Performance Assessment of the M1028, 120MM APERS Tank Round

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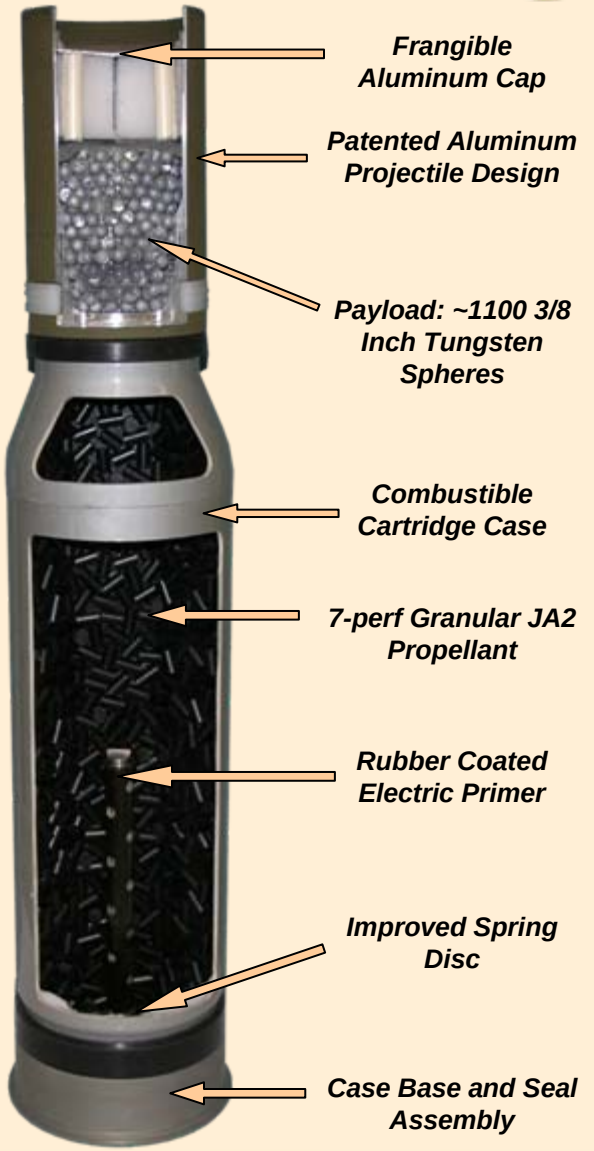
M1028 Evaluation Improvements

- M1028 Overview
- Requirements
- Lethality Evaluation
- 400 Meter Target
- 55 Meter Target
- Statistical Approach
- Conclusions

M1028 Overview

- **Provides revolutionary anti-personnel capability to the Abrams Main Battle Tank.**
- **Also provides the Abrams with a secondary capability against a variety of urban targets.**
- **Named one of the U.S. Army's Greatest Inventions of 2003**

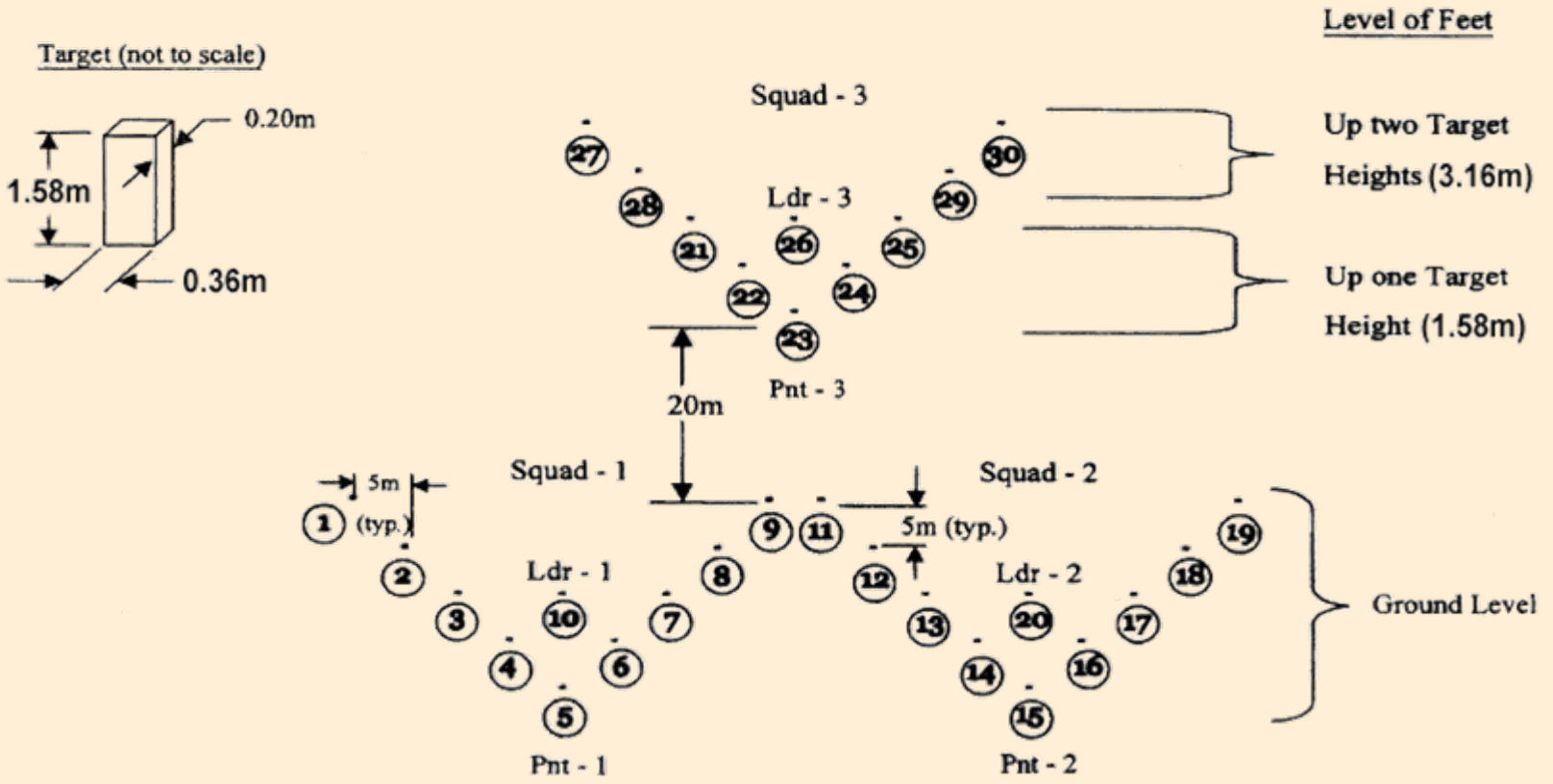
M1028 Canister Characteristics	
Muzzle Velocity (@21°C)	1410 ± 10 m/s
Chamber Pressure (@21°C)	5750 bars
Cartridge Weight	22.9 kg
Cartridge Length	780 mm



Basic Troop Array

Troop Array, Squad in Wedge

2 Up - 1 Back (Top View)



Requirements

- **Operational Requirements Documents (ORD):**
  - **Defeat 50% or more of an advancing squad with one shot.**
  - **Defeat 50% or more of an advancing platoon with two shots.**
  - **Objective: 100 – 700 meters**
  - **Threshold: 200 – 500 meters**

Lethality Evaluation

- **ComputerMan program is used to determine the level of incapacitation given a single hit.**
  - **The ComputerMan lethality model is a U.S. ARMY approved method for determining the incapacitation of a human subjected to various fragment impacts.**
- **Required data to calculate total level of incapacitation:**
  - **Downrange velocity**
  - **ComputerMan single hit incapacitation**
  - **Payload hit locations**

400 Meter Target

Shoot 5 rounds per target → Hand score each target → Excel and TableCurve calculate standard deviation of hits → MathCad calculates Estimated Incapacitation

includes ComputerMan data

Acceptance based on Estimated Incapacitation of each target

400 Meter Target - Process

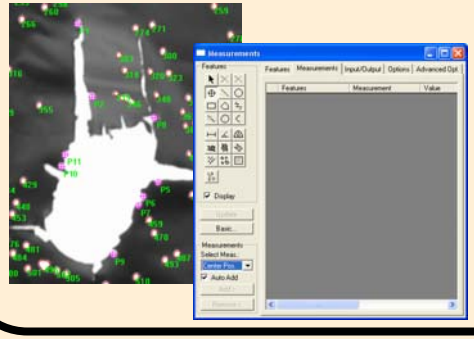
- **Benefits**
  - **Incapacitation data directly reflects the ORD.**
  - **There is a bank of historical data with which to compare.**
- **Potential Improvements**
  - **Reduce the time it takes to hang the target.**
  - **Simplify the scoring method.**
  - **Collect data on individual rounds.**

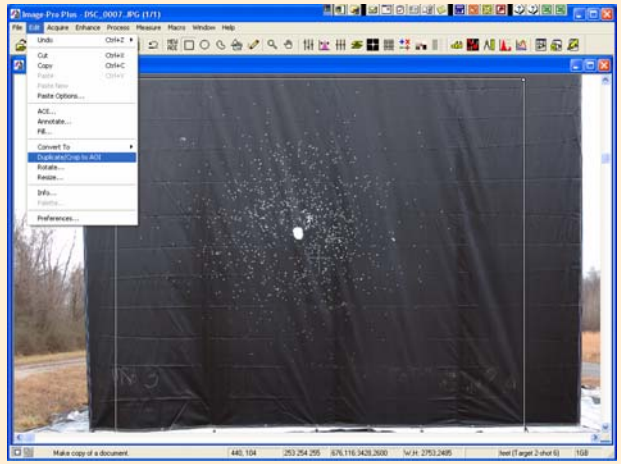
55 Meter Target - Correlation

- 25 rounds were fired through targets set at 55 and 400 meters downrange.
  - Each 55 meter target consisted of a single shot.
  - Each 400 meter target consisted of 5 shots.
- The standard deviations of dispersion on all 25 of the 55 meter targets were averaged together.
- The standard deviations of dispersion on all 5 of the 400 meter targets were averaged together.
- A linear correlation was established between 55 and 400 meters.

55 Meter Target - Digital Scoring

Image-Pro PLUS





Sort Program

Microsoft Excel - M1028 Auto Target Program

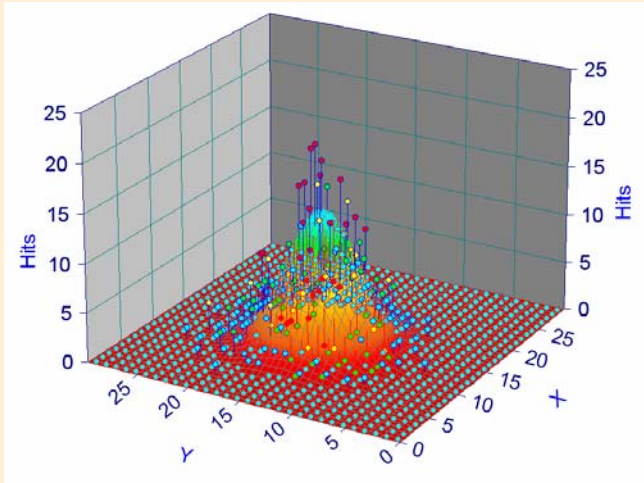
File Edit View Insert Format Tools Data Window Help

Draw AutoShapes

S48

	A	B	C	D	E	F	G
1	#Total Count:	936			BIN #	Count	
2					0.5	0	
3	Obj#				1.5	0	
4					2.5	0	
5	1	16.34545	-24.1887		3.5	0	
6	2	14.03869	-21.7623		4.5	0	
7	3	15.87378	-21.2643		5.5	0	
8	4	16.73216	-21.2504		6.5	0	
9	5	11.84659	-21.1973		7.5	0	
10	6	14.34553	-21.11		8.5	0	
11	7	15.08253	-21.0708		9.5	0	
12	8	9.643307	-20.8751		10.5	0	

TableCurve 3D



55 Meter Target - Digital Scoring

- A completely automated system introduced > 5% error.
- Revised system was set up which significantly decreased error.
  - Same sorting program as the automated system
  - Manual correction for tears and marks (~ 2 additional minutes)
- Revised automated system shows < 2% error.
- Revised automated system errs on the side of caution.
- Use non-automated digital system for any failing targets.

55 Meter Target

Shoot 1 round per target → Digitally score each target using Image-Pro Plus Software → Correlation fit converts 55 meter data to 400 meters → Excel and TableCurve 3D calculate standard deviation of hits → MathCad calculates Estimated Incapacitation

includes ComputerMan data

Acceptance based on Estimated Incapacitation of average of all targets

55 Meter Target - Process

- **Benefits**
  - Incapacitation data reflects the ORD.
  - Data is collected for each individual round.
  - Reduced time to hang and score targets.
  - There is a bank of historical data (at 400 meters) with which to compare (using the 55m – 400m correlation).
- **Potential Improvements**
  - Incorporate production variation into testing requirements.
  - Reduce data reduction.
  - Give proving ground the capability to perform analysis.

Statistical Dispersion - Concept

- Considering all production rounds in PY1 to be acceptable, if a round behaves similarly it should be considered acceptable.
- Compile 55 meter target data from all available tests.
- Find the average and standard deviation of those targets and create limits based on those values.

Statistical Dispersion - Process

	Statistical Dispersion Limits
Max Limit	Avg + 3 StdDev
Min Limit	Avg – 3 StdDev

PY1 FAAT, PY1 Lots 1-3, PY1 Lot 3 CV:

- **60 Ambient Rounds**
- **55 Hot Rounds**
- **50 Cold Rounds**

Acceptance based on statistical information from historical data

Statistical Dispersion - Process

- **Conclusion**
  - **Reduced time to hang and score targets.**
  - **Accounts for round-to-round variations due to natural randomness and production.**
  - **No additional calculations are needed.**
  - **Data is collected for each individual round.**
  - **Proving ground performs all analysis.**