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Development of Cast Cure Explosives for Comp B Replacement

Prepared by:
Robert Hatch, Paul Braithwaite, Nathan Seidner, and Jim Wright
ATK Launch Systems

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Outline

Two cast cure formulations developed:

- Formulation DLE-C054 (RDX, NTO, HTPB binder)
- Formulation DLE-C055 (RDX, TEX, HTPB binder)

Formulation Characterization

- Formulation and processing features
- Small scale sensitivity
- Subscale performance testing
- Subscale Insensitive Munitions testing

Background

A replacement explosive for Comp B must meet the following objectives:

- Low Cost
- High Performance
- Castable, with good processing characteristics
- Respond well to IM threats of impact, cookoff, and sympathetic detonation

Potential advantages of cast cure versus melt pour formulations:

- Problems with volume changes due to phase changes avoided
- Rubbery nature of binder provides damage resistance and improves response to impact events
- Cast cure charges usually contain low numbers of defects that can increase shock sensitivity
- Proven IM capabilities demonstrated in formulations such as PBXN-110 and PBXN-109

DLE-C054 Formulation and Processing

Formulation

- HTPB binder system
- 88% Solids
  - Coarse RDX
  - Coarse NTO (3-nitro-1,2,4-triazal-5-one)
  - Fine RDX

Processing

- Viscosity minimized by adjusting ratio of coarse and fine RDX
- Excellent processing with end-of-mix viscosities from 7-12 kp
- Material flows easily through slit or hole plate when casting

DLE-C054 Scale Up

- Made in ¼ pint, pint, 1-gallon, and 5-gallon mix sizes
- Scale up was straightforward with just slightly longer mix times at larger mix sizes
- End-of-mix viscosity and processing was identical at each mix size
- Expected to scale easily to production 600-gallon mixers
- ATK Launch Systems has mix facilities capable of producing millions of pounds per year

DLE-C054 Small Scale Sensitivity

Excellent sensitivity

DLE-C054 Sensitivity			
	Uncured	Cured	Class 5 RDX
ABL Impact (cm) – TIL	41	51	1.8
ABL Friction (lbs) – TIL	≥800 @ 8 ft/s	≥800 @ 8 ft/s	25 @ 6 ft/s
ABL ESD (J) - TIL	5.7	0.133	0.025
DSC Onset (°C)	221	216	219

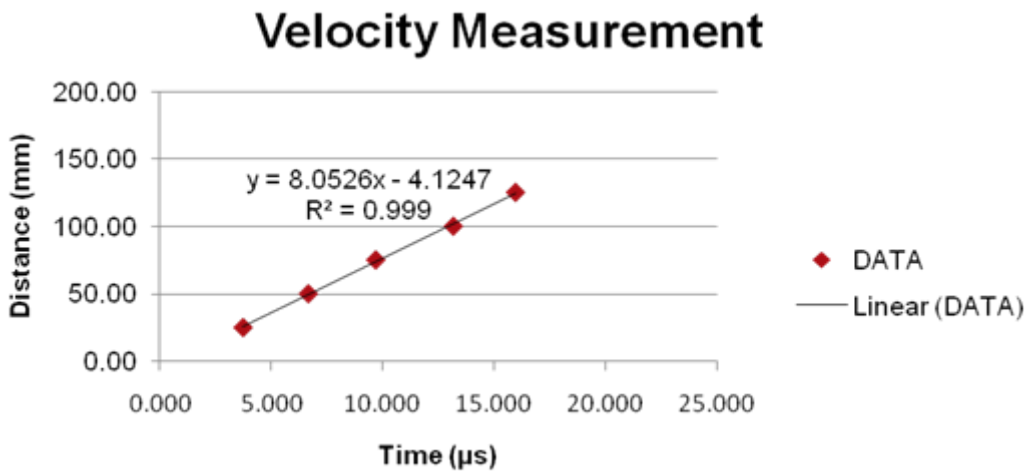
DLE-C054 Dent/Rate Tests

Two dent/rate tests performed

- LSGT Hardware (13.97 cm long by 3.65 cm diameter charge)

Excellent performance

- Detonation velocity = 8.0 km/s (Comp B = 7.9 km/s)



Dent Depth (DLE-C054)	Dent Depth (Comp B)	Percentage of Comp B
0.398”	0.433”	92%

DLE-C054 VCCT Testing

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Variable Confinement Cookoff Testing Performed

- Heat rate = 6°F/hr

VCCT		
Wall Thickness (in.)	Reaction Temperature (ºF)	Result
0.030	342	burn
0.045	342	pressure rupture
0.075	341	pressure rupture
0.090	341	pressure rupture
0.120	341	deflagration

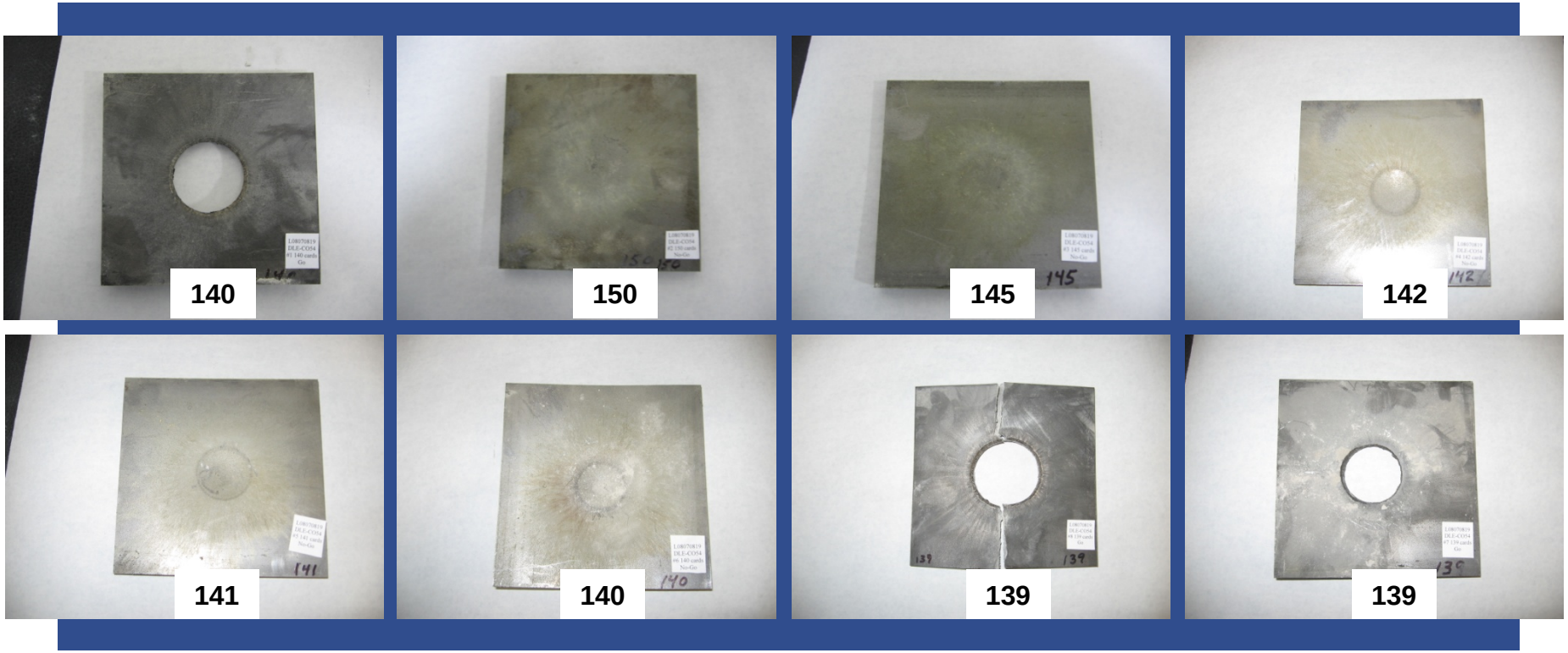
VCCT at heavy 0.12 inch confinement

•steel sleeve in one piece
•no fragmentation

DLE-C054 LSGT Testing

Large Scale Gap Testing Performed (8 tests)

- 140 cards (compared to 201 for Comp B)
- Significant reduction in shock sensitivity compared to Comp B



DLE-C055 Formulation and Processing

Formulation

- HTPB binder system
- 88% Solids
  - Coarse RDX
  - Coarse TEX (4,10-dinitro-2,6,8,12-tetraoxa-4,10-diazatetracyclododecane)
  - Fine RDX

Processing

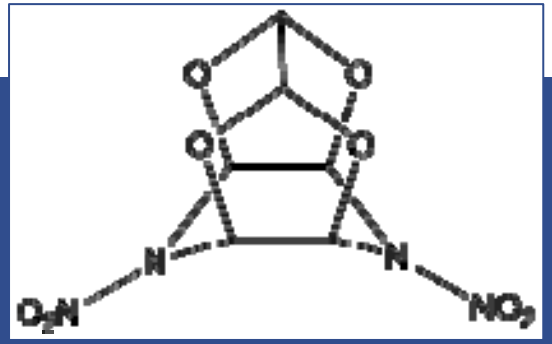
- Viscosity minimized by adjusting ratio of coarse and fine RDX
- Excellent processing with end-of-mix viscosities from 7-11 kp
- Material flows easily through slit or hole plate when casting
- Made in ¼ pint, pint, and 1-gallon mix sizes

Insensitive Energetic Material TEX

TEX

- 4,10-dinitro-2,6,8,12-tetraoxa-4,10-diazatetracyclododecane
- Cheetah thermochemical code theoretical performance a little better than NTO
- Has been manufactured in the past at ATK Launch Systems
- Not currently manufactured in large quantities in the US
- Synthesis starts with inexpensive materials – has the potential to be reasonably low cost

Caged molecular structure results in high density of 1.99 g/cc



DLE-C055 Small Scale Sensitivity

Excellent sensitivity

DLE-C055 Sensitivity		
	Uncured	Cured

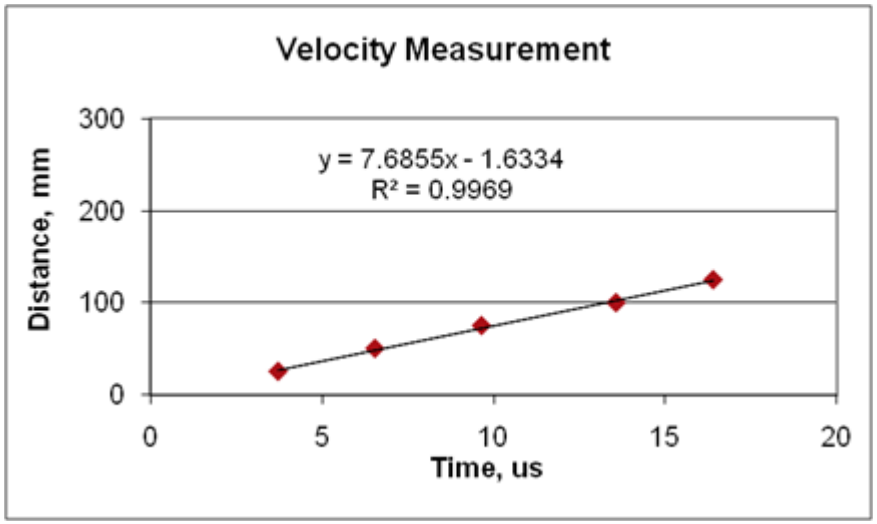
DLE-C055 Dent/Rate Tests

Two dent/rate tests performed

- LSGT Hardware (13.97 cm long by 3.65 cm diameter charge)

Excellent performance

- Detonation velocity = 7.7 km/s (Comp B = 7.9 km/s)

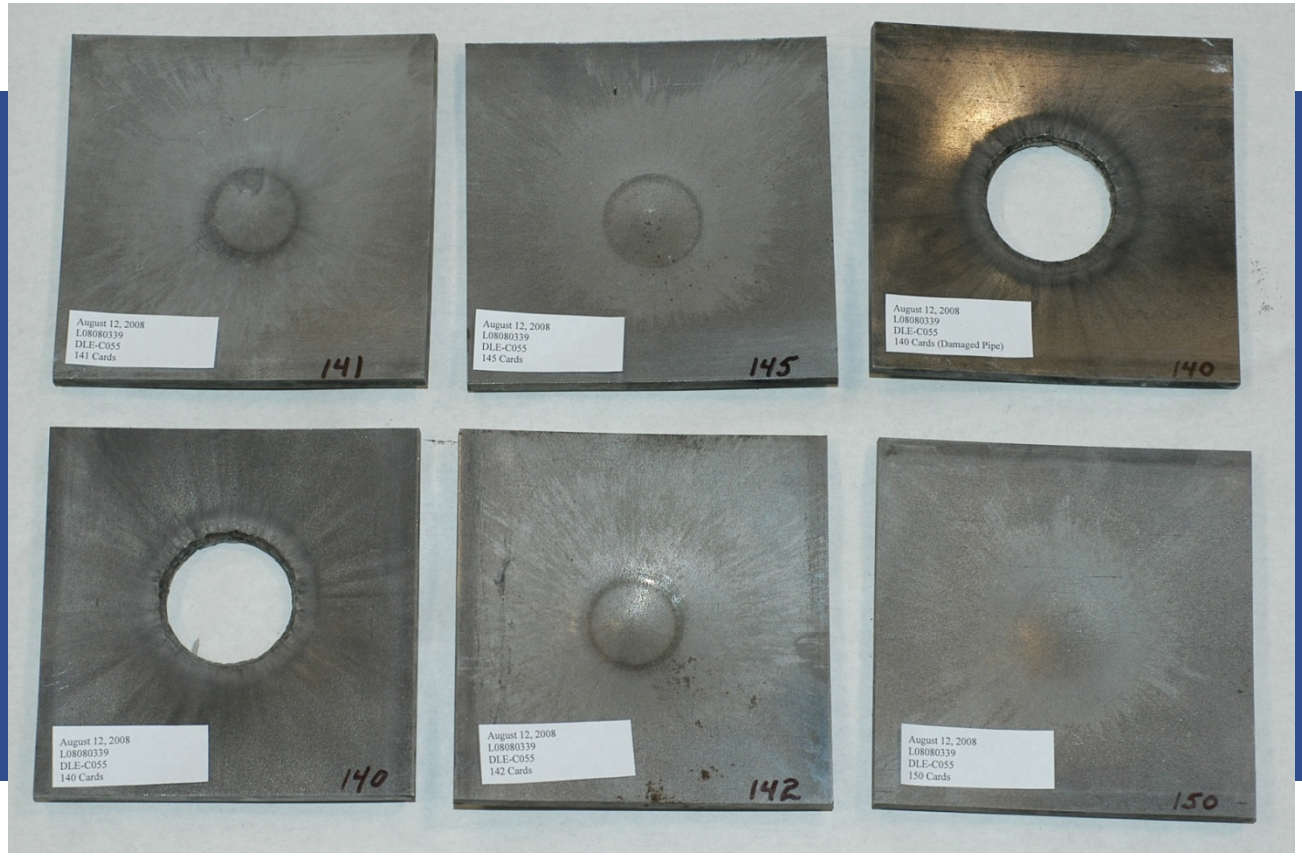


Dent Depth (DLE-C055)	Dent Depth (Comp B)	Percentage of Comp B
0.419”	0.433”	97%

DLE-C055 LSGT Testing

Large Scale Gap Testing Performed (6 tests)

- 141 cards (compared to 201 for Comp B)
- Significant reduction in shock sensitivity compared to Comp B



Summary and Conclusions

DLE-C054 is a promising composition for Comp B replacement

- Good performance
- Excellent shock sensitivity compared to Comp B
- Good small-scale slow cookoff response
- Excellent processing characteristics
- Potentially low cost

DLE-C055 has features very similar to DLE-C054 but with improved performance

- However, a good commercial source of large quantities of TEX is not available at this time