

Evaluation of Instruments, Colorimetric Tests and Decontamination Solutions

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Introduction

One of the capabilities of the Analytical Support/Testing and Evaluation capability group is to evaluate instruments, colorimetric test, and decontamination solutions. MRIGlobal evaluates these instruments ability to correctly identify targets of interest at varying concentrations and when in varying matrices.

Instrument testing can be completed for multiple reasons:

- Feedback during instrument development.
- Final instrument validation.
- Instrument comparison to find best fit for a client's need or end use for detection.

Once the evaluation is complete a report is drafted with the results and recommendations to the client. These recommendations can include:

- Further development of the product to achieve better results.
- Whether or not the instrument is worth the investment for the client.

Raman Instruments

Chemical Category	Chemical	Cora 100	Mira DS	ResQ CQL	Defender RM
Fluorescent Challenge Materials	3,5-Dichloroaniline	0/2	0/3	0/3	0/3
	Copper (II) acetate	0/2	0/3	0/3	0/3
	2,4,6-Trichlorophenol	1/2	3/3	2/3	3/3
Narcotics	2-Bromobenzamide HCl	--	--	2/3	0/3
	Acetaminophen	2/2	3/3	3/3	3/3
Pharmaceutical and Illicit Drug Cutting Agents	Fentanyl	2/2	0/3	2/3	3/3
	Caffeine	2/2	3/3	3/3	3/3
	Calcium sulfate	2/2	0/3	2/3	3/3
Inorganic Poisons and Related Compounds	Talc	2/2	0/3	3/3	3/3
	Lactose*	2/2	3/3	0/3	3/3
	Potassium cyanide	2/2	2/3	3/3	3/3
	Potassium carbonate	1/2	3/3	2/3	3/3
Energetics	Sodium cyanide	2/2	3/3	3/3	3/3
	Sodium carbonate	2/2	3/3	3/3	3/3
	Diesel Fuel	2/2	3/3	3/3	3/3
	TNT	2/2	3/3	3/3	3/3
	Ammonium nitrate	1/2	3/3	3/3	3/3
	Total	25/32	32/48	37/51	42/51

We have evaluated multiple handheld Raman instruments including, but not limited to, the Cora 100, Mira DS, ResQ CQL, and FirstDefender RM. When these instruments are tested, we test them against fluorescent challenge materials, narcotics, pharmaceutical and illicit drug cutting agents, inorganic poisons and related compounds, and energetics. They are tested with each chemical in duplicate or triplicate and compared against previous evaluations.

In addition to single chemicals tested during the evaluations, mixtures are also tested. These results are typically compared to the FirstDefender RM results since that has historically had the most success identifying mixtures.

Mixture	Target/Excipient Ratio				Totals
	50:50	20:80	10:90	5:95	
Potassium cyanide/ Potassium carbonate	0/3 ResQ CQL 3/3 Defender	1/3 ResQ CQL 2/3 Defender	0/3 ResQ CQL 1/3 Defender	0/3 ResQ CQL 0/3 Defender	1/12 ResQ CQL 6/12 Defender
Sodium cyanide/ Sodium carbonate	2/3 ResQ CQL 3/3 Defender	2/3 ResQ CQL 2/3 Defender	3/3 ResQ CQL 1/3 Defender	0/3 ResQ CQL 1/3 Defender	7/12 ResQ CQL 7/12 Defender
Acetaminophen /Talc	0/3 ResQ CQL 1/3 Defender	0/3 ResQ CQL 3/3 Defender	1/3 ResQ CQL 2/3 Defender	0/3 ResQ CQL 0/3 Defender	1/12 ResQ CQL 6/12 Defender
Acetaminophen/ Lactose	0/3 ResQ CQL 2/3 Defender	0/3 ResQ CQL 3/3 Defender	0/3 ResQ CQL 1/3 Defender	0/3 ResQ CQL 1/3 Defender	0/12 ResQ CQL 8/12 Defender
Fentanyl/Starch	0/3 ResQ CQL 1/3 Defender	0/3 ResQ CQL 0/3 Defender	1/3 ResQ CQL 0/3 Defender	0/3 ResQ CQL 0/3 Defender	1/12 ResQ CQL 1/12 Defender
Totals	2/15 ResQ CQL 10/15 Defender	3/15 ResQ CQL 10/15 Defender	5/15 ResQ CQL 6/15 Defender	0/15 ResQ CQL 2/15 Defender	10/60 ResQ CQL 28/60 Defender

The Mira DS has a standoff testing attachment, and in the evaluation this function was tested. The results we achieved at the 1.5 m distance were impressive, no other handheld Raman has this capability. However, the need to use a tripod and conduct the analysis in the dark, may lessen the utility of this technique.

Sample	Standoff Distance				Totals
	1.5 m	1.0 m	0.50 m	0.25 m	
Sugar	3/3	3/3	2/3	0/3	8/12
Acetone	3/3	0/3	0/3	0/3	3/12
Methanol	3/3	3/3	0/3	0/3	6/12
Totals	9/9	6/9	2/9	0/9	17/36

FLIR G510 Field Portable GC/MS

FLIR G510 Evaluated against Inficon HAPSITE ER

- Chemical mix 8270 contains 56 analytes of interest.
- Explosive chemical mix 8330 contains 7 analytes.
- Physical parameters are also evaluated for field portability.



Analyte	G510 Retention Time Liquid Inject	HAPSITE ER Retention Time TD Analysis
Nitrobenzene	3.98	7.23
1,3-Dinitrobenzene	5.73	9.48
2,4-Dinitrotoluene	6.10	11.32
1,3,5-Trinitrobenzene	6.75	nd
2,4,6-Trinitrotoluene	6.79	nd
HMX	nd	nd
RDX	nd	nd

Chemical Mix	G510 (Detection/Possible)	HAPSITE ER (Detection/Possible)
8270 Mix	55/56	40/56
8330 Mix	5/7	4/7
Custom Mix	15/20	6/20

Parameter	G510	HAPSITE ER
Mass Range	15-615 m/z	43-300 m/z
Scan Rate	~3 scan/sec	(1 scan/sec)
Inlet Temperature	Adjustable	250°C
GC Column	DB-6MS (15 m x .18 mm x 0.25 µm); others available	15m Rtx-1MS, 0.25mm i.d. 1.0µm thickness
GC/MS Interface	Direct interface	PDMS membrane, 100°C (SM), 120°C (HT)
Probe Temperature	50-80°C	40-60°C
Temperature Profile	40-300°C (150°C/min)	60-180°C (SM), 60-200°C (HT)
Dimensions	13.25 x 13.25 x 15.75 inches	18 x 17 x 7 inches
Weight	36 lbs.	42 lbs.
Battery Life	4 hrs. (survey) 2 hrs. (confirmation)	2-3 hours
Carrier Gas	On-board (Helium)	On-board (Nitrogen)
Sample Phase	Vapor, Liquid, Solid	Vapor
Sample Intro	Vapor (probe), SPME, Liquid injection, PSI Probe	Probe, SPME, TD Tube
Analysis Time	Survey - near real time Confirmation - 4-15 min	Survey - near real time GC/MS - 10-15 min
Temperature Range	40-300°C	45-200°C

Colorimetric Tests

There have been a variety of colorimetric tests evaluated by MRIGlobal including:

- Fentanyl test strips
- MobileDetect MDT Kit
- Date rape drug testing

Selectivity	Solid			Liquid		
	DFT	Fen-Her	Test Kit Plus	DFT	Fen-Her	Test Kit Plus
Fentanyl FB	3/3	1/1	3/3	3/3*	0/1*	3/3*
Fentanyl Citrate	3/3	1/1	3/3	3/3	0/1	3/3
Fentanyl Oxalate	3/3	1/1	3/3	3/3	1/1	3/3
3-methylfentanyl HCl	3/3	1/1	3/3	3/3	1/1	0/3
Alfentanil HCl	0/3	0/1	0/3	0/3	0/1	0/3
Carfentanil HCl	3/3	1/1	0/3	3/3	0/1	0/3
Lofentanil HCl	3/3	1/1	0/3	3/3	0/1	0/3
Mirfentanil HCl	3/3	1/1	3/3	3/3	0/1	3/3
Remifentanil HCl	0/3	1/1	0/3	0/3	0/1	0/3
Sufentanil HCl*	3/3*	1/1	0/3	0/3	0/1	1/3
Heroin	3/3*	1/1*	0/3	--	--	--
Diacetylmorphine HCl	--	--	--	3/3*	0/1	0/3
(Positive Test/Total Trials)	27/33	10/11	15/33	24/33	2/11	13/33

The Test Kit Plus Fentanyl test strip had the lowest verified liquid LOD (400 ng); Fen-Her (1 µg) and DFT (20 µg). The solid LOD was 2.5% for all three-test kits. The DFT Fentanyl test produced positive results for 82% of tested solids and 73% for liquids of the related compounds and provides the widest variety of fentanyl-related detection coverage.

No	Description	Analyst Result	Quick Detect Result
1	5% Fentanyl Freebase in Starch Rep 1	Positive - Fentanyl	No Detection
2	5% Fentanyl Freebase in Starch Rep 2	Positive - Fentanyl	Positive - Amphetamines
3	5% Fentanyl Freebase in Starch Rep 3	Positive - Fentanyl	Positive - Amphetamines
4	1% Fentanyl Freebase in Starch Rep 1	Positive - Fentanyl	No Detection
5	1% Fentanyl Freebase in Starch Rep 2	Positive - Fentanyl	Positive - Cocaine
6	1% Fentanyl Freebase in Starch Rep 3	Positive - Fentanyl	No Detection

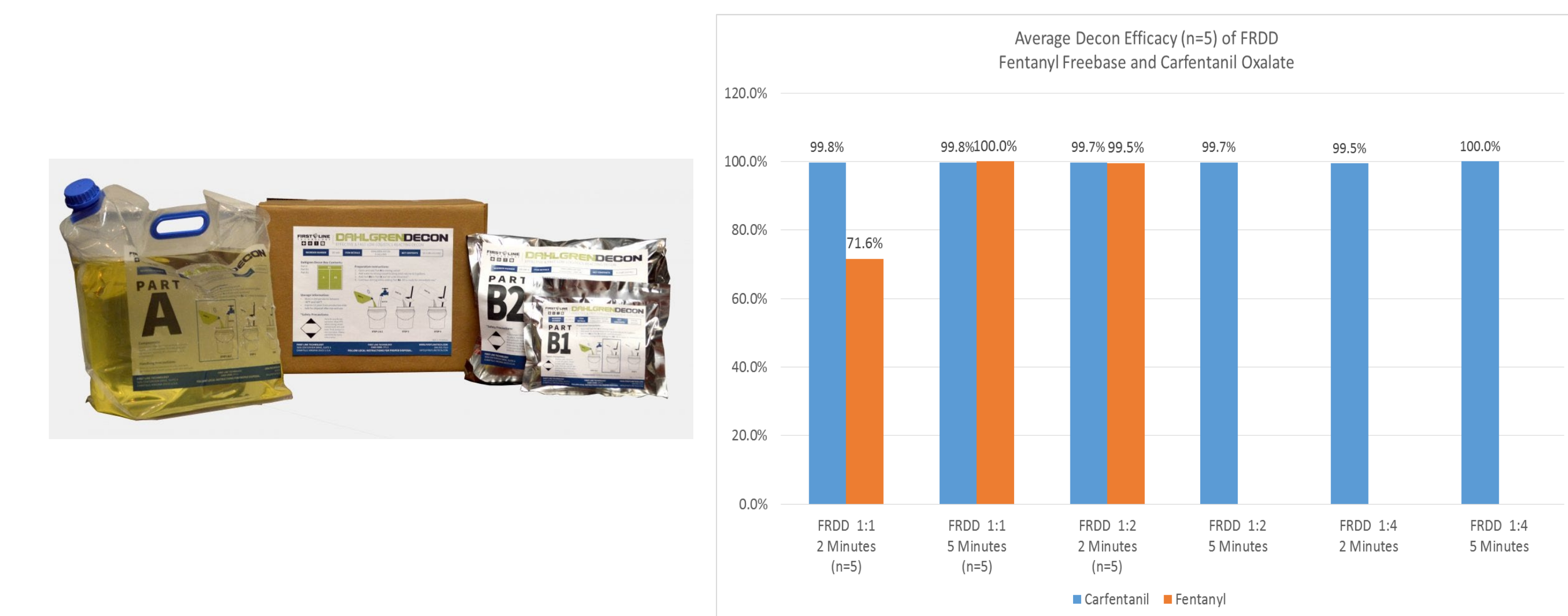


We evaluated 6 different products that claimed to be able to identify common date rape drugs. During this evaluation, we saw some products detected all chemicals claimed, while others did not correctly identify what they claimed they could. For example, the DrugLab was not able to identify any benzodiazepines. However, the SipChip was extremely effective at identifying all targets at low levels in a variety of matrices.

Decontamination Solutions

There are wide varieties of chemical and biological decontamination solutions available on the market today. These products are designed for field use and typically include multiple components to be mixed together immediately before use. Dahlgren Decon is one example of these products originally designed for chemical weapons decontamination that may have utility in helping with increasing fentanyl incident reports.

Dahlgren decontamination solution is a three (3) part mixture for which the manufacturer states is a viable solution for 12-24 hours after mixing. The shelf life of the individual components is months long.



Conclusion

When evaluating any instrument or product, there is a chance that they will not produce results as stated by the manufacturer. One example of this is shown by the Mistral test results. Samples tested resulted in a positive result, including the negative controls. Our evaluations allowed us to recommend use of different tests to quickly identify fentanyl in the field.



On the other hand, when an instrument performs better than the instrument a client is currently using, we can recommend investing in replacing the current instruments with the higher performing one. This was the case with the G510. It was recommended to this client to replace the HAPSITE ERs they were using with new G510s.

Quality testing allows for unbiased results to reveal the best instrument or test for use in different scenarios. Our evaluations allow us to recommend these instruments or tests to our clients.

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