NAVSEA
WARFARE CENTERS
CRANE

ACCURACY MEASUREMENT METHODOLOGIES

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AMMUNITION ACCURACY MEASUREMENT METHODOLOGIES

Ammunition Accuracy (precision) Definition

- The demonstrated ability of a lot of ammunition to place each projectile in close proximity to one another when fired from a rigidly mounted firing devise, at a predetermined distance.

IN OTHER WORDS

How tight can I expect to “group” a string of shots.

If I properly zero my weapon with this ammunition and my weapon and I do our part, how close to the point of aim can I expect the bullet to impact?

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Measurement Methods

- Mean Radius (MR)– *(Calculated)*
- Radial Standard Deviation (RSD) – *(Calculated)*
- Horizontal and Vertical SD. – *(Calculated)*
- Extreme Spread (ES) – (Measured)
- Milliradian (Mils) – (Measured)
- Minute of Angle (MOA) – *(Calculated)*
- Inches – (Measured)

ALL methods require actual X and Y shot measurements for their calculations.

The X and Y measurements provide the data for all accuracy calculations and is therefore the baseline.

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Measurement Methods - How do they relate one to another?

- Minute of Angle (MOA) = 1.047 inch each 100 yd / 1.145 inch each 100 m.
- 1 Milliradian (Mil) = 3.375 MOA (or 3.5 in. at 100 yd).
  - 1 MOA is 0.29 Mils.
- Extreme Spread = The furthest distance between shots of a group.

THESE ARE MEASUREMENTS,
NOT CALCULATIONS OF MEASUREMENTS.

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Calculated Methods:

- Mean Radius- Average distance of each round from the Center of Impact (CoI).
- Radial Standard Deviation - Average deviation of each round from the group's CoI.
- Horizontal (X) / Vertical (Y) Standard Deviation - Average deviation of the (X) and (Y) shots of a group.

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- What do they look like?

Radial Standard Deviation

Mean Radius

Circular Probable Error

Extreme Spread

Extreme Horizontal Spread

Extreme Vertical Spread

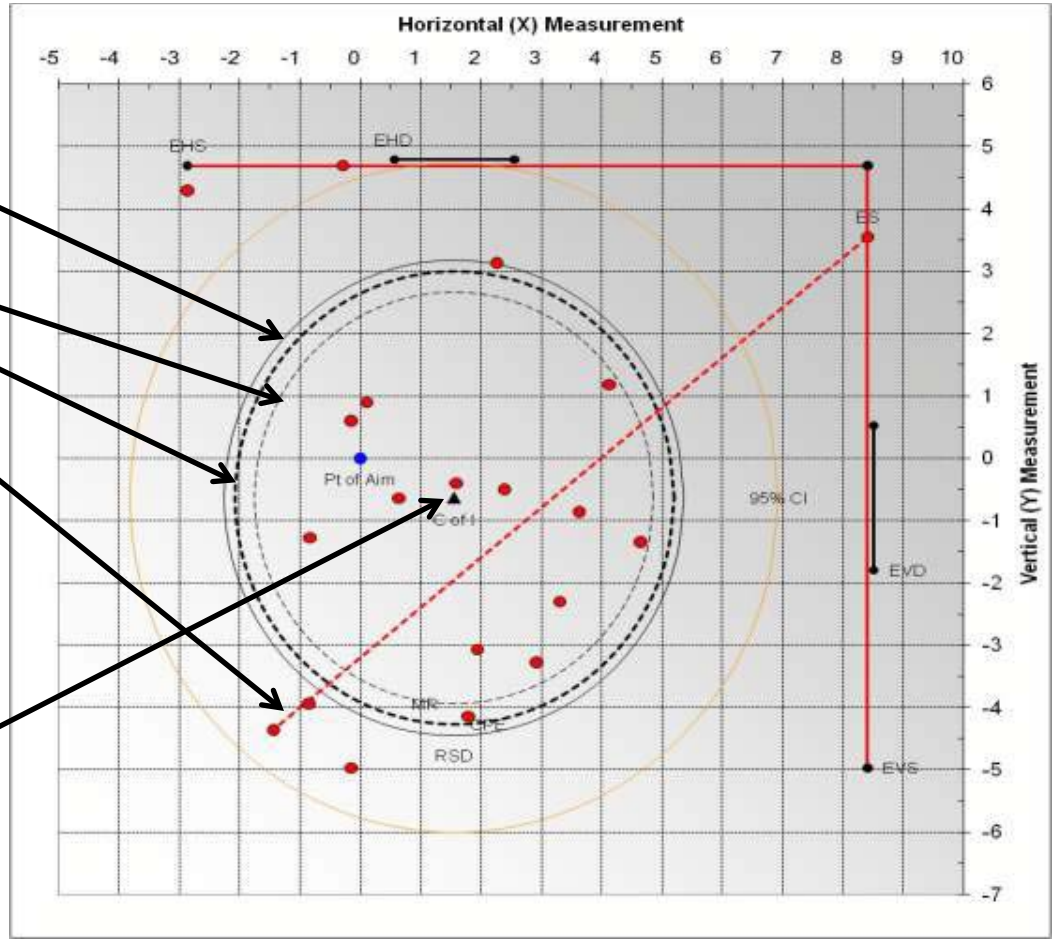
Diagonal

Mean Horizontal/Vertical Deviation

95% Tolerance Interval

Center of Impact

Point of Aim



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- Measurement Methods – Which is best depends on what you want to do with that information

- LCAAP needs statistical data.

- Private Industry is contractually required to meet the ammunition specification.

- User needs Dope Chart (inches, MOA or Mils). MR, Radial SD, EVS, EHS, Horz. SD, Vert. SD are of no use to user.

(Depends on who are you working for?)

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BLUF

- Using a *Max Extreme Spread* Accuracy Requirement in Lot Acceptance would result in:
  - Significant increase in risk to the soldier and the producer
    More than double the risk of passing 'bad' lots of ammunition and failing 'good' lots of ammunition
  - Unnecessary cost increase to the producer and the government
  - Inefficient and imprecise test results
    - Radial Standard Deviation and Mean Radius are the most statistically efficient way of evaluating shot groups

    Ex: 14 rounds with ES is needed to achieve the precision of 10 rounds with RSD or 11 with MR

Slide extracted from presentation sent to USSOCOM for the purpose of discrediting ES in Accuracy Requirements and to validate the Army's use of MR, Radial SD or Horz. And Vert. SD.

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- LOT ACCEPTANCE REQUIREMENT:

- AA53: 5.56MM SPECIAL BALL, LONG RANGE MK 262 MOD 1

- Five (5) each ten (10) round groups fired through two (2) 5.56mm SCATP Accuracy Test Barrels.
  - (50 rounds per barrel, 100 rounds total.)

- Average ES of all ten (10) groups shall not exceed 3.5 inches.

- No individual group shall exceed 4.5 inch ES.

IN REALITY, HOW DOES THIS ES REQUIREMENT STACK UP TO CALCULATED STATISTICAL METHODOLOGY?

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PRODUCTION MK 262 MOD 1 LAT Data from last 5 years

	EXTREME SPREAD			CALCULATED FROM ACTUAL MK 262 MOD 1 LAT TARGETS.														
				MEAN RADIUS			Radial S.D.			ARL RADIAL S.D.			Horz. St. Dev.			Vert. St. Dev.		
Lot Number	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
BLH06J123-001	3.06	2.29	3.89	1.11	0.71	1.67	0.50	0.32	0.83	0.95	0.83	1.20	0.63	0.35	1.00	0.82	0.52	1.10
BLH07L120-008	2.32	1.44	2.59	0.80	0.55	0.96	0.37	0.30	0.46	0.74	0.44	0.90	0.51	0.26	0.80	0.55	0.28	0.77
BLH08E123-008	2.55	1.11	4.13	0.94	0.43	1.67	0.45	0.08	0.83	0.87	0.44	1.20	0.62	0.28	1.00	0.61	0.27	1.10
BLH09D120-013	2.33	1.52	3.29	0.78	0.42	1.29	0.38	0.20	0.63	0.73	0.46	0.87	0.54	0.34	0.77	0.52	0.29	0.66
BLH10C120-016	2.10	1.73	2.64	0.70	0.51	1.15	0.35	0.24	0.54	0.71	0.49	0.92	0.42	0.27	0.76	0.62	0.34	0.76

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LETS COMPARE . . . .

- M855 REQ = Avg Horz & Vert SDs NTE 1.8 inches at 200 yd

- MK 262 MOD 1 300 yd results = roughly 1/3 of M855 200 yd requirement.

BUT.....

- EXTREME SPREAD IS NOT GOOD AS AN ACCURACY REQUIREMENT.
  - (10 years worth of production data says otherwise)

- M855A1 EPR HAS IMPROVED ACCURACY!!
  - M855A1 EPR HAS SAME ACCURACY SPEC AS M855 (?)

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    Ex: 14 rounds with ES is needed to achieve the precision of 10 rounds with RSD or 11 with MR

Only risk to soldier is better ammo.

MK262 no accuracy reports – ever.
(How bout M855 or M118LR?)

MK 316 is $0.78, M118LR is $1.14.

Same data used in calculations?

How bout a single 50 rnd grp?

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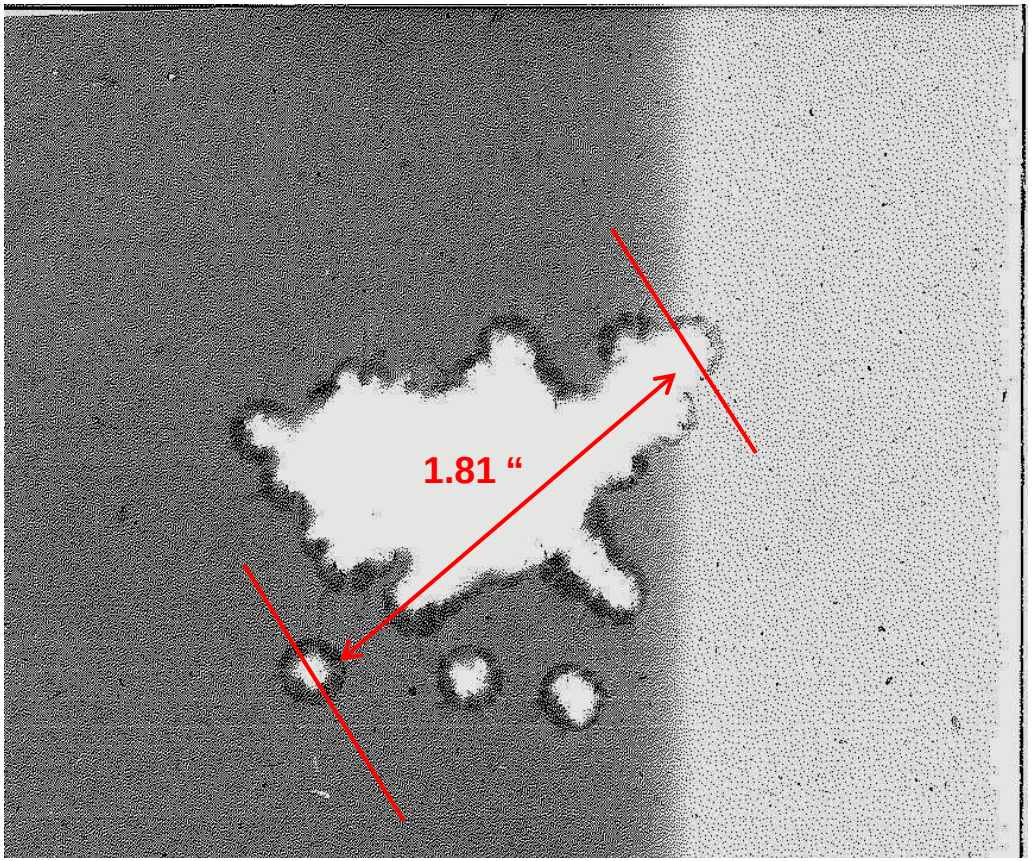
HERE IS WHAT A 50 ROUND GROUP OF AB39 LOOKS LIKE

Group #1 ES = 1.81 inch
Group #2 ES – 1.44 inch
Group #3 ES – 1.61 inch
Group #4 ES – 1.18 inch
Group #5 ES – 1.19 inch

Measured ES of 50 round group
1.81 inch at 200 yds (.86 MOA)

The only risk of Extreme Spread is to the target in the cross hairs.



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Summary

- No single method provides everyone with all the information they may need or desire.
- All methods require the individual shot X and Y measurements.
- Statistics can be manipulated to hide the truth.
- Rulers (or calipers) on the other hand don't lie.
- The key is the pass/fail criteria used. M855's 6.8 inch Horz. & Vert. SD equates to 6.5 MOA or 40.8 inches at 600 yds. Perfectly adequate for machine guns!
  - Not adequate for any precision fire application.

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COST

- MK 316 - $0.78 a round / M118LR $1.14 a round.
  - Army currently working M118 L/R PIP. Why?
- MK 262 MOD 1 $0.59 a round. No Army equivalent, no Army requirement.
- MK 318 MOD 0 $0.49 a round.
- MK 319 MOD 0 $0.70 a round / M80 - $0.67 A165 linked. Little to no M80 clipped produced since 1995.