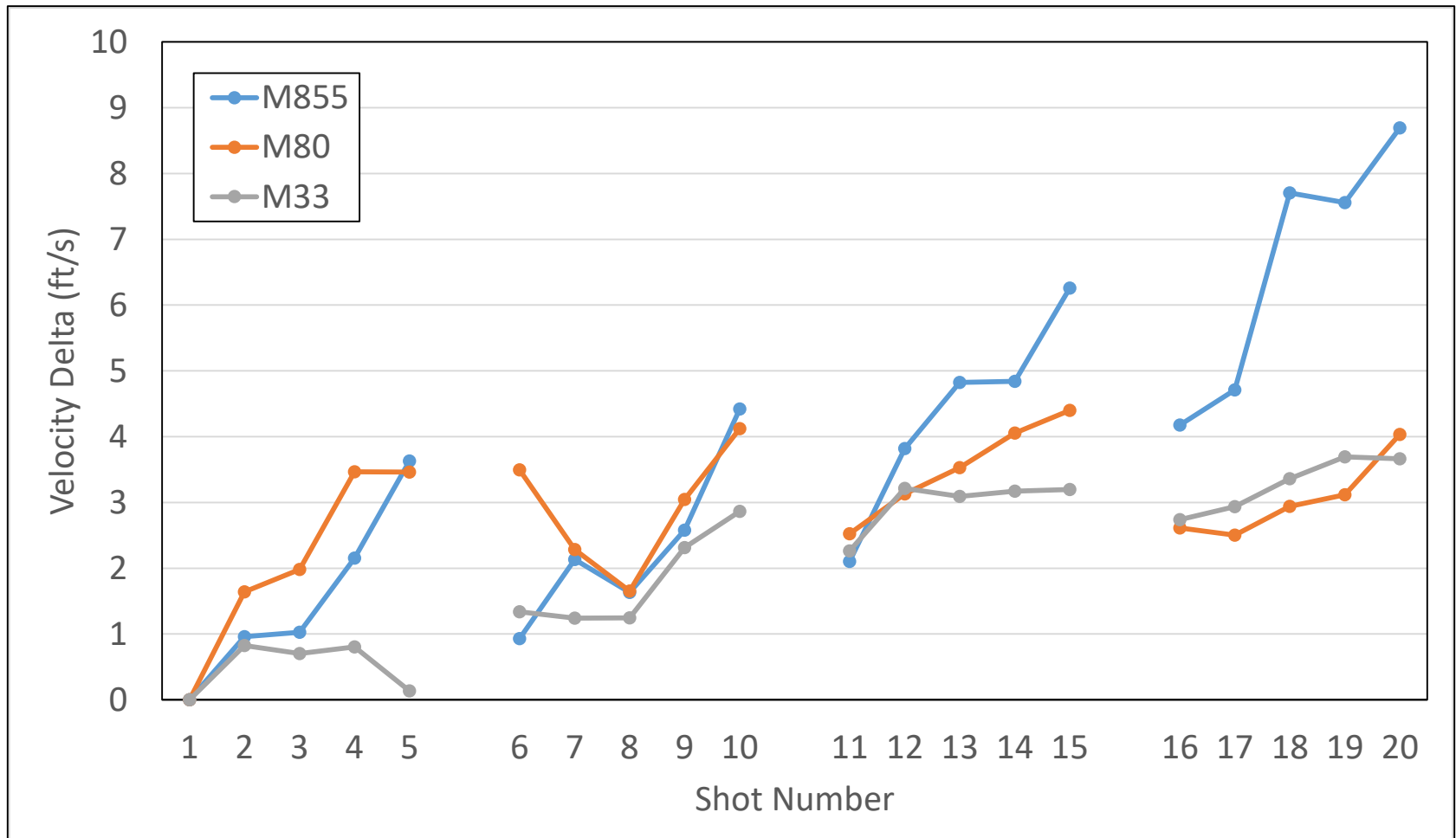
- Calculate the average uncorrected velocity for each round fired during the 20-round reference evaluation over a two year period.

Conclusion:

- Average velocity generally increases throughout a 20-round shot sequence as follows:
 - 5.56mm (M855) = 8 ft/s
 - 7.62mm (M80) = 4 ft/s
 - Caliber .50 (M33) = 4 ft/s



Shot-to-Shot Velocity Delta



M855 Average Velocity increases by 8 ft/s over 20 rounds fired
M33 & M80 Average Velocity increases by 4 ft/s over 20 rounds fired



Observations from Normal Production



Observations from Normal Production



- Lake City consumes many propellant lots during cartridge production.
- As with any manufactured product, propellant is subject to marginal performance variability.
- Lake City goes through a rigorous evaluation process to select a custom charge weight for each propellant lot used in its entirety during ammunition production.
- This process provides an excellent opportunity to evaluate propellant influence to velocity performance.



Propellant Charge Weights



- Propellant variations will inevitably lead to fluctuations in charge weights, and in turn, ballistic performance.
 - Grain size/distribution, deterrent placement/quantity, surface coatings, chemical weight percentage variations, moisture content, etc.
- Other variables, sometimes related to trends in subcomponents at the time of charge establishment, can also contribute to differences.
 - Web thickness, projectile weight, case volume, ullage, etc.

Method of Evaluation:

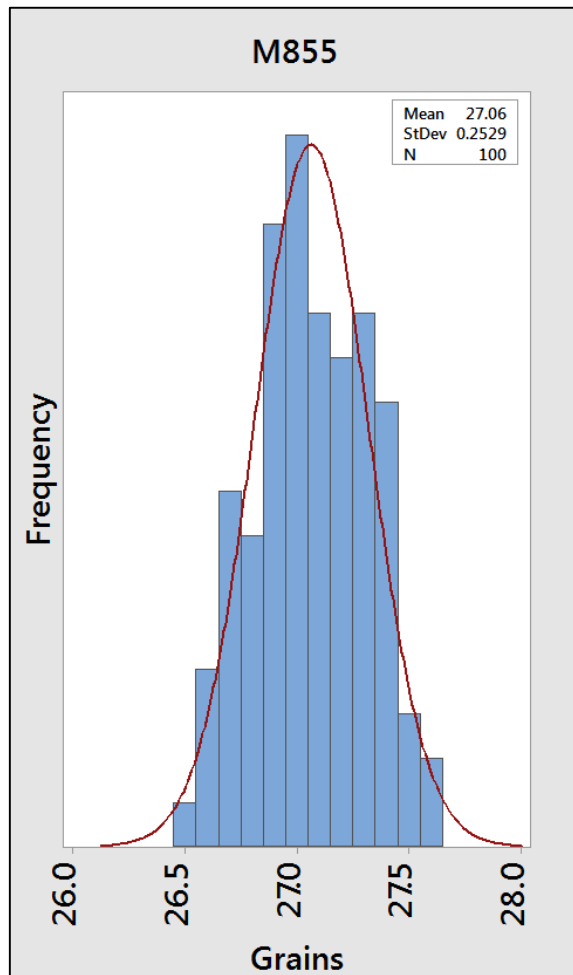
- Compare target charge weight for 100 propellant lots for each caliber.

Conclusion:

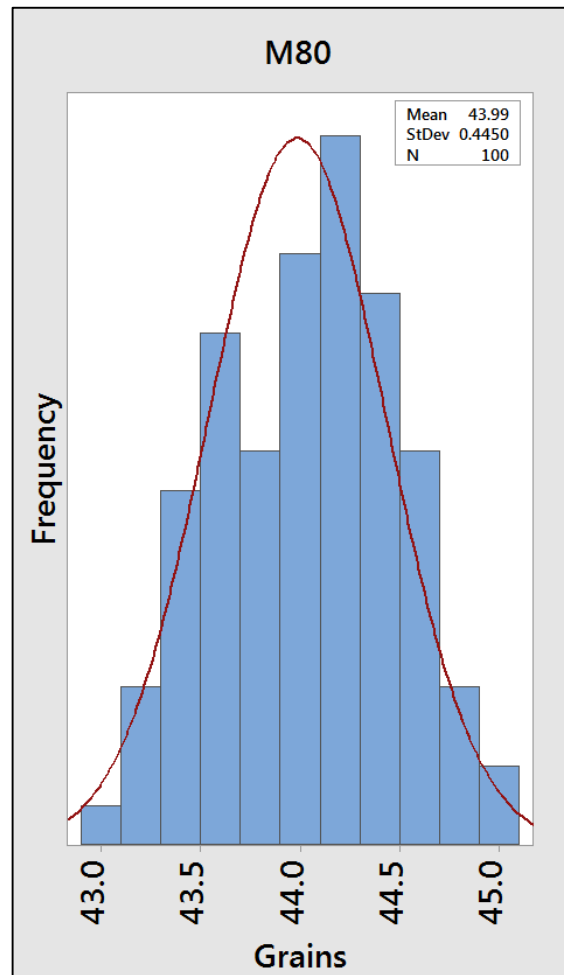
- Target charge weight variations to achieve velocity requirements demonstrate the following trends:
 - 5.56mm (M855) = 1.5 grains / 6%
 - 7.62mm (M80) = 2.5 grains / 6%
 - Caliber .50 (M33) = 24 grains / 10%



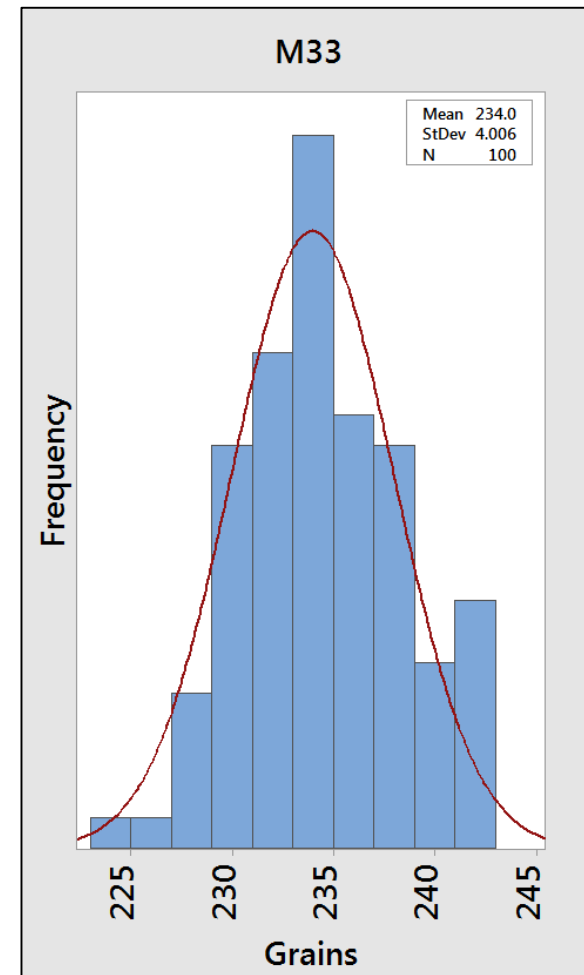
Propellant Charge Weights (100 Propellant Lots)



1.5 grains / 6%



2.5 grains / 6%



24 grains / 10%



Charge Weight Velocity Deltas



- The propellant variables previously discussed, when paired with general variation in cartridge production, have potentially widespread ballistic effects when charge weights are subsequently adjusted.

Method of Evaluation:

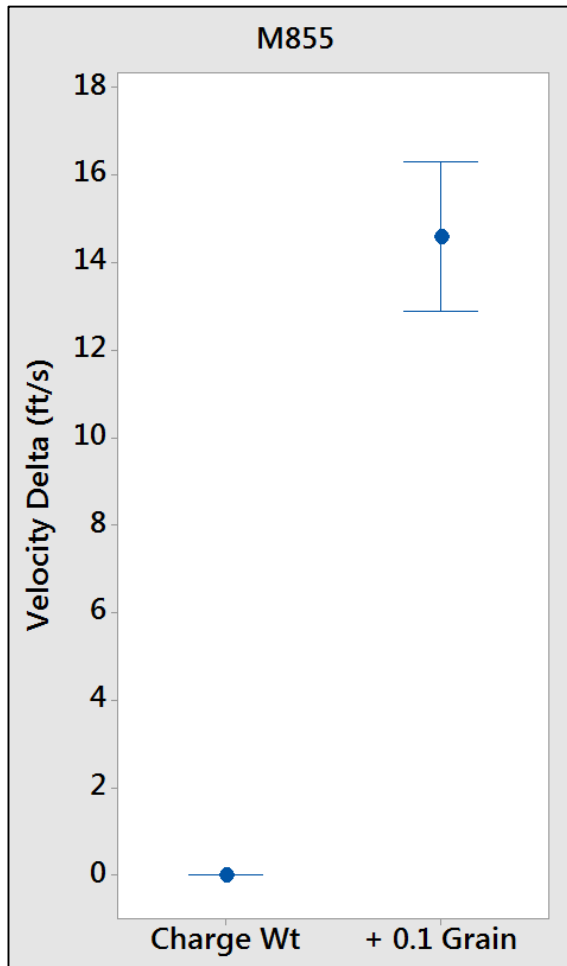
- Identify 100 propellant lots from each caliber that were loaded with at least 2 different charge weights. Perform regression on effect of increasing charge weights.

Conclusion:

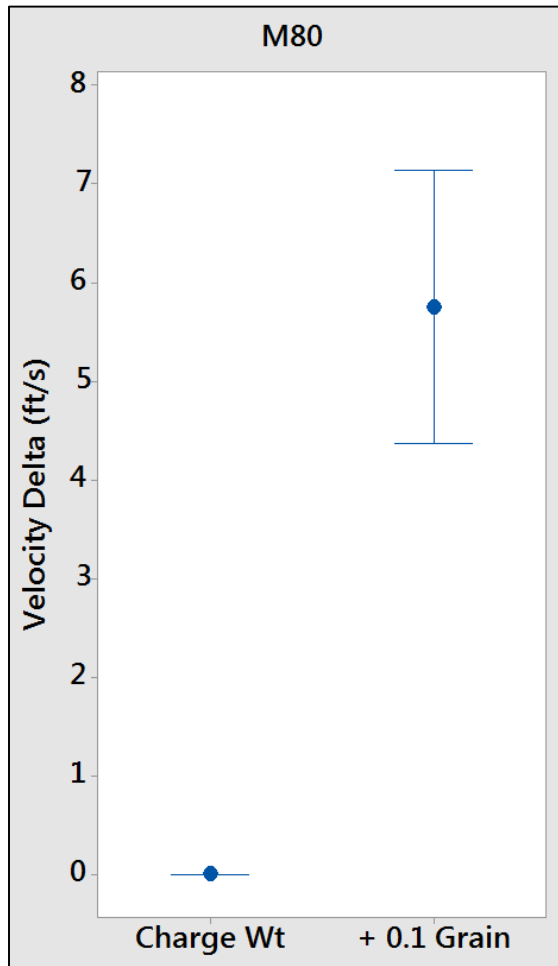
- The effect of incremental charge weight adjustments:
 - 5.56mm (M855): 0.1 grain = 14 ft/s
 - 7.62mm (M80): 0.1 grain = 6 ft/s
 - Caliber .50 (M33): 1.0 grain = 7 ft/s



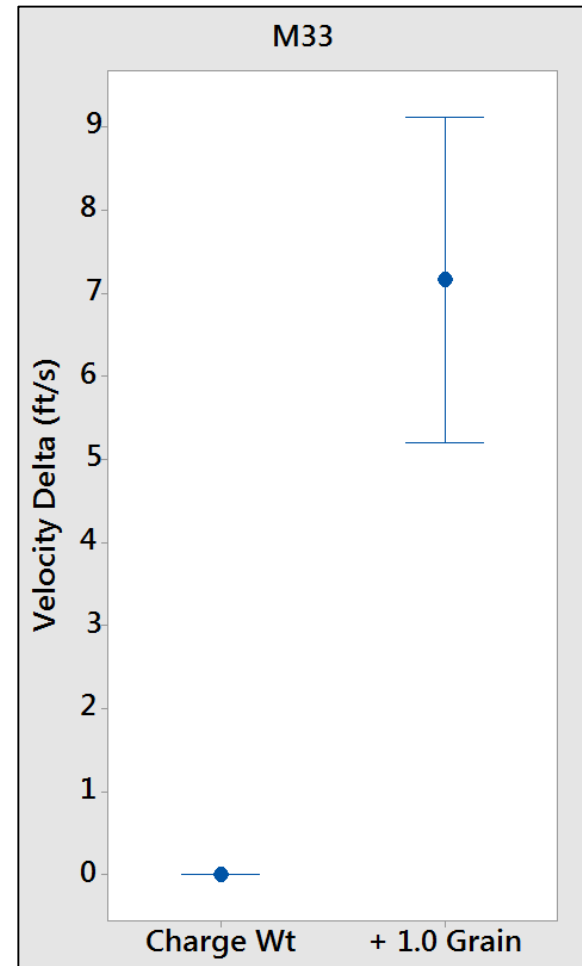
Charge Weight Velocity Deltas (60 Propellant Lots each)



0.1 grain = 14 ft/s



0.1 grain = 6 ft/s



1.0 grain = 7 ft/s



Contact Info and Acknowledgements



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