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SCIENCE SERVING JUSTICE

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Evaluation of the Thermo Scientific® FirstDefender RM™ Portable Raman Spectrometer

Project Information

Title: Evaluation of the Thermo Scientific® FirstDefender RM™ Raman Spectrometer

Evaluation Type: Portable Raman Spectrometer

Stakeholder: (formerly Ahura Scientific); Thermo Scientific, part of Thermo Fisher Scientific Start Date: 05/10/2010 End Date: 07/14/10

Kit Model Number(s): FirstDefender RM

Manufactured: October 2009

Serial Number(s): RM2245

MSRP: ~$50,000 MSRP; GSA: ~$48,500

Manufacturer Information

Manufacturer: Thermo Scientific (formerly Ahura Scientific)

Phone Number: (978) 657-5555

Internet address: www.ahurascientific.com

www.thermoscientific.com

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Evaluation Overview

The Forensic Services Chemistry Section of the National Forensic Science Technology Center (NFSTC) performed an evaluation of the Thermo Scientific FirstDefender RM. This hand-held Raman spectrometer is

currently used by law enforcement, border patrol officers, military personnel and other first responders to chemically characterize unknown solids, liquids, and powders encountered in field environments. The evaluation included accuracy and reproducibility assessments of conformity, mixture sensitivity, specificity, ruggedness, portability, and ease of use, including sample preparation and training requirements. The evaluation team also briefly examined the FirstDefender RM's library-building capabilities. The objective of this product assessment was to provide data to agencies interested in incorporating portable Raman technology into their laboratory or field-testing protocols.

The FirstDefender RM was evaluated using samples representative of categories likely to be encountered in a field or first-responder environment, including: controlled substances, common diluents of controlled substances, explosives, common chemicals, and ignitable liquids. In addition, the unit was transported to the Manatee County Sheriff's Office, Forensic Chemistry Laboratory to analyze 20 adjudicated case samples. Each sample was analyzed in triplicate, using the external sampling method, and each of these three trials was performed by a different evaluator. Each sample was then analyzed in triplicate using the internal sampling mode (vial mode).

Product Specifications

The FirstDefender RM weighs approximately 816 grams (1.8 lbs) including a rubberized outer casing ("boot") and measures approximately 19 cm (7.6") long, 4 cm (1.75") deep, and 11 cm (4.2") wide*. The FirstDefender RM comes with two battery options, a rechargeable 3.7V lithium ion battery or a disposable OTS Surefire® battery. In addition, there is a universal power transformer for the unit, multiple plug adapters, and a battery charger included. The unit comes in a rugged Pelican case with a polystyrene standard for performance checks, a memory card and reader, and sample vials. Liquids and solids can be analyzed directly or through a bottle or bag using an external sampling method ("point-and-shoot mode") or through the glass of a 4-mL vial with the internal sampling method ("vial mode"). It is not necessary for the user to choose the mode on a menu. When either mode is used, a hinged laser shield protects the user from exposure to energy levels above the maximum permissible exposure. There is a display screen in the center of the unit with a keypad below comprised of a number of keys (buttons) for using the onscreen menus. These include an "arm" key labeled with a key icon, a "scan" key labeled with a diamond graphic, a round central "arrow" key labeled with arrows, a "cancel/escape" key labeled with an "X", an "enter" key labeled with a bent arrow, and a "sleep/wake" key, which also serves as the power key, labeled with a circle. In addition, there is an on-screen keyboard for naming sampling sessions and library spectra. When the unit is charging, the status is displayed on the screen whether the instrument is powered on or off and disappears when the unit is charged. The rechargeable battery life average is listed at approximately 3.5 hours of use at room temperature, and the Surefire battery life is listed at 5 hours. After five minutes without use, the instrument sets itself to a power-saving "sleep mode" and can be awakened by pressing the sleep/wake key.

**Measurements according to page 59 of the User Manual: 7.6" x 4.2" x 1.75" (30 cm x 15 cm x 7.6 cm).*

The FirstDefender RM is based on Raman spectroscopy, which measures the inelastic scattering of monochromatic light from an infrared laser source. The FirstDefender RM has a class IIIB laser with an excitation wavelength of 785 nm, settable output (default is 250 mW), and a spectral range between 250 and 2875 cm^{-1}. When the sample of interest is bombarded with the laser light, the molecules scatter it. Some of the scattered light is collected by optics and separated, by wavelength, by a dispersive spectrometer. A charge-coupled detector then measures the intensity of light at each wavelength and converts it to a spectrum that is characteristic of a

chemical compound. The spectrum from the sample is searched against entries in the libraries in the instrument memory using a search algorithm called "DecisionEngine™", which uses a process of elimination to categorize results. Results of sampling are listed with colors that indicate additional information about the match. For example, a "match" or multiple matches list the compound(s) against a green background. Possible mixtures of up to six items are listed on a blue background, each listed with percentages indicating how well the sample data matched the library data (not percent contribution to the mixture). Compounds that are similar but not considered a match by the software are listed on a yellow background. For the purposes of this evaluation, "similar" results are considered an inconclusive result and not included when counting for accuracy or reproducibility (with matches and mixtures). Samples that do not match anything in the existing libraries return a message of "No Match Found" against a red background. In addition, because of fluorescence or poor signal, some samples will not produce a usable spectrum in a reasonable length of time. These scans were aborted during evaluation, and are reflected in data as "excessive analysis time", and are defined for this evaluation as a negative result.

The FirstDefender RM allows for spectral comparison and for additions to the library directly on the instrument. Spectra files are stored on an included memory card in a variety of digital formats (.jpg, .spc, .txt or .arb), can be exported by copying to the memory card, and uploaded onto a computer for storage, reporting, or printing. Library files (.lrd) can be exported onto a memory card and imported onto another FirstDefender RM.

References

FirstDefender RM Quick Reference Guide, Part Number 112-00025-03.

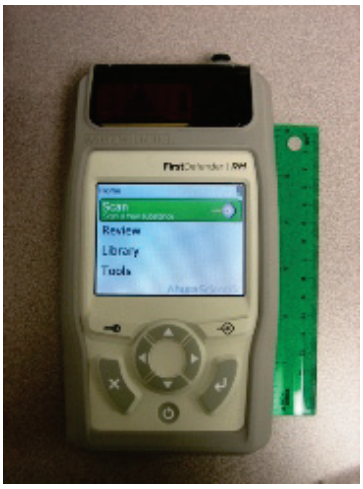
FirstDefender RM User Manual, Part Number 110-00013-05, Ahura Scientific, Inc., Copyright© 2009.

Koussiafes, Perry M. The Interpretation of Data Generated from Fire Debris Examination: Report Writing and Testimony, *Analysis and Interpretation of Fire Scene Evidence*; Ed. Jose Almirall and Kenneth Furton; Boca Raton, FL; 2004.

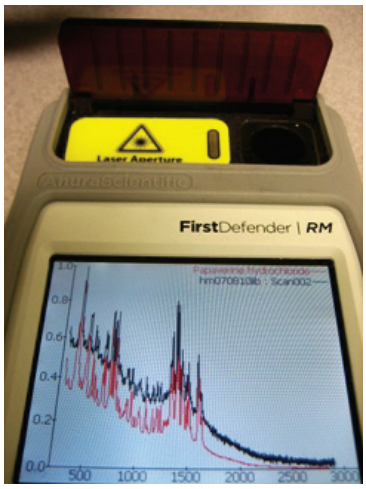
Safe Travel with Batteries and Devices, Transportation Security Administration website, http://www.tsa.gov/travelers/airtravel/assistant/batteries.shtm, accessed January 11, 2011.

Skoog, D., Holler, F., and Nieman, T. Raman Spectroscopy. *Principles of Instrumental Analysis*; Fifth Edition; USA; 1998.

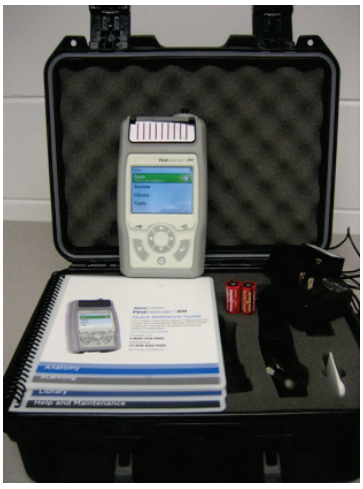
Photos



FirstDefender RM (powered on)



Spectral comparison: Papaverine HCl (red) and sample (black)



FirstDefender RM in Pelican® carrying case, with chargers, batteries, and manual (memory card within unit)

Product Uses

The FirstDefender RM can be used to identify a variety of chemical compounds, including a number of drugs (illicit) and pharmaceuticals, explosives, ignitable liquids, oxidizers, and toxic compounds. This function is useful in forensic science applications such as on-target military use, or field use by first responders or law enforcement officers.

Level of Operator Knowledge (Set per Manufacturer)

☒ Non-Scientist ☐ Technician ☐Scientist

Minimal training is required to safely and properly use the instrument and to interpret the results.

Procedure

The self-test method was performed before each sampling session as follows:

Self-Test Method

1) Power on the FirstDefender RM by holding down the sleep/wake key for ~1 second.
2) Create a new session:
    a. Using the arrow keys, select the “Scan” menu and press the enter key.

   b. Using the arrow keys, highlight “Session” and press the enter key.
   c. Using the arrow keys, highlight “Create new session”.
   d. Enter the appropriate data using the arrow keys and the enter key to select letters and numbers on the on-screen keyboard.
   e. When finished, highlight “Done” and press the enter key.
   f. Press the cancel/escape key to return to the main menu.
3) Using the arrow keys, select the “Tools” menu.
4) Select the “Self test” menu.
5) Place the supplied polystyrene standard into the vial holder and press the scan key.
6) Press the arm key to arm the laser.
7) Enter the laser password by pressing the left arrow twice and the down arrow once. Then press the enter key. (It will say “Accepted”.)
8) When the warning appears, press any key to continue.
9) Press the scan key again to scan the polystyrene standard. A passing result will result in a green box with a check mark icon that says “Pass”.
10) Press the enter key to continue.
11) Select from a menu to view the spectrum, export the result, or explain the result.
12) Press the cancel/escape key to exit to the “Tools” menu screen and again to exit to the main menu screen.
13) If the self test passes, proceed to sample analysis. If it fails, contact Reachback (support).

Alternatively:

1) Perform the sample analysis method listed below, using the polystyrene calibration standard.
2) Record the results; if polystyrene matches, proceed to sample analysis.

A total of approximately 111 samples (333 trials) were analyzed for the point-and-shoot mode and approximately 103 (309) samples for the vial mode:

Sample Analysis: Point-and-Shoot Mode and Vial Mode

1) Using the arrow keys, select the “Scan” menu from the main menu.
2) If necessary, arm the laser, using the steps outlined in the self-test method.
3) Initiate contact of the instrument with the sample:
   a. External: Hold the sample to the external sampling window while the scan is in progress. Ensure the laser shield is in the upright position.
   b. Internal: Place the vial in the vial holder and cover with the laser shield.
4) When the results are listed, record as follows on the data chart:

a. Match(es):
    i. Record “Y” in the “Match? Y/N” column.
    ii. Scroll though the matches and record, including the number of match quality bars displayed (e.g., “Y-2” if there are two matches listed).
    iii. Record “Y” in the “Correct? Y/N” column if any of the following criteria are met:
        1. The identity of any of the matches listed matches the identity of the sample.
        2. The identity of any of the matches listed is a synonym for the sample name (e.g., nicotinamide and niacinamide; Tylenol and acetaminophen).
        3. If in a mixture, one of the two components was identified with the preceding criteria. (Note: If in an ignitable liquid mixture, the component must be something that will identify the entire mixture; e.g., “diesel”.)
    iv. Record “N” in the “Correct? “Y/N” column if none of the criteria in “4aiii” are met.
b. No Match/Excessive Analysis Time:
    i. Record “N” in the “Match? Y/N” column.
    ii. Record “Excessive Analysis Time” if appropriate in the “Other ID(s)/comments” column.
c. Mixture:
    i. Record “Y” or a check mark in the “Mixture” column.
    ii. Record the mixture components and associated percentages listed. (Note: If the accurate response is listed as any of the results, record it with its percentage.)
    iii. For mixture components with low match values (at the discretion of the analyst, but typically <10%):
        1. Inaccurate result: Results may be listed as “other”.
        2. Accurate result: Record results despite percentage listed.
    iv. Record “Y” in the “Correct? Y/N” column if the identity of the sample is listed as one of the components.
    v. Record “N” in the “Correct? Y/N” column if the identity of the sample is not listed as one of the components.
d. Similar:
    i. Record “Y” or a check mark in the “Similar” column.
    ii. Record the result.
    iii. Record “N” in the “Correct? Y/N” column.

5) Press the enter key to access the spectrum menu that includes:
    a. View info
    b. View spectrum
    c. Export scan

   d. Explain result
6) Select the “cancel/escape” key to return to the previous menu.

Ruggedness Trials

1) Place the FirstDefender RM in the following locations for approximately two hours, performing one trial per day:
   a. **Trial One:** Dashboard of a car
   b. **Trial Two:** Front seat of a car
   c. **Trial Three:** Trunk of a car
2) Place a portable electronic thermometer at the location with the FirstDefender RM.
3) Record the temperature upon placement and removal.
4) Perform testing as soon as possible using the previously described method.

Library Build Analysis

1) Perform the calibration check.
2) Select “Library” from the main menu and search the library using the arrow buttons to determine if the compound is already in the library.
3) Select the “Tools” menu from the main menu.
4) Select “Library scan”.
5) Scan the following two compounds using the sampling method described and record results:
   a. Papaverine HCl
   b. Levamisole HCl
6) When the library scan is complete, select the enter key to access the sample menu:
   a. View spectrum
   b. Export scan
   c. Add Scan to Library
7) Select “Add Scan to Library” and enter the appropriate information by selecting the corresponding letters and numbers on the on-screen keyboard.
8) When finished entering, place the cursor over “Done” and press the enter key.
9) Re-scan the added compounds to ensure they will be identified.

Exporting Results

1) Select “Review” from the main menu.

2) Select the appropriate session using the arrow buttons.
3) Export the data as follows:
    a. Entire session: (.arb, .spc. or .txt file) (any file in the session may be highlighted to select the entire session)
    b. Individual scan: (.arb, .spc, .txt, or .jpg file) (the file of interest must be highlighted)

Results and Discussion

A total of 111 samples (333 trials) were evaluated using the point-and-shoot mode on the FirstDefender RM, and the results are listed in Appendix A (Table 1). Each sample was analyzed using three trials, and each trial was conducted by a different evaluator at a different time. Analysis was repeated in triplicate on 103 samples (309 trials) using the vial mode, and the results are listed in Appendix A (Table 2). A performance check was conducted by each evaluator prior to each testing session.*

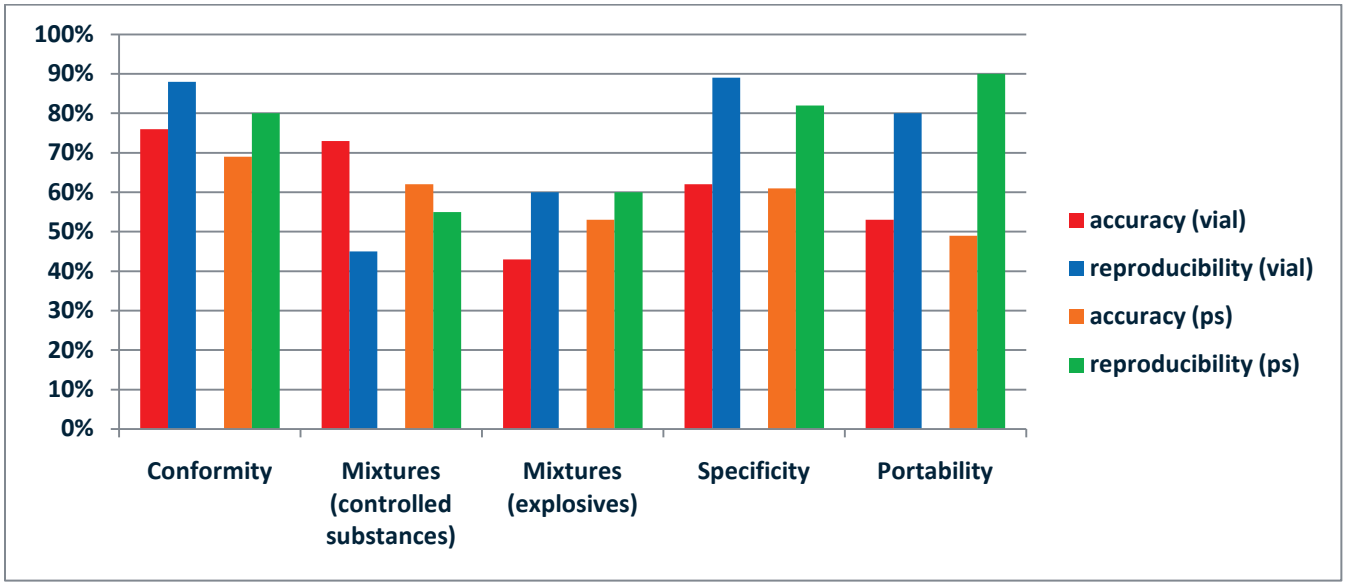
**Performance checks were not included in the sample/trial count.*

Criteria to define accuracy are listed in the described method. (Because the ignitable liquids in this evaluation are mixtures of many compounds, an accurate answer was defined as one that would enable the user to make an identification. For example, ethanol may be a component of gasoline, but identifying ethanol will not enable a user to identify an unknown liquid as gasoline.) (See also "Limitations" and "Areas for Improvement".)

Results were defined as reproducible (precise) if the "match" result, one of multiple match results, and/or the first listed match result in a mixture (mixture result with the highest percentage) were the same for all three replicates. This included results that were "no matches found" and synonyms (e.g., sugar and sucrose) to correct for the absence of a compound from existing libraries. For the purposes of this evaluation, samples returning a "no match" and "excessive analysis time" results were both defined as negative and thus reproducible results. Results with listing "similar" compounds were defined as inconclusive and not included with match or "no matches found" results for the purposes of examining reproducibility. However, if a sample resulted in the same compound for three "similar" results, it was considered reproducible.

Accuracy and reproducibility results for conformity, mixture, sensitivity and portability, measured for each sampling mode, are summarized in the chart below.

Data Summary of Accuracy and Reproducibility Percentages for Vial and Point-and-Shoot (PS) Sampling Modes



Conformity Sample Set

Accuracy

Point-and-Shoot: Of the 25 samples used to evaluated conformity, the FirstDefender RM accurately identified the target compound in 52 of the 75 trials (~69%). The instrument did not return any match results for heroin or cumin.

Vial: Of the 25 samples, the FirstDefender RM accurately identified the target compound in 57 of the 75 trials (76%). The instrument returned negative results for four trials total (one heroin and three cumin trials).

Reproducibility

Point-and-Shoot: Twenty of 25 conformity samples (80%) identified the same compound (or synonym) for each of three replicates as a match or the top component of a mixture, or had three negative results (heroin and cumin). Four additional samples had at least two reproducible results.

Vial: Twenty-two of 25 conformity samples (88%) identified the same compound (or synonym) for each of three replicates as a match or the top component of a mixture. Two additional samples had two reproducible results and cumin had three negative results.

Discussion

The FirstDefender RM had slightly better reproducibility between trials than accuracy. Inaccuracy may be due to a number of factors, including certain compounds having inherently weak spectra and thus requiring excessive analysis time, the nature of the sample (e.g., ignitable liquid), and the exclusion of the sample compounds from existing libraries. However, the FirstDefender RM returned very few inconclusive and negative results.

In this set of samples, the vial mode was slightly more accurate and reproducible than the point-and-shoot mode, and it returned fewer negative results. The vial mode removes human error caused by bad contact between the laser aperture and the sample container. Though the sampling time is short, laser safety considerations prevent the user from looking at the contact between the container and the aperture. Background light also becomes a factor in obtaining a spectrum using the point-and-shoot mode.

Notably, the instrument was not able to identify many of the ignitable liquids tested. Some compounds in the library that were frequent matches were specific to brand names. Thus a user would have to be familiar with the specific product to identify the components (and their properties, hazards, implications, etc.). Because ignitable liquids are often mixtures of many compounds, identifying a single component of an ignitable liquid mixture would likely not enable the user to make an identification of the liquid mixture. For example, ethanol may be a component of gasoline, but identifying ethanol will not identify an unknown liquid as gasoline. (See also "Limitations" and "Areas for Improvement".)

Mixture Sensitivity Set

Four controlled substances mixture series and two explosive substances series were analyzed in triplicate using each sampling mode. Five mixture ratios were prepared by weight of the target compound to the weight of the diluent as follows: 80:20, 60:40, 50:50, 40:60, and 30:70.

Accuracy

Point-and-Shoot: Of the four controlled substances mixture series (20 samples with 60 trials), the FirstDefender RM correctly identified one of the two components in 37 of the 60 trials (~62%). Of these, it correctly identified both components in 12 of 60 trials (20%). Six additional trials returned an accurate inconclusive result ("similar").

The FirstDefender RM identified either ammonium nitrate or sugar as the first result in 16 of the 30 (~53%) mixture trials, and both components in eight of these trials. In the mixture series with cumin, ammonium nitrate was only detected once.

Vial: Of the four controlled substances mixture series (20 samples with 60 trials), the FirstDefender RM correctly identified one of the two components in 44 of the 60 trials (~73%) and both components in 14 of 60 trials. Three additional trials returned an accurate inconclusive result ("similar").

The FirstDefender RM identified either ammonium nitrate or sugar as the first result in 13 of 30 trials (~43%) and both in three of the ammonium nitrate and sugar trials. It did not return a match, multiple match, or mixture result for any of the trials of ammonium nitrate and cumin.

Reproducibility

Point-and-Shoot: Of the four controlled substances mixture series (20 samples, 60 trials), the FirstDefender RM identified the same component over half of the time (11 samples, or 33 trials) (55%). In two additional samples (six trials), three accurate but different results were returned.

In the explosive substances series, six of the ten samples (18 of 30 trials) returned the same matches for all three trials (60%). Four of these six samples (12 trials) were negative results, reporting a "no matches found" or "excessive analysis time".

Vial: Of the four controlled substances mixture series (20 samples, 60 trials), the FirstDefender RM identified the same component approximately half of the time (9 samples, or 27 trials) (45%). In two of the methamphetamine and DMS samples, three accurate results were returned, but one result was not listed reproducibly with the highest match percentage.

In the explosive substances series, six of the ten samples (18 of 30 trials) (60%) returned the same matches for all three trials (60%). Four of these six samples (12 trials) were negative results, reporting "no matches found" or "excessive analysis time". One additional sample was correctly identified as ammonium nitrate and sugar in all three trials, but one component was not reproducibly listed with the highest match percentage.

Discussion

The vial mode was slightly more accurate than the point-and-shoot mode for the controlled substance mixture series, but about the same for the explosive substance mixture series. Reproducibility was also similar between modes for the explosive substance mixture series but slightly more reproducible using the point-and-shoot mode than the vial mode.

The identification of a component within a (non-liquid) mixture is highly reliant on which component particle of the mixture the Raman laser happens to be fixed. Therefore, identifying either component in a mixture could be considered correct.

While ammonium nitrate was detected throughout the mixture series with sugar, it was matched only once between both sampling modes when mixed with cumin. Cumin, a common yellow-brown spice, can be used as the fuel in an explosive mixture with ammonium nitrate. Color and fluorescence are two properties known to interfere with Raman spectroscopy.

In the cocaine mixture series, caffeine was detected more often than cocaine in both mixture series and in both sampling modes. In the heroin series, quinine was detected more often than the heroin, as the Raman spectrum from heroin is inherently weak. The explosive mixtures were less predictable, as ammonium nitrate was detected throughout the series. An identification trend corresponding to the ratio of components was not observed.

Specificity Set

A total of 84 trials were performed on 28 samples to evaluate the ability of the FirstDefender RM to differentiate between compounds similar to common target compounds or commonly associated with target compounds.

Accuracy

Point-and-Shoot: The FirstDefender RM accurately identified the target compound in 51 of 84 trials (~61%). Most uncontrolled substances such as acetaminophen, aspirin, ibuprofen, and pseudoephedrine – common diluents and over the counter (OTC) drugs – were identified at all trials. Two of the MDMA trials returned mixture results listing MDMA with low correlation (5% and 4%), and it did not return a match for any of the trials with MDA or MDEA. It also failed to identify amphetamine, guaifenesin, chlorpheniramine, sodium hydroxide, ammonium hydroxide, and a (50:50) mixture of turmeric and cardamom (two common spices) in any of the trials.

Vial: The FirstDefender RM accurately identified the target compound in 52 of 84 trials (~62%). The instrument was unable to accurately identify amphetamine sulfate or any of the phenethylamines (MDMA, MDA, and MDEA). In contrast to the point-and-shoot mode, it inaccurately identified MDA as a mixture, with MDMA the component with the highest percentage. While most other OTC drugs and common diluents were identified in all trials, it failed to identify guaifenesin and chlorpheniramine, as well as common chemicals such as ammonium hydroxide and sodium hydroxide.

Reproducibility

Point-and-Shoot: In 23 of 28 samples (~82%), the results were reproducible across all three trials. Eight of the 23 samples returned negative results. The remaining five samples (MDMA, lidocaine, fertilizer prills, fertilizer – ground, and citric acid) produced two consistent trials.

Vial: In 25 of 28 samples (~89%), the results were reproducible across all three trials. Seven of the 25 samples returned negative results. An additional three samples (amphetamine sulfate, MDA, and fertilizer – ground) produced two consistent trials.

Discussion

Results for the phenethylamine compounds (MDEA, MDA, and MDMA) and mixtures, such as fertilizer* and turmeric and cardamom, showed little accuracy, though rarely resulted in a match. MDMA was identified with a low percentage using the point-and-shoot mode, though the sample was USP grade. It was identified with the highest percentage in a mixture for the MDA sample. Since MDMA was also listed as a result, the ability of the FirstDefender RM to differentiate between it and other similar phenethylamines is suspect.

**Fertilizer is a mixture of many compounds, but the identity of a single compound in this case will not help to identify the sample as fertilizer. In this way, both the fertilizer prills and fertilizer – ground were treated like the ignitable liquids. Though fertilizer is a mixture, it unexpectedly resulted in a match or similar match to sulfur powder in 9 of 12 trials (across both sampling modes).*

The instrument was highly reproducible, as all samples in the specificity trials resulted in at least two consistent results. The return of negative results (no match or excessive analysis time) in eight of 23 samples for the point-and-shoot mode, and seven of 25 samples for the vial mode, indicates that false positives would be limited.

Ruggedness Set

Eight samples were tested using heat to measure the ruggedness of the unit. These trials were intended to model some of the storage and transportation practices by law enforcement officers, first responders, and field users. Samples were chosen to represent different categories of compounds. According to the User Manual (p. 58), the

instrument should function at temperatures from -20 to 40°C (-4 to 104°F), and can be stored in temperatures from -30 to 60°C (-22 to 140°F). The unit is dust- and water-resistant and can be submerged in water if the rear door (battery door) is shut but should not be stored in direct sunlight. Ruggedness was tested using the point-and-shoot mode only.

(Note: Trials are not listed in chronological order by date performed.)

Trial One:

The instrument was placed on the dashboard of a car for approximately two hours. The interior temperature upon placement was ~141°F (~60°C). Upon removal, the thermometer's screen was not readable*.

**It is possible that the temperature exceeded the threshold of the thermometer (~158°F or ~70°C) and was thus immeasurable.*

Accuracy
The performance check passed and the FirstDefender RM correctly identified all eight of the target compounds.

Reproducibility
N/A: The conditions were not similar enough after sampling eight samples to perform in triplicate.

Trial Two:

The instrument was placed on the front seat of a car for approximately two hours. The interior temperature upon placement was ~81°F (~27°C). Upon removal, the interior temperature was ~106°F (~41°C).

Accuracy
The performance check passed and the FirstDefender RM correctly identified all eight of the target compounds.

Reproducibility
N/A: The conditions were not similar enough after sampling eight samples to perform in triplicate.

Trial Three:

The instrument was placed in the trunk of a car for approximately two hours. The interior temperature of the trunk upon placement was ~97°F (~36°C). Upon removal, the interior temperature was ~97°F (~36°C).

Accuracy
The performance check passed and the FirstDefender RM correctly identified all eight of the target compounds.

Reproducibility
N/A: The conditions were not similar enough after sampling eight samples to perform in triplicate.

Discussion

Despite the fact that the temperature neared the limit of the recommended operating temperature in two trials, and most likely exceeded the limit in the third, the performance of the FirstDefender RM was as accurate as its performance in normal laboratory conditions.

Portability Set

The FirstDefender RM was transported to the Manatee County Sheriff's Office to test a variety of adjudicated controlled substance case samples. Each sample was tested by three evaluators using each sampling method. A performance check was performed by each evaluator before proceeding. Samples included six tablets, seven cocaine HCl and base* exhibits, five heroin exhibits, and two exhibits in which no controlled substance was detected (lidocaine, and presumably acetaminophen). Tablets were crushed and placed into vials before testing. Since Lortab and Darvocet tablets have such a large percentage of acetaminophen, and this substance could help identify a tablet, acetaminophen was defined as a positive identification for these tablets. One sample (presumed acetaminophen) had not been identified by the Sheriff's Office. Results from analyzing the sample were used only for reproducibility.

**See Appendix B for a cocaine base spectral comparison report.*

Accuracy

Point-and-Shoot: In total, the FirstDefender RM correctly identified the reported substances in 28 of 57 trials (~49%).

The FirstDefender RM was able to identify acetaminophen in three of the six trials (Lortab), but returned three "similar" matches to acetaminophen for the Darvocet, the major component of two of the tablets (Darvocet and Lortab). It correctly identified oxycodone as a minor component in a mixture (Oxycodone HCl 30 mg). All other pharmaceutical tablet trials resulted in other identifications (i.e., a-lactose monohydrate or doxycycline HyC (sic) 20 mg) or in a "no match" result.

The FirstDefender RM identified cocaine* in 21 of 21 total trials (100%) and correctly distinguished between cocaine base and cocaine hydrochloride (HCl) in all but three of those trials (in which it identified a sample reported as cocaine base as cocaine HCl).

**The match of "cocaine std" and "cocaine HCl" was counted as a correct match for both cocaine HCl and cocaine base exhibits.*

Vial: In total, the FirstDefender RM correctly identified the reported substances in 30 of 57 trials (~53%).

The FirstDefender RM was able to identify acetaminophen in six of the six trials (Lortab and Darvocet). It correctly identified oxycodone as a minor component in a mixture (Oxycodone HCl 30 mg). All other pharmaceutical tablet trials resulted in other identifications (i.e., a-lactose monohydrate or doxycycline HyC 20 mg) or in a "no match" result.

The FirstDefender RM identified cocaine* in 20 of 21 total trials (~95%) and correctly distinguished between cocaine base and cocaine hydrochloride (HCl) in all but one sample. This sample, reported to be cocaine base, had one "no match" and two reporting "cocaine HCl".

**The match of "cocaine std" and "cocaine HCl" was counted as a correct match for both cocaine HCl and cocaine base exhibits.*

Reproducibility

Point-and-Shoot: Eighteen of the 20 samples (90%) had reproducible results across the three trials and were either all "matches" or all "no matches". This included one sample in which all evaluators reported "No Match, No Signal" and three samples of heroin in which there were no matches listed but "aniline-2-sulfon" was listed first. Three of the cocaine samples reported cocaine as the mostly highly correlated result for all three trials, but were mixed "match" and "no match" results.

Vial: Sixteen of the 20 samples (80%) had reproducible results across the three trials.

Discussion

The sample set provided to the evaluators included six tablets and one non-controlled, unidentified sample. Each tablet had to be crushed in order to sample it using the same method as the other samples in this evaluation. The presence of an entire crushed tablet in a field-type setting is unlikely. The ability to identify a small amount of a target controlled substance in a tablet is also unlikely, though the FirstDefender RM did identify oxycodone once, as a component of a mixture in the 30-mg tablet. The FirstDefender RM performed well with cocaine identification, correctly distinguishing between the salt and base forms in most trials. The FirstDefender RM was as accurate and precise on the case samples as on the samples in the laboratory, though its inability to identify heroin could be an issue in jurisdictions where heroin is a problem.

Library Build

Accuracy

Papaverine HCl and levamisole HCl were successfully added to the library on the FirstDefender RM unit and were then correctly identified.

Reproducibility

N/A: This trial was not performed in triplicate.

Discussion

The evaluator was able to scan samples to a user library and subsequently identify those compounds.

Findings

Strengths

- The FirstDefender RM is compact and weighs less than two pounds.
- Raman spectroscopy is non-destructive, and very little sample preparation is required.
- The instrument was accurate for most samples and produced reproducible results.
- The User Manual is extremely thorough, and the spiral-bound Quick Reference Guide is easy to follow and thickly laminated for ruggedness.
- The scanning procedure is depicted and explained on the back of the instrument.
- The unit is easy to operate with a menu-driven user interface.
- The on-screen keyboard allows the user to name sessions and spectra, enabling easy data retrieval.

- Spectral and match results can be reviewed directly on the device by session and spectrum.
- The on-screen keyboard allows the user to name sessions.
- Data formats for GRAMS software (.spc), text files (.txt), report files (.jpg) and Reachback files (.arb) allow users to access files with other programs or send them to a Reachback representative for assistance.
- Additional information is included with many matches, including National Institute for Occupational Safety and Health (NIOSH) information; descriptions such as color, uses, and smell; gear including suggested personal protective equipment (PPE); fire response information; and first aid for exposure.
- According to the User Manual, the software has multiple language options.
- The laser setting (75, 125, and 250 (default) mW) and exposure setting (5–10,000 ms) are adjustable, enabling users to lower energy output for samples that appear to be rapidly heating.
- The FirstDefender RM has a settable scan delay to enable sampling at a distance.
- The FirstDefender RM is equipped with multiple battery options, including Surefire batteries that may be interchangeable between other pieces of issued equipment (military).
- According to the User Manual (p. 60), the FirstDefender RM passed a number of military ruggedness tests (MIL-STD-810F), including mechanical shock, vibration, transit shock (drop), humidity, sand and dust, thermal shock, low temp. (operation), high temp. (operation), low temp. (storage), high temp. (storage), and immersion.
- The only consumables for the unit are optional sampling vials for those samples that cannot be analyzed through their original containers.
- According to product literature, the libraries are extensive, containing approximately 8,550 compound spectra. Additional library entries can be added by the user.
- The search algorithm allows for matching and automatically searches for mixtures analysis if a statistically similar is not detected. If neither is found, then it returns a “no match” or similar match result.
- The screen prompts the user with suggestions for finding the identity of the unknown sample if a match, mixture, or similar spectrum is not found.
- There are two available sampling modes that are similar in performance. While the vial mode eliminates background interference, the point-and-shoot mode allows the user to analyze smaller amounts of samples.
- Consumables are limited to 4-mL vials that can be purchased from multiple vendors.

Areas for Improvement

- The “similar” result category may cause misinterpretation by a user, either falsely including a result or falsely excluding one. The screen does not say what made the two spectra similar (for example, a functional group). This information may be available in the spectra themselves, but would require advanced knowledge of Raman spectroscopy.
- The percentages listed in mixtures were misleading; as they did not represent the percentages of each result in the mixture, but rather the percentage of the sample spectrum that matched the library spectrum. For example, a mixture listing “cocaine” at 57% indicates that 57% of the sample spectrum matches the library spectrum for cocaine, not that 57% of the mixture is cocaine. These percentages did not correlate well with the actual mixture percentages in the samples.

- Identification of phenethylamines such as MDMA, MDA, and MDEA was not accurate. Scans did not produce results in the "similar" category to other phenethylamines. (For example, scans of MDA resulted in mixture results of "MDMA" (vial mode only), but MDMA and MDEA had "no match" results.)
- Matches were not accompanied by a correlation/confidence score.
- Library entries, especially for ignitable liquids, were very specific to brand names. Often, only a signal component of a complex mixture was reported as a "match". It may be more informative to report on the nature of the product. For example, instead of "Spectracide Pro Wasp & Hornet Cleaner", the result could read "petroleum based ignitable liquid present".

Limitations

- Portable Raman spectroscopy cannot easily be performed on trace quantities of samples. A sufficient quantity of the compound of interest must be available for sampling.
- Raman spectroscopy does not work well on highly fluorescent or pigmented items.
- Raman scattering is an inherently weak signal that can be affected by background light, which can interfere with the quality of Raman spectra.
- Accurate identification of materials is limited to the reference samples contained in supplied libraries and the accuracy of those reference samples added to user libraries by the operators. Additions to user libraries are limited by compound availability and by expectations to see specific compounds.
- The identification of a compound in a mixture did not necessarily correspond with the compound in the highest ratio in the mixture.
- Proper training must be conducted in order to correctly interpret results.
- Raman scattering is limited to molecules that have a change in polarization potential in regard to distance between nuclei.

Health and Safety Issues

- The unit has a Nominal Ocular Hazard Distance of 19 inches (the distance at which the radiation has decreased to 2 mW/cm^2). The unit should be held at this distance from the eyes, the laser shield should be engaged, and safety goggles, with an optical density greater than three, are recommended to be worn for protection.
- The laser has the ability to explode samples such as black gunpowder. It should not be used to sample dark-colored materials, nor used near bulk materials. Small samples should be isolated for testing.
- Included lithium ion batteries may require documentation for transport and should not be stored in checked luggage during air travel.

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APPENDIX A

Table 1

Point-and-Shoot Sampling Mode

Sample	Trial	Match? (Y/N)	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
PERFORMANCE CHECK	1	Y			Polystyrene	Y		
	2	Y			Polystyrene	Y		
	3	Y			Polystyrene	Y		
CONFORMITY								
Cocaine HCl	1	Y			Cocaine (HCl)	Y		
	2	Y			Cocaine (HCl)	Y		
	3	Y			Cocaine (HCl)	Y		
Cocaine Base	1	Y			Cocaine (free base)	Y		
	2		Y		Cocaine (free base)	N		
	3	Y			Cocaine (free base)	Y		
Methamphetamine	1	Y			Methamphetamine HCl	Y		
	2	Y			Methamphetamine	Y		
	3	Y			Methamphetamine HCl	Y		
Heroin	1	N						
	2	N						
	3	N						
Mannitol	1	Y			D-Mannitol	Y		
	2	Y			D-Mannitol	Y		
	3	Y			D-Mannitol	Y		
Niacinamide	1	Y			Nicotinamide	Y		
	2	Y			Nicotinamide	Y		
	3	Y			Nicotinamide	Y		
Boric Acid	1	Y			Boric Acid	Y		

Sample	Trial	Match? (Y/N)	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
	2	Y			Boric Acid	Y		
	3	Y			Boric Acid	Y		
Inositol	1	Y			myo-Inositol	Y		
	2	Y			myo-Inositol	Y		
	3	Y			myo-Inositol	Y		
Caffeine	1	Y			Caffeine	Y		
	2	Y			Caffeine	Y		
	3	Y			Caffeine	Y		
Quinine	1	Y			Quinine	Y		
	2	Y			Quinine	Y		
	3	Y			Quinine	Y		
RDX	1	Y-2			RDX/HMX	Y	RDX (cyclonite)	
	2	Y-2			RDX/HMX	Y	RDX (cyclonite)	
	3	Y-2			RDX/HMX	Y	RDX (cyclonite)	
Ammonium Nitrate (prills)	1	Y			Ammonium nitrate	Y		
	2	Y			Ammonium nitrate	Y		
	3	Y			Ammonium nitrate	Y		
Ammonium Perchlorate	1	Y			Ammonium perchlorate	Y		
	2	Y			Ammonium perchlorate	Y		
	3	Y			Ammonium perchlorate	Y		
Sugar	1	Y			Sugar	Y		
	2	Y			Sugar	Y		
	3	Y			Sugar	Y		
Cumin	1	N					Excessive Analysis Time	
	2	N					Excessive Analysis Time	
	3	N					Excessive Analysis Time	

Sample	Trial	Match? (Y/N)	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
Urea Nitrate	1	Y			Urea Nitrate	Y		
	2	N						
	3	Y			Urea Nitrate	Y		
Ammonium Nitrate (powder)	1	Y			Ammonium nitrate	Y		
	2	Y			Ammonium nitrate	Y		
	3	Y			Ammonium nitrate	Y		
Mineral Spirits	1	Y			Spectracide Pro (cont)	N	Wasp & Hornet Killer	
	2	N						
	3	N						
BP® 87 Octane Gasoline	1	Y			Gasoline (Lot F)	Y		
	2			Y	91%: Gasoline (Lot B)	Y	4%: Gasoline (lot D)	
	3	Y		Y	95% Gasoline (lot D) mix	Y		
BP® Diesel Fuel	1	Y			Diesel (Lot C)	Y		
	2			Y	89% Diesel #2	Y	6% Japan drier, kerosene, diesel lot B, lot C, and 6% petroleum	
	3			Y	Diesel #2 (95% mix id'd)	Y	Japan drier, kerosene, diesel (lot B), diesel (lot C)	
Kerosene	1	Y			Diesel (Lot B)	N		
	2			Y	Diesel (Lot C)	Y	Diesel (lot B), kerosene, diesel #2	
	3	N						
Klean-Strip® VM&P Naptha Thinner	1	Y-2			Kerosene (Lot B)	Y	VM&P Naphtha	
	2	Y			Kerosene (Lot B)	N		
	3	Y			VM&P Naptha (80% mix id'd)	Y	1,3 -dimethylcyclohexa	
Lamplight® Lamp Oil	1	Y			Raid	N		

Sample	Trial	Match? (Y/N)	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
	2	Y			Raid	N		
	3	Y			Raid	N		
Ronsonol Lighter Fuel®	1			Y	91% VM&P Naphtha	N	2%: Spectracide PW&HK, Build-up remover, and Raid	
							1% cis-1,3-dimehtyl cyclohexane	
	2			Y	92% VM&P Naphtha	N	2% White fuel (campfire); 1% Spectracide	
	3			Y	VM&P Naphtha	N	White fuel (campfire); 3-methyl heptane	
Kingsford® Charcoal Lighter Fluid	1	Y			Spectracide Pro (cont)	N	Pro Wasp & Hornet Killer	
	2	Y			Spectracide Pro (cont)	N	Pro Wasp & Hornet Killer	
	3	Y			Spectracide Pro (cont)	N	Pro Wasp & Hornet Killer	
MIXTURE SENSITIVITY								
Cocaine HCl: Caffeine (80:20)	1	N						
	2	N						
	3		Y		Cocaine HCl	N		
Cocaine HCl: Caffeine (60:40)	1	N						
	2			Y	64% Caffeine	Y	15% Cocaine HCl lots A, B, C	
	3			Y	Caffeine	Y	Cocaine HCl lots A, B, C	
Cocaine HCl: Caffeine (50:50)	1			Y	69% Caffeine	Y	26%: Cocaine HCl lot A and lot B	
	2	N						
	3			Y	60% Caffeine	Y	36% Cocaine HCl lots A, B, C	
Cocaine HCl: Caffeine (40:60)	1			Y	69% Caffeine	Y	4% 3-[3-(Trifluormethyl) phenoxy]	

Sample	Trial	Match? (Y/N)	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
	2			Y	67% Caffeine	Y	4% 3-[3-(Trifluormethyl) phenoxy]	
	3			Y	68% Caffeine	Y	3% phenoxyacetaldehyde; 2% 3-(trifluoroethyl) benzyl alcohol	
Cocaine HCl: Caffeine (30:70)	1			Y	91% Caffeine	Y	2%: 5 compounds listed	
	2			Y	88% Caffeine	Y	2%: 5 compounds listed	
	3			Y	84% Caffeine	Y	5%: 2,2,4-trimehtyl-1,3…; 5% isobutyl benzoate	
Cocaine Base: Caffeine (80:20)	1		Y		Cocaine (free base)	N		
	2		Y		Cocaine (free base)	N		
	3	Y			Cocaine (free base)	Y		
Cocaine Base: Caffeine (60:40)	1	N						
	2			Y	83% Caffeine	Y	4% N,N'-dibenzylphthalamide	
	3			Y	73% Caffeine	Y	8%: N,N'-bibenzylphthal.; 1% other; 1% other	
Cocaine Base: Caffeine (50:50)	1			Y	75% Caffeine	Y	9% N,N'-dibenzyl phthalamide 2% other	
	2			Y	64% Caffeine	Y	11% N,N'-dibenzyl phthalamide; 3% other	
	3			Y	81% Caffeine	Y	6%: Ethyl phenylacetate; 6% other; 6% other	
Cocaine Base: Caffeine (40:60)	1			Y	77% Caffeine	Y	7% N,N'dibenzyl phthalate 2% other	
	2			Y	73% Caffeine	Y	7% Dephenylacetaldehyde	
	3			Y	73% Caffeine	Y	10% diphenyl methane; 1-phenyl dodecane	

Sample	Trial	Match? (Y/N)	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
Cocaine Base: Caffeine (30:70)	1	N						
	2	N						
	3			Y	71% Caffeine	Y	3% 3-(trifluoromethyl) benzyl alcohol	
Methamphetamine: DMS (80:20)	1		Y		Methamphetamine HCl	N		
	2		Y		Methamphetamine HCl	N		
	3			Y	74% Methamphetamine	Y	3% Potassium hexachlorop	
Methamphetamine: DMS (60:40)	1			Y	77% DMS	Y	12% ethyl phenylacetate, benzyl phenyl acetate	
	2			Y	51% DMS	Y	45% Meth and Meth HCl	
	3			Y	58% DMS	Y	39% Meth; 39% Meth HCl	
Methamphetamine: DMS (50:50)	1			Y	93% DMS	Y	2% 3-(Trifluoromethyl)benzyl alcohol	
	2			Y	81% DMS	Y	8% Meth and Meth HCl	
	3			Y	88% DMS	Y	6% diphenylmethane; 6% 1-phenyl dodecane;	
							6% 2-(benzyloxy) ethanol	
Methamphetamine: DMS (40:60)	1			Y	83% DMS	Y	14% Meth and Meth HCl	
	2			Y	97% DMS	Y	1% Meth and Meth HCl	
	3			Y	91% DMS	Y	3% 3-(trifluoromethyl) benzyl alcohol	
Methamphetamine: DMS (30:70)	1			Y	95% DMS	Y	3% Meth and Meth HCl	
	2			Y	94% DMS	Y	4% Meth and Meth HCl	
	3		Y		DMS	N		

Sample	Trial	Match? (Y/N)	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
Heroin: Quinine (80:20)	1	N						
	2	N						
	3	N					fluorescence prevented ID	
Heroin: Quinine (60:40)	1			Y	65% Heroin	Y	25% Hydroquinine	
	2	N						
	3			Y	52% Quinine	Y	44% Heroin	
Heroin: Quinine (50:50)	1	N						
	2	N						
	3	N					high fluorescence	
Heroin: Quinine (40:60)	1	N						
	2	N						
	3	N					Excessive Analysis Time	
Heroin: Quinine (30:70)	1			Y	90% Quinine	Y	5% Trimethylsilyl trimethylsiloxyacetate	
	2			Y	Quinine	Y	hydroquinine (25 similar items found)	
	3	Y			Quinine	Y		
Ammonium Nitrate: Sugar (80:20)	1			Y	86% Ammonium nitrate	Y	8% Sucrose/Sugar, granulated, confect. sugar	2% Nitric Acid
	2	Y			Ammonium nitrate	Y		
	3	Y			Ammonium nitrate	Y		
Ammonium Nitrate: Sugar (60:40)	1	Y			Ammonium nitrate	Y		
	2			Y	Ammonium nitrate	Y	16% Sucrose, Sugar; 2% Nitric Acid	
	3			Y	92% Ammonium nitrate	Y	4% Sugar; 2% Nitric Acid	
Ammonium Nitrate: Sugar (50:50)	1			Y	90% Ammonium nitrate	Y	4% Sucrose/Sugar, granulated, confect. Sugar	3% other

Sample	Trial	Match? (Y/N)	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
	2			Y	94% Ammonium nitrate	Y	7% lanthanum, Ga NO3, Mn NO3	2% Nitric Acid
	3	Y			Ammonium nitrate	Y		
Ammonium Nitrate: Sugar (40:60)	1			Y	80% Ammonium nitrate	Y	14% Sucrose/Sugar, granulated, confect. Sugar	
							3% Nitric Acid	
	2			Y	67% Sucrose, Sugar, confect. sugar	Y	27% AN, 2% Silver NO3	
	3			Y	50% Sucrose	Y	50% confect sugar; 46% AN	
Ammonium Nitrate: Sugar (30:70)	1			Y	70% Sucrose/Sugar,	Y	24% Mn (II) nitrate 4H2O, Ammonium bicarb.	
					granulated, confect. Sugar		Ammonium carbonate	
	2			Y	70% Ammonium Nitrate	Y	22% Sucrose, Sugar, Conf. Sugar	
	3	Y			Ammonium Nitrate	Y		
Ammonium Nitrate: Cumin (80:20)	1	N						
	2		Y		Ammonium nitrate	N	Silver nitrate, Mn nitrate, tetral?, Ammonium	
							carbonate, nitric acid, etc. (10 total similar found)	
	3	Y			Ammonium nitrate	Y		
Ammonium Nitrate: Cumin (60:40)	1	N						
	2	N						
	3	N					Excessive analysis time	
Ammonium Nitrate: Cumin (50:50)	1	N						
	2	N					Excessive analysis time	
	3	N					Excessive analysis time	

Sample	Trial	Match? (Y/N)	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
Ammonium Nitrate: Cumin (40:60)	1	N						
	2	N					Excessive analysis time	
	3	N					Excessive analysis time	
Ammonium Nitrate: Cumin (30:70)	1	N					Excessive analysis time	
	2	N					Excessive analysis time	
	3	N					Excessive analysis time	
SPECIFICITY								
d,l-Amphetamine Sulfate	1	N						
	2	N						
	3	N						
MDMA	1			Y	6% Piperonyl acetate	Y	5% MDMA HCl	
	2	N						
	3			Y	66% Piperonyl acetate	Y	4% MDMA HCl; 4% 5-amino-1-(4-methoxyphenyl)	
MDA	1	N						
	2	N						
	3	N						
MDEA	1	N						
	2	N						
	3	N						
Morphine Sulfate	1	Y			Morphine sulfate	Y		
	2	Y			Morphine sulfate	Y		
	3	Y			Morphine sulfate	Y		
Codeine Sulfate	1	Y			Codeine sulfate	Y		
	2			Y	81% codeine sulfate	Y	2% Ethyl acetate	
	3	Y			Codeine sulfate	Y		
Benzocaine	1	Y			Benzocaine	Y		

Sample	Trial	Match? (Y/N)	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
	2	Y			Benzocaine	Y		
	3	Y			Benzocaine	Y		
Lidocaine	1	Y			Lidocaine (lot B)	Y		
	2	N						
	3	Y			Lidocaine (lot B)	Y		
Procaine	1	Y			Procaine HCl	Y		
	2	Y			Procaine HCl	Y		
	3	Y			Procaine HCl	Y		
Acetylsalicylic Acid (ASA)	1	Y			Acetylsalicylic Acid	Y		
	2	Y			Acetylsalicylic Acid	Y		
	3	Y			Acetylsalicylic Acid	Y		
Ibuprofen	1	Y			Ibuprofen	Y		
	2	Y			Ibuprofen	Y		
	3	Y			Ibuprofen	Y		
Guaifenesin	1	N						
	2	N						
	3	N						
Diphenhydramine	1	Y			Diphenhydramine HCl	Y		
	2	Y			Diphenhydramine HCl	Y		
	3	Y			Diphenhydramine HCl	Y		
Chlorpheniramine	1	N						
	2	N						
	3	N						
Pseudoephedrine	1	Y			(+)-Pseudoephedrine HCl	Y		
	2	Y			(+)-Pseudoephedrine HCl	Y		
	3	Y			(+)-Pseudoephedrine HCl	Y		

Sample	Trial	Match? (Y/N)	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
Dimethyl Sulfone (DMS)	1	Y			Dimethyl sulfone	Y		
	2	Y			Dimethyl sulfone	Y		
	3	Y			Dimethyl sulfone	Y		
Baking Soda	1	Y			Sodium bicarbonate	Y		
	2	Y			Sodium bicarbonate	Y		
	3	Y			Sodium bicarbonate	Y		
Acetaminophen (ACE)	1	Y			Acetaminophen	Y		
	2	Y			Acetaminophen	Y		
	3	Y			Acetaminophen	Y		
Urea	1	Y			Urea	Y		
	2	Y			Urea	Y		
	3			Y	48% Urea	Y	Nicotinic acid N-oxide	
Ferric Nitrate	1	Y-6			Iron(III)nitrate nonohydrate	Y	Mn(II)nitrate sol'n, etc.	
	2	Y-6			Iron(III)nitrate nonohydrate	Y	Mn(II)nitrate sol'n, etc.	
	3	Y-4			Iron(III)nitrate nonohydrate	Y	Al NO3, etc.	
Sodium Perborate	1	Y			Sodium perborate 4H2O	Y		
	2	Y			Sodium perborate 4H2O	Y		
	3	Y			Sodium perborate 4H2O	Y		
Fertilizer (13% Total N) Prills	1		Y		Sulfur powder	N		
	2	N					Excessive analysis time	
	3	Y			Sulfur powder	N		
Fertilizer (13% Total N) – Ground	1	N						

Sample	Trial	Match? (Y/N)	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
	2		Y		Sulfur powder	N	Phosphorus pentabromide	
	3		Y		Sulfur powder	N	Phosphorus pentabromide	
Turmeric: Cardamom (50:50)	1	N					Excessive analysis time	
	2	N					Excessive analysis time	
	3	N					Excessive analysis time	
Sodium Hydroxide (Lye)	1	N					Excessive analysis time	
	2	N					Excessive analysis time	
	3	N					Excessive analysis time	
Sulfuric Acid	1	Y			Sulfuric Acid	Y		
	2	Y			Sulfuric Acd	Y		
	3	Y			Sulfuric Acid	Y		
Ammonium Hydroxide	1	N					Excessive analysis time	
	2	N					Excessive analysis time	
	3	N					Excessive analysis time	
Citric Acid	1	Y			Citric Acid	Y		
	2	N						
	3	Y			Citric Acid Monohydrate	Y		
RUGGEDNESS								
Performance Check								
5/21/2010	1	Y			Polystyrene	Y	Front Seat	
5/20/2010	2	Y			Polystyrene	Y	Trunk	
5/19/2010	3	Y			Polystyrene	Y	Dashboard	
Cocaine HCl	1	Y			Cocaine (hydrochloride)	Y		
	2	Y			Cocaine HCl	Y		
	3	Y			Cocaine HCl	Y		
Methamphetamine	1	Y			Methamphetamine HCl	Y		

Sample	Trial	Match? (Y/N)	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
	2	Y			Methamphetamine HCl	Y		
	3	Y			Methamphetamine HCl	Y		
Caffeine	1	Y			Caffeine	Y		
	2	Y			Caffeine	Y		
	3	Y			Caffeine	Y		
Ammonium Nitrate (Powder)	1	Y			Ammonium nitrate	Y		
	2	Y			Ammonium nitrate	Y		
	3	Y			Ammonium nitrate	Y		
Ammonium Perchlorate	1	Y			Ammonium perchlorate	Y		
	2	Y			Ammonium perchlorate	Y		
	3	Y			Ammonium perchlorate	Y		
RDX	1	Y-2			RDX/HMX	Y	RDX (cyclonite)	
	2	Y-2			RDX/HMX	Y	RDX (cyclonite)	
	3	Y-2			RDX/HMX	Y	RDX (cyclonite)	
BP 87 Octane Gasoline	1			Y	91% Gasoline (lot B)	Y	4% Gasoline (lot D)	
	2			Y	90% Gasoline (lot B)	Y	Gasoline (lot B)	
	3			Y	Gasoline (lot D)	Y		
BP Diesel Fuel	1			Y	88% Diesel #2	Y	6% Japan drier; kerosene; diesel (lots B + C)	
	2			Y	88% Diesel #2	Y	6% Japan drier, diesel (lots B + C); 6% petroleum	
	3			Y	89% Diesel #2	Y	6% Japan drier; 6% kerosene; 6% Diesel (lot b)	
PORTABILITY								
Performance Check								

Sample	Trial	Match? (Y/N)	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
6/4/10 Manatee County	1	Y			Pass	Y		
6/4/10 Manatee County	2	Y			Pass	Y		
6/4/10 Manatee County	3	Y			Pass	Y		
PREVIOUS ID								
501: 7.5 mg Hydrocodone/500 mg ACE	1	Y			Acetaminophen	Y		
501: (Lortab)	2	Y			Acetaminophen	Y		
501	3	Y			Acetaminophen	Y		
502: 100 mg Propoxyphene/650 mg ACE	1		Y		Acetaminophen	N		
502: (Darvocet)	2		Y		Acetaminophen	N		
502	3		Y		Acetaminophen	N		
503: 15 mg Oxycodone HCl	1	N						
503: (Roxicodone)	2			Y	a-lactose monohydrate (76%)		Glass, borosilicate 6%, other 2%	
503	3	N						
504: 30 mg Oxycodone HCl	1	N						
504: (Roxicodone)	2			Y	a-lactose monohydrate (67%)	N	Glass, borosilicate 7%, other 6%	
504	3			Y	a-lactose monohydrate	Y	oxycodone HCl, (3-Glycidyloxpropyl)trimethoxy, other	
505: Cocaine Base	1	Y			Cocaine (free base)	Y		
505	2	Y			Cocaine (free base)	Y		
505	3	Y			Cocaine (free base)	Y		
506: 2 mg Alprazolam (Xanax)	1			Y	Doxycycline HyC 20 mg (65%)	N	Barium oxalate (3%), Other (1%)	

Sample	Trial	Match? (Y/N)	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
506	2			Y	Doxycycline HyC 20 mg (71%)	N	Corn starch & Other (3%), Other (2%), Other (1%)	
506	3			Y	Doxycycline HyC 20 mg	N	Cornstarch and other	
507: Cocaine Base	1	Y			Cocaine (free base)	Y		
507	2	Y			Cocaine (free base)	Y		
507	3	Y			Cocaine (free base)	Y		
508: Lidocaine	1	Y-2			Lidocaine hydrochloride…	Y	monohydrate	Lidocaine (lot A)
508	2	Y-2			Lidocaine hydrochloride…	Y	monohydrate	Lidocaine (lot A)
508	3	Y			Lidocaine hydrochloride…	Y	monohydrate	
509: 10 mg Methadone HCl	1			Y	a-lactose monohydrate (75%)	N	Other (2%), Glass, borosilicate (1%)	
509: (Methadone)	2			Y	a-lactose monohydrate (66%)	N	Glass, borosilicate (3%)	Ethoxyacetic Acid (2%)
509	3	Y			a-lactose monohydrate	N		
510: Cocaine Base	1	Y			Cocaine (free base)	Y		
510	2	Y			Cocaine (free base)	Y		
510	3	Y			Cocaine (free base)	Y		
511: Heroin	1	N					Excessive Analysis Time	
511	2	N					Excessive Analysis Time	
511	3	N					Excessive Analysis Time	
50: Cocaine HCl	1	Y			Cocaine (hydrochloride)	Y		
50	2	Y			Cocaine (hydrochloride)	Y		
50	3	Y			Cocaine HCl	Y		
49B: Cocaine Base	1	Y			Cocaine (free base)	Y		

Sample	Trial	Match? (Y/N)	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
49B	2	Y			Cocaine (free base)	Y		
49B	3	Y			Cocaine (free base)	Y		
44B: Cocaine Base	1	Y			Cocaine (free base)	Y		
44B	2	Y			Cocaine (free base)	Y		
44B	3	Y			Cocaine (free base)	Y		
39: Heroin	1	N					Excessive Analysis Time	
39	2	N					Excessive Analysis Time: high fluorescence	
39	3	N					Excessive Analysis Time: high fluorescence	
38: Heroin	1	N					Excessive Analysis Time	
38	2	N					Excessive Analysis Tim: high fluorescence	
38	3	N					Excessive Analysis Tim: high fluorescence	
35: Heroin	1	N					Excessive Analysis Time: high fluorescence	
35	2	N					Excessive Analysis Time: high fluorescence	
35	3	N					Excessive Analysis Time: high fluorescence	
34: Heroin	1	N					Excessive Analysis Time	
34	2	N					Excessive Analysis Tim: high fluorescence	
34	3	N					Excessive Analysis Tim: high fluorescence	
10: Cocaine Base	1			Y	Cocaine HCl (lot A, B, C) (81%)	Y	Other (1%)	
10	2	Y-3			Cocaine HCl (lot A) (79%)	Y	Cocaine HCl (lot B) (79%)	Cocaine HCl (lot C) (79%)
10	3	Y			Cocaine HCl	Y		

Sample	Trial	Match? (Y/N)	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
9: NCSD, Fake Cocaine Base	1	Y			Acetaminophen			
9	2	Y			Acetaminophen			
9	3	Y			Acetaminophen			

Table 2

Vial Sampling Mode

Sample	Trial	Match? Y/N	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
PERFORMANCE CHECK	1				PASSED	Y		
	2				PASSED	Y		
	3				PASSED	Y		
CONFORMITY								
Cocaine HCl	1	Y			Cocaine hydrochloride)	Y		
	2	Y			Cocaine (hydrochloride)	Y		
	3	Y			Cocaine (hydrochloride)	Y		
Cocaine Base	1	Y			Cocaine (free base)	Y		
	2	Y			Cocaine (free base)	Y		
	3	Y			Cocaine (free base)	Y		
Methamphetamine	1	Y			Methamphetamine hydrochloride	Y		
	2	Y			Methamphetamine hydrochloride	Y		
	3	Y			Methamphetamine hydrochloride	Y		
Heroin	1			Y	Heroin (57%)	Y	Thioacetic Acid (4%)	Misc. Other (12%)

Sample	Trial	Match? Y/N	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
	2			Y	Heroin (59%)	Y	Trimethylsilyl/Trimethylsiloxyac 3%, Misc. Other 8%	
	3	N					Excessive Analysis Time	
Mannitol	1	Y			D-Mannitol	Y		
	2	Y			D-Mannitol	Y		
	3	Y			D-Mannitol	Y		
Niacinamide	1	Y			Nicotinamide	Y		
	2	Y			Nicotinamide	Y		
	3	Y			Nicotinamide	Y		
Boric Acid	1	Y			Boric Acid	Y		
	2	Y			Boric Acid	Y		
	3			Y-2	Boric Acid- 58%	Y	Glass,borosilicate 34%	
Inositol	1	Y			myo-inositol	Y		
	2	Y			myo-inositol	Y		
	3	Y			myo-inositol	Y		
Caffeine	1	Y			Caffeine	Y		
	2	Y			Caffeine	Y		
	3	Y			Caffeine	Y		
Quinine	1	Y			Quinine	Y		
	2	Y			Quinine	Y		
	3	Y			Quinine	Y		
RDX	1	Y-2			RDX/HMX	Y	RDX (cyclonite)	
	2	Y			RDX/HMX	Y		
	3	Y-2			RDX/HMX	Y	RDX(cyclonite)	
Ammonium Nitrate (Prills)	1	Y			Ammonium nitrate	Y		
	2	Y			Ammonium nitrate	Y		
	3	Y			Ammonium nitrate	Y		
Ammonium Perchlorate	1	Y			Ammonium perchlorate	Y		

Sample	Trial	Match? Y/N	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
	2	Y-5			Ammonium perchlorate	Y	Mn (II) perchlorate, Mg perchlorate 6H2O	
	3	Y-4			Ammonium perchlorate	Y	Mn (II) perchlorate, Mg perchlorate 6H2O	
Sugar	1	Y			Sugar	Y		
	2	Y			Sugar	Y		
	3	Y			Sugar	Y		
Cumin	1	N					Excessive Analysis Time	
	2	N					Excessive Analysis Time	
	3	N					Excessive Analysis Time	
Urea Nitrate	1	Y			Urea Nitrate	Y		
	2	Y			Urea Nitrate	Y		
	3	Y			Urea Nitrate	Y		
Ammonium Nitrate Powder	1	Y			Ammonium nitrate	Y		
	2	Y			Ammonium nitrate	Y		
	3	Y			Ammonium nitrate	Y		
Mineral Spirits	1	Y			Spectracide Pro (cont.)	N	Wasp & Hornet Killer	
	2	Y			Spectracide Pro (cont.)	N	Wasp & Hornet Killer	
	3	Y			Spectracide Pro (cont.)	N	Wasp & Hornet Killer	
BP 87 Octane Gasoline	1			Y	Gasoline (lot A) (91%)	Y	Gasoline (lot D)	
	2	Y			Gasoline (Lot F)	Y		
	3	Y-4			Gasoline (Lot F)	Y	Gasoline (Lots B, E & D)	
BP Diesel Fuel	1			Y	Diesel #2 (89%)	Y	Other (5%)	
	2			Y	Diesel #2 (89%)	Y	Other (6%)	
	3	Y			Diesel #2 Lot C	Y		
Kerosene	1	Y-2			Diesel (lot B)	N	Diesel (lot C)	

Sample	Trial	Match? Y/N	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
	2			Y	SpectracidePro Wasp&Hornet Killer 92%	Y	Japan Drier/Kerosene 4%	
	3			Y	Japan Drier, Kerosene, Diesel(LotB) 94%	Y	Petroleum Parathinoil, Baby Oil, Mineral Oil 2%	
Klean Strip VM&P Naptha Thinner	1	Y			Kerosene (lot B)	N		
	2			Y	VM & Naptha 85%	Y	1,3-Dimethylcycolohexane, mixture 2%	
	3			Y	VM & Naptha 84%	Y	1,3-Dimethylcycolohexane, mixture 2%	
Lamplight Lamp Oil	1	Y-2			Raid	N	Spectracide Pro Wasp & Hornet Killer	
	2	Y			Raid	N		
	3	Y			Raid	N		
Ronsonol Lighter Fluid	1	Y-2			VM&P Naptha	N	Kerosene (lot B)	
	2			Y	VM &P Naphta 92%	N	Coleman Fuel/Combustible 2%, Other 1%	
	3			Y	VM&P Naptha 92%	N	Coleman Fuel/Combustible 2%	
Kingsford Charcoal Lighter Fluid	1	Y			Spectracide Pro Wasp…	N		
	2	Y			Spectracide Pro Wasp…	N		
	3	Y			Spectracide Pro Wasp..	N		
MIXTURE SENSITIVITY								
Cocaine HCl: Caffeine (80:20)	1			Y	Cocaine HCl (lot A) (81%)	Y	Glass, borosilicate (1%)	
	2			Y	Cocaine HCL (Lot A, B, C) 82%	Y	Glass, borosilicate (2%)	
	3			Y	Cocaine HCL (Lot A, B, C)	Y	Glass, borosilicate (2%)	
Cocaine HCl: Caffeine (60:40)	1		Y		Cocaine (hydrochloride)	N		

Sample	Trial	Match? Y/N	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
	2			Y	Caffeine 78%	Y	3-[3-(trifluoromethyl)phenoxy]benzaldehyde 1%	
	3			Y	Caffeine 61%	Y	Cocaine (Lot A, B, C) 24%	
Cocaine HCl: Caffeine (50:50)	1			Y	Caffeine (70%)	Y	Cocaine HCl (lots A, B, C) (27%)	
	2			Y	Caffeine (64%)	Y	Cocaine HCL (lots A, B, C) (31%)	
	3			Y	Caffeine 85%	Y	Cocaine HCL (lots A, B, C) 12%	
Cocaine HCl: Caffeine (40:60)	1			Y	Caffeine (64%)	Y	Cocaine HCl (lots A, B, C) (17%); Glass, borosil. (1%)	
	2			Y	Caffeine 79%	Y	Glass, borosilicate 2%	
	3			Y	Caffeine 78%	Y	Glass borosilicate 2%	Other 2%
Cocaine HCl: Caffeine (30:70)	1			Y	Caffeine (93%)	Y	Other (2%)	
	2			Y	Caffeine 82%	Y	Cocaine HCL (Lots A, B, C) 16%	
	3			Y	Caffeine 92%	Y	Hexanophenane 2%	Other 2%
Cocaine Base: Caffeine (80:20)	1	Y			Cocaine (free base)	Y		
	2	N						
	3			Y	Cocaine (free base) 76%	Y	Glass, borosilicate 12%	
Cocaine Base: Caffeine (60:40)	1	N						
	2	N						
	3	N						
Cocaine Base: Caffeine (50:50)	1			Y	Caffeine (76%)	Y	N,N'-Dibenzylphthalamide (9%); other (2%)	
	2	N						
	3			Y	Caffeine 73%	Y	ethylphenylacetate 11%	Benzyl(5)-(-)-lactate11%
Cocaine Base: Caffeine	1			Y	Caffeine (78%)	Y	N,N'-Dibenzylphthalamide (7%); other (2%)	

Sample	Trial	Match? Y/N	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
(40:60)								
	2		Y		Caffeine	N		
	3			Y	Caffeine 91%	Y	Hexanophenone 3%, other 3%	
Cocaine Base: Caffeine (30:70)	1	N						
	2	N						
	3			Y	Caffeine 80%	Y	Benzl-3-brumoproplyether 2%	glass borosilicate 2%
Methamphetamine: DMS (80:20)	1	Y-2			Methamphetamine HCl	Y	Methamphetamine	
	2			Y	Meth./Meth HCL 96%	Y	Glass, borosilicate 1%	
	3			Y	Meth/Meth. HCL 79%	Y	4-Bromophenylbipronic 2, glass, borosil. 1%	
Methamphetamine: DMS (60:40)	1			Y	Dimethyl Sulfone (57%)	Y	methamphetamine and meth. HCl (41%)	
	2			Y	Meth./Meth. HCl 60%	Y	Dimethyl Sulfone 37%	
	3			Y	Meth/Meth. HCL 69%	Y	Potassium hexachloropalladate 3%	
Methamphetamine: DMS (50:50)	1			Y	Dimethyl Sulfone (83%)	Y	Other (9%)	
	2	N						
	3			Y	Dimethyl Sulfone 73%	Y	Meth/Meth HCL 24%	glass, borosilicate2%
Methamphetamine: DMS (40:60)	1			Y	Meth./Meth. HCl (53%)	Y	Dimethyl Sulfone (45%)	
	2			Y	Meth./Meth. HCl (53%)	Y	Dimethyl Sulfone (45%)	
	3			Y	Dimethyl Sulfone 67%	Y	Meth/Meth HCL 31%	
Methamphetamine: DMS (30:70)	1			Y	Dimethyl sulfone (78%)	Y	Meth./Meth. HCl (21%)	
	2			Y	Dimethyl sulfone (76%)	Y	Meth./Meth HCL 22%	

Sample	Trial	Match? Y/N	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
	3	Y			Dimethyl Sulfone	Y		
Heroin: Quinine (80:20)	1			Y	Quinine (75%)	Y	Di-allate (8%)	Glass, borosilicate (2%)
	2	N						
	3	N						
Heroin: Quinine (60:40)	1			Y	Quinine (87%)	Y	Glass, borosilicate (2%)	
	2	N						
	3	N					Excessive Analysis Time	
Heroin: Quinine (50:50)	1	N						
	2		Y-2		Quinine	N	Hydroquinine	
	3	Y			Quinine	Y		
Heroin: Quinine (40:60)	1	Y			Quinine	Y		
	2	Y			Quinine	Y		
	3			Y	Quinine 57%	Y	Di-allate (16%)	
Heroin: Quinine (30:70)	1	Y			Quinine	Y		
	2			Y	Quinine 64%	Y	Heroin 33%, glass borosilicate 1%	
	3	Y			Quinine	Y		
Ammonium Nitrate: Sugar (80:20)	1	Y			Ammonium nitrate	Y		
	2			Y	Ammonium nitrate 84%	Y	Sucrose, Sugar,granulated, Confectioners Sugar 20%, Nitric Acid 2%	
	3	Y-2			Ammonium nitrate	Y	Nitric Acid	
Ammonium Nitrate: Sugar (60:40)	1			Y	Sucrose, sugar, graulated, conf. sugar (72%)	Y	Ammonium nitrate (26%)	
	2			Y	Ammonium nitrate 84%	Y	Sucrose, Sugar,granulated, Conf. Sugar 14%	

Sample	Trial	Match? Y/N	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
	3			Y	Sucrose, sugar, graulated, conf. sugar (67%)	Y	Ammonium nitrate (29%)glass, borosilicate 1%	
Ammonium Nitrate: Sugar (50:50)	1	N			No Match			
	2	Y			Ammonium Nitrate	Y		
	3			Y	Silver Nitrate 50%	N	Mn II nitrate tetrahyd/Ammonium bicarb 50%	
Ammonium Nitrate: Sugar (40:60)	1	Y			Ammonium nitrate	Y		
	2	Y			Sugar	Y		
	3	Y			Ammonium Nitrate	Y		
Ammonium Nitrate: Sugar (30:70)	1	Y			Sugar	Y		
	2	Y			Sugar	Y		
	3	Y			Sugar	Y		
Ammonium Nitrate: Cumin (80:20)	1		Y-10		Am. Nitrate	N	silver nitrate; Mn (II) nitrate tetrahydrate; etc.	
	2	N					Excessive Analysis Time	
	3	N					Excessive Analysis Time	
Ammonium Nitrate: Cumin (60:40)	1	N					Excessive Analysis Time	
	2	N					Excessive Analysis Time	
	3	N					Excessive Analysis Time	
Ammonium Nitrate: Cumin (50:50)	1	N					Excessive Analysis Time	
	2	N					Excessive Analysis Time	
	3	N					Excessive Analysis Time	
Ammonium Nitrate: Cumin (40:60)	1	N					Excessive Analysis Time	
	2	N					Excessive Analysis Time	

Sample	Trial	Match? Y/N	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
	3	N					Excessive Analysis Time	
Ammonium Nitrate: Cumin (30:70)	1	N					Excessive Analysis Time	
	2	N					Excessive Analysis Time	
	3	N					Excessive Analysis Time	
SPECIFICITY								
d,l-Amphetamine Sulfate	1	N						
	2	N						
	3			Y	D-Amphetamine sulfate 65%	Y	Glass, borosil. 8%, 2-phenylpropylisobutyrate 7%	
MDMA	1	N					very small amount	
	2	N						
	3	N						
MDA	1			Y	MDMA (64%)	N	Piperonyl acetate (4%)	Other (2%), Glass (1%)
	2	N						
	3			Y	MDMA HCL 59%	N	Glass, borosilicate 5%	Piperonylacetate 4%
MDEA	1	N						
	2	N						
	3	N						
Morphine Sulfate	1	Y			Morphine sulfate	Y		
	2	Y			Morphine sulfate	Y		
	3	Y			Morphine sulfate	Y		
Codeine Sulfate	1	Y			Codeine sulfate	Y		
	2	Y			Codeine sulfate	Y		
	3	Y			Codeine sulfate	Y		
Benzocaine	1	Y			Benzocaine	Y		

Sample	Trial	Match? Y/N	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
	2	Y			Benzocaine	Y		
	3	Y			Benzocaine	Y		
Lidocaine	1	Y			Lidocaine	Y		
	2	Y			Lidocaine (Lot B)	Y		
	3	Y			Lidocaine (Lot B)	Y		
Procaine	1	Y			Procaine hydrochloride	Y		
	2	Y			Procaine hydrochloride	Y		
	3	Y			Procaine hydrochloride	Y		
Acetylsalicylic Acid (ASA)	1	Y			Acetylsalicylic acid	Y		
	2	Y			Acetylsalicylic acid	Y		
	3	Y			Acetylsalicylic acid	Y		
Ibuprofen	1	Y			Ibuprofen	Y		
	2	Y			Ibuprofen	Y		
	3	Y			Ibuprofen	Y		
Guaifenesin	1	N						
	2	N						
	3	N						
Diphenhydramine	1	Y			Diphenhydramine HCl	Y		
	2	Y			Diphenhydramine HCl	Y		
	3	Y			Diphenhydramine HCl	Y		
Chlorpheniramine	1	N						
	2	N						
	3	N						
Pseudoephedrine	1	Y			(+)-Pseudoephedrine HCl	Y		
	2	Y			(+)-Pseudoephedrine	Y		

Sample	Trial	Match? Y/N	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
					HCl			
	3	Y			(+)-Pseudoephedrine HCl	Y		
Dimethyl Sulfone (DMS)	1	Y			Dimethyl sulfone	Y		
	2	Y			Dimethyl sulfone	Y		
	3	Y			Dimethyl sulfone	Y		
Baking Soda	1	Y			Sodium bicarbonate	Y		
	2	Y			Sodium bicarbonate	Y		
	3	Y			Sodium bicarbonate	Y		
Acetaminophen (ACE) (Crushed Tab)	1	Y			Acetaminophen	Y		
	2	Y			Acetaminophen	Y		
	3	Y			Acetaminophen	Y		
Urea	1	Y			Urea	Y		
	2	Y			Urea	Y		
	3	Y			Urea	Y		
Ferric Nitrate	1	Y			Iron(III)nitrate monohydrate	Y	crystalline	
	2	Y			Iron(III)nitrate nonohydrate	Y		
	3	Y			Iron(III)nitrate nonohydrate	Y		
Sodium Perborate	1	Y			sodium perborate tetrahydrate	Y		
	2	Y			sodium perborate tetrahydrate	Y		
	3	Y			sodium perborate tetrahydrate	Y		
Fertilizer (13% Total N) Prills	1	Y			sulfur powder	N		

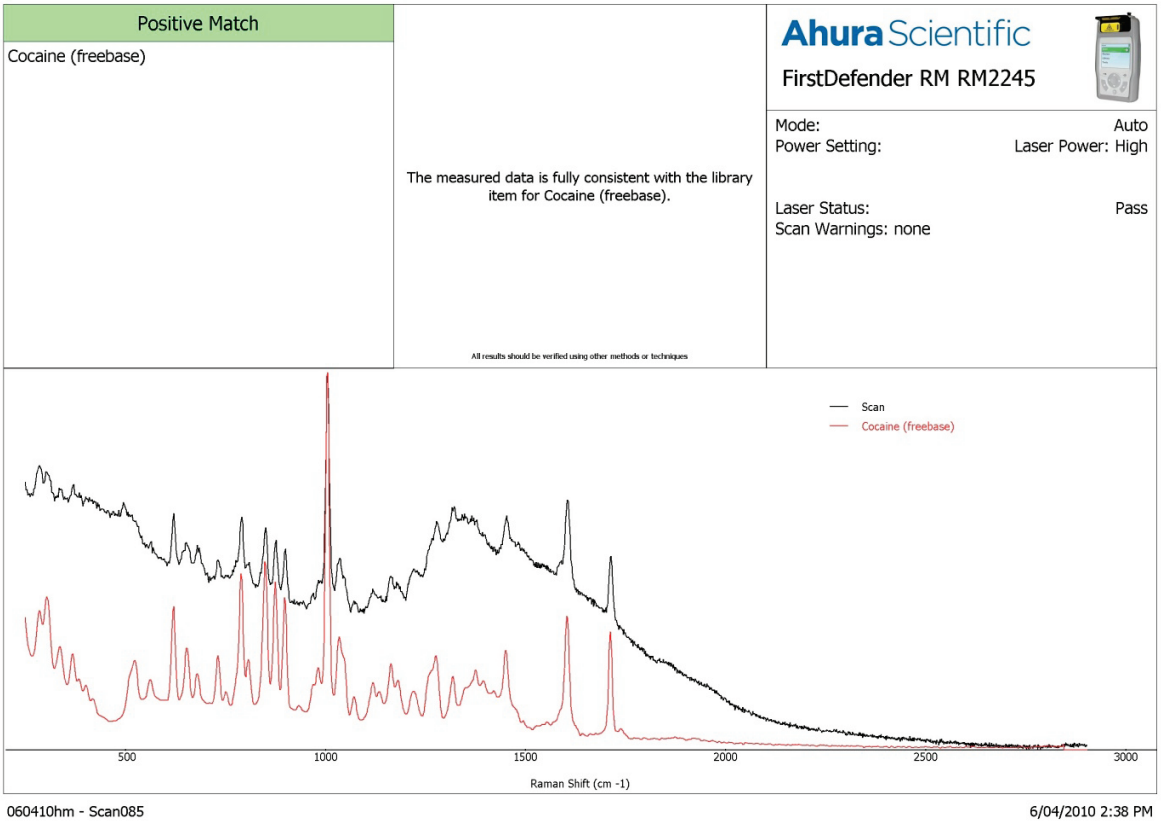
Sample	Trial	Match? Y/N	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
	2	Y			sulfur powder	N		
	3	Y			sulfur powder	N		
Fertilizer (13% Total N) – Ground	1		Y-2		Sulfur powder	N		
	2	N						
	3	Y			sulfur powder	N		
Turmeric: Cardamom (50:50)	1	N					high fluorescence	
	2	N					Excessive Analysis Time	
	3	N					Excessive Analysis Time	
Sodium Hydroxide (Lye) (Pellets)	1	N					Excessive Analysis Time	
	2	N						
	3	N						
Sulfuric Acid	1	Y			Sulfuric Acid	Y		
	2	Y			Sulfuric Acid	Y		
	3	Y			Sulfuric Acid	Y		
Ammonium Hydroxide	1	N						
	2	N					Excessive Analysis Time	
	3	N					Excessive Analysis Time	
Citric Acid	1	Y			Citric acid monohydrate	Y		
	2	Y			Citric acid monohydrate	Y		
	3	Y			Citric acid monohydrate	Y		
PORTABILITY								
Performance Check	1	Y			Pass	Y		
6/4/10 Manatee County	2	Y			Pass	Y		
	3	Y			Pass	Y		

Sample	Trial	Match? Y/N	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
PREVIOUS ID:								
501: 7.5 mg Hydrocodone/500 mg ACE	1	Y			Acetaminophen	Y		
501: (Lortab)	2	Y			Acetaminophen	Y		
501	3	Y			Acetaminophen	Y		
502: 100 mg Propoxyphene/ 650 mg ACE	1	Y			Acetaminophen	Y		
502: (Darvocet)	2			Y	Acetaminophen (84%)	Y	3,5-bis(trifluoromethyl)phenyl (2%)	
502	3	Y			Acetaminophen	Y		
503: 15 mg Oxycodone HCl	1	N						
503: (Roxicodone)	2	N						
503	3			Y	a-lactose monohydrate	N	Glass, borosilicate; 1-[3-(trimethoxysilyl)propyl	
504: 30 mg Oxycodone HCl	1	N						
504: (Roxicodone)	2			Y	a-lactose monohydrate (46%)	Y	Oxycodone HCl (29%)	Glass, borosilicate (7%)
504	3			Y	a-lactose monohydrate	N	N-(-3-trimethoxysilyl)propyl; glass borosilicate	
505: Cocaine Base	1	Y			Cocaine (free base)	Y		
505	2	Y			Cocaine (free base)	Y		
505	3	Y			Cocaine (free base)	Y		
506: 2 mg Alprazolam (Xanax)	1		Y		Doxycyline Hyc 20 mg	N		
506	2	N						
506	3			Y	Doxycycline Hyc 20 mg	N	Corn starch & Other	
507: Cocaine Base	1	Y			Cocaine (free base)	Y		

Sample	Trial	Match? Y/N	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
507	2	Y			Cocaine (free base)	Y		
507	3	Y			Cocaine (free base)	Y		
508: Lidocaine	1	Y			Lidocaine HCl monohydrate	Y		
508	2	Y-2			Lidocaine HCl monohydrate	Y	Lidocaine (lot A)	
508	3	Y			Lidocaine HCl monohydrate	Y		
509: 10 mg Methadone HCl	1			Y	a-lactose monohydrate (85%)	N	Glass, borosilicate (4%)	
509: (Methadone)	2			Y	a-lactose monohydrate (75%)	N	Glass, borosilicate (1%)	Ethoxyacetic Acid (1%)
509	3			Y	a-lactose monohydrate	N	Glass, borosilicate	
510: Cocaine Base	1	Y			Cocaine (free base)	Y		
510	2	Y			Cocaine (free base)	Y		
510	3	Y			Cocaine (free base)	Y		
511: Heroin	1	N					Excessive Analysis Time	
511	2	N					Excessive Analysis Time	
511	3	N					Excessive Analysis Time	
50: Cocaine HCl	1	Y			Cocaine (hydrochloride)	Y		
50	2	Y			Cocaine (hydrochloride)	Y		
50	3	Y			Cocaine (hydrochloride)	Y		
49B: Cocaine Base	1	Y			Cocaine (free base)	Y		
49B	2	Y			Cocaine (free base)	Y		
49B	3	Y			Cocaine (free base)	Y		
44B: Cocaine Base	1	Y			Cocaine (free base)	Y		
44B	2	Y			Cocaine (free base)	Y		

Sample	Trial	Match? Y/N	Similar	Mix	Primary ID	Correct? Y/N	Other ID(s)/ Comments	Other ID(s)/ Comments
44B	3	Y			Cocaine (free base)	Y		
39: Heroin	1	N					Excessive Analysis Time	
39	2	N					Excessive Analysis Time	
39	3	N					Excessive Analysis Time	
38: Heroin	1	N					Excessive Analysis Time	
38	2	N					Excessive Analysis Time	
38	3	N					Excessive Analysis Time	
35: Heroin	1	N					Excessive Analysis Time	
35	2	N					Excessive Analysis Time	
35	3	N					Excessive Analysis Time	
34: Heroin	1	N					Excessive Analysis Time	
34	2	N					Excessive Analysis Time	
34	3	N					Excessive Analysis Time	
10: Cocaine Base	1	N			No Signal		small amount in vial	
10	2	Y			Cocaine (hydrochloride)	Y		
10	3	Y			Cocaine (hydrochloride)	Y		
9: NCSD, Fake Cocaine Base	1	Y			Acetaminophen			
9	2	Y			Acetaminophen			
9	3	Y			Acetaminophen			

APPENDIX B



Cocaine Base Spectral Comparison Report