Fentanyl Decontamination Studies

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EPA Decontamination Research and Development Conference

Challenging Problems.
Smart Solutions.

Financial Disclosure

- Neither myself nor MRIGlobal hold any reportable financial positions
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  - MRIGlobal Projects # 311474 & 311493

MRIGlobal


OUR MISSION
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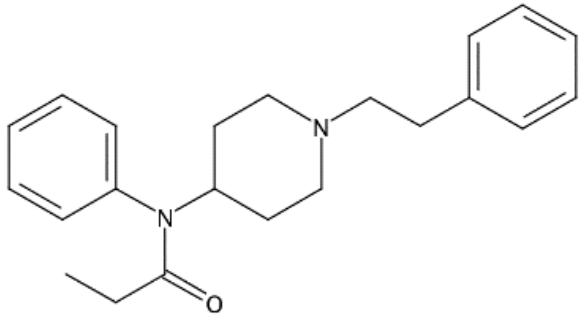
Colorado
Florida
13%
20%
67%
Bachelors
Masters
PhDs

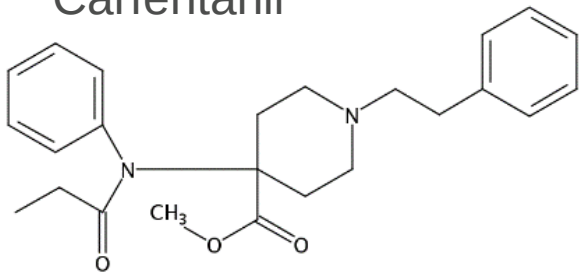
The Process

- ✓ Proof-of-concept Testing
- ✓ Fentanyl Operational testing
- ✓ Carfentanil Operational Testing
- ✓ Effluent Evaluation
- • Optimization

Fentanyl



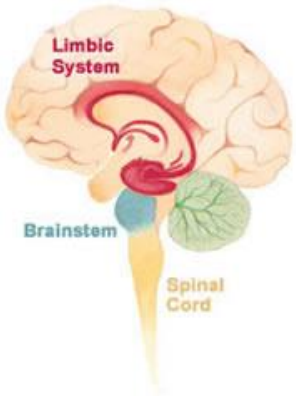
Carfentanil



Opiates - Physiology

- Attach to opioid receptors on nerve cells

Receptor location	Function	Opiate affect
Limbic System	Controls emotions	Creates feelings of pleasure, relaxation, and contentment
Brainstem	Controls automatic functions (breathing)	Slows breathing, reduce feelings of pain
Spinal cord	Receives sensations from body to send to brain	Decrease pain feelings



- Each analog elicits a different physiological response according to the sum of occupancies of the different receptor types and the associated binding kinetics

- Lethal dose of Heroin ≈ 20-30mg
- Lethal dose of Fentanyl ≈ 2mg
- Lethal dose of Carfentanil ≈ 0.2mg

Image from www.dea.gov/.../fentanyl_briefing Guide...

“China White”

- First fentanyl illicit case 1979 in CA. Drug overdose tested negative for narcotics. In 1981 >100 over doses.
- "China White" refers to any of a number of clandestinely produced fentanyl analogues, especially α-methylfentanyl (AMF).
- Appeal of AMF: resultant drug relatively more resistant to metabolic degradation
- Other street names: Apache, China Girl, Dance Fever, Goodfella, Jackpot, Murder 8, King Ivory, Tango & Cash, Great Bear
- Pure heroin also known as China White
- Jan-March 2017, single toxicology lab[1] analyzed 293 heroin samples
  - 78% contained detectable amounts of fentanyl
- Advantages
  - Appearance: white powder; easy to mix with heroin or sugar
  - Potency: small batches and easy to hide from authorities
- Disadvantage
  - Potency: easy to overdose

1. Clark, Andrew. Director of Lab Operations – Bluewater Toxicology

Global Incidents & Emergence

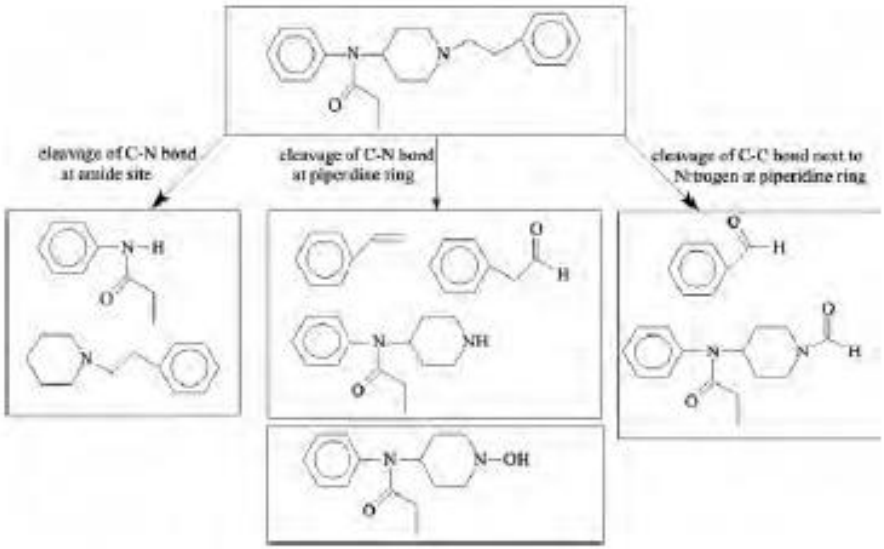
- October 2002 Moscow theater hostage crisis. Russian security forces used a fentanyl cocktail to incapacitate
  - ~130/850 hostages dead
- April 2006 in Azusa, CA. Domestic fentanyl lab bust. Contained bulk fentanyl and counterfeit 80mg OxyContin tablets with fentanyl instead of oxycodone.
- June 2006, 945g of 83% pure fentanyl powder seized by Border Patrol California in a vehicle from Mexico.
- April 2016 – **PRINCE!!**
- November 2016 Cottonwood Heights, UT. Counterfeit pills oxycodone (~70,000) and Xanax (>25,000). The accused owned a pill press and ordered fentanyl powder from China.
- Increased uses (and deaths) in Europe last 10 years as heroin supply is low due to Taliban/ISIS control on opiate production
- June 2017- 45 Kilos seized in New Jersey
- Countless others…

Potential for Dual-Use

- Wide variety of chemical and biological decontamination solutions available on the market
- Designed for field use and typically include multiple components
- Originally designed for chemical weapons decontamination
- Three (3) part mixture viable for 12-24 hours after mixing
- Shelf life of the individual components is >10 yrs

Considerations

- Standard?
- TTOP-08-2-061A decontamination verification studies
- Previous Studies
  - Garg et. al. 2010
  - Qi et. al. 2011
    - Peroxides & hypochlorites



Scheme 1. The degradation pathways of fentanyl in peracetic acid solution

Source: Qi et. al. Oxidative Degradation of Fentanyl in Aqueous Solutions of Peroxides and Hypochlorites. Defence Science Journal. 61 (1). 2011

Synthesis QA/QC

- Purity analyses
  - LC, NMR, Elemental

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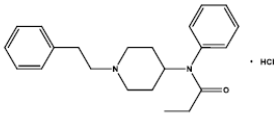
CERTIFICATE OF ANALYSIS
Project No. 111031.01.001

Original data is archived under MRIGlobal Project No. 111031.01.001
Serial No. 14067

Compound Identification



Product:	Fentanyl Hydrochloride
IUPAC Chemical Name:	*N*-Phenyl-*N*-[1-(2-phenylethyl)-4-piperidinyl]propanamide, monohydrochloride; *N*-(1-Phenethyl-4-piperidyl)-propionanilide hydrochloride; 1-Phenethyl-4-(*N*-phenylpropionamido)piperidine hydrochloride; Fentanil hydrochloride
Molecular Formula:	$C_{22}H_{28}N_2O \cdot HCl$
Molecular Weight:	372.94
CAS Number:	1443-54-5
MRIGlobal Lot No.:	14067-24-21

Quality

Purity:	+99% by HPLC
Identity:	Confirmed by NMR and MS
Storage Conditions:	Ambient, inert atmosphere
Date of Analysis:	August 16, 2017
Expiration Date:	No stability testing has been done for this compound

CoA Date

Original Date: August 24, 2017

Approved: _____ Date: September 13, 2017
Desmond Slade, Ph.D.
Associate Section Manager

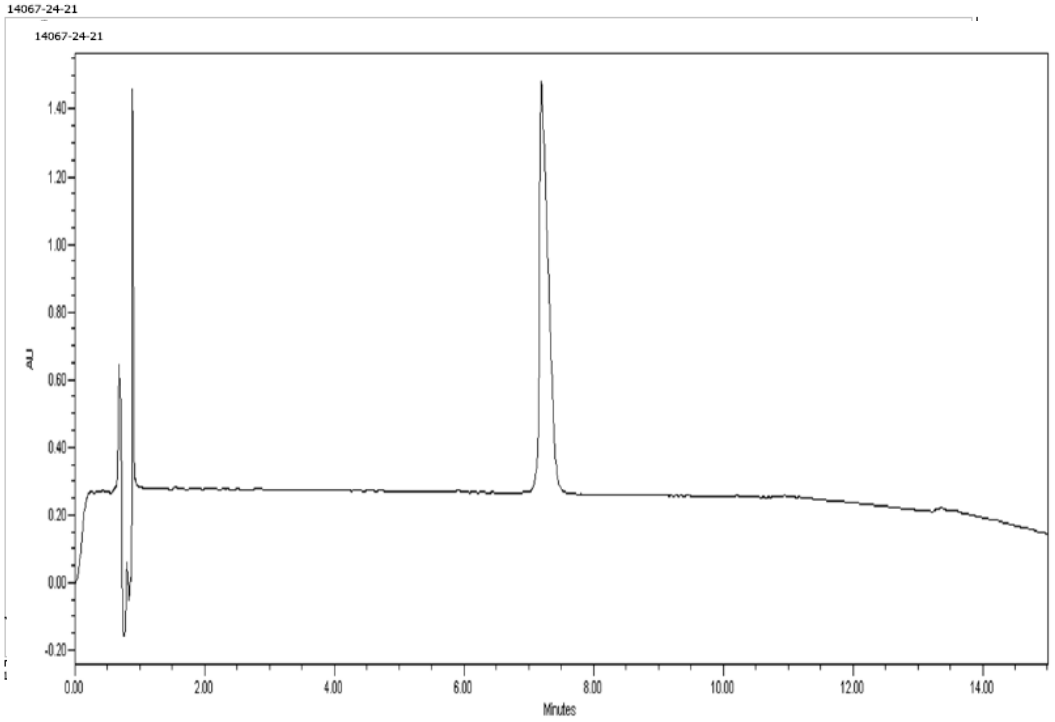


Figure 3. HPLC Chromatogram (UV) of Fentanyl Hydrochloride, Lot No. 14067-24-21.

Analytical Methods – LC/MS/MS

- Waters Acquity I-Class ultra-performance liquid chromatograph (UPLC) coupled to a Waters Xevo TQ-XS tandem triple quadrupole mass spectrometer (MS/MS)

Analyte	MRM Ion Transitions	Polarity	Cone Voltage (V)	Collision energy (volts)
Carfentanil	395.5 > 246 395.5 > 363 395.5 > 335	Positive	15 15 15	19 10 15
Fentanyl	337 > 105 337 > 188 337 > 216	Positive	15 15 15	37 21 21

- Column: Phenomenex Kinetex PFP 1.7µm 50 × 2.1mm; S/N H15-146651
- Mobile Phase A: 0.1% Formic Acid in Water
- Mobile Phase B: 0.1% Formic Acid in Acetonitrile
- Column Temperature: 50°C
- Autosampler Temperature: 5°C
- Sample Solvent: MeOH
- Injection Volume: 0.5 µL
- Flow rate: 1.0 mL/min

Analytical Methods – GC/MS

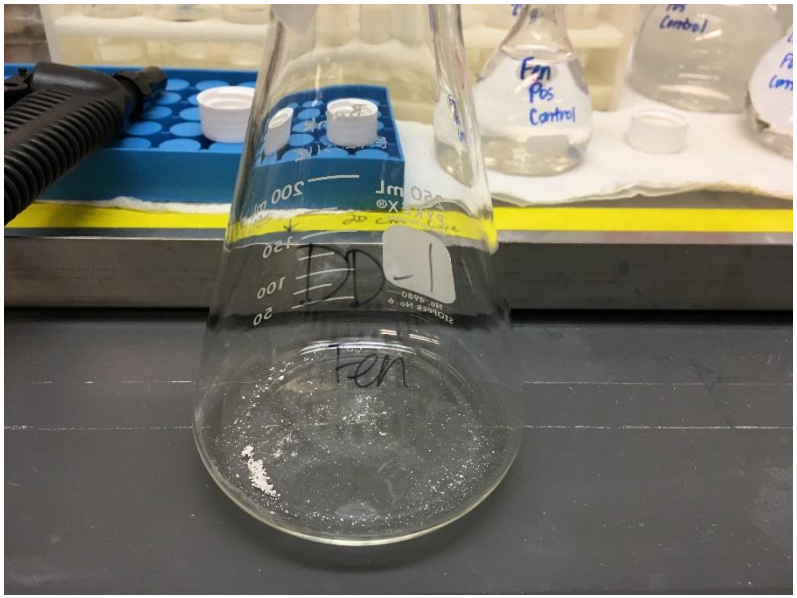
- Agilent 7890 gas chromatograph (GC) coupled to an Agilent 5977B Inert Mass Spectrometer (MS)

- Column: Restek Rtx-5MS; 30 m × 0.25 mm × 0.1 µm df
- Oven Program: 40°C initial, 10°C/min to 280°C hold 3 min
- Total Run Time 27 min
- Pressure: 16 psi
- Initial Flow: 2 mL/min
- Inlet: Splitless, 230°C
- Injection Volume: 1 µL
- Scan Range 40-400 m/z
- Solvent Delay 4 min
- MS Source: 230°C
- MS Quad: 150°C

Proof of Concept Objectives

- Determine 2 and 5 minute efficacy of Dalhgren Decon
  - Fentanyl Freebase and Carfentanil Oxalate
  - Two target:decontamination ratios

- Determine 2 and 5 minute efficacy of First Responder Dahlgren Decon
  - Fentanyl Freebase and Carfentanil Oxalate
  - Two target:decontamination ratios



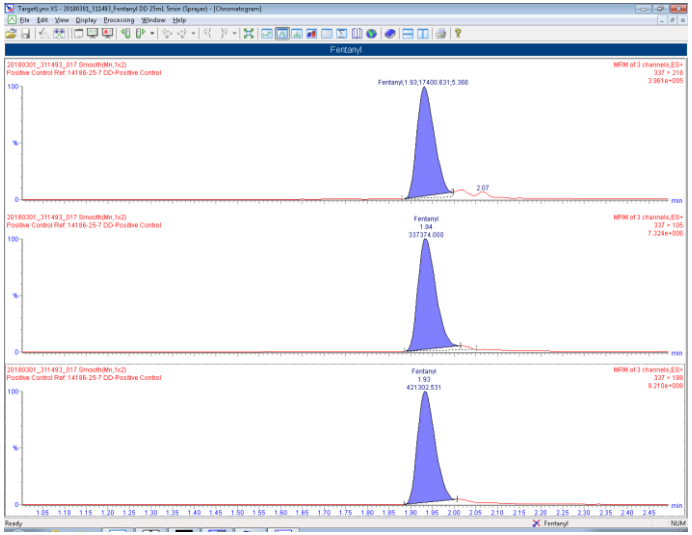
Quality Assurance & Control

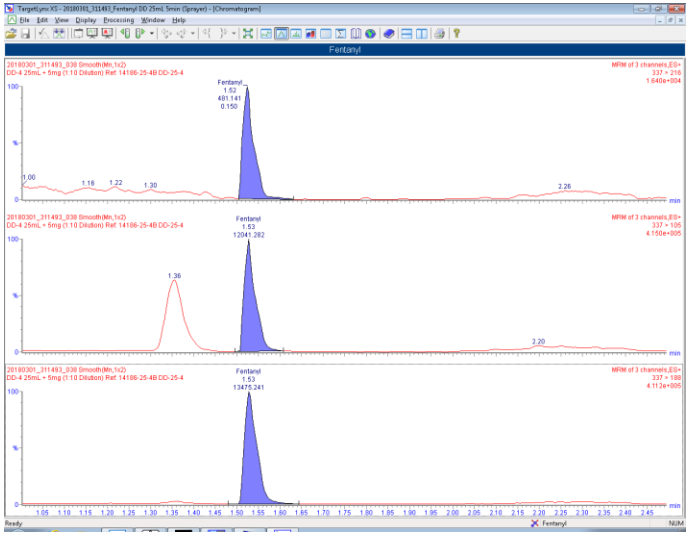
- All test trials included negative control samples used to monitor system cleanliness each day
  - **Solvent Method Blank:** A volume of solvent equal to the volume of target solution used. The sample is analyzed to verify a non-detection at the start of each testing day and/or for each solvent.
  - **Decon Matrix Blank:** A volume of decon solution equal to the volume of decon solution used in test trials. The sample is analyzed to verify a non-detection at the start of each testing day and/or for each formulation.

Solvent/System Blank (left) vs Decon Matrix Blank (Right)

Quality Assurance & Control

- All test trials included positive control samples used to verify the presence and quantity of the target compounds each day
  - **Continuing Calibration Verification (CCV):** A mid-level (usually C2-C4) calibration standard was periodically analyzed to verify system performance and recovery.
  - **Sensitivity Verification Standard (SVS):** The low level (C1) calibration standard was periodically analyzed to verify system sensitivity.
  - **Positive Control Spike:** A volume of target solution equal to the volume of target solution used is transferred into a container, a volume of solvent equal to the volume of decon solution used is transferred into the same container, mixed briefly, and analyzed to verify system performance and recovery.
  - **Positive Control Spike Time:** A volume of target solution equal to the volume of target solution used is transferred into a container, a volume of solvent equal to the volume of decon solution used is transferred into the same container, mixed for the appropriate time, and analyzed to verify system performance.

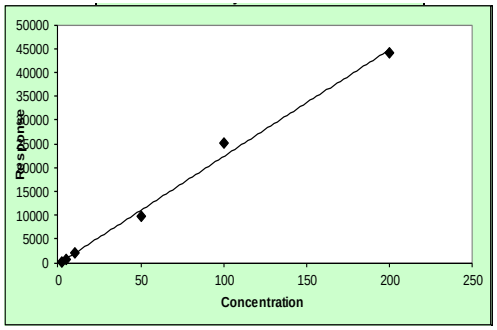


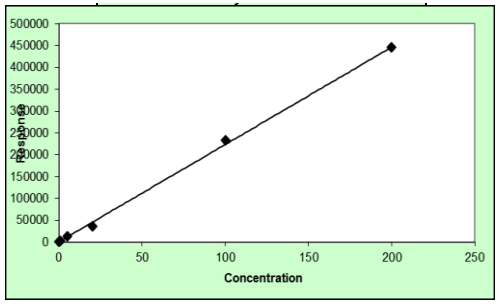


Fentanyl Control Spike (left) vs Sprayer 5 Minute 1:10 Decontaminated Sample (Right)

Quality Assurance & Control

Quality Control Measurement	Frequency	Data Quality Objective
Average relative error from standard curve	Each analyte Daily	The average of the absolute values of the relative deviation across all calibration levels included in the curve must be less than 10%.
Regression Fit	Each analyte Daily	The R^2 value associated with a calibration curve must be 0.98 at minimum. Values over 0.99 are preferred.
Single point relative error in curve	Each analyte Daily	No single calibration point can have a relative deviation greater than ± 30%.
Low level standard sensitivity	Each analyte Daily	Signal-to-noise of at least 3:1 for each ion used for identification.
System Blanks	Not set	No indication of carryover of background contamination (i.e., less than 3:1 signal-to-noise for peak at analyte retention time.
Number of Calibration points	Each Curve	A minimum of four points must be used for linear regressions and five points for quadratic regressions. Removal of any point is allowable, when necessary, to meet the acceptance criteria or to improve linearity, provided the sample response remains bracketed by standards.
Quantitation Range	Each Sequence	It is acceptable to provide quantified results for samples within ± 25% of the calibrated range. Samples outside the calibrated range but within the 25% must be caveated.

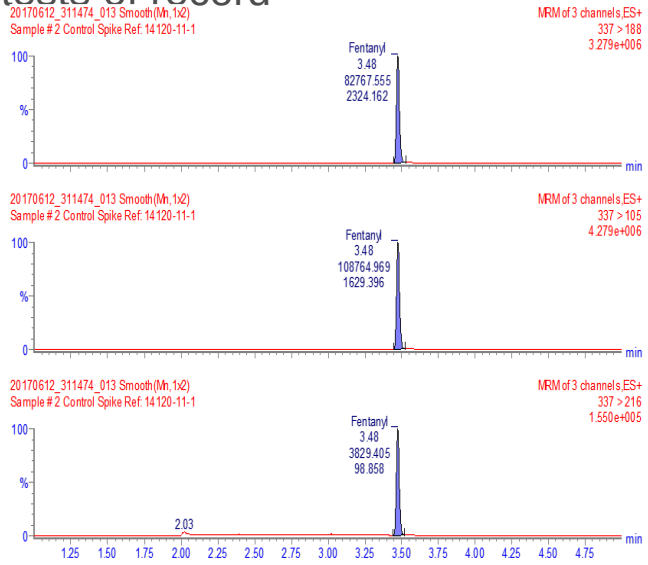


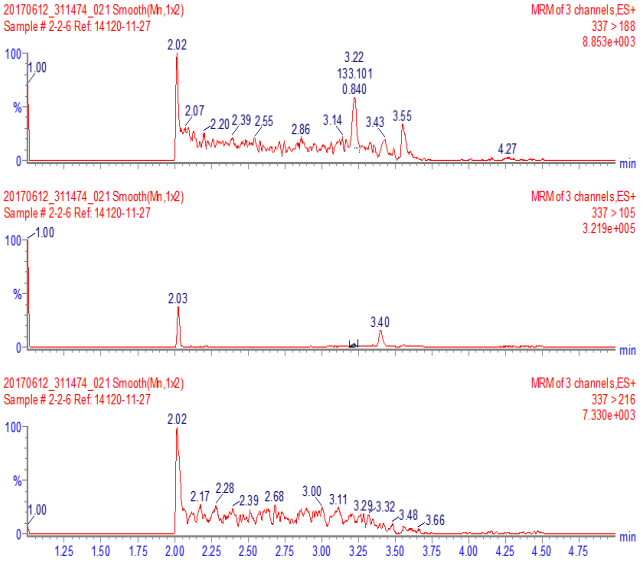


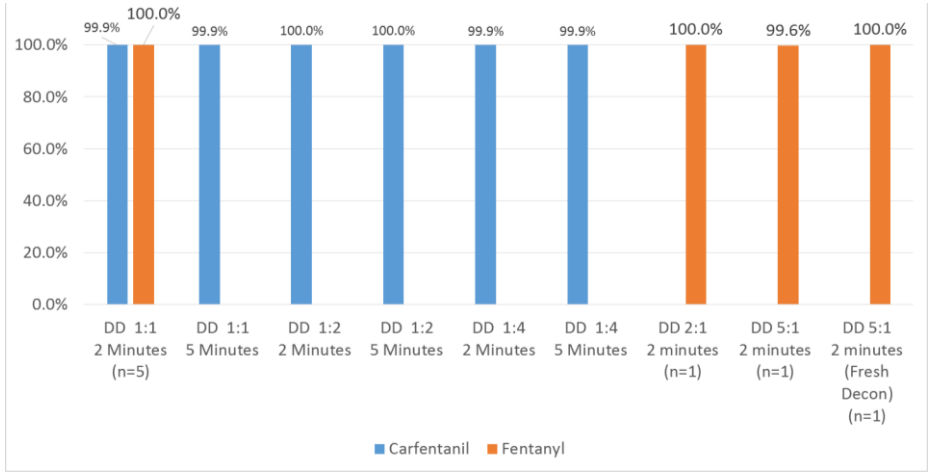
Analyte	Type	Weighting	# points	R^2	Average % Dev.
Fentanyl	Linear	1/x	6	0.998	12.1
Carfentanil	Linear	$1/x^2$	6	0.994	8.1

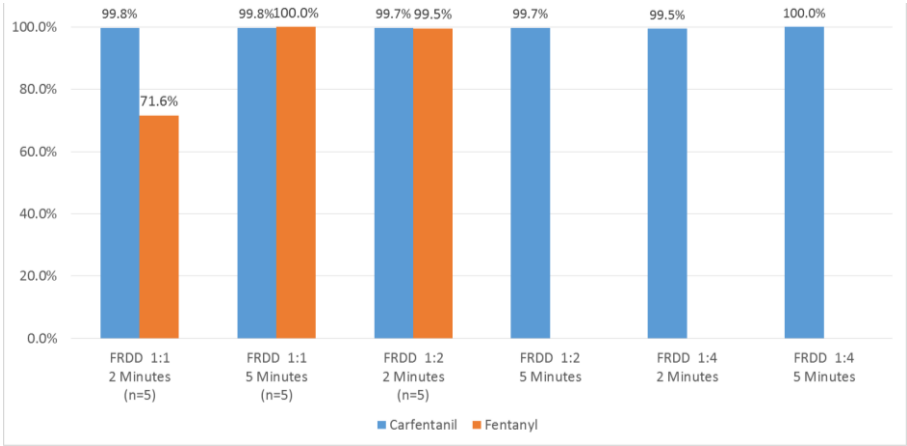
Initial Results

- ~100 tests of record









Proof-of-Concept → Operational

- In-solution vs. Pure powder
- 5mg (remember LD_{50} is ~ 2mg for 150lb person)
- Controlled laboratory pour vs. Tactical Sprayer

- Fentanyl HCl is not immediately soluble in the aqueous product
  - ~ 5 minutes for the 5mg Fentanyl to be visibly gone in the Dahlgren solution
    - Minimum reaction time tested was 5 minutes
    - Water solubility dramatically increased[1]
    - ~ 1mg/mL at pH 7 to nearly 14mg/mL at pH 6
    - Dahlgren Decon pH was recorded at 6.51-7.15.

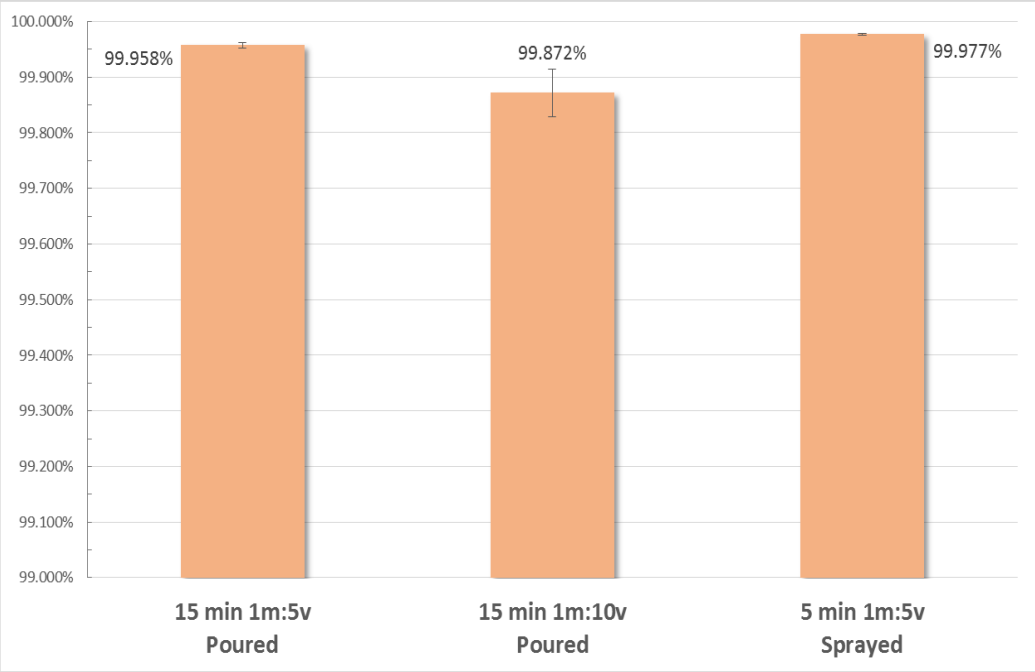
1. Samir D. Roy and Gordon L. Flynn. *Solubility behavior of Narcotic Analgesics in Aqueous Media: Solubilities and Dissociation Constants of Morphine, Fentanyl, and Sufentanil*. Pharmaceutical Research. 6. (2) 1989.

Bulk Results – Fentanyl HCl

Condition (Analyte Mass [mg]: Decon mass[mL])	Target mass (mg)	Decon volume (mL)	Sample pH	Dilution Volume(mL)	Expected Concentration (mg/mL)	[2]Observed Concentration (mg/mL)	Percent Recovery	[1]Percent Recovery (corrected for T_0)	Decon Efficacy
DD Positive Control 1	4.61	--	6.51	25000	6.65E-06	6.23E-06	93.695%	100%	--
DD 5:25 - 15 minutes A	4.94	25		10.00	1.78E-02	7.79E-06	0.044%	0.047%	99.95%
DD 5:25 - 15 minutes B	5.84	25		10.00	2.11E-02	6.92E-06	0.033%	0.035%	99.96%
DD 5:25 - 15 minutes C	4.60	25		10.00	1.66E-02	6.83E-06	0.041%	0.044%	99.96%
DD 5:25 - 15 minutes D	4.49	25		10.00	1.62E-02	6.93E-06	0.043%	0.046%	99.95%
DD 5:25 - 15 minutes E	4.45	25		10.00	1.61E-02	6.11E-06	0.038%	0.041%	99.96%
DD Negative Control 1	--	25		10.00	--	--	--	--	--
DD Positive Control 2	5.92	--		25000	8.54E-06	8.35E-06	97.786%	100%	--
DD 5:50 - 15 minutes A	5.74	50		100.00	1.04E-03	1.74E-06	0.168%	0.172%	99.83%
DD 5:50 - 15 minutes B	4.93	50		100.00	8.89E-04	1.54E-06	0.173%	0.177%	99.82%
DD 5:50 - 15 minutes C	6.24	50		100.00	1.13E-03	1.01E-06	0.090%	0.092%	99.91%
DD 5:50 - 15 minutes D	5.54	50		100.00	9.99E-04	9.94E-07	0.099%	0.102%	99.90%
DD 5:50 - 15 minutes E	6.14	50		100.00	1.11E-03	1.05E-06	0.095%	0.097%	99.90%
DD Negative Control 2	--	50		100.00	--	--	--	--	--
DD Positive Control Spray	5.13	--	7.15	25000.00	7.40E-06	5.98E-06	80.752%	100%	--
DD 5:25 - 5 minutes Spray A	5.74	25		10.00	2.07E-02	4.11E-06	0.020%	0.02%	99.98%
DD 5:25 - 5 minutes Spray B	5.17	25		10.00	1.87E-02	3.68E-06	0.020%	0.02%	99.98%
DD 5:25 - 5 minutes Spray C	5.85	25		10.00	2.11E-02	3.61E-06	0.017%	0.02%	99.98%
DD 5:25 - 5 minutes Spray D	5.14	25		10.00	1.85E-02	3.37E-06	0.018%	0.02%	99.98%
DD 5:25 - 5 minutes Spray E	5.45	25		10.00	1.97E-02	3.38E-06	0.017%	0.02%	99.98%
DD Negative Control 3 Spray	--	25		10.00	--	--	--	--	--

Bulk Results – Fentanyl HCl

- >99.9% efficacy

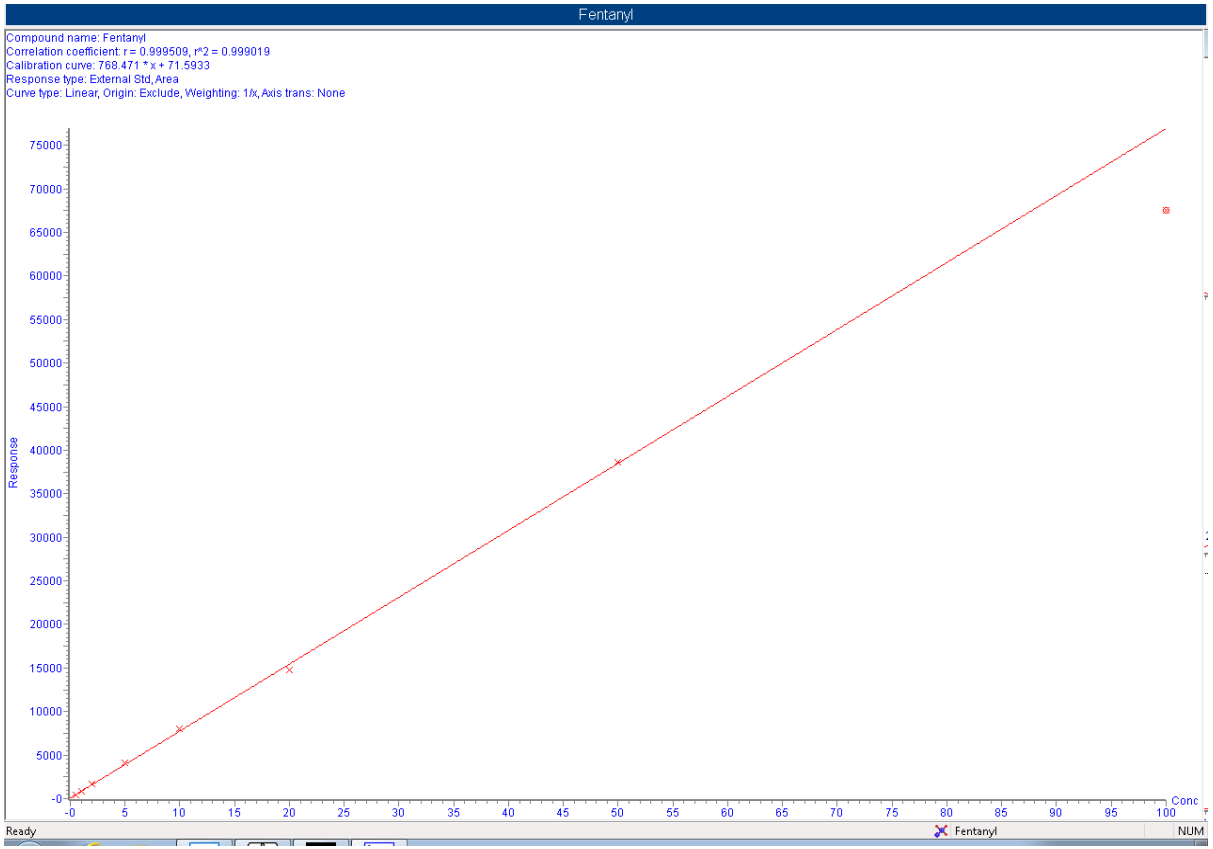


n=5 each condition

- 15 liters of Dahlgren decon could potentially neutralize (to the LD_{50} level) around 3 kilos of pure fentanyl
- Active fentanyl may still be present but at significantly less hazardous levels

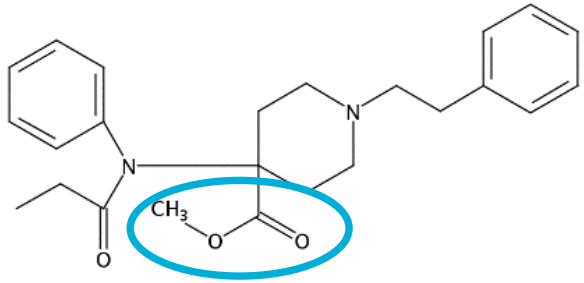
Bulk Results – Fentanyl HCl

Analyte	Type	Weighting	# points	R2	Average % Dev.	Data Set
Fentanyl	Linear	1/x	8	0.997	7.2	25 mL
Fentanyl	Linear	1/x	7	0.999	3.7	50 mL



What about Carfentanil?

- ~ 10X stronger than Fentanyl



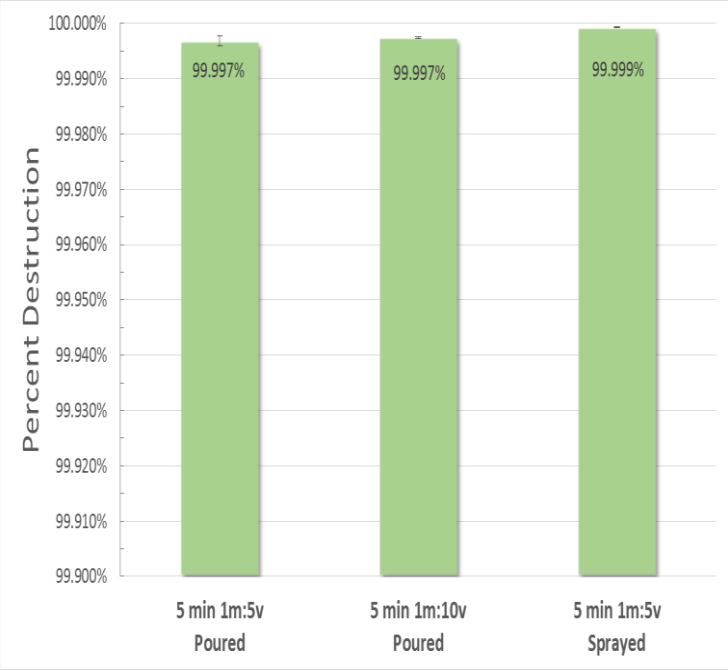
- Bulk (5mg) testing

Bulk Results – Carfentanil HCl

Condition (Analyte Mass [mg]: Decon mass[mL])	Target mass (mg)	Decon volume (mL)	Sample pH	Dilution Volume(mL)	Expected Concentration (mg/mL)	[2]Observed Concentration (mg/mL)	Percent Recovery	[1]Percent Recovery (corrected for T_0)	Decon Efficacy
DD Positive Control 1 (T_0)	5.79	--	7.14	25000.00	7.97E-06	7.53E-06	94.467%	100%	--
DD 5:25 - 5 minutes A	5.70	25		10.00	1.96E-02	3.51E-07	0.0018%	0.0019%	99.998%
DD 5:25 - 5 minutes B	5.93	25		10.00	2.04E-02	5.21E-07	0.0026%	0.0027%	99.997%
DD 5:25 - 5 minutes C	5.47	25		10.00	1.88E-02	6.95E-07	0.0037%	0.0039%	99.996%
DD 5:25 - 5 minutes D	5.55	25		10.00	1.91E-02	7.40E-07	0.0039%	0.0041%	99.996%
DD 5:25 - 5 minutes E	5.67	25		10.00	1.95E-02	5.51E-07	0.0028%	0.0030%	99.997%
DD Negative Control 1	--	25		10.00	--	--	--	--	--
DD Positive Control 1 (T_0)	5.16	--	6.99	50000.00	3.55E-06	3.99E-06	112.468%	100%	--
DD 5:50 - 5 minutes A	5.56	50		10.00	9.57E-03	2.92E-07	0.0031%	0.0027%	99.997%
DD 5:50 - 5 minutes B	5.77	50		10.00	9.93E-03	2.93E-07	0.0030%	0.0026%	99.997%
DD 5:50 - 5 minutes C	5.40	50		10.00	9.29E-03	2.43E-07	0.0026%	0.0023%	99.998%
DD 5:50 - 5 minutes D	5.41	50		10.00	9.31E-03	2.84E-07	0.0031%	0.0027%	99.997%
DD 5:50 - 5 minutes E	5.13	50		10.00	8.83E-03	2.35E-07	0.0027%	0.0024%	99.998%
DD Negative Control 1	--	50		10.00	--	--	--	--	--
DD Positive Control 1 (T_0)	5.50	--	6.78	25000.00	7.55E-06	8.78E-06	115.474%	100%	--
DD 5:25 - 5 minutes Spray A	5.20	25		10	2.03E-02	1.59E-07	0.000781%	0.000676%	99.999%
DD 5:25 - 5 minutes Spray B	5.00	25		10	2.11E-02	1.97E-07	0.000932%	0.000807%	99.999%
DD 5:25 - 5 minutes Spray C	4.90	25		10	1.98E-02	1.43E-07	0.000723%	0.000626%	99.999%
DD 5:25 - 5 minutes Spray D	5.30	25		10	1.98E-02	1.11E-07	0.000560%	0.000485%	99.999%
DD 5:25 - 5 minutes Spray E	5.00	25		10	1.88E-02	1.80E-07	0.000958%	0.000830%	99.999%
DD Negative Control 1	--	25		10.00	--	--	--	--	--

Bulk Results – Carfentanil HCl

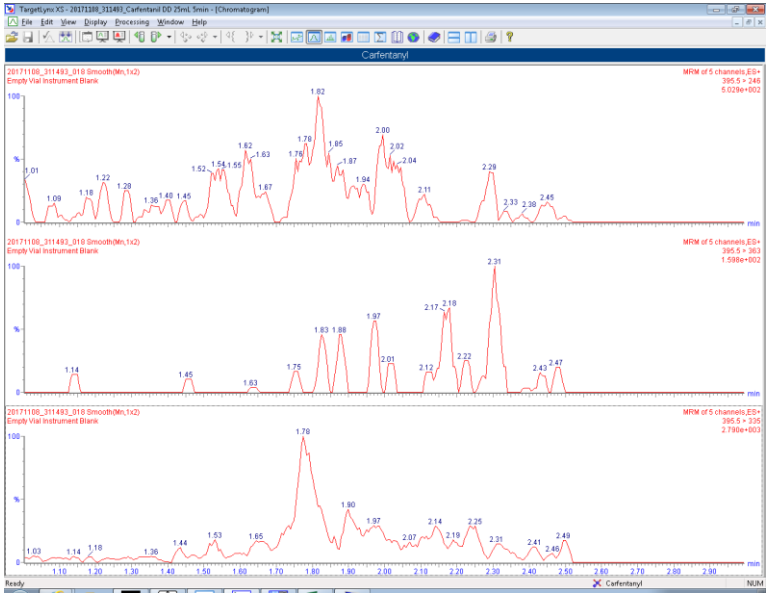
- >99.99% efficacy

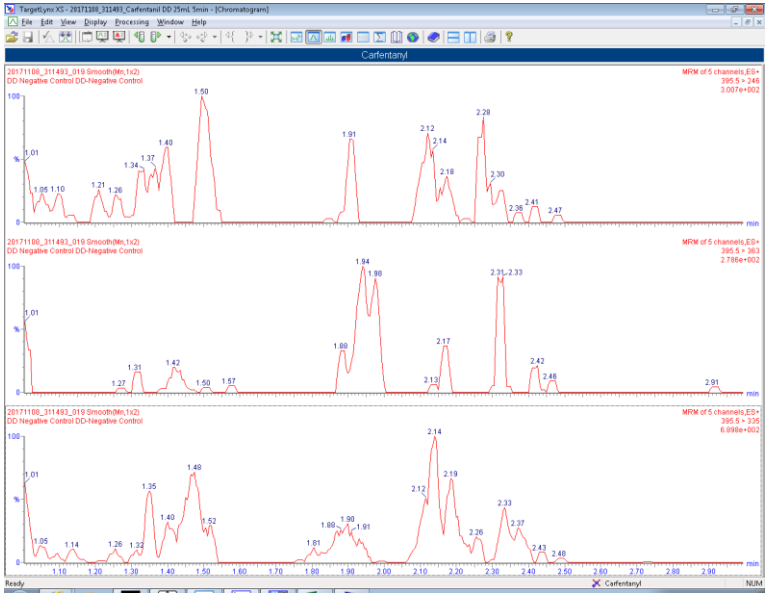


- The LD_{50} of Carfentanil HCl not well characterized
- 5 liters of Dahlgren decon could potentially neutralize (to the LD_{50} level) around 1 kilo of pure carfentanil
- Active carfentanil may still be present but at significantly less hazardous levels

Quality Assurance & Control

- All test trials included negative control samples used to monitor system cleanliness each day
  - **Solvent Method Blank:** A volume of solvent equal to the volume of target solution used. The sample is analyzed to verify a non-detection at the start of each testing day and/or for each solvent.
  - **Decon Matrix Blank:** A volume of decon solution equal to the volume of decon solution used in test trials. The sample is analyzed to verify a non-detection at the start of each testing day and/or for each formulation.

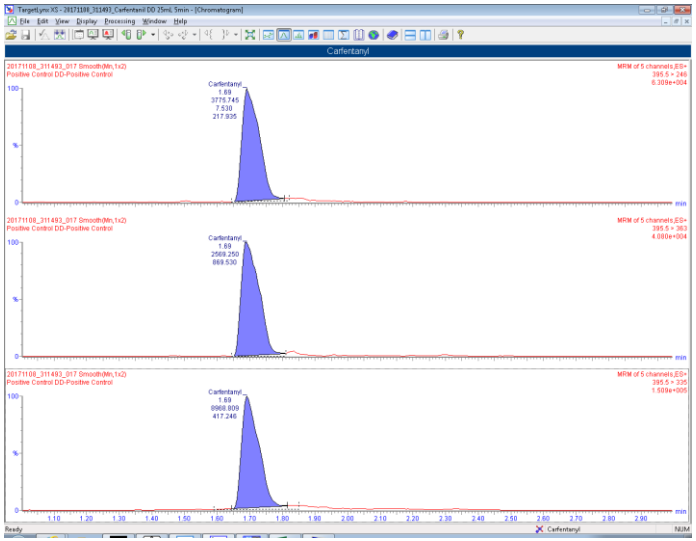


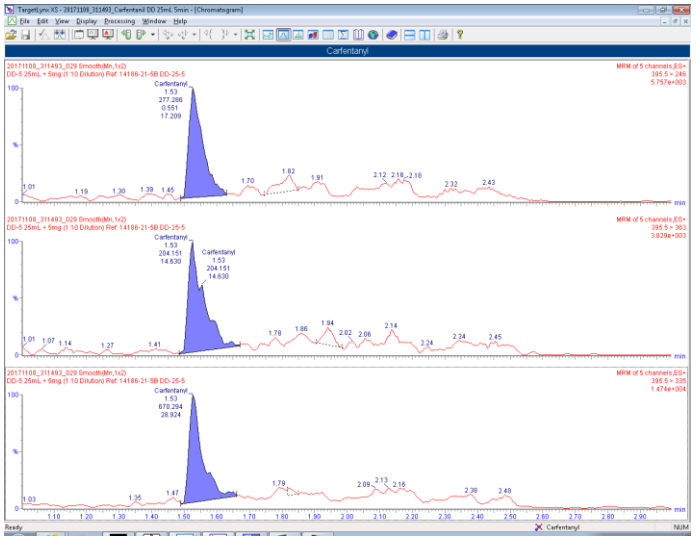


Solvent/System Blank (left) vs Decon Matrix Blank (Right)

Quality Assurance & Control

- All test trials included positive control samples used to verify the presence and quantity of the target compounds each day
  - **Continuing Calibration Verification (CCV):** A mid-level (usually C2-C4) calibration standard was periodically analyzed to verify system performance and recovery.
  - **Sensitivity Verification Standard (SVS):** The low level (C1) calibration standard was periodically analyzed to verify system sensitivity.
  - **Positive Control Spike:** A volume of target solution equal to the volume of target solution used is transferred into a container, a volume of solvent equal to the volume of decon solution used is transferred into the same container, mixed briefly, and analyzed to verify system performance and recovery.
  - **Positive Control Spike Time:** A volume of target solution equal to the volume of target solution used is transferred into a container, a volume of solvent equal to the volume of decon solution used is transferred into the same container, mixed for the appropriate time, and analyzed to verify system performance.

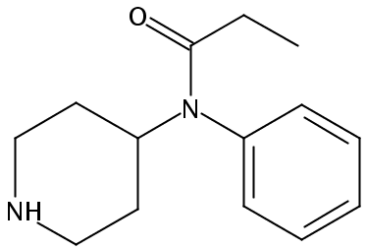


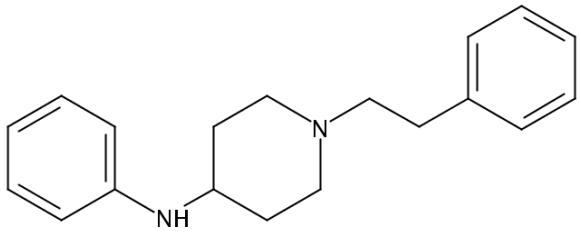


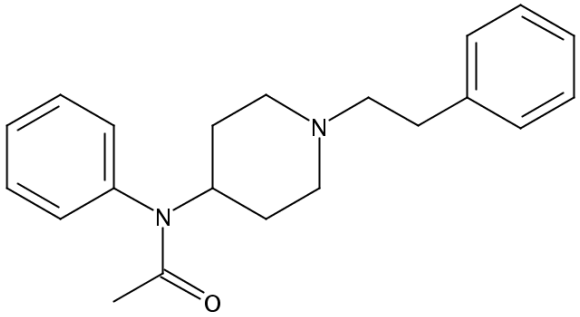
Carfentanil Control Spike (left) vs 5 Minute 1:5 Decontaminated Sample (Right)

Effluent

- Creating a hazardous waste stream?
- Known metabolites/degradants/analogues
  - Norfentanyl
  - ANPP
  - Acetyl Fentanyl
- Unknown & Unintended components

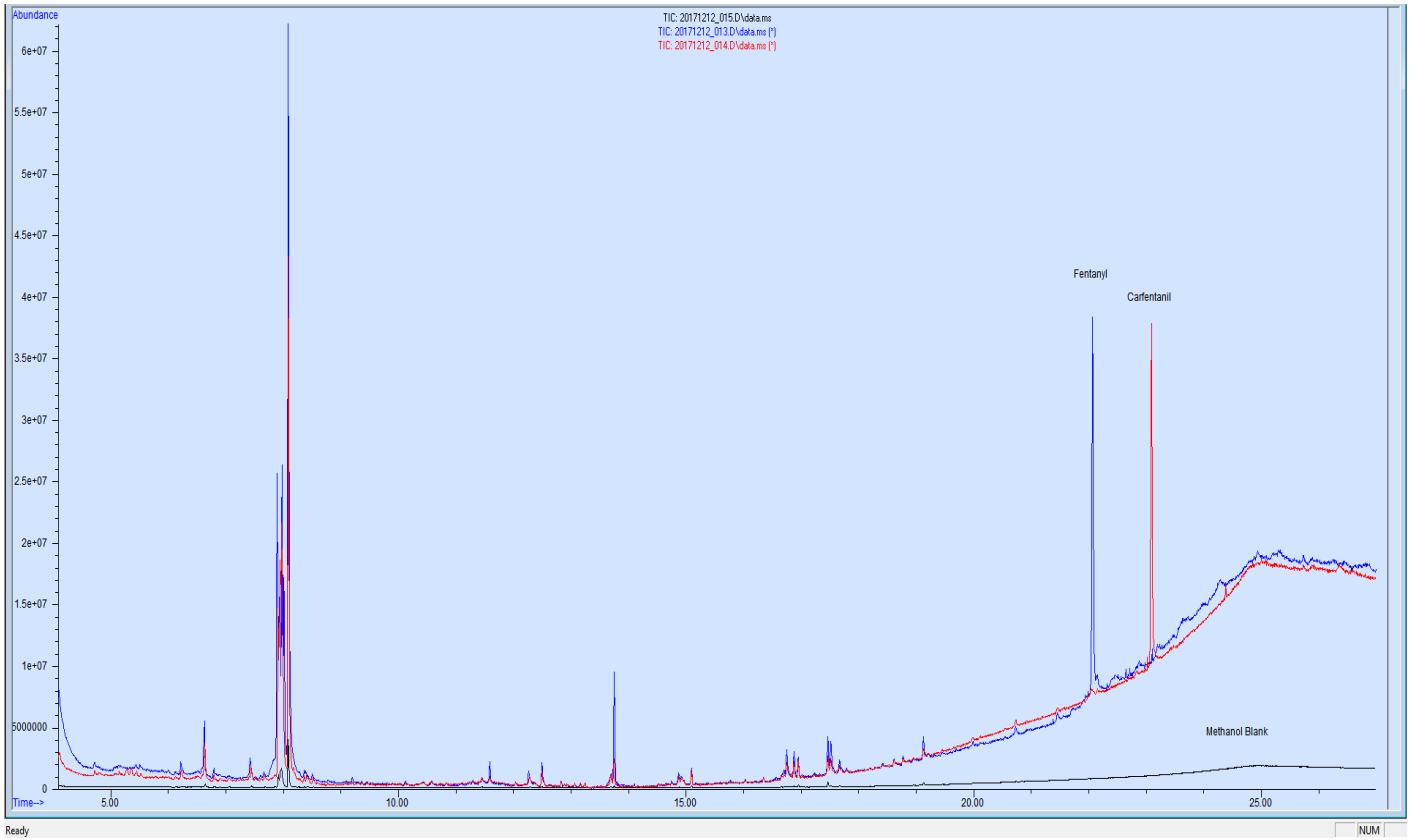






Quality Assurance & Control

- All test trials included positive control samples used to verify the presence and quantity of the target compounds each day
  - **Positive Control Spike:** A volume of target solution equal to the volume of target solution used is transferred into a container, a volume of solvent equal to the volume of decon solution used is transferred into the same container, mixed briefly, and analyzed to verify system performance and recovery.



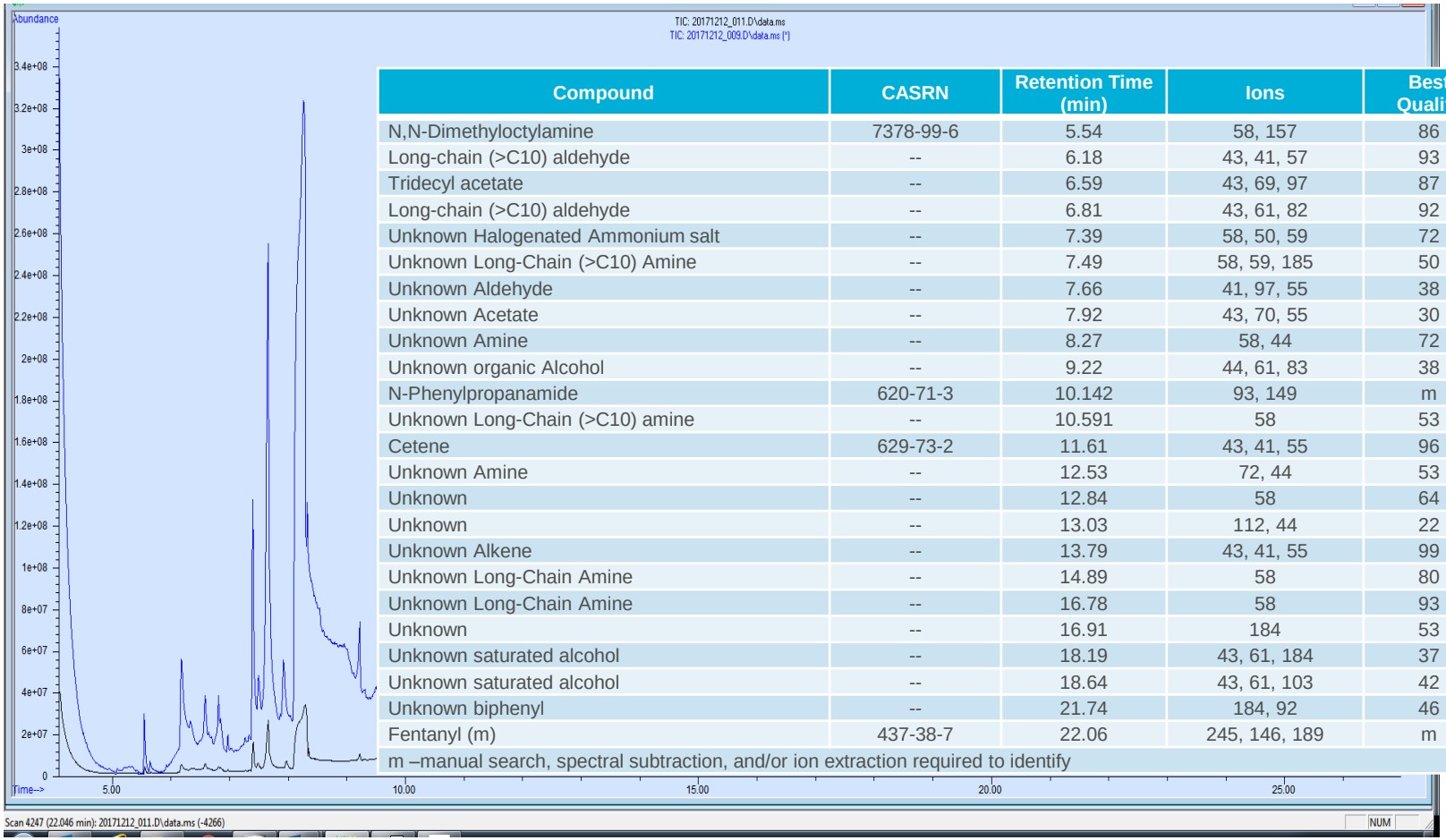
Fentanyl (Blue trace) and Carfentanil (Red Trace) Locator Solutions Overlaid on MeOH blank (Black trace)

What's in the Waste?

- Six compounds entered as target chemicals and each sample chromatogram more fully interrogated via extracted ion chromatograms
- Definitively evaluate the presence/absence of the six compounds listed

Compound	CASRN	Retention Time (min)	Target Ions	Present in Blank
Fentanyl	437-38-7	22.06	245, 146, 189	No
Carfentanil	59708-52-0	23.09	303, 304, 187	No
Norfentanyl	1609-66-1	15.81	83, 82, 120	No
N-Phenylpropanamide	620-71-3	10.17	93, 60, 149	No
Despropionyl fentanyl (ANPP)	21409-26-7	17.00	146, 189, 44	No
Acetyl fentanyl	3258-84-2	19.00	231, 146, 188	No

Fentanyl Effluent



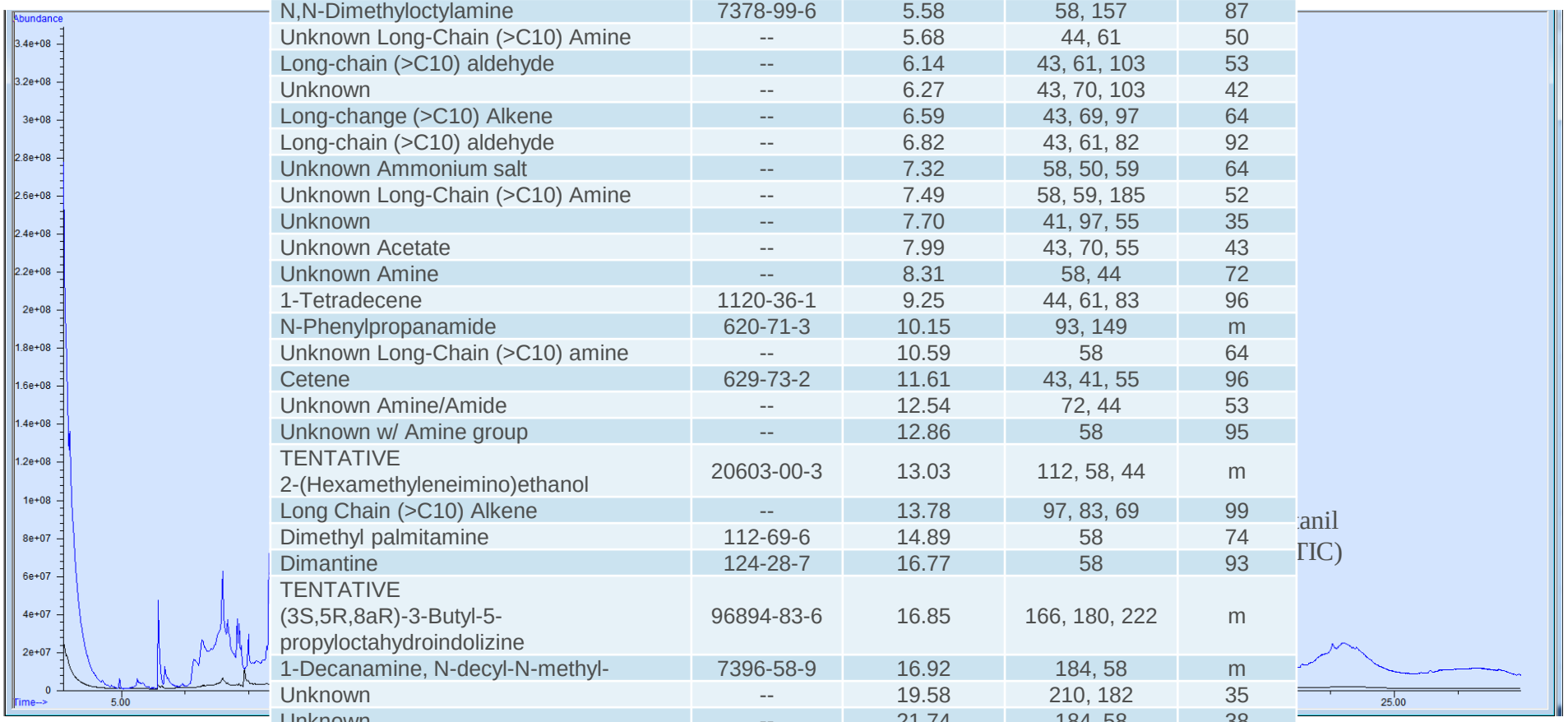
Compound	CASRN	Retention Time (min)	Ions	Best Quality
N,N-Dimethyloctylamine	7378-99-6	5.54	58, 157	86
Long-chain (>C10) aldehyde	--	6.18	43, 41, 57	93
Tridecyl acetate	--	6.59	43, 69, 97	87
Long-chain (>C10) aldehyde	--	6.81	43, 61, 82	92
Unknown Halogenated Ammonium salt	--	7.39	58, 50, 59	72
Unknown Long-Chain (>C10) Amine	--	7.49	58, 59, 185	50
Unknown Aldehyde	--	7.66	41, 97, 55	38
Unknown Acetate	--	7.92	43, 70, 55	30
Unknown Amine	--	8.27	58, 44	72
Unknown organic Alcohol	--	9.22	44, 61, 83	38
N-Phenylpropanamide	620-71-3	10.142	93, 149	m
Unknown Long-Chain (>C10) amine	--	10.591	58	53
Cetene	629-73-2	11.61	43, 41, 55	96
Unknown Amine	--	12.53	72, 44	53
Unknown	--	12.84	58	64
Unknown	--	13.03	112, 44	22
Unknown Alkene	--	13.79	43, 41, 55	99
Unknown Long-Chain Amine	--	14.89	58	80
Unknown Long-Chain Amine	--	16.78	58	93
Unknown	--	16.91	184	53
Unknown saturated alcohol	--	18.19	43, 61, 184	37
Unknown saturated alcohol	--	18.64	43, 61, 103	42
Unknown biphenyl	--	21.74	184, 92	46
Fentanyl (m)	437-38-7	22.06	245, 146, 189	m
m –manual search, spectral subtraction, and/or ion extraction required to identify				

Overlaid TICs of 25mL (Blue Trace) and 50mL (Black Trace) Fentanyl Effluent

Carfentanil Effluent

Compound	CASRN	Retention Time (min)	Ions	Best Quality
N,N-Dimethyloctylamine	7378-99-6	5.58	58, 157	87
Unknown Long-Chain (>C10) Amine	--	5.68	44, 61	50
Long-chain (>C10) aldehyde	--	6.14	43, 61, 103	53
Unknown	--	6.27	43, 70, 103	42
Long-change (>C10) Alkene	--	6.59	43, 69, 97	64
Long-chain (>C10) aldehyde	--	6.82	43, 61, 82	92
Unknown Ammonium salt	--	7.32	58, 50, 59	64
Unknown Long-Chain (>C10) Amine	--	7.49	58, 59, 185	52
Unknown	--	7.70	41, 97, 55	35
Unknown Acetate	--	7.99	43, 70, 55	43
Unknown Amine	--	8.31	58, 44	72
1-Tetradecene	1120-36-1	9.25	44, 61, 83	96
N-Phenylpropanamide	620-71-3	10.15	93, 149	m
Unknown Long-Chain (>C10) amine	--	10.59	58	64
Cetene	629-73-2	11.61	43, 41, 55	96
Unknown Amine/Amide	--	12.54	72, 44	53
Unknown w/ Amine group	--	12.86	58	95
TENTATIVE 2-(Hexamethyleneimino)ethanol	20603-00-3	13.03	112, 58, 44	m
Long Chain (>C10) Alkene	--	13.78	97, 83, 69	99
Dimethyl palmitamine	112-69-6	14.89	58	74
Dimantine	124-28-7	16.77	58	93
TENTATIVE (3S,5R,8aR)-3-Butyl-5-propyloctahydroindolizine	96894-83-6	16.85	166, 180, 222	m
1-Decanamine, N-decyl-N-methyl-	7396-58-9	16.92	184, 58	m
Unknown	--	19.58	210, 182	35
Unknown	--	21.74	184, 58	38
Unknown	--	22.05	182, 184, 131	90
Carfentanil	59708-52-0	23.09	303, 212, 105	m

m –manual search, spectral subtraction, and/or ion extraction required to identify



Effluent Summary

- N-Phenylpropanamide
- LD_{50} Oral – mouse of 1,100 mg/kg
- Not considered a dangerous good by IATA, the US DOT, or IMDG
- NFPA health hazard rating of one
- Automated Integration and Search
- Manual Search and Confirmation

Component	Decontaminated Fentanyl Effluent	Decontaminated Carfentanil Effluent
Fentanyl	✓	X
Carfentanil	X	✓
N-Phenylpropanamide	✓	✓
N,N-Dimethyloctylamine	✓	✓
Cetene	✓	✓
Diamantine	✓	✓
1,1'-Biphenyl, 4-methoxy-	✓	X
1-Tetradecene	X	✓
TENTATIVE 2-(Hexamethyleneimino)ethanol	X	✓
Dimethyl palmitamine	X	✓
1-Dodecanamine, N,N-dimethyl-	X	✓
1-Tetradecanamine, N,N-dimethyl-	X	✓

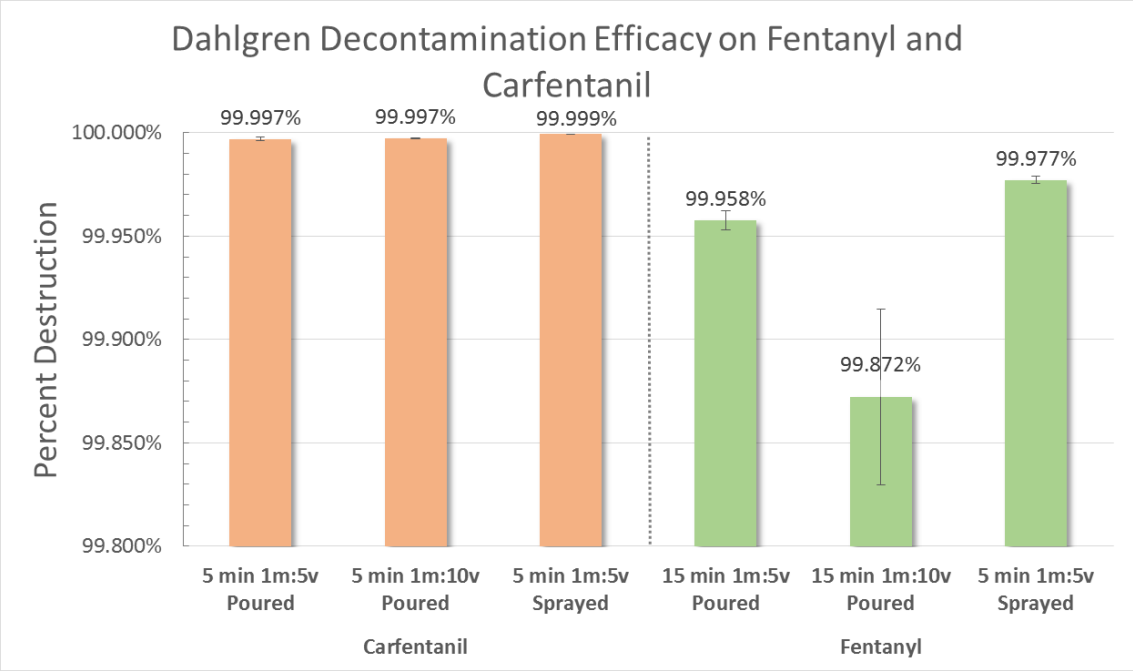
X = absent; ✓ = present

Component	Decontaminated Fentanyl Effluent	Decontaminated Carfentanil Effluent
Acetyl Fentanyl	X	X
Norfentanyl	X	X
Propanil	X	X
Benzaldehyde	X	X
Benzonitrile	X	X
Despropionyl fentanyl (ANPP)	X	X

X = absent; ✓ = present

In Conclusion….

- >99.9% effective



- Effluent is free of hazardous byproducts

- NOT final field guidance
  - Specific decon to threat ratio needed
  - Specific decon time needed
  - Efficacy on additional analogues

Questions?

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