The Salt Lake Tribune

Target shooters have caused 19 wildfires in Utah this year

Fire • Despite growing problem, state law prevents any regulation of firearms.

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BY JACK WANG THE SALT LAKE TRIBUNE

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Two years ago, firearm use caused 20 wildfires in Utah. Last year, the number ticked up to 24.

This year, with roughly three months of dry season to go, officials have already attributed 19 fires toshooting guns.

"This year's the polar opposite of last year," said state fire marshal Brent Halladay. "Last year, you had to work to get a fire going. If you spit wrong, you're gonna get a fire this year."

In the past, such fires started in May or June and ended in late September. This year, firearm use began causing fires throughout the state as early as February. Low precipitation, dry heat and high winds have hit the West hard, exacerbating the risk that bullets may glance off rocks and create sparks.

Debate

- Utah Governor closed public lands to shooting
  - Public safety & fire protection vs. RTKBA
- Arguments:
  - Most people say "can't start fire from shooting"
  - Fire investigators say "yes you can, we see it all the time"
- No data or study

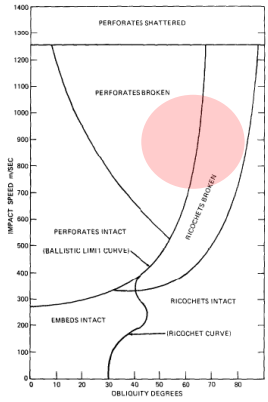
Can Rifle Bullets Cause Ignitions?

- Inert materials (not tracers)
  - Lead, copper, steel
- In theory it's possible – kinetic energy converted to thermal energy on impact
- Many studies of ballistic impacts – none concerned with post-impact projectile temperature
- Objectives: test ignitions & bullets, estimate bullet temperatures, describe processes

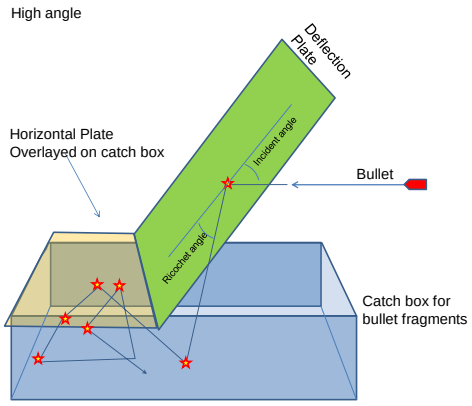
Main Experimental Factors

- External Ballistics
  - Kinetic Energy
  - Velocity, Rifle bullets -2300-3200 f s^{-1} (pistol =1/3 to 1/2)
- Terminal ballistics: Impact angle, resistant target
  - Oblique, bigger fragments, directed down
- Organic material,
  - fine particles, very dry peat moss
- Bullet materials/construction

Response Diagram for ballistic
Impacts on aluminum plate

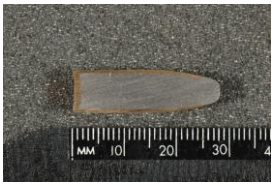


Johnson, W., A.K. Sengupta and S.K. Ghosh. 1982. High velocity oblique impact and ricochet mainly of long rod projectiles: an overview. Intl. J. Mech. Sci. 24(7):425-436

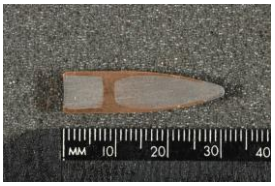


Bullet Types

- Lead Core, Copper Jacket (most common)



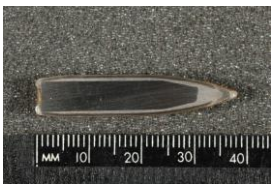
7.62x51 Winchester JSP



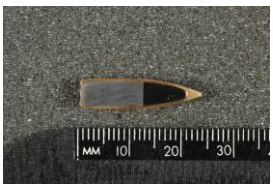
7.62x51 Nosler Partition

Bullet Types

- Steel Core, Steel Jacket, Copper Jacket



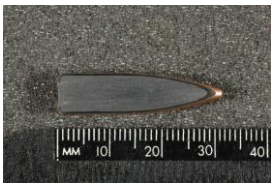
7.62x54R 180gr Czech



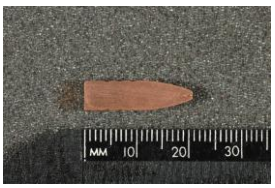
5.56x45, 62gr, steel penetrator

Bullet Types

- Lead Core, Steel Jacket, Solid Copper



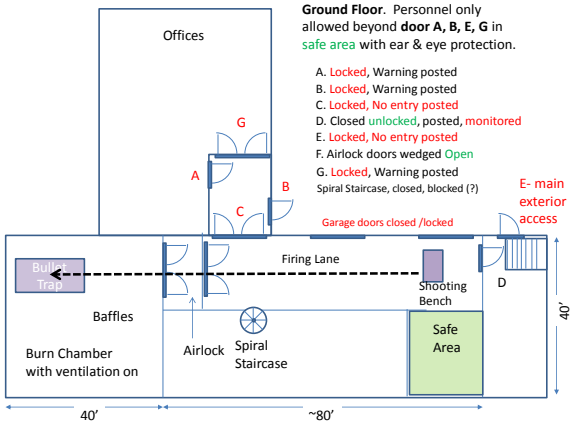
7.62x39 123gr, Silver Bear



5.56x45, 55gr, Barnes TSX


7.62x54R, 180gr Czech
7.62x54R, 149gr Russian
7.62x54R, 178gr Silver Bear
7.62x54R, 180gr Winchester
7.62x51, 165gr Nosler
7.62x51, 150gr Barnes
7.62x51, 168gr Sierra OTM
5.56x45, 62gr Lake City
5.56x45, 55gr Barnes
5.56x45, 55gr Remington FMJ
5.56x45, 55gr Wolf FMJ
7.62x39, 123gr Wolf FMJ
7.62x39, 123gr Fiocchi FMJ
7.62x51, 150gr Federal FMJ

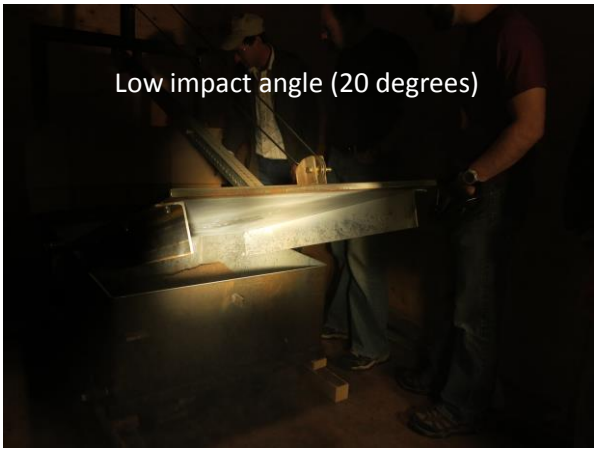

Preliminary Tests Outside

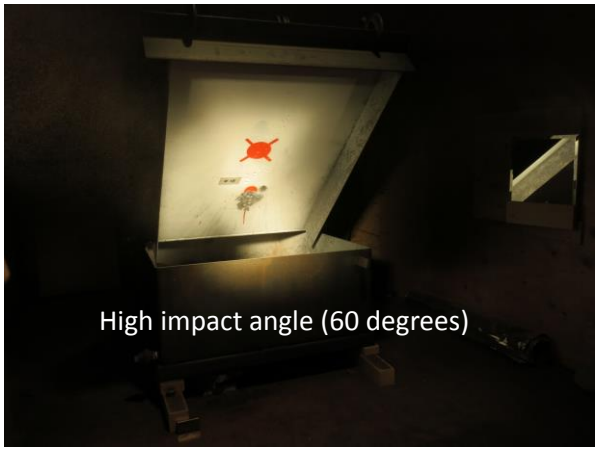

Offices
G
A
B
C
Ground Floor. Personnel only allowed beyond door A, B, E, G in safe area with ear & eye protection.
A. Locked, Warning posted
B. Locked, Warning posted
C. Locked, No entry posted
D. Closed unlocked, posted, monitored
E. Locked, No entry posted
F. Airlock doors wedged Open
G. Locked, Warning posted
Spiral Staircase, closed, blocked (?)
E- main exterior access
Garage doors closed /locked
Firing Lane
Bullet Trap
Shooting Bench
D
Baffles
Airlock
Spiral Staircase
Safe Area
Burn Chamber with ventilation on
40'
40'
~80'

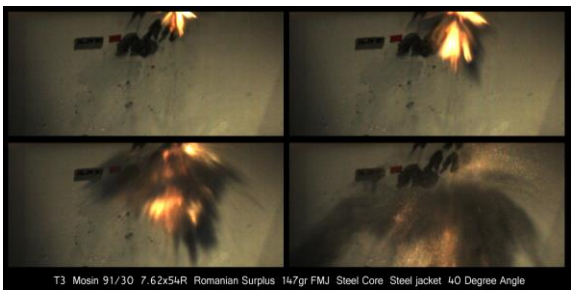

Chronograph – for bullet speed


Shooting through
suppressor box


Shooting through
suppressor box


Low impact angle (20 degrees)


High impact angle (60 degrees)

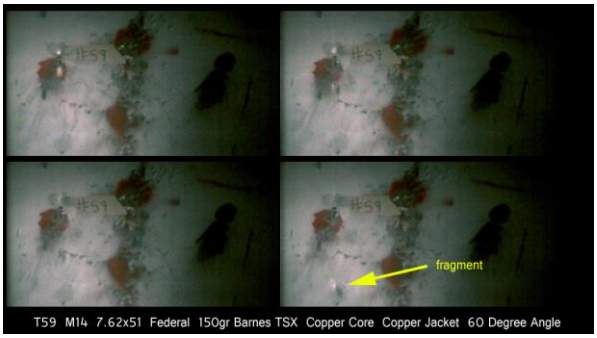

T3 Mosin 91/30 7.62x54R Romanian Surplus 147gr FMJ Steel Core Steel jacket 40 Degree Angle

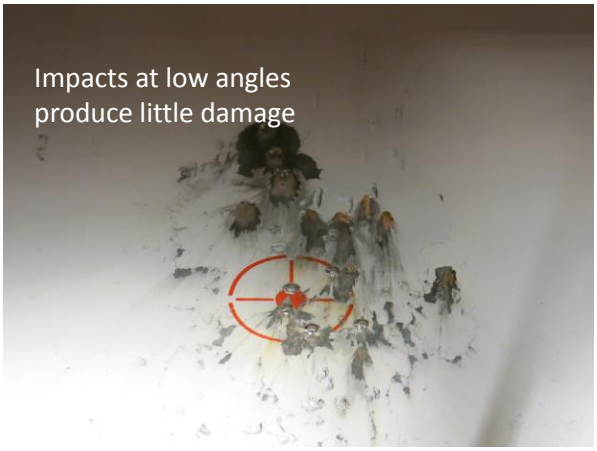

Test 2 Round 1
7.62x54R Romanian Surplus 147gr FMJ
Steel Core - Steel Jacket
30 Degree Angle
12500FPS


T28 AR15 5.56x45 Lake City 62gr FMJ Steel/Lead Core Copper Jacket 40 Degree Angle


Test 29 Round 3
5.56x45 Lake City 62gr FMJ
Steel/Lead Core - Copper Jacket
60 Degree Angle
8000FPS


Test 53 Round 1
7.62x51 Federal 150gr FMJ
Lead Core-Copper Jacket
40 Degree Angle
10000FPS (playback at 2 frames per second)

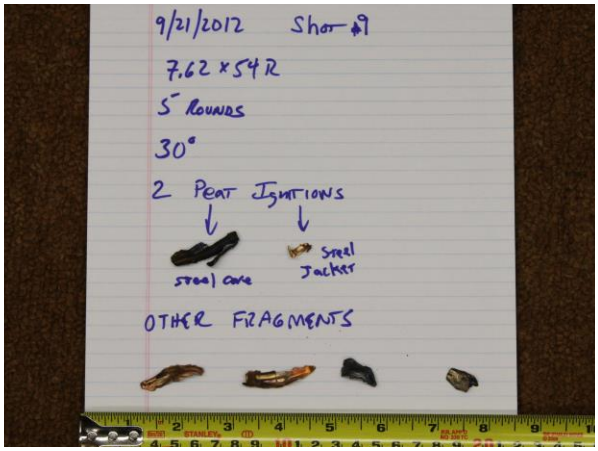


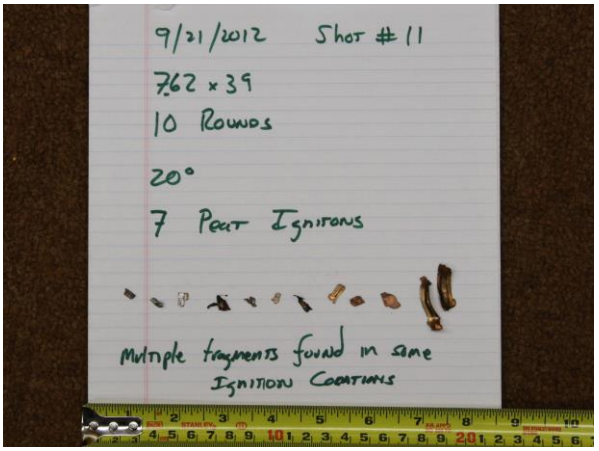


Steel Core, High Impact Angle

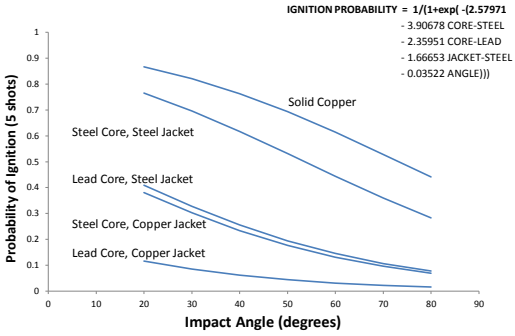

Smoldering ignitions


Smoldering ignitions


9/21/2012 Shot #9
7.62 x 54R
5 Rounds
30°
2 Peat Ignitions
steel case
steel Jacket
OTHER FRAGMENTS


9/21/2012 Shot #11
7.62 x 39
10 Rounds
20°
7 Peat Ignitions
Multiple fragments found in same Ignition Coatings

Ignition Results



Fragmentation, Water Collection

7.62x39, 123gr, Lead Core Steel Jacket

7.62x54R, 149gr, Steel Core, Steel Jacket

7.62x51, 150gr, Lead Core, Copper Jacket FMJ

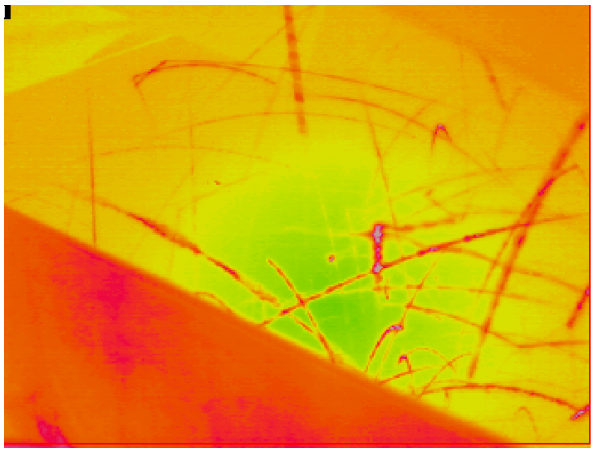
7.62x51 150gr Solid Copper

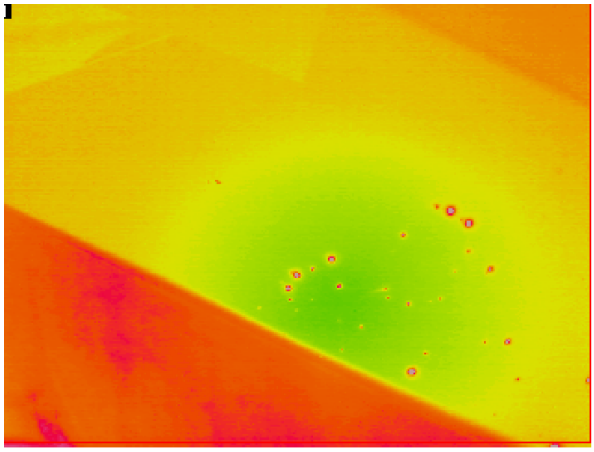
Other Ignition Results

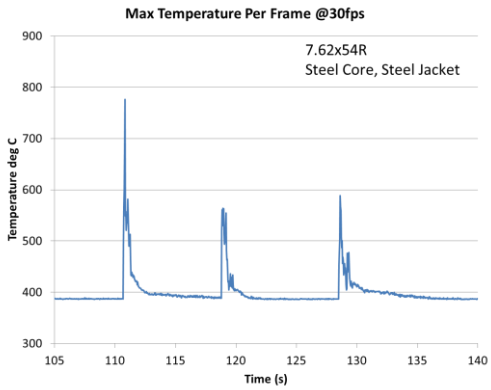
- Granite Target: Ignitions from copper solids
  - Target broke with steel core, 7.62x54R
  - Inconclusive because of target breakage
- Excelsior: Ignitions from copper solids
  - No tests with other bullets, just wanted to see if it was possible (yes, it is) – smoldering ignition too

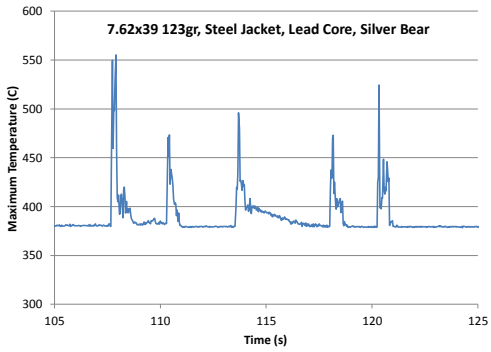
Fragment Temperatures

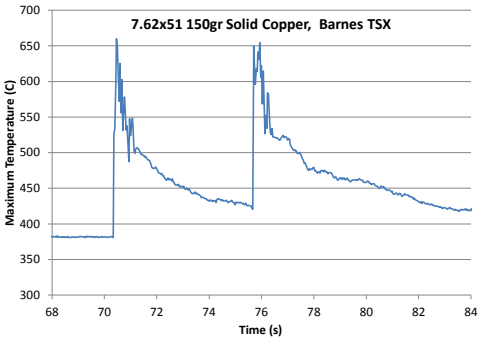
- Thermal camera
- Direct measurement – temperature sensitive paints



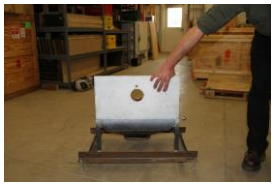



Max Temperature Per Frame @30fps
7.62x54R
Steel Core, Steel Jacket
Temperature deg C
900
800
700
600
500
400
300
105
110
115
120
125
130
135
140
Time (s)

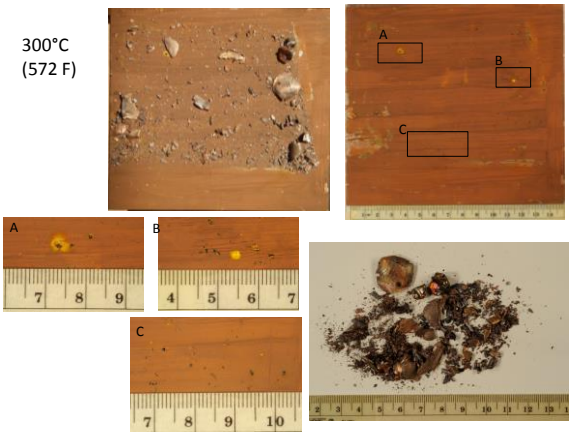

7.62x39 123gr, Steel Jacket, Lead Core, Silver Bear
Maximum Temperature (C)
600
550
500
450
400
350
300
105
110
115
120
125
Time (s)



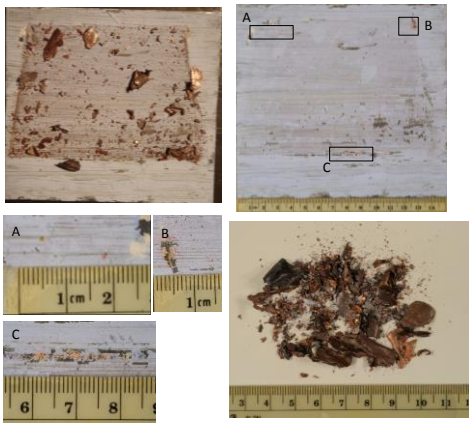
Direct Measurement of Particle Temperature



300°C
(572 F)



800°C
(1472 F)



Summary: Findings

- Yes, bullet impacts can cause ignitions
  - Most likely: steel components, solid copper
- Fragment temperatures reached at least 800C
- Bullet fragments: small, but larger for steel and copper solids
- Dry duff or organic material
- Smoldering ignitions – may take a while to be detected
- Cool quickly, short distance from impact site

Physical Explanation

1. Impact against resistant target
   - Nearly instantaneous change in speed of bullet
   - Rapid deformation & fracturing (high strain rates)

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Physical Explanation

1. Impact against resistant target
   - Nearly instantaneous change in speed of bullet
   - Rapid deformation & fracturing (high strain rates)
2. Bullet material
   - Toughness - resistance to plastic strain
   - At high strain rates, >90% of energy in plastic strain goes to heat
3. Rapid contact with dry ignitable material
   - Small fragments cool very quickly

Future Possibilities

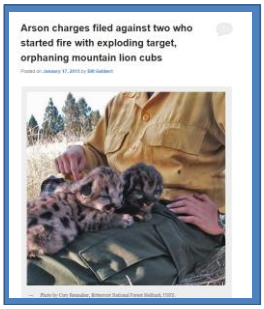
- More granite-target tests (laboratory)
- Other organic material (excelsior, grass etc.)
- Moisture content effects
- Pistol bullets (lead/copper & solid copper)
- Field experiments – can it be done out of the laboratory?

Preliminary Tests of Ignition from Exploding Targets

Mark Finney (USFS, Missoula FSL)
Ian Grob (USFS, MTDC)
Trevor Maynard (BATFE)
Chris Froula (BATFE)

Exploding Targets &Wildfires

- Exploding Targets banned from Nat. Forests, R1, R2, R4, R5, R6
- Question: how do exploding targets cause fires?
- Manufacturers claim its not possible



Procedures

- Exploding Targets: Ammonium Nitrate (AN) and Aluminum powder (AL)
- Mix

Procedures

- AN/AL mixture
- Place near ignitable material

Procedures

- High speed cameras

Results

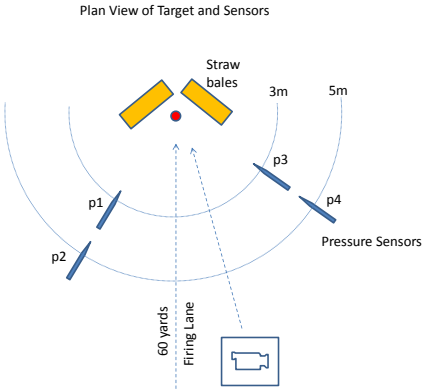
Extra Aluminum

Conclusions

- 3/10 tests caused ignition
- Suspected causes – burning aluminum metal
  - Rapid flaming ignition
  - AL burns at ~3000-3500 C (5400-6300 F)
  - Poor mixing (concentrations of AL remain)
  - Incomplete detonation (bullet placement etc.)
- Fuel type does not appear as important

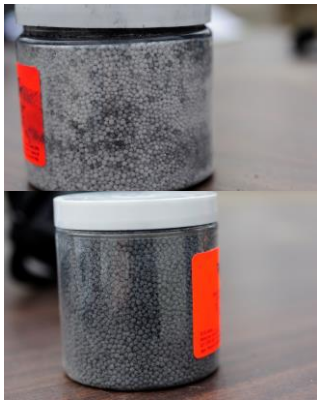
New tests conducted Nov. 2015

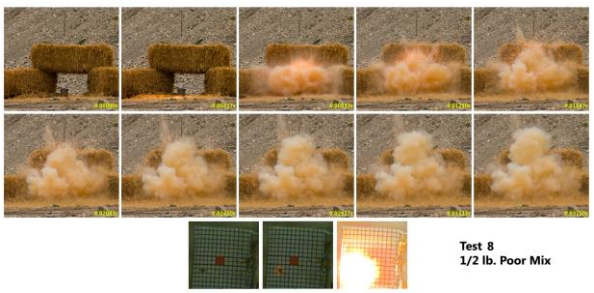
- No ignitions, too cool and wet
- Visible burning aluminum in all tests – more when poorly mixed.
- More testing summer 2016, dry conditions

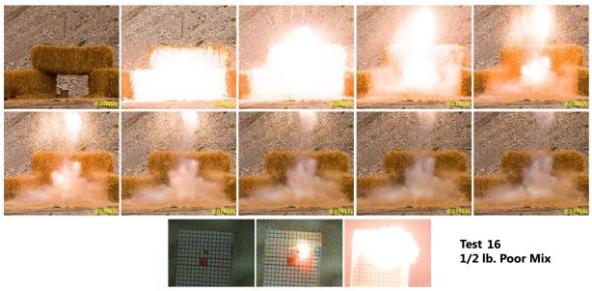


Poorly Mixed

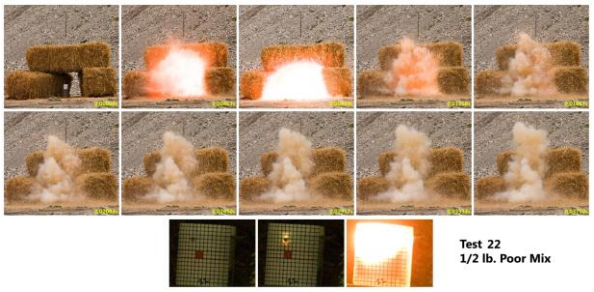
Well Mixed



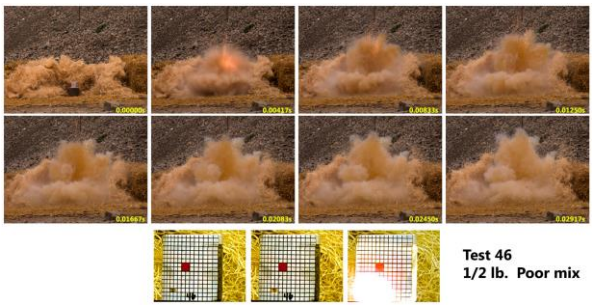




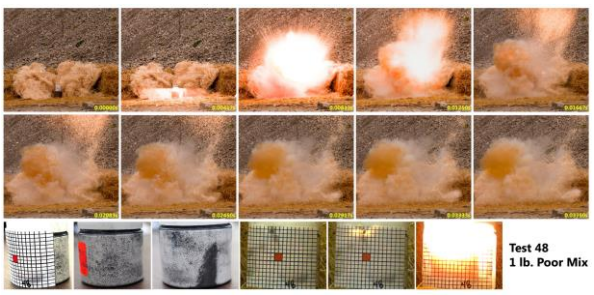
Test 16
1/2 lb. Poor Mix



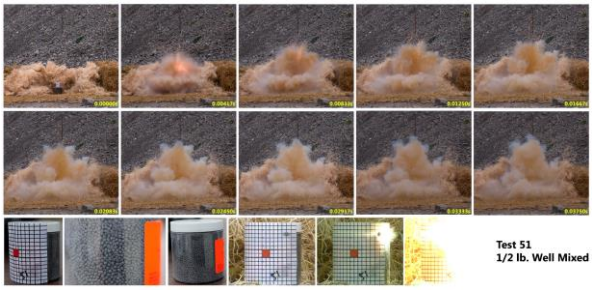
Test 22
1/2 lb. Poor Mix

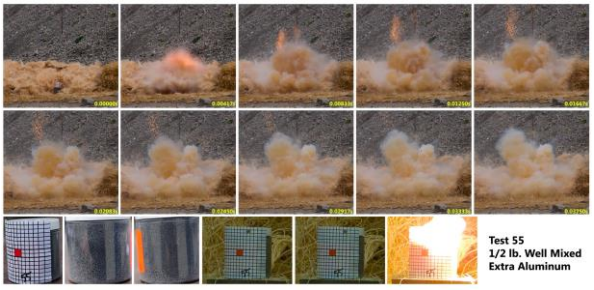


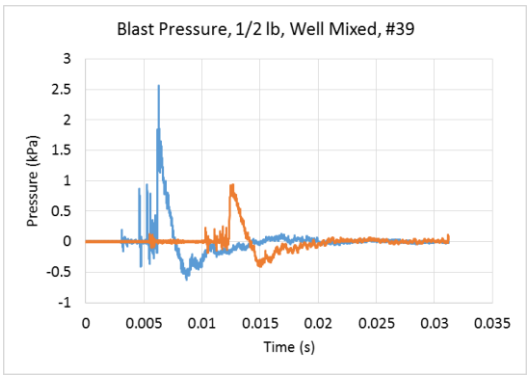
Test 46
1/2 lb. Poor mix

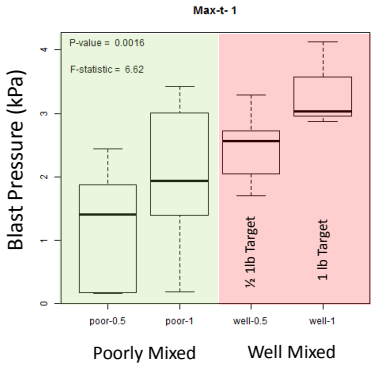


Test 48
1 lb. Poor Mix


Test 51
1/2 lb. Well Mixed


Test 55
1/2 lb. Well Mixed
Extra Aluminum


Blast Pressure, 1/2 lb, Well Mixed, #39
Pressure (kPa)
3
2.5
2
1.5
1
0.5
0
-0.5
-1
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
Time (s)


Max-t- 1
P-value = 0.0016
F-statistic = 6.62
Blast Pressure (kPa)
0
1
2
3
4
½ 1lb Target
1 lb Target
poor-0.5
poor-1
well-0.5
well-1
Poorly Mixed
Well Mixed

Conclusions

- Mixing seems to matter in terms of blast overpressure, “brightness” of explosion
- Not enough data to reveal effect (or not) of bullet placement
- Burning aluminum still seems to be the key to wildfire ignition (not fireball)