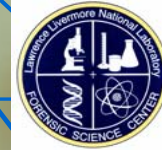# Thin-Layer Chromatography
a Field Technique for Propellant Stabilizers and Explosives Analysis

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Global Demilitarization Symposium
Reno, NV
May, 2007

Agenda

Propellant Stability Analysis in the Field with TLC

TLC Explosives Module

Future Developments

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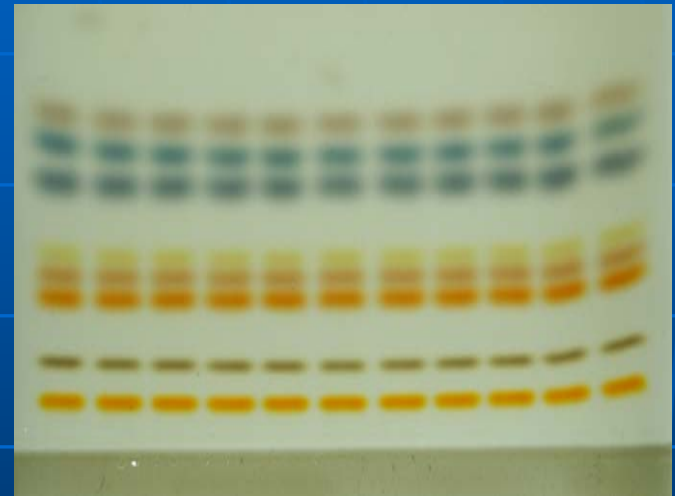
TLC Project – How We Got Here

Project Inception -- 1996

- **R & D Effort to Develop TLC for Propellant Stability**

- **From Screening to Quantification**

- **Fieldable Kit Development**

- **Validation Trips – 2000, 2002**

- **Validation testing – 2004**

- **PSSB Endorsement – 7/06**

- **Fielding & Commercialization - 2006**

2N
NNO
DPA

2,4
2,2'
2,4'

4
4,4'

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Propellant Stability Analysis in the Field with Thin-Layer Chromatography

Commercialized to:

Pelatron Inc. –   Honolulu, HI
                          (808) 543-5290

TLC Sales and Support
                          (866) 460-1356
                          www.pelatron.com/tlc

PIKA International – Houston, TX
                          (281) 340-5523

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Explosive Analysis Module

- Typical Military Explosives

    - TNT, NG, RDX, Picric Acid, Exp. D, CL-20, HMX, Tetryl, & PETN

- Other Explosives
    - Urea, Urea Nitrate
    - Ammonium perchlorate & nitrate, Sodium nitrate, chlorate, & bromate

- Areas of Use
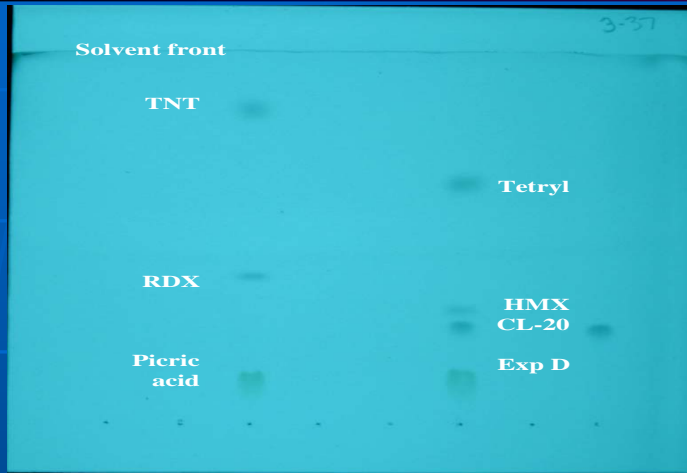   - Trace & Bulk analysis, Environmental Clean-up, etc.

The TLC Kit

TLC system
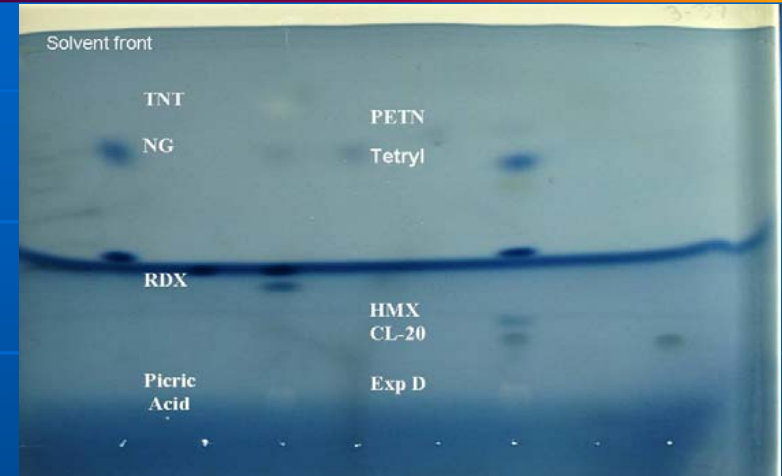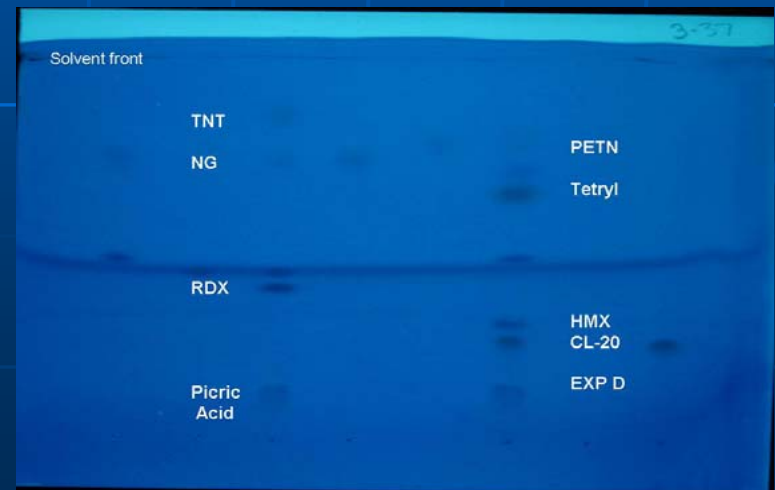
Imaging

Filtration

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Chromatography Solution #1
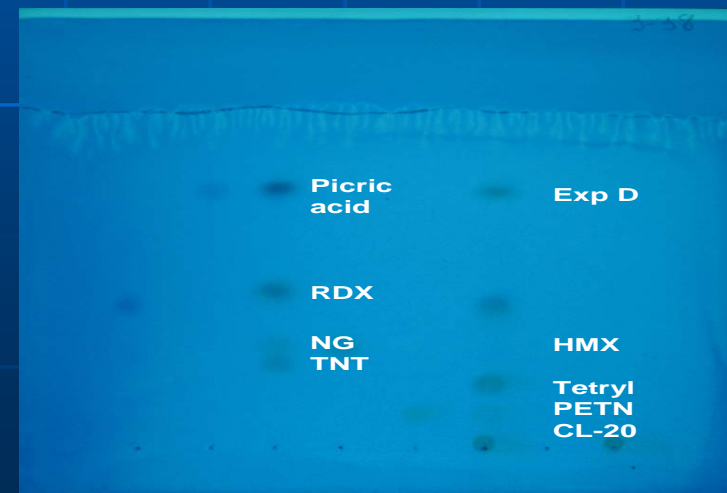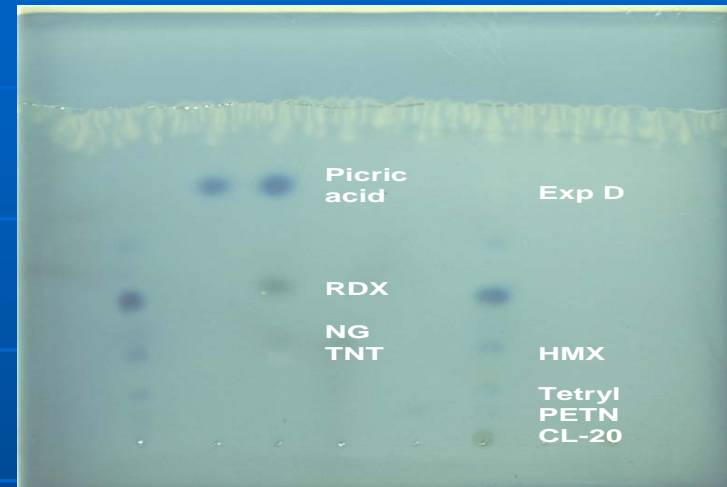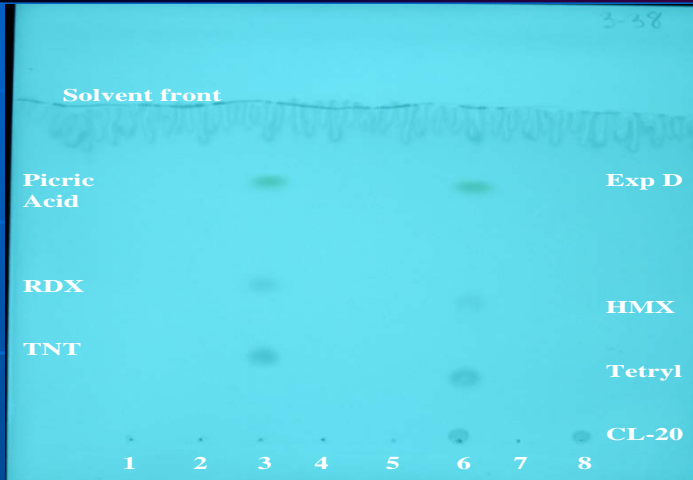

Viewed under UV light after elution

- View with UV light
- Color
- View with white light
- Develop and view with UV light

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Chromatography Solution #2

- Order of explosives reversed
- Same type plate used with both solvents
- Not all explosives appear in each view
- Second method confirms results

RF values	Syst. #1	Syst. #2
Explosive	RP plate*	RP plate**
picric acid	0.09	0.76
Exp D	0.09	0.76
HMX	0.31	0.41
RDX	0.39	0.44
Tetryl	0.61	0.16
NG	0.73	0.28
CL-20	0.28	0.01
PETN	0.78	0.08
TNT	0.86	0.23
	* Non-Polar	
	** Polar	

Visualization

Explosive	UV	Coloring Sol'n	Coloring + UV	DL (ng)
picric acid	+		+	25
Exp D	+		+	25
HMX	+		+	50
RDX	+		+	50
Tetryl	+		+	50
NG			+	100
CL-20	+	+	+	50
PETN			+	100
TNT	+		+	100

5/17/2007

Urea and Urea Nitrate TLC

Lane
1 urea nitrate, 0.2 μg
2 urea nitrate, 0.5 μg
3 urea nitrate, 1.0 μg
4 urea nitrate, 2.0 μg
5 urea, 0.2 μg
6 urea, 0.5 μg
7 urea, 1.0 μg
8 urea, 2.0 μg

Solvent front
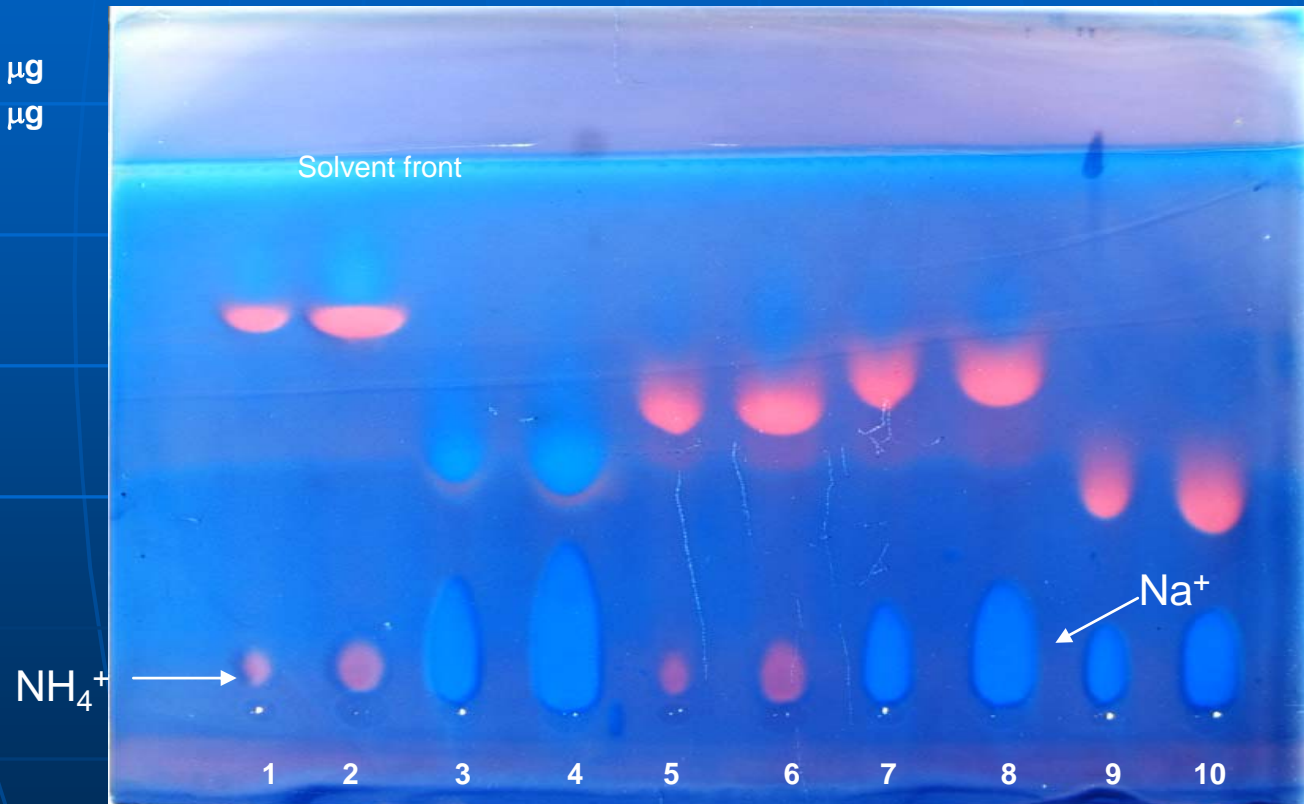
Rf = 0.6

1 2 3 4 5 6 7 8

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Ions of interest

Lane
1 NH_4 perchlorate, 2 µg
2 NH_4 perchlorate, 5 µg
3 Na nitrite, 2 µg
4 Na nitrite, 5 µg
5 NH_4 nitrate, 2 µg
6 NH_4 nitrate, 5 µg
7 Na chlorate, 2 µg
8 Na chlorate, 5 µg
9 Na bromate, 2 µg
10 Na bromate, 5 µg

Solvent front

Na^+

NH_4^+

1 2 3 4 5 6 7 8 9 10

Common Tools

- Sampling Tools

- Filtration Syringe

- Light Box

- TLC Process Tank

- Dip Tank

- TLC Plate – Explosives and Urea Nitrate
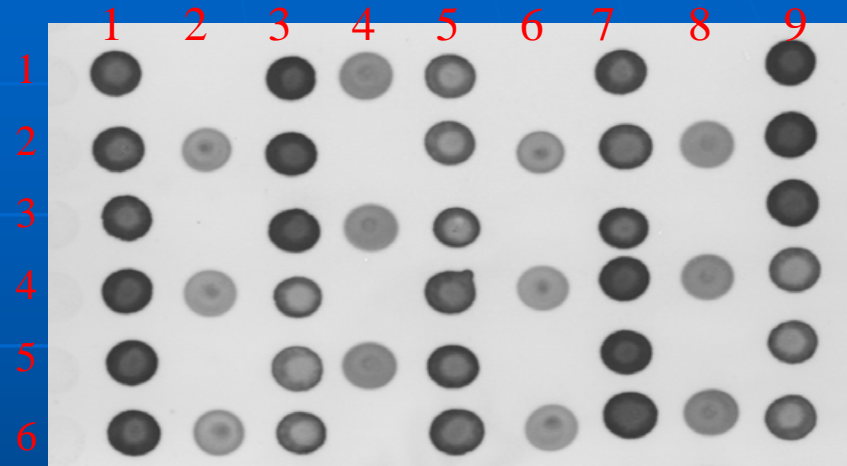
Expanding Capabilities

- Add quantification to explosives module

- Additional modules – CW, TIC, Street Drugs

- High Throughput Screening for Propellant Stability

  Pre-Screen for strong Cat A
  Unknowns

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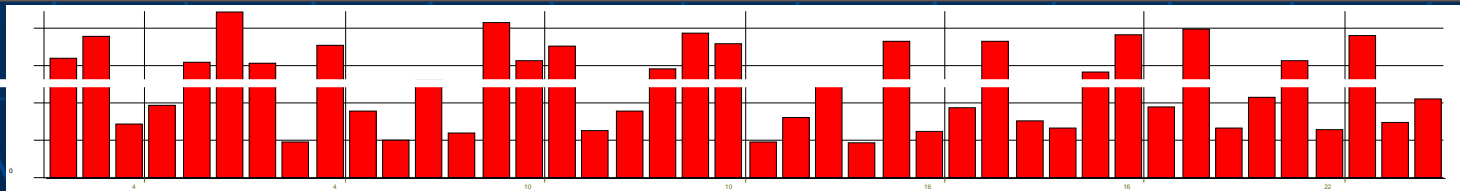# High Throughput Screening for Propellant Stability

- **Rapidly screen 50 propellant samples**
- **Each spot contains all the components in the standard**
- **Determine strong Category A's**
- **Samples prepared for TLC analysis**
- **Spotted and colored with no separation**
- **Uses same software and camera**

Integrated Intensity (%)

File Show Update Help

Max: 4424.8459

Min: 945.75030

Mean: 2465.0879

Std. Dev.: 1073.0416

\Col Row	1		2		3		4		5		6		7		8		9	
1		100.0				118.3		44.7		60.4				96.1				137.9
2		100.0		31.8		115.6				58.3		32.8		85.4		39.3		135.5
3		100.0				112.4		40.6		57.3				93.4				123.7
4		100.0		26.8		45.2				69.1		26.3		101.9		34.8		51.10
5		100.0				41.6		36.5		77.3				104.3				52.1
6		100.0		33.6		54.5				78.7		32.2		95.9		37.5		53.1

Conclusion

- Propellant analysis with TLC is commercialized

- Fielded at TEAD, HWAD, APG, YPG

- Explosive Module being added

- Expand propellant analysis

- Expand kit capabilities

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Acknowledgements

Defense Ammunition Center

Pelatron Inc.

PIKA International Inc.

Picatinny Arsenal