ENVIRONMENTALLY FRIENDLY PROPELLANT FOR THE LARGE CALIBER TRAINING ROUNDS

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TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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Outline

- **Team Objective**
- **System Requirements**
  - Propellant Requirements
  - Mechanical Properties
  - Manufacturing Process
- **Performance Test**
- **Conclusions**

Collaborative Effort: ARDEC, JMC, and ATK Development IPT

Team Objective: Replace M-14 propellant in the 120mm tank ammunition training rounds with an alternative propellant that has improved Insensitive Munitions (IM), Green, and Vulnerability characteristics.

Name	Organization
John Kostka – Co-Chairman	ARDEC – PM
D. A. Worrell – Co-Chairman	ATK-Radford – PM
Dena Porterfield	AFSC – Contracts
Thelma Manning	ARDEC - Engineer
Andrew Krause	ARDEC – QA
Jason Mishock	ARDEC – Systems Engineer
Katherine Murphy	ARDEC – QA
Matthew Rinehardt	ATK – PM Engineer
Mark Cook	ATK – QA
Roger Hollins	ATK – Product Engineering
Steve Ritchie	ATK – Ballistician
Carlton Adams	ARDEC - Ballistician

M14 Propellant Used in 120mm Training Rounds Has Drawbacks

Ingredient, wt. %	M14
NC, 13.15% N	90.0 ± 2.0
DNT	8.0 ± 2.0
DBP	2.0 ± 1.0
DPA (added)	1.05 ± 0.15
Graphite (added)	0.06 ± 0.04
Residual Solvent	0.7 Max
Moisture	0.6 ± 0.2
Flame Temp., [K]	2774
Ballistic Pot., [J/g]	3982
Abs. Density, [g/cc]	1.60

- **Residual Solvent implicated in July 2002 and May 2003 Tank Fires**
- **DNT, DBP and DPA are environmentally undesirable**
- **IM Properties poor compared with tactical ammunition**

M865 TPCSDS-T

Projectile Weight = 5.50 kg
MV (21 °C) = 1700 ± 20 m/s
MV (52 °C) = 1740 ± 20 m/s
MV (-32 °C) = 1620 ± 30 m/s
Pressure (63 °C) <= 5900 bars
M14 Charge Weight = 7.2 kg

M1002 MPAT-TP-T

Projectile Weight = 10.55 kg
MV (21 °C) = 1375 ± 10 m/s
MV (52 °C) = 1404 ± 10 m/s
MV (-32 °C) = 1335 ± 10 m/s
Pressure (63 °C) <= 6400 bars
M14 Charge Weight = 7.6 kg

PM-MAS Prioritized Requirements for Replacement Candidates

1. Eliminate (or reduce) residual solvents.
2. Meet existing interior ballistic requirements for the M865 and M1002.
3. Improved IM characteristics for each round.
4. Affordable solution relative to existing M14 costs.
5. Environmentally friendly formulation and process.
6. Producible at the quantities required to meet near term cartridge needs.
7. Propellant compatible with existing cartridge materials.
8. Propellant shall not negatively impact barrel/gun tube life.
9. Propellant storage life and hazard classification meet existing requirements.

PAP8386 – ARDEC Formulation

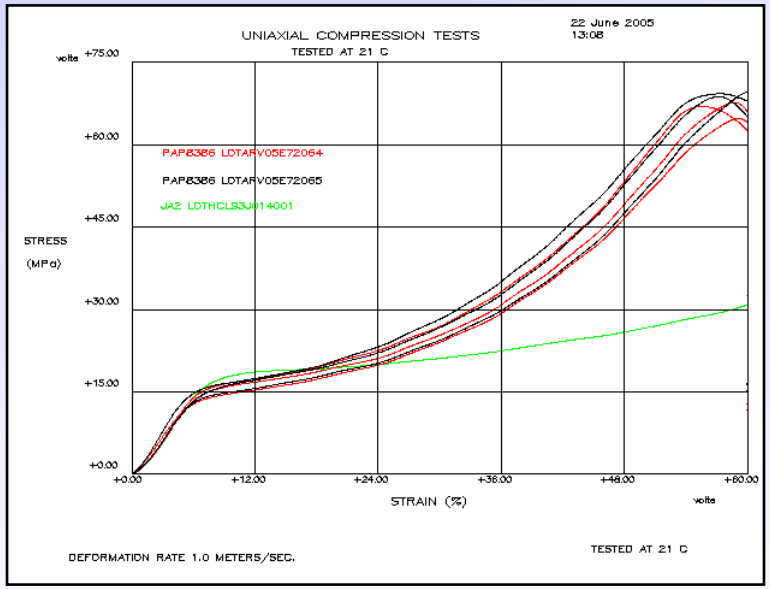
An Excellent Candidate for the Training Rounds

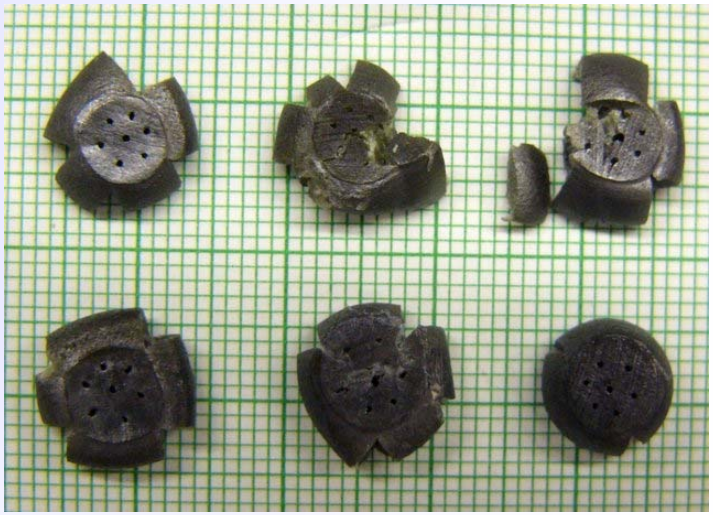
Thermochemical Parameter	Value
Flame Temperature, [K]	2948
Impetus, [J/g]	1063.6
Gas Molecular Weight, [g/gmol]	23.049
Covolume, [cc/g]	1.042
Frozen Gamma	1.244

- Solventless formulation – Completely eliminates solvent vapor fire potential
- Material Properties similar to JA2 – Improved impact sensitivity
- Environmentally-friendly formulation – VOC's, DNT, DPA and DBP eliminated
- Same Ingredients as JA2 and RPD380 –
  - Compatible with existing systems
  - 1.3c Hazard Classification
  - Similar storage life
- Flame Temperature < 3000 K – Low barrel erosion

PAP8386 Has Demonstrated

Superior Properties In High Rate Mechanical Response Testing At ARL

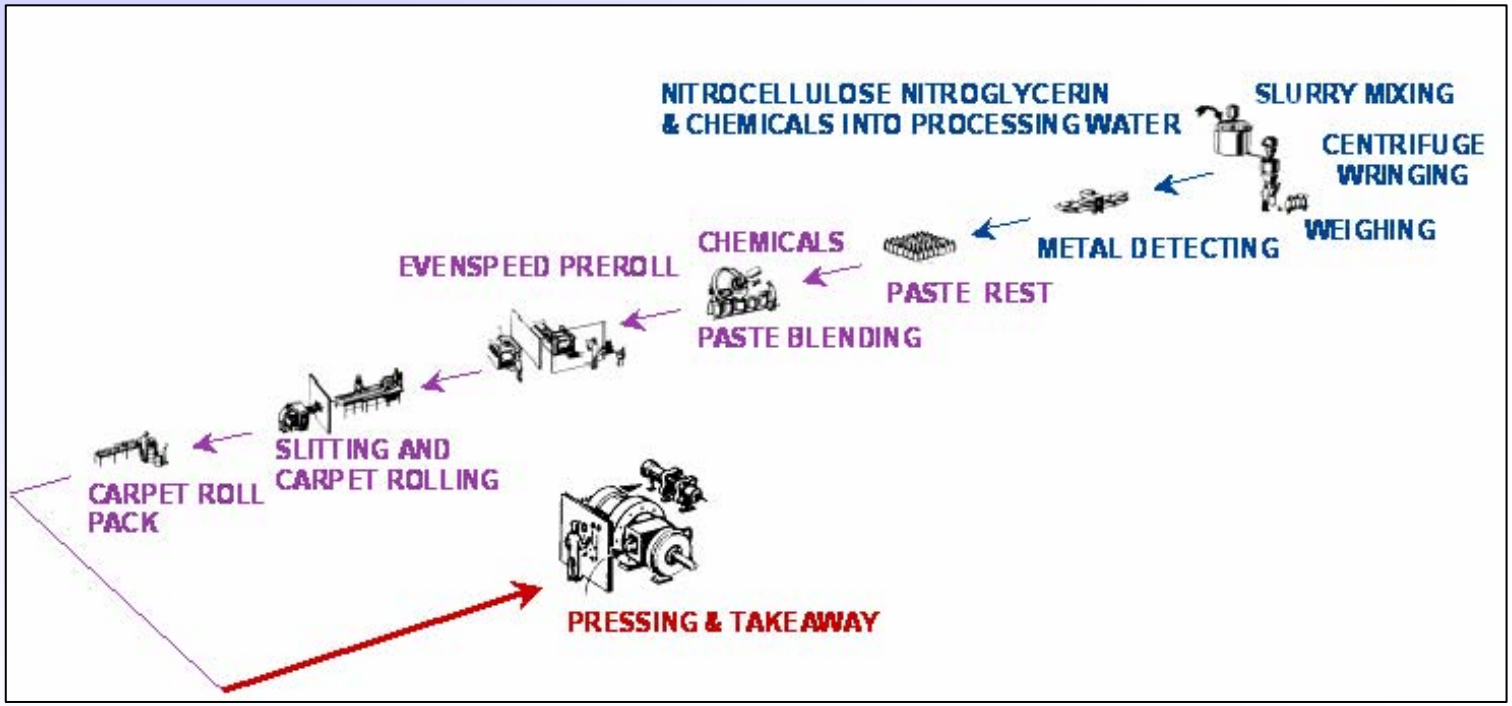




Ambient Results for PAP8386 compared to JA2

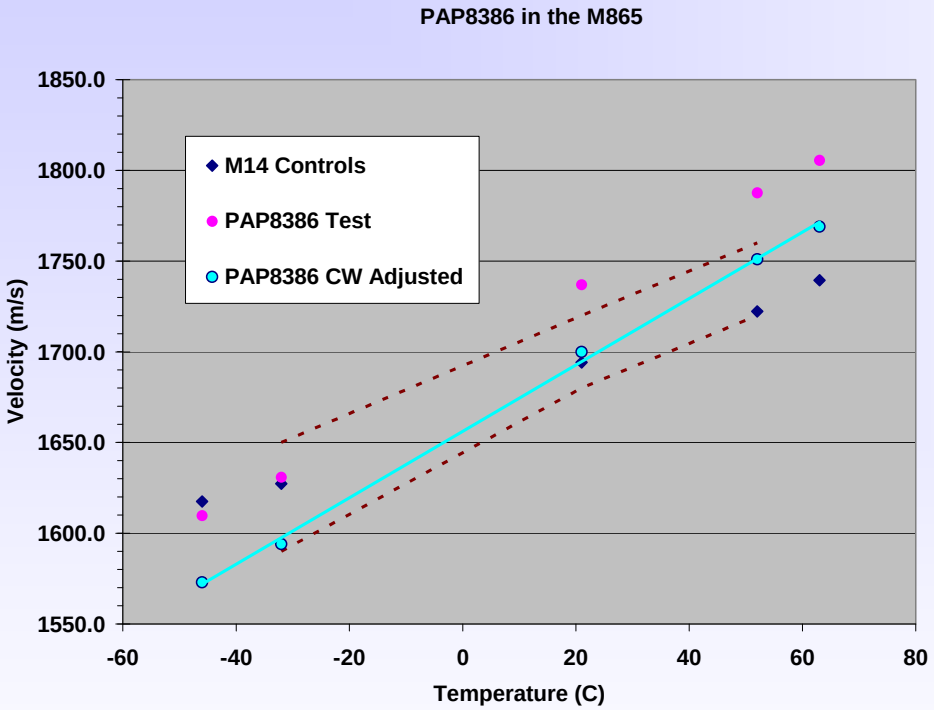
"Overall, the PAP8386 mechanical response was very good. In particular, the -32ºC and -46ºC responses were most impressive. The minimal amount of fracture observed at these temperatures is atypical of the single-, double-, triple-base, and composite gun propellants that have been mechanically tested by the Army Research Laboratory."

A Solventless Propellant Is the Best Solution To The Requirements



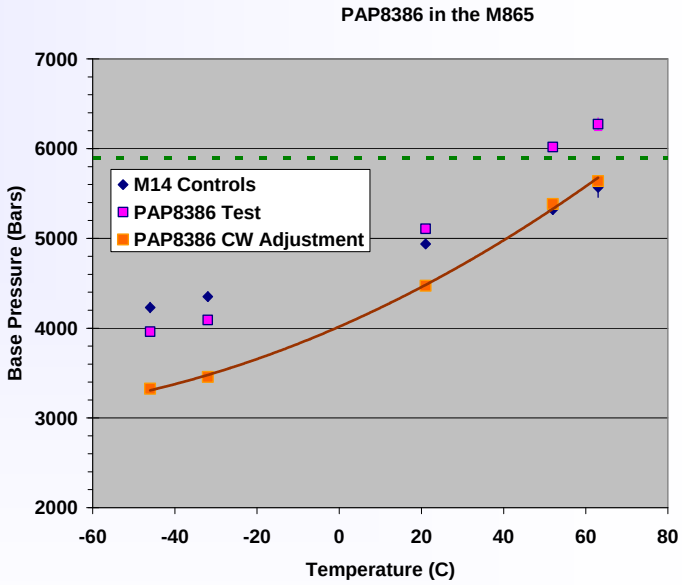
Solventless propellant manufacturing process at the Radford Army Ammunition Plant

PAP8386 Meets M865 Performance Requirements For Muzzle Velocity

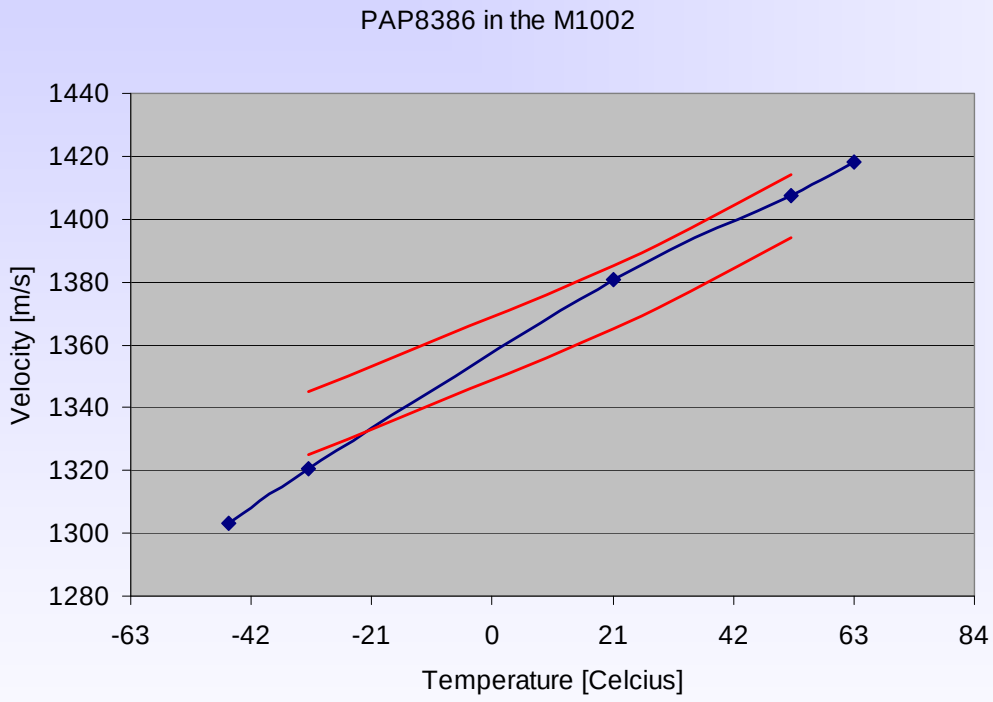


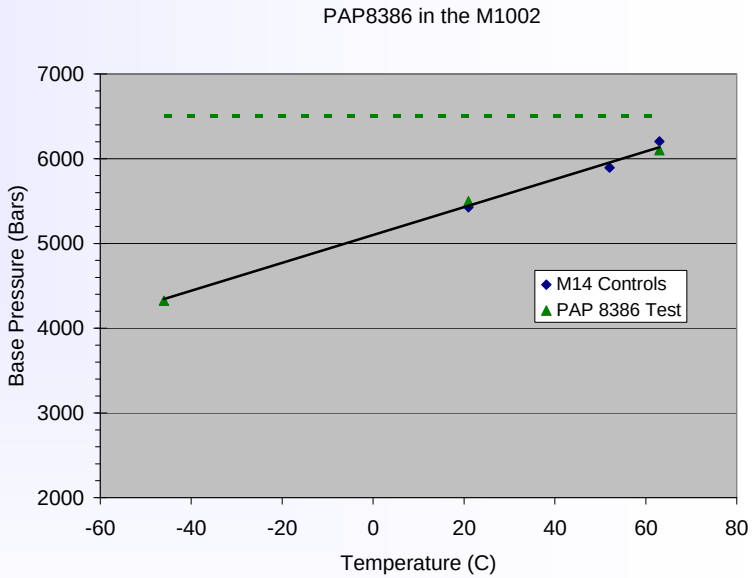
Muzzle velocity falls within M865 requirements

Peak pressure is equivalent to existing round



PAP8386 Meets M1002 Performance Requirements For Muzzle Velocity Across Most of the Operating Range





Muzzle Velocity Performance falls just below the performance envelope at -32 C. Further optimization is necessary.

Pressure levels equivalent to existing round

CONCLUSIONS:

PAP8386 Is A Strong Replacement Candidate For M14 In 120mm Tank Training Ammunition

- Completely eliminates residual solvents.
- Meets M865 ballistic requirements.
- Meets M1002 ballistic requirements above -21 C. Additional work needed to improve low temperature match.
- IM Improvement – demonstrated improvement in impact response.
- Affordable solution– economy of scale will make PAP8386 affordable.
- Environmentally friendly - solventless process removes VOC's, DNT, DBP and DPA.
- Manufacturing capacity – existing U.S. Army solventless facilities at RFAAP sufficient for near term requirements.
- Propellant is compatible with existing cartridge materials.
- Propellant shall not negatively impact gun barrel life – low flame temperature.
- Propellant storage life of 30 years and hazard classification 1.3c meet existing requirements.