Non-Lethal Blunt Trauma Grenade Performance Improvement

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RDECOM ARDEC

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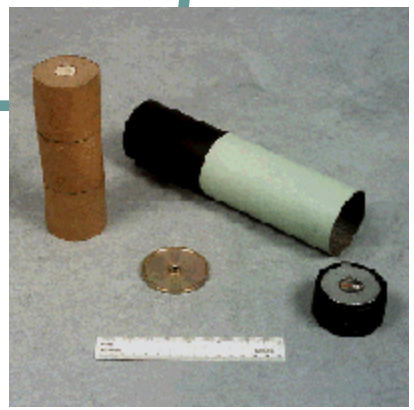
LVOSS



Problem Statement

- Item not meeting quantitative requirement for ball velocity with a statistically significant test sample.

Battlefield Threats

- Changes in the battlefield threats result in identified need for a new material solution.
  - Threatening civilian buildup
  - Hostile civilian gatherings
  - Rioting in detainee camps

- These threats require an effective non-lethal solution to stop, confuse, disorient, and/or temporarily incapacitate without escalating the situation.

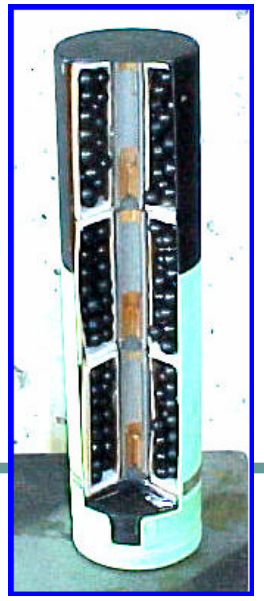
Non-Lethal Materiel Solutions

- Available non-lethal solutions
  - Flash bang/stun grenades
  - Tear gas grenades
  - Various blunt trauma devices
    - Stingball grenade
    - Rubber bullets
    - Non-Lethal Claymore
  - Tasers
  - Batons
  - Etc…

- Gap in capability- Long range riot control non-lethal munitions

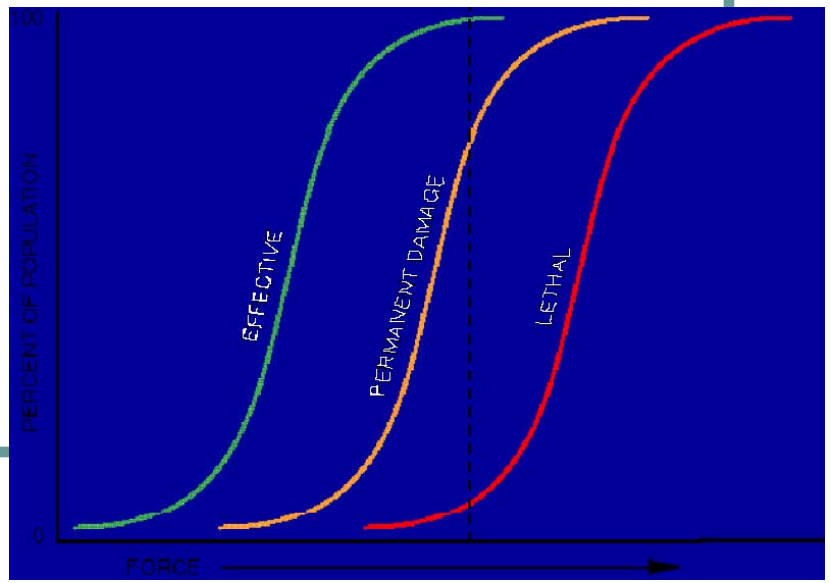
M99

- 66 mm Light Vehicle Obscuration Smoke System (LVOSS) launched, blunt trauma grenade.
- Grenade contains three sub-munitions that can effectively launch downrange, producing a bright flash, loud bang, and dispersion of PVC balls.
  - M98 - training / flash bang version. No blunt trauma balls



“Effective” Non-Lethal Requirement

- Qualitative user need for “effective” non-lethal must be reflected as quantitative requirement in item specification.
  - Qualitative Requirement - Multiple blunt trauma devices to produce enough force upon impact against identified targets to be an effective non lethal solution.
  - Quantitative Requirement -
    - Ball Velocity Threshold:
      - 290 ft /s at 3 feet
    - Sound Output:
      - 160 db at 5 feet



Requirement Verification

- Dispersion pattern requires innovative method to verify item specification for ball velocity
  - Calibrated foam panels
  - balls penetrate panels
  - Depth of penetration correlated to velocity

Course of Action

- Identify root cause for performance deficiency
- Identify and implement an immediate corrective action
- Test statistically significant test sample to demonstrate corrective action

Root cause Analysis

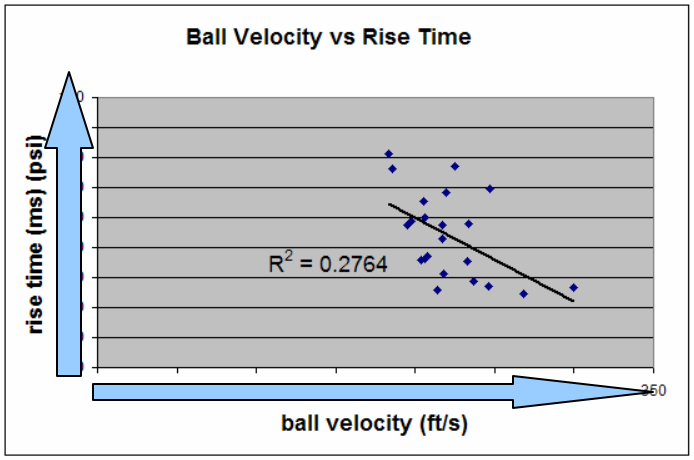
- Lean /Six Sigma process used to address entire system:
  - Cause and effects analysis identified potential causes for performance deficiency
  - Failure Modes and Effects Analysis (FMEA) was used to identify the risk associated with each cause.
  - Design of Experiments (DOE) was generated to experimentally evaluate the interactions of risk areas
- Program Decision to investigate item identified with the highest risk- energetic (burster mix) production.

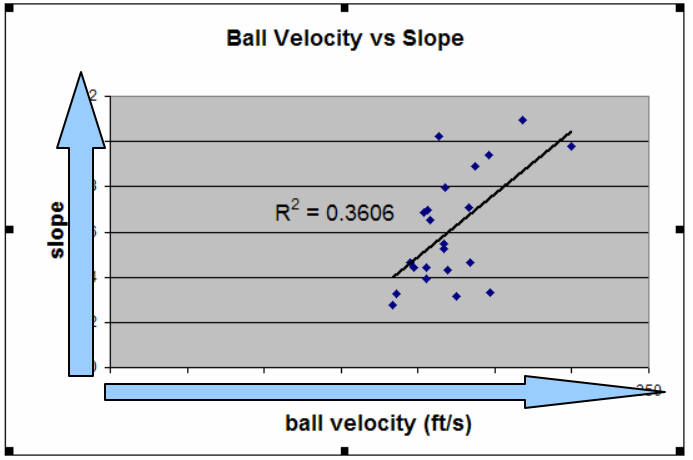
Burster Mix Production Effort

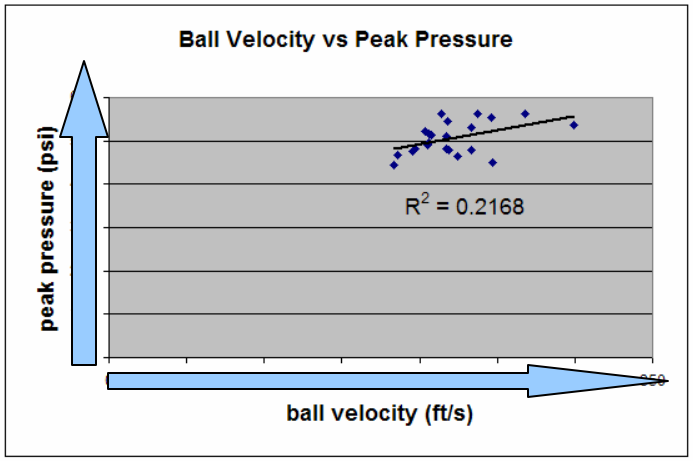
- Objective:
  - Quality controlled scale-up of laboratory burster mix to production batch
  - Compare with older batches to give insight on how variations of the mix affect the performance.
  - Correlate performance of submunition to burster mix properties
- Quality control verification - particle size, sieve analysis, bulk density, composition analysis, etc…
- Closed bomb testing. Key burster mix performance measurements:
  - rise time
  - peak pressure
  - Slope
  - function time
- Submunition testing. Key end item performance factors:
  - Ball velocity
  - Reliability (rate of low order functions)
  - Sound level

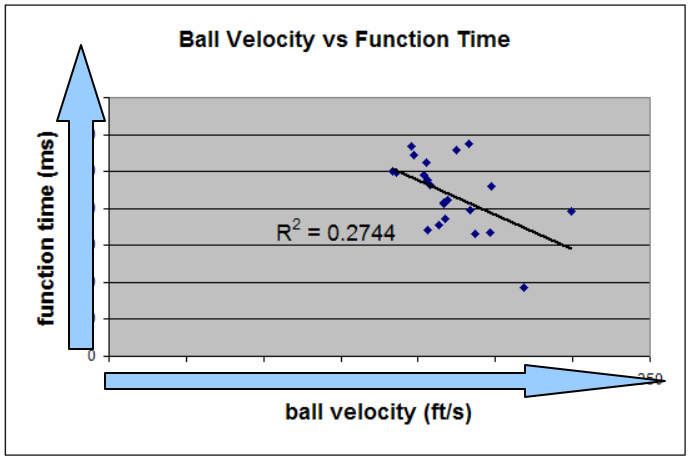
Performance Correlations

Closed bomb Burster mix performance compared to ball velocity









Burster Mix Effort Results

- Consistent lab batch and production level batch could not be generated. Large standard deviations for closed bomb test within each batch sample.
- Correlation between performance of the different batches and batch properties was low due to mix inconsistency.
- Performance was not improved. Average ball speed for all variations of mix was lower then the item specification requirement.
- FMEA re-addressed: Burster mix formulation identified as the new item with the highest risk.

Burster Mix Formulation Effort

- Decision to replace the burster mix due to high risk.
- An Analysis of Alternatives (AoA) downselect matrix was generated to carefully outline and rank criteria for selecting a replacement mix.
- Testing was conducted and data for other AoA criteria was gathered to fill the necessary information into the matrix.
- Upon matrix evaluation, the mix with the largest value was selected as the prime candidate.

Burster Mix Down Select Matrix

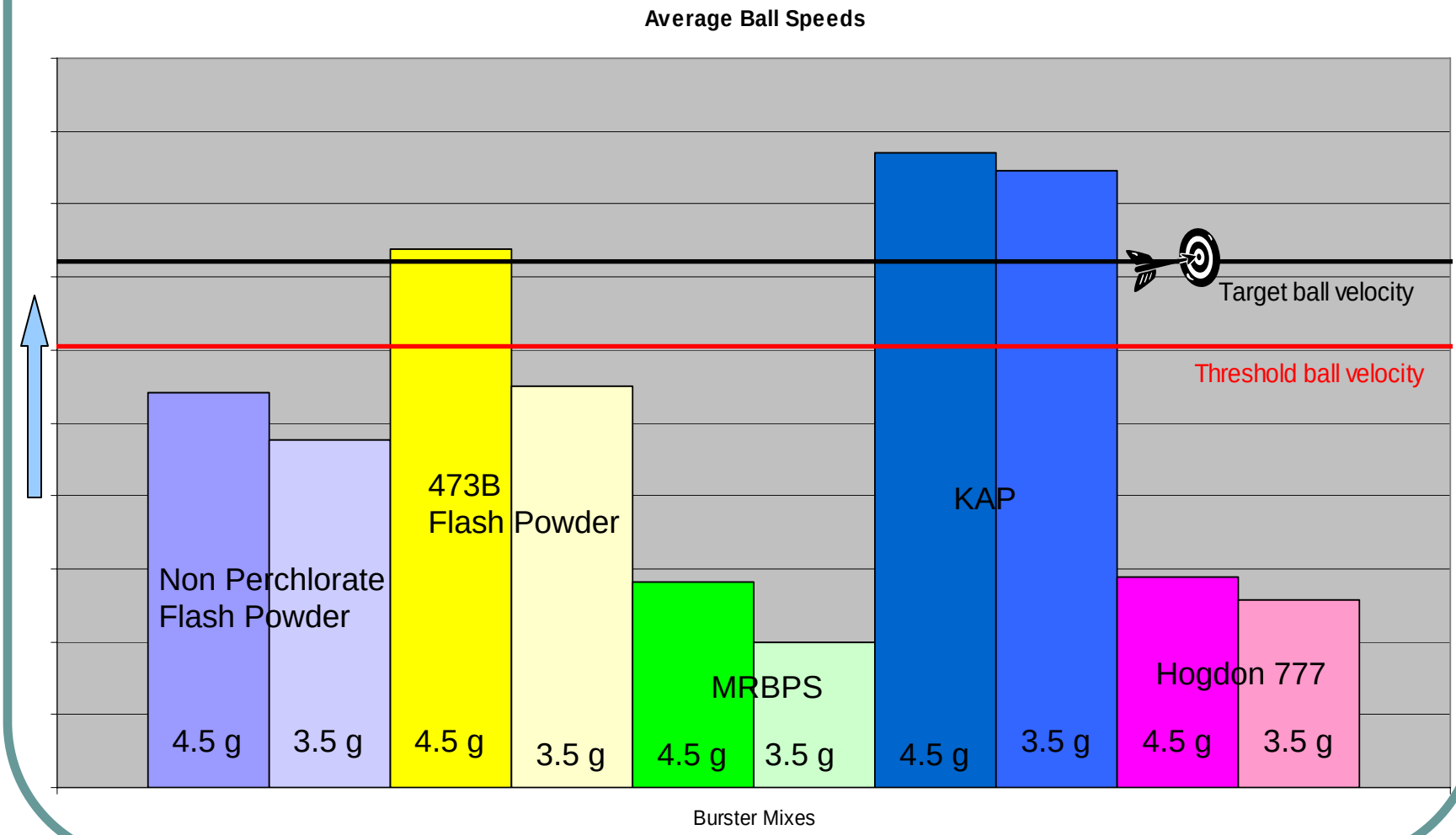
mix selection criteria	cost of material	avalability	producibility	EMQ qualified	Perchlorate content	used in other items	existing contract for	qty needed to purchase	existing data	range restrictions	safety	government /proprietary	performance in submunition	**Total**	**Weighted total**
criteria ranking	3	6	9	8	7	4	2	3	6	4	8	2	9		
mix candidates															
KAP															
MRBPS 83B3 cl 5															
473B-M115/M116															
Hogdon 777															
non-perchlorate flash bang															

mix properties	consistancy	rise time	function time	peak pressure	shelf life	**Total**	**Weighted total**
criteria ranking	10	5	5	5	2		
mix candidates							
KAP							
MRBPS 83B3 cl 5							
473B-M115/M116							
Hogdon 777							
non-perchlorate flash bang							

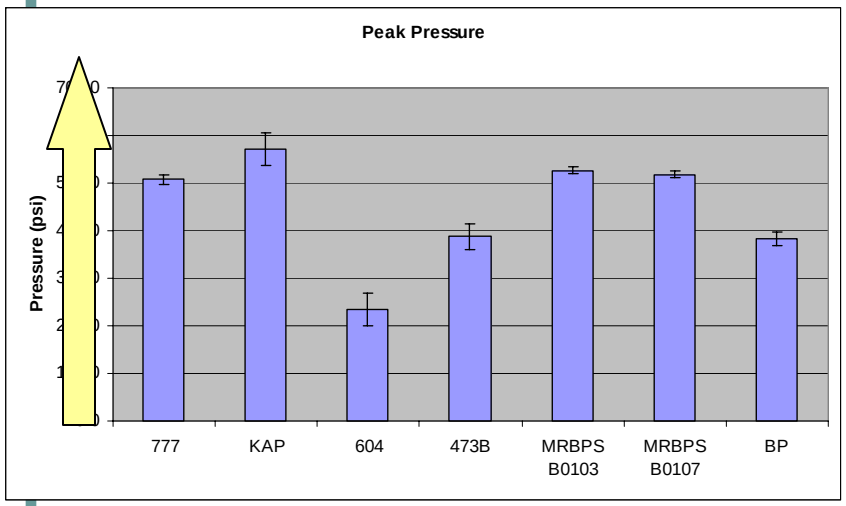
Testing Needed

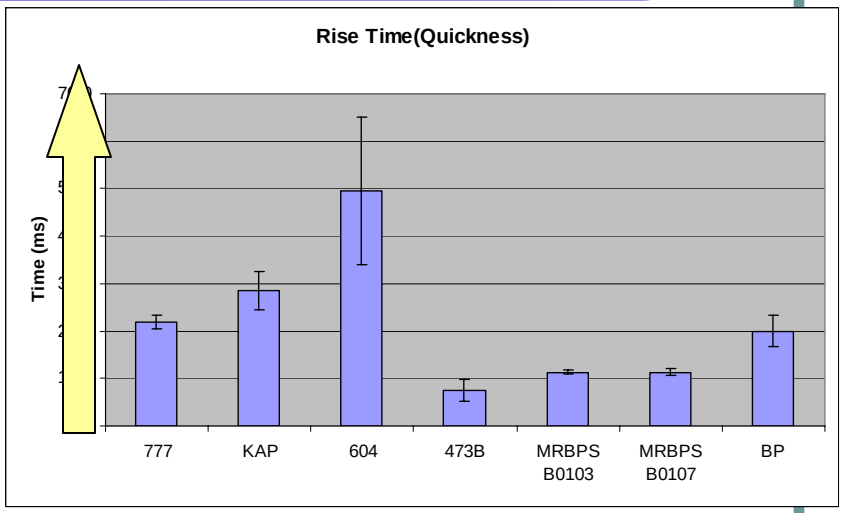
- Submunition Performance Testing
  - Ball velocity
  - Reliability
  - Sound level
- Closed Bomb Lab Testing
  - Pressure rate of rise
  - Function time
  - Peak pressure
  - Slope

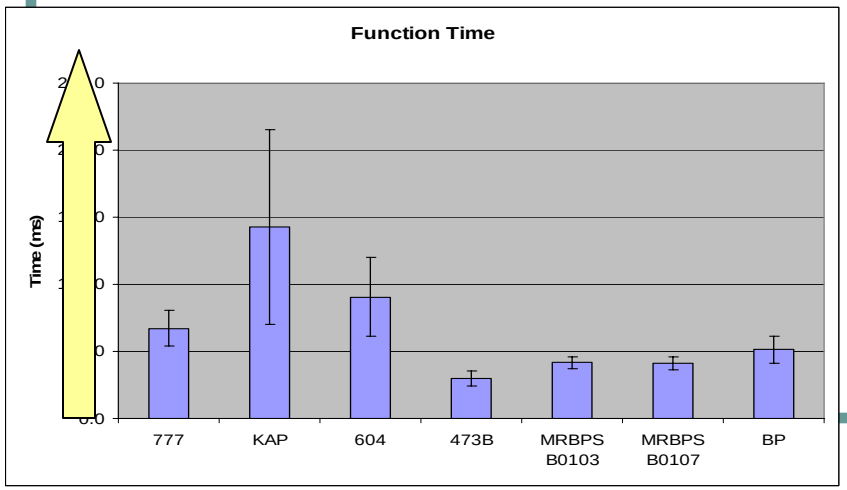
Performance Testing

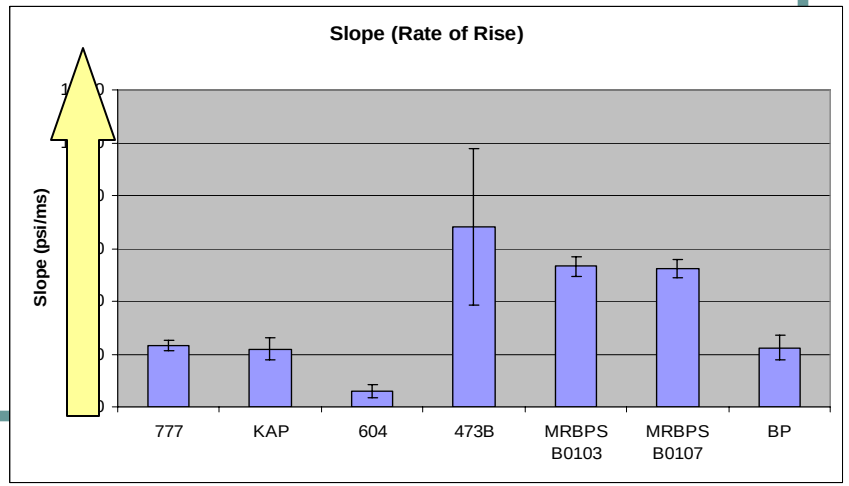


Closed Bomb Testing









Completed Matrix

mix selection criteria	cost of material	availability	producibility	EMQ qualified	Perchlorate content	used in other items	existing contract for	qty needed to purchase	existing data	range restrictions	safety	government /proprietary	performance in submunition	**Total**	**Weighted total**
criteria ranking (suggested)	3	6	9	8	7	4	2	3	6	4	8	2	20		
criteria ranking (adjusted)						2	0	1							
mix candidates															
KAP	10	10		0	1	0		10	3		5	10	8	57	365
MRBPS 83B3 cl 5	5	10		10	5	4		0	8		8	0	0	50	318
473B-M115/M116	8	10		10	3	10		5	9		1	10	9	75	502
Hogdon 777	10	10		0	5	0		0	3		5	0	0	33	183
non-perchlorate flash bang	5	10		5	10	2		5	7		3	10	4	61	374

mix properties	consistancy	rise time	function time	peak pressure	shelf life	**Total**	**Weighted total**
criteria ranking (suggested)	10	5	5	5	2		
criteria ranking (adjusted)		0	0	0			
mix candidates							
KAP	5				5	10	60
MRBPS 83B3 cl 5	10				5	15	110
473B-M115/M116	4				5	9	50
Hogdon 777	8				5	13	90
non-perchlorate flash bang	4				5	9	50

Grand Total

425
428
552
273
424

473B flash powder had the highest total

Test Statistically Significant Sample

- Engineering Level Test plan generated to validate performance of new configuration prior to full Production Verification Testing (PVT) testing.

- If testing is successful, PVT testing will commence with Full Material Release to follow.

Future Efforts

- Investigate correlation of qualitative requirement to quantitative item specification requirement.
- Develop robust and reliable test method for verifying quantitative effective non-lethal requirement for non-lethal bursting munitions.
- Investigate a perchlorate free replacement energetic that yields acceptable end item performance.

Contact Information

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Questions?