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Effects of Explosive Type and Form on Contact Trace Sampling Efficiency

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Outline

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- Contact sampling issues – those covered and not covered in this presentation
- Explosive type: RDX, TNT, NG
- Form of explosive: RDX from solution vs. C-4; NG from smokeless powder versus NG from dynamite
- Additional comments on
  1. Wet versus dry sampling
  2. How volatile can an explosive be before trace contact sampling becomes ineffective?
  3. Human factors (variation for one sampler, sampler to sampler variation)

General Comments

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- Most work to be presented is from a DHS study to quantify trace contamination on vehicles loaded with bulk explosives.
- *Approximate* quantification of sampling efficiencies was important, but intent was to estimate sampling efficiencies, not try to maximize them, nor to measure them as accurately as possible.

Factors Affecting Contact Sampling Efficiency

- Type of sampling medium: covered in another talk at this workshop – work presented here used **Smiths Ionscan 400B swabs**
- Type of surface: covered in another talk at this workshop – work presented here used **4" square coupons cut from a vehicle hood**
- Type and form of explosive: main emphasis of this talk
- Human factors: not a primary focus of this workshop but some data presented
- Wet versus dry sampling: limited data presented
- Explosive volatility: limited data on usefulness of contact sampling versus explosive vapor pressure
- Environmental factors – temperature, humidity, etc. – not covered in this talk

Standard Procedure to Quantify Sampling Efficiency in this Study

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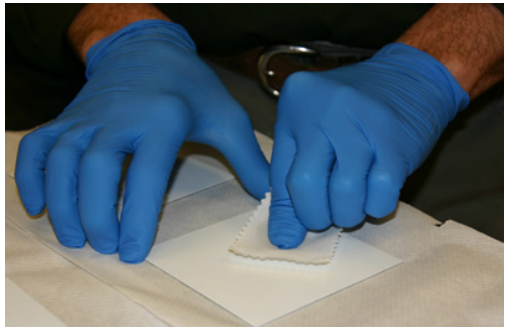
- Use syringe to deposit known amount of explosive in standard solution onto Bytac dry transfer strip provided by TSL; let solvent evaporate
- Use Bytac strip to perform dry transfer onto 4" square coupon from vehicle hood
  1. Other studies had shown the dry transfer efficiency was typically > 90%
  2. Confirmed in our work by small masses of explosive remaining on used Bytac strips
- Deposit 100 µl isopropanol onto Smiths 400B swab and swipe the hood coupon; an identical swab is used to swipe the used Bytac strip following the dry transfer
- Place swabs in vials with 2 ml acetonitrile and refrigerate
- Analyze with GC-ECD (± 20%)
- $$Sampling\ efficiency = \frac{Mass\ on\ swipe\ from\ coupon}{Initial\ mass\ on\ Bytac\ strip - Mass\ on\ swipe\ from\ used\ Bytac\ strip}$$



Dry vs. Wet Sampling: RDX

	Dry Ionscan Swab	IPA Wetted Ionscan Swab	Prepackaged IPA Swipe*
First Swipe Efficiency	15 - 20%	40 - 47%	38 – 54%
Eight Swipes Efficiency	31 – 35%	62 – 70%	83 – 115%

- 84 ng RDX from solution deposited onto hood coupons
- Two samplers, each swiping one hood coupon with a dry Ionscan 400B swab, an identical swab wetted with isopropyl alcohol (IPA), and a prepackaged commercial IPA wipe
- This was a quick, semi-quantitative experiment but it suggests that wetting may improve sampling efficiency. ***However, in real-world applications wetting the swipe adds time and effort, so dry sampling may be preferred.***

* High chromatographic background made quantification difficult

Sampling Efficiency Data: RDX from C-4

RDX from C-4	
Sampler 1 (n=45)	Sampler 2 (n=20)
49 ± 16%	49 ± 9%

- Bytac strips from TSL containing approximately 110 ng C-4, dry transfer to hood coupons
- Sample hood coupon with Ionscan 400B swab wetted with 100 µl isopropanol
- Efficiency similar to RDX from standard solution

Sampling Efficiency Data: TNT

Sampler	Hood Piece Swipes (n=19-20)	Used Bytac Strip (n=19-20)	Direct Swipes of Bytac Strip (n=3)	Direct Deposit onto Swabs (n=3)
Sampler 1	52.7 ± 8.4	2.5 ± 3.5	95 ± 5.0	102 ± 16.1
Sampler 2	54.1 ± 15.5	11.9 ± 14.1	95 ± 15.0	107 ± 5.7
Sampler 3	67.5 ± 9.1	2.7 ± 4.4	102 ± 7.6	102 ± 7.6
Average	58.1%	5.7%	97.3%	104%

- ~104% (100% within experimental error) recovery for direct solution deposit onto swab
- ~97% recovery for direct swipe of Bytac strip with deposited TNT
- ~6% recovery from used Bytac strip
- ~58% sampling efficiency for swipe of hood coupon with TNT deposited via dry transfer

Sampling Efficiency Data: NG from Smokeless Powder

Sampler	Swipes from Hood Pieces (n=20)	Swipes from Used Bytac Strips (n=20)	Swipes from Unused Bytac Strips (n=3)	Direct Deposit onto Swabs (n=3)
Sampler 1	46.7 ± 9.1	3.5 ± 3.6	85.0 ± 0.0	103 ± 5.8
Sampler 2	36.6 ± 9.2	0.9 ± 1.8	69.3 ± 20.5	87.0 ± 10.6
Sampler 3	43.2 ± 9.3	6.0 ± 6.8	65.0 ± 5.0	117 ± 4.6
Sampler 4	53.0 ± 18.7	6.8 ± 7.8	85.0 ± 13.2	103 ± 5.8
Average	44.9	4.3	76.1	102.5

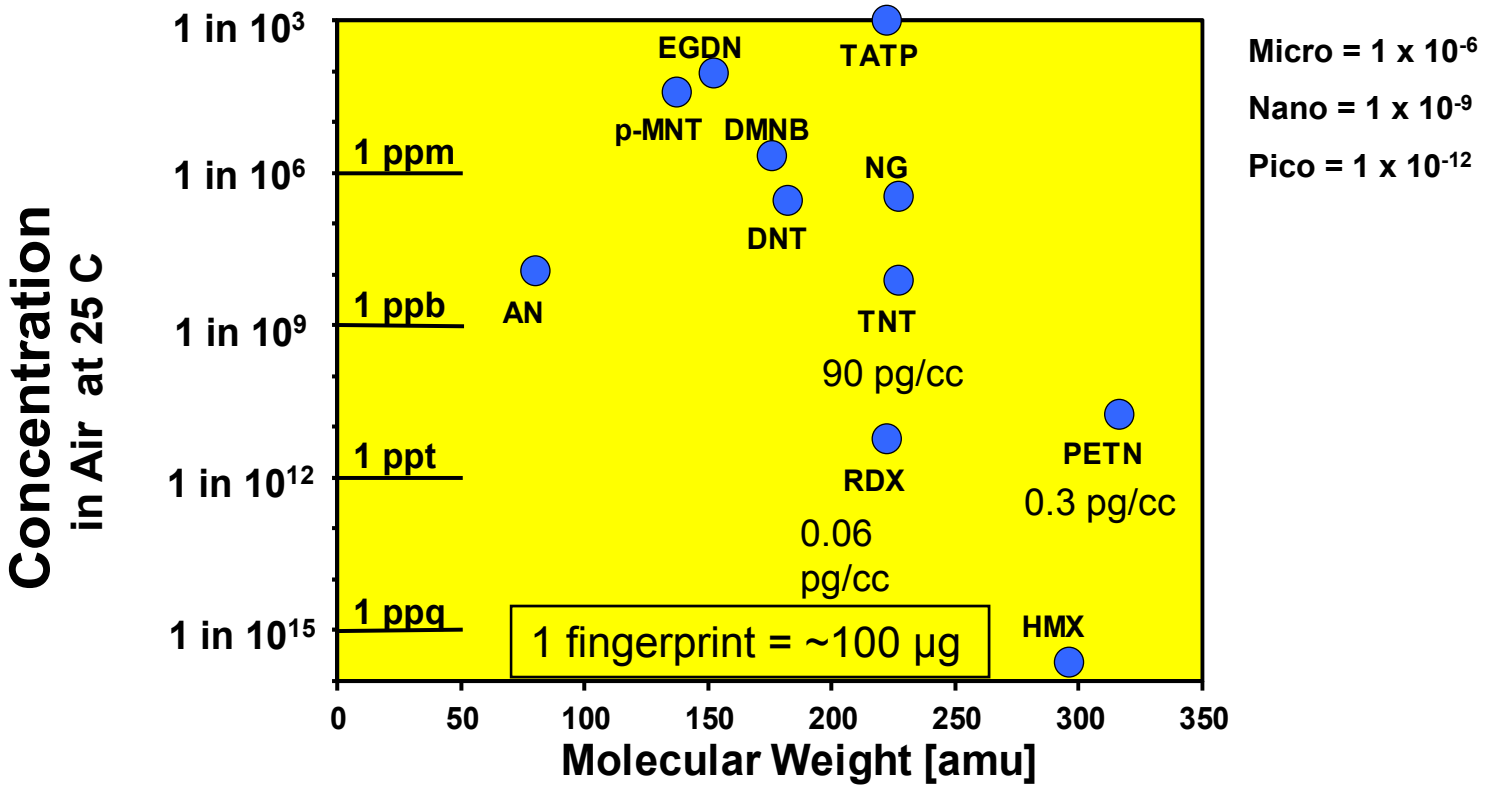
- Smokeless powder 40% NG by weight
- Standard solution of smokeless powder in acetonitrile nominally 100 ng/µl NG
- Solution deposit onto Bytac strip, then dry transfer to hood coupon

Sampling Efficiency Data: NG from Dynamite

NG from Dynamite	
Sampler 1 (n=20)	Sampler 2 (n=20)
82 ± 15%	67 ± 18%

- Dynamite is 22% EGDN and 4.4% NG by weight
- Standard dynamite solution in acetonitrile ca. 70 ng/µl NG and 300 ng/µl EGDN
- Solution deposit onto Bytac strip followed by dry transfer to hood coupon

Attempts to Measure Contact Sampling Efficiency for EGDN Failed



- Nominal efficiency for both samplers 15-20% using same dynamite solution and same procedure as for NG
- EGDN vaporizes too quickly to obtain meaningful results

Summary

	TNT	C-4	Smokeless Powder	Dynamite
Sampler	**TNT**	**RDX**	**NG**	**NG**
1	53 ± 8	49 ± 16	47 ± 9	82 ± 15
2	54 ± 16	49 ± 9	37 ± 9	67 ± 18
3	68 ± 9		43 ± 9	
4			53 ± 19	
Average	58 ± 11%	49 ± 13%	45 ± 12%	75 ± 17%

- Direct contact sampling efficiencies often near 50% (RDX from C-4, TNT, NG from smokeless powder)
- Wetting swab appeared to improve efficiency in our study
- Sampling efficiencies appear to differ for NG from smokeless powder solution and NG from dynamite solution
- EGDN is too volatile to quantify using our methods