THE
INTERAGENCY
BOARD
FOR EQUIPMENT STANDARDIZATION AND
INTEROPERABILITY

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Infrared Chemical Detector Procurement Guidance

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CONTENTS

THE INTERAGENCY BOARD (IAB) 3

ACKNOWLEDGEMENTS 5

1 PURPOSE 7

2 A BASIC OVERVIEW OF INFRARED SPECTROSCOPY 7

3 FACTORS TO CONSIDER FOR INFRARED SPECTROSCOPY FIELD USE 10

3.1 Sufficient Material 10
3.2 Mixtures 11
3.3 The Library 11
3.4 Illumination and Interrogation 12
3.5 Combining Technologies 13

4 GUIDANCE FOR THE PROCUREMENT PROCESS 14

4.1 Establish a Team of Knowledgeable Personnel 14
4.2 Research the IAB SEL 15
4.3 Identify the Mission Space Assumptions 15
4.4 Identify and Contact Prospective Manufacturers and Vendors 16
4.5 Perform Evaluation and Downselect 16

5 REFERENCES 17

6 APPENDIX A – INFRARED ELEMENTS WITH DISCUSSION / QUESTIONS 19

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The InterAgency Board (IAB)

The ***InterAgency Board for Equipment Standardization and Interoperability*** (IAB) was founded in 1998 by the Department of Defense (DoD) and the Federal Bureau of Investigation (FBI) Weapons of Mass Destruction (WMD) Countermeasures Unit and was sanctioned by the US Attorney General as a resource for federal, state and local governments. An all-volunteer organization, it has evolved from its WMD focus to all-hazards response, with a special emphasis on CBRNE (Chemical, Biological, Radiological, Nuclear, and Explosive) issues. Members include active emergency responder members and subject matter experts from law enforcement, firefighting, emergency management, medical/health, emergency communications, and other relevant disciplines.

The IAB is a unique national public resource – the only existing volunteer organization in which emergency responders from all disciplines collaborate to discuss equipment requirements, operational policies, and responder safety issues. For example, the IAB was responsible for the first CBRN standard for Self-Contained Breathing Apparatus, which drove a fundamental change in personal protective equipment (PPE) for responders across the country. Their Standardized Equipment List (the SEL) [1] is a technology reference for all responders and is used by the Federal Emergency Management Agency (FEMA) in establishing eligible equipment for their Homeland Security Grant Programs. Recently, the IAB has addressed serious carcinogenic problems in post-fire environments, the impact of untreated severe mental illness on community first responders and law enforcement, and the hosting of two Active Shooter Summits. One effort, a critical paper on responding to events involving synthetic opioids, was used by the National Security Council in preparing their national guidance. In addition, IAB members work with many standards development organizations such as ASTM and The National Fire Protection Association (NFPA), helping to ensure meaningful, practical standards, particularly in personal protection and safety.

The most visible output produced by the IAB is the SEL. The SEL was originally developed in the late 1990s to assist the DoD, the National Institute of Justice and the FBI in identifying equipment items that were necessary for a standardized response among local, federal and DoD assets during a domestic incident involving CBRNE

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materials. In the mid-2000s the SEL grew into an "all hazards" equipment list with additional information concerning operating considerations, important features, training impacts, relative costs and mandatory and recommended standards. The SEL provides input to FEMA's Grant Programs Directorate (GPD) for items that should be listed on the Authorized Equipment List (AEL) to determine grant eligibility. The SEL and AEL utilize the same item numbering system and are approximately 90% congruent with the items listed. While the AEL lists only the equipment title and description, the SEL goes further by providing equipment selection and operational considerations. Neither list contains any brand name items – SEL/AEL items represent generic equipment/technology types.

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1 Purpose

This Procurement Guidance Document is intended to assist emergence response organizations with the process of evaluating infrared (IR) spectroscopy-based chemical detection equipment for purchasing for field use. It is applicable to systems that utilize IR spectroscopy as their sole detection modality, as well as the IR spectroscopy-based portion of chemical detection equipment with multiple sensing modalities (e.g. combined Raman/Fourier-transform infrared (FTIR) systems); accompanying guidance on Raman-based systems is also available [2]. This guidance is NOT intended for systems performing Infrared Thermography (IRT), also known as thermal imaging.

2 A Basic Overview of Infrared Spectroscopy

There are websites that provide a good overview of the history and science of infrared spectroscopy [3, 4]. In short, infrared spectroscopy is a technique for interrogating molecules with light. Examining how the incoming light changes after interacting with the molecule provides information about the molecule's structure. The structure of the molecule – what elements are present, how the atoms are attached to one another, and how the molecule is shaped in its local environment – governs the response, or spectrum, obtained from the molecule. As the incoming light interacts with the molecules, those molecules ***may*** absorb light at frequencies that are resonant with the specific vibrations. Infrared spectroscopy is named as such as most of these resonant frequencies fall in the infrared region of the electromagnetic spectrum. For light, energy is directly proportional to its frequency; as such, energy and frequency are interchangeable.

Molecules are constructed from their constituent atoms which are bonded to one another in a pattern that is unique to that specific molecule. Similar to masses attached by a spring, these bonds vibrate at a characteristic frequency specific to the masses and bonding involved. The more complex a molecule is, the greater the number of vibrations (modes) that may be accessible. Spectroscopists use the general formula of 3N – 6, where N is the number of atoms, to calculate the number of

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vibrational modes in the molecule (for linear molecules, the formula is 3N – 5). A simple molecule such as carbon monoxide (CO) has only one vibrational mode, while benzene (C_6H_6) has 30 vibrational modes.

It is noted that just because incoming light is resonant with a vibrational frequency in a molecule does not mean that a molecule will absorb at that frequency. Only those molecular vibrations that cause the molecule's electric dipole moment (distribution of positive/negative charges within the molecule) to change will lead to absorption. Nitrogen (N_2) has one vibrational mode, a symmetric stretch; as no change in dipole moment is created by this motion, it cannot be observed via infrared spectroscopy (this vibration can be observed by Raman spectroscopy, however). Carbon dioxide (CO_2), as a linear molecule, has four vibrational modes: a symmetric stretch, an antisymmetric stretch and two bending modes that are degenerate (same vibrational frequency) [5]. The symmetric stretch (Fig. 1, upper left) does not change the dipole moment, and as such, it is not infrared-active. The other three modes are infrared active, giving rise to strong absorption of infrared energy. Similarly, infrared spectroscopy is useful for the detection of methane (CH_4) but cannot be used to detect hydrogen (H_2).

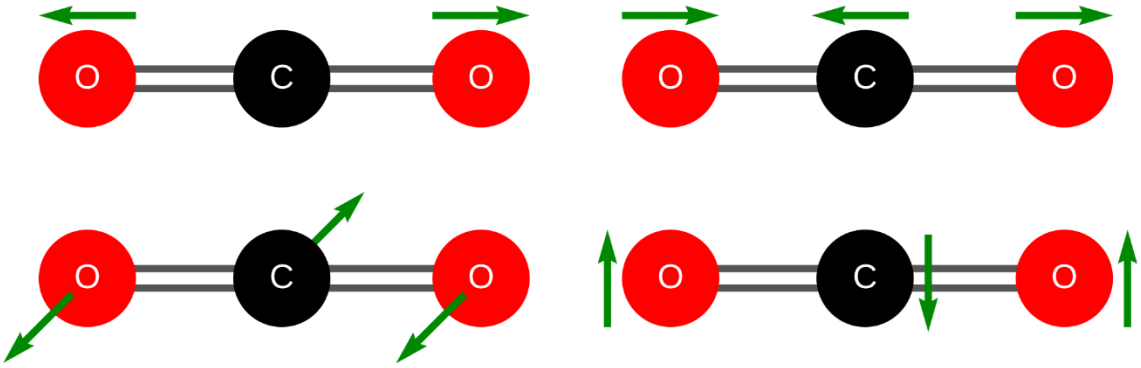

Figure 1. Stretching and bending oscillations of the CO_2 molecule. Upper left: symmetric stretching. Upper right: antisymmetric stretching. Lower line: degenerate pair of bending modes. Reproduced from [5].

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Infrared spectroscopy usually refers to use of the mid-infrared region of the electromagnetic spectrum to study vibrational modes [4, 6]. This region is from 2.5 to roughly 25 microns (μm) in wavelength, however, vibrational frequencies are commonly expressed in wavenumber units (cm^{-1}); the mid-infrared region covers vibrations in the range 400 cm^{-1} to 4,000 cm^{-1}. Using wavenumber units allows for direct comparison with vibrational frequencies obtained from Raman spectroscopic measurements [2, 7, 8]. Some characteristic intramolecular vibrations for larger molecules, along with intermolecular vibrations of crystalline solids may be observable in the far-IR/terahertz region below 400 cm^{-1} [9, 10]. Near-infrared (NIR) spectroscopy can be utilized to study vibrations that are highly excited (overtones) or combinations of vibrations where the excitation energy is essentially a sum of the constituent vibrations.

Infrared spectroscopy has proved useful for field applications towards identification of unknown materials. The spectrum obtained from the unknown material is compared against a library of spectra stored internally to attempt identification of the material being interrogated. Mathematical techniques (chemometric algorithms) are used to rank the internal library spectra against the collected spectrum, with the field instrument reporting the top scoring material (or materials) to the end user as possible identification of the unknown material.

There are different techniques that have been developed to perform infrared spectroscopic measurements. For spectral measurements, one common technique, Fourier Transform Infrared (FTIR) spectroscopy, uses a mathematical function to perform measurements at multiple frequencies simultaneously in one domain (e.g. time or linear spatial dimension) to the spectral frequency domain [11, 12] Alternatively, as in the case of tunable diode laser absorption spectroscopy (TDLAS), the operating frequency of a laser is swept while monitoring for changes in the intensity of the signal [13]. With regard to sampling, gases are typically sampled through direct transmission/absorbance measurements as they are largely transparent except for sharp absorption features. For solid and liquid samples, their spectra are commonly obtained using the Attenuated Total Reflectance (ATR) technique, where infrared light is propagated through a thin crystal in contact with the sample, with the sample absorbing at its characteristic vibrational frequencies as the light propagates through the crystal. Note that this technique does not interrogate the

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bulk of the sample, but instead only those molecules within microns of the surface [14]. As this list is not exhaustive, please obtain subject matter expertise from your friendly neighborhood spectroscopist where necessary.

3 Factors to Consider for Infrared Spectroscopy Field Use

There are a number of detection techniques available for field use, each with their own advantages and disadvantages. It is important for end users to understand where pitfalls lie prior to allocating scarce resources towards the acquisition of one or more field units. End users should consider all aspects of their concept of operations (CONOPS) prior to acquiring any new technology, and certainly infrared spectroscopy-based field units are no different. Ranking features most pertinent to your CONOPS prior to engaging with vendors allows buyers to be better informed ahead of engaging with commercial sales representatives, thus ensuring pertinent features are available on systems before acquisition. Below are technical considerations that are appropriate to using infrared spectroscopy in the field.

3.1 Sufficient Material

Absorbance is directly related to the concentration (number of molecules in a volume) of a material times the interrogated pathlength [15]. In other words, for an infrared spectrum to be obtained from an unknown material, enough material must be present in the optical pathlength to absorb enough light (number of photons) to produce a detectable difference. As such, infrared spectroscopy for field use is most suitable for interrogating bulk quantities of materials, not trace quantities. For the purposes of this discussion, if a solid/liquid material can be seen with the naked eye (e.g., visible residues on a surface, a bag of powder, a bottle of liquid), the quantity of material is above trace levels. While infrared microscopy is applicable for laboratory studies, it is currently more appropriate for certain forensic applications [16] and not for general use as a rapid screening tool.

The mathematical formula for absorbance doesn't care about the relative location of the molecules, nor does it separate the concentration from pathlength. This becomes particularly pertinent for detection of gases. For example, the absorbance measured

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from 1 meter of methane at its 100% Lower Explosion Limit (LEL) concentration would be identical to that of 25% LEL over 4 m. Similarly, if interrogating over a 100 m distance, the signal obtained from a cloud of ammonia 10 m away would appear identical to the same cloud 50 m away. If a field unit is unable to determine the pathlength being interrogated, hazards may be reported in units such as %LEL*m or similar, which leaves the end user having to determine the true hazard level based on their estimation of the pathlength. This factor should be considered when developing guidance to end users, such as thresholds for barring entry, to ensure sufficient personnel safety. True concentration can be determined if the pathlength is known, such as through range measurement or by direct sampling into an internal gas cell with fixed length. End users should ask questions regarding technical specifications such as limits of detection, concentration determination and accuracy, optical pathlength, etc. prior to purchase.

3.2 Mixtures

The identification of mixtures is challenging for infrared spectroscopy for similar reasons – sufficient quantities of individual components in the mixture must be present AND these components must have appreciable signatures in the infrared. As a rule of thumb, components must be at least 10% or more of the total composition to be identifiable; however, a material cannot be detected if it does not appreciably absorb in the infrared. In other words, identifying a pill as lactose via infrared spectroscopy DOES NOT mean that heroin is not present; it means that the bulk of the material interrogated by the instrument was appreciably lactose. A recent study showed that the limit of detection of 3,4-Methylenedioxymethamphetamine (MDMA) via ATR-FTIR was 25% by weight [17]. False negatives for street drugs are likely for dilute mixtures, and other means of detection (e.g., colorimetric testing) should be employed where appropriate. It is also noted that water is a strong absorber of infrared light; as such, Raman spectroscopy is often preferred for analysis of aqueous samples [18].

3.3 The Library

A fielded infrared spectrometer is only as good as its library! End users should review the list of chemicals contained within the unit's internal library to ensure maximum potential to detect materials pertinent to your CONOPS. A handheld infrared

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spectrometer may provide a result of "NO MATCH" (or similar) or even potentially misidentify an unknown chemical based on the result of its internal chemometric algorithm. Ideally, the library spectra in on-board spectral libraries should be of single, high-purity samples/standards. It may be useful to discuss quality control processes used by the vendor in the generation of their spectral library; for example, if a library spectrum for methamphetamine were collected from a sample containing 50% ephedrine, only mixtures of methamphetamine/ephedrine will result in an identification as "methamphetamine". Changes in material phase (e.g., solid to liquid, change in crystal structure) can dramatically alter the infrared spectrum; for example, phase changes in solid acetaminophen with temperature can be observed using infrared spectroscopy [19]. Performing preliminary testing of certain library spectra to ensure correct results, either individually or in collaboration with other agencies, can provide higher confidence in the quality of vendor libraries.

3.4 Illumination and Interrogation

For techniques such as TDLAS that utilize an infrared laser as the illumination source, safety concerns discussed in IABPUB 2025-01 Field Raman Chemical Detector Procurement Guidance [2] may still be applicable. Infrared light is generally invisible to the eye, though the eye has some sensitivity in the NIR range [20]. This means a strong infrared laser source capable of permanent eye damage could appear faint to the casual observer, leading to a false sense of safety. End users should review product information closely to understand any ocular hazards presented by fielded equipment. Consider such hazards when developing procedures for field use to ensure safety of personnel and bystanders, and use personal protective equipment as appropriate.

For use of techniques such as ATR-FTIR, hazards arising from infrared illumination are generally not of concern. Unlike laser-based, the internal source should be low power and will not present ocular hazards or potentially ignite samples. Hazards are more likely to be associated with the handling of unknown materials under interrogation. ATR requires the sample to be in close contact with the internal crystal, which is often accomplished by applying pressure to the sample. Caution should be taken when interrogating materials that may be friction or shock sensitive, such as primary explosives.

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The mathematical formula for absorbance ratios the signal obtained from a sample with that of the source alone [15]. Typically, a user performs a background measurement of the empty spectrometer before measuring the sample spectrum. Care must be taken to avoid introducing external signals that can affect obtained results. For example, if the spectrometer's background spectrum is contaminated with sharp infrared emission lines that might be present in fluorescent lighting, and the sample spectrum is not contaminated, it will lead to NEGATIVE peaks in the resulting spectrum. Presence of negative peaks are likely to lead to failure of the spectrometer's library matching algorithm to properly identify the material being interrogated. Users may wish to review obtained spectra, particularly when a result of "NO MATCH" is obtained, to look for the possible presence of appreciable negative peaks .

3.5 Combining Technologies

Finally, use of IR spectroscopy-based field detection systems may be worth considering in conjunction with Raman spectroscopy-based field detection systems. Raman spectroscopy is similar to infrared spectroscopy in that spectra consist of molecular vibrations present in the sample; these techniques are *complimentary* but are not identical as they may not probe some, or any, of the same vibrations. The spectral range of handheld FTIR spectrometers are typically wider than Raman spectrometers and include the C-H stretching region. This may be useful for identifying weak hydrocarbon fuel components mixed with strong oxidizers e.g. ammonium nitrate fuel oil (ANFO) mixtures.

There are additional pros/cons to be considered; for example, Raman spectroscopy which has through-barrier capability (barrier material-dependent) and some standoff capability, utilizes a laser and may introduce ocular hazards to personnel or lead to burning/ignition of materials if heating from laser absorption is significant. Users can review IABPUB 2025-01, Field Raman Chemical Detector Procurement Guidance [2] at the InterAgency Board website for complementary guidance on these systems.

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4 Guidance for the Procurement Process

The IAB recognizes that the wide variety of infrared spectrometer applications and characteristics can make selection of devices for procurement challenging. The variabilities between manufacturers can be dramatic. Understanding both the intended CONOPS and the details of how the device will be used has a significant impact on the selection process.

This guidance document is intended to support those charged with the selection and procurement of infrared spectrometers through an informed selection process. In addition, it provides information that will enhance the knowledge of the end user concerning the device's true capabilities and limitations. The IAB believes that the evaluation process and factors presented will raise the level of understanding concerning the TRUE capabilities of these instruments.

The recommendations within this document are designed to assist the agency through the various steps of evaluation. The agency should follow an organized assessment process.

4.1 Establish a Team of Knowledgeable Personnel

From within your organization and/or other allied organizations, develop a team of anticipated users, persons knowledgeable in detection devices, procurement personnel and, if available, subject matter experts (SMEs) to aid in the evaluation program.

EVALUATION TEAM SELECTED	
ROLE	NAME/ORGANIZATION
Project Manager	
End User	
End User	
End User	
Subject Matter Expert	
Procurement Officer	

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4.2 Research the IAB SEL

Use the SEL website, www.interagencyboard.org/sel, to determine important features, operational considerations, training requirements, and applicable standards for the appropriate equipment item(s) from the following list:

- 07CD-01-FTIR, Detector, Fourier Transform Infrared, Point
- 07ED-01-IRED, Detector, Explosive, Infrared Spectroscopy

List the considerations identified in the SEL that are deemed to be important to your CONOPS and why.

List the considerations identified in the SEL that are deemed important to your consideration and explain why they are important.

4.3 Identify the Mission Space Assumptions

Determine the anticipated application(s) of the device(s). Consider factors such as conditions of use, anticipated chemicals to be encountered, sampling methods, method of storage, means of maintenance and calibration, and methods of user training and competency maintenance. Identify what your organization considers to be "Must Have," "Desired," and "Other" features for the device.

ANTICIPATED CONDITIONS FOR USE	ANTICIPATED CHEMICALS ENCOUNTERED

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MUST-HAVE FEATURES	NICE-TO-HAVE FEATURES	OTHER FEATURES

4.4 Identify and Contact Prospective Manufacturers and Vendors

Select potential equipment manufacturers and their vendor points of contact. Perform internet searches, investigate vendors at trade shows, inquire with colleagues in other organizations. The vendor representative should be prepared to answer detailed questions concerning the characteristics, capabilities and limitations of the instrument. Request any/all available documentation (e.g., brochures, specification sheets, etc.) that can be shared with the evaluation team. Obtain estimated pricing on system acquisition / sustainment where possible.

VENDOR	MODEL	POINT OF CONTACT

4.5 Perform Evaluation and Downselect

Distribute system documentation/estimated pricing to the evaluation team. Features identified above must be weighed against unit acquisition/sustainment costs! For example, System A contains thousands more compounds in its spectral libraries than System B, but if those compounds are not anticipated as part of your CONOP, is it worth paying the incremental cost increase? Your organization may be better served forgoing some features in favor of buying several lower-cost units to increase field coverage. Use information obtained above from colleagues in other agencies to assist

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where possible. Organizations may be able to obtain one or more units from vendors for field trials to assist with evaluation.

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6 APPENDIX A – Infrared Elements with Discussion / Questions

6.1 Specifications:

Ability to Add Materials to User Library	• Feature that may be useful for larger organizations that have chemical analysis capabilities (e.g., DEA) but is NOT RECOMMENDED for use by most end users. • The detector is only as good as the library it contains; if a material is misidentified when entered into the spectral library, it will cause errors in the field. For example, if fentanyl cut with baby formula is entered into the user library, it could lead to all baby formula being identified as fentanyl if proper care is not taken to ensure the spectrum entered is ONLY that of pure fentanyl.
Battery Life	• How long does a battery last? • Will this factor into what type of operations can be accomplished? • Will battery weight be a determining factor for operations?
Battery Type	• Rechargeable battery or consumable? • Is the instrument able to support multiple battery types? • Will the type of battery used hinder or enhance capabilities for the operator? • Is battery operation the only available electrical source?
Detector	• Do not expect this to be an appreciable concern of most buyers but could impact other features (e.g., ruggedness, mean time for calibration).
ITAR-restricted	• Is this a hinderance to your operations based on the stakeholders of your organization? Is this a requirement of your organization?
Laser Classification	• Should be considered in conjunction with safety features. Review laser classification versus laser safety recommendations (e.g. IEC 60825-1). Consider eye protection (PPE) if laser is Class 3/4; not required for systems where the sample is completely enclosed during interrogation.

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Onboard Data Storage / Data Export	• Can analytical results be accessed by operators at a later date, or must this information be stored external to the device? • Organizations looking to procure these units likely have a need to record spectra and save for evidentiary purposes. Prospective buyers should ask questions about the process of saving/exporting data to determine if needs are met.
Ruggedness, Environmental Rating, Operating Temperature Range	• Is this device going to be used in a field environment? Will it be carried often to multiple locations, or be primarily used in a single stationary location? Is this instrument adequately drop protected? Will normal wear and tear from operations significantly hinder the instrument's operation?
Size/Weight	• A general evaluation of size and weight should be assessed. This assessment should take into consideration these factors with the addition of any attachments in regard to anticipated modes of operation.
Spectral Range / Resolution	• Most materials can be identified from the fingerprint spectral range of ~ 400 cm^{-1} to 1900 cm^{-1}. FTIR spectrometers will typically extend above this range to the 3000 – 4000 cm^{-1} range. • Small differences in resolution when comparing systems may not be a significant factor. • Low resolution systems may be sufficient for presumptive evidence purposes. • No benefit to exceeding 4 cm^{-1} resolution for solid/liquid samples.
Spectrometer Type	• Do not expect this to be an appreciable concern of most buyers, but could impact other features (e.g., ruggedness, mean time for calibration).
Storage Temperature	• Will this instrument be able to be maintained easily within the temperatures recommended by the manufacturer? • Will this hinder operations?

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6.2 Operations:

Ability to Add Materials to User Library	• Feature that may be useful for larger organizations that have chemical analysis capabilities (e.g., DEA) but is NOT RECOMMENDED for use by most end users. • The detector is only as good as the library it contains; if a material is misidentified when entered into the spectral library, it will cause errors in the field. For example, if fentanyl cut with baby formula is entered into the user library, it could lead to all baby formula being identified as fentanyl if proper care is not taken to ensure the spectrum entered is ONLY that of pure fentanyl.
Ability to Scan Through Translucent Packaging	• Glass is a poor infrared pass-thru medium, and plastics will produce characteristic absorptions associated with polymer vibrational modes. If through-barrier capability is required, consider Raman spectroscopy as an alternative.
Ability to Switch into Various Languages	• Will this make your organization more effective when using this instrument? • Is the capability required based on the personnel within your organization?
Automated Mixture Analysis Capabilities	• Sufficient material needs to be present at the sample pathlength for detection to occur. For example, this means that while infrared spectroscopy may identify pure fentanyl, it would not be reasonably expected to detect fentanyl present in a cutting agent below a concentration less than 10% - 25% by mass.
Button Operation via Gloves	• Are buttons of a suitable size to be operated in all manner of PPE utilized by the organization?
Connectivity to Desktop	• Can this instrument connect to a desktop/laptop? • Is this capability important to anticipated operations? • Will this capability provide increased capability or greater range of use/ operational capability for the organization?

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Connectivity to Mobile	• Can this instrument connect to a mobile device? • Is this a cable connection or Bluetooth/RF connection? • Is this capability important to anticipated operations? • Will this capability provide increased capability or greater range of use/ operational capability for the organization?
Create Custom Applications (e.g., create scan parameters)	• Only recommended for advanced users.
Data Output Format Types	• Recommend data output formats that are easily accessible and interpretable (e.g., .csv, .dx) instead of proprietary formats that lead to vendor lock-in and complicate offline analysis.
Display Font	• Is the font of appropriate size and color to be read while using PPE?
Display Size	• Can the operator easily understand any written prompts by the instrument? • Can the operator adequately observe and interpret any graph/spectrum displayed by the instrument?
Display Type	• Is the display intended to communicate graphical information or only text? Is the display color, or black and white?
Laser Wavelength	• Should be considered in conjunction with laser classification and safety features to determine if eye protection is necessary and ensure proper coverage of the operating wavelength.
Power Button Location	• Is this easy to operate in PPE?
Proper Use/Deployment	• End users should fully read the manual to understand how to properly deploy the system in the field. For example, if system is sensitive to vibration, data collection should be performed on a stable surface instead of the tailboard of a running fire truck.

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Result Screen Interpretation	• It is preferable that only a single chemical / mixture result be presented to the end user to simplify use for non-experts. • Is an end-user able to display library and sample spectra overlayed to ensure there is good visual agreement between the spectra / look for additional absorption peaks that may not be accounted for? • May be useful if result screen contains additional hazard information about the chemical identified (i.e., description, common names, known synonyms).
Sampling Accessories Available	• ATR-FTIR must be in direct contact with the sample, so sample accessories are likely not necessary. • Does your anticipated use dictate a need for optional attachments or accessories for the instrument? • Are these available and how easily can they be replaced? • Are they covered under a warranty? • Can they be easily damaged or are they one-time use?
Self-contained System with No Need for External Systems to Operate	• Is the ability of the instrument to operate independently of any other device or system crucial to its anticipated operations? • Does the ability to rely on external systems provide needed enhancement to the instrument's capability or functionality? • Will this hinder or enhance operations?
Spectral Library Categories / List of Spectra	• Is the spectral library capable of satisfying anticipated operational needs for identification of materials? • Do your operations require purchase of additional libraries of spectra for identification of anticipated materials? These are important for consideration by the purchasing organization. • Recommend prospective end users review the list of materials contained within spectral libraries provided by the vendor to ensure materials of interest are included to the maximum extent possible. Prospective buyers may wish to ask questions about the library building process to ensure sufficient quality control to prevent misidentification.
Spectral Library Matching Algorithm	• How is the spectral library matching being performed? Is the vendor reporting only the best match to the library or is a more in-depth analysis being performed to prevent incorrect results?

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Touchscreen	• Does the instrument have a touch screen? • Is this capability compatible with all PPE and modes of operation? • Does this capability enhance or hinder operations based on anticipated modes of operation?
Typical Analysis Time	• Is the time required for analysis a significant criterion for evaluation based on anticipated operational modes? • Is identification accuracy affected by the speed at which a sample is analyzed? • Can the analysis time be controlled by the operator?
User Login Privileges	• Does this device have a requirement for a user login? • Is this capability desired by your organization for purposes of recordkeeping or chain of evidence?

6.3 Maintenance and upkeep:

Battery Hot Swap	• Does the unit allow for continuous operation while changing batteries? • Is this a capability that is desired based on anticipated mode of operation?
Consumables	• What consumables are required for instrument operations? • How long does it take to replace these materials or items? • What cost is associated with using these materials? (Cleaning wipes can usually be sourced independently.)
Estimated Annual Sustainment Costs	• How much does it cost to maintain the operation of this instrument for one year? • Does this cost change in subsequent years outside of normal wear and tear due to operation?
Extended Warranty Coverage	• Is this offered and what does it cover?

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Factory Calibration Needs	• Does this instrument have to be calibrated? • What additional costs and equipment are associated with the calibration requirements? • How long before the materials used to calibrate the instrument are expired or no longer capable of being used to calibrate the instrument? • Is this instrument calibrated at set intervals by the manufacturer? • How long will the instrument be unavailable due to these factory calibrations? • Who is responsible for the cost of these factory calibrations?
Factory Maintenance Needs	• Can this instrument be serviced in the field? • Is the manufacturer the only entity authorized to perform maintenance on this instrument? • What is the dwell time for maintenance?
Fleet Management Capability	• Are multiple instruments required for operations? • How does your organization plan to maintain your equipment? • Does the manufacturer provide the ability to establish agreements to manage the maintenance of multiple units as part of the purchase process?
Manufacturer Warranty	• How long is the warranty provided? • What damage and maintenance does it cover? • How long does the manufacturer take to return the instrument to the organization? • Who is responsible for cost associated with transportation to repair site.
Purchase Price	• Does this instrument fit within your organizational budget? • Can you purchase a sufficient number of units to meet your CONOPS?

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Reachback Support	• Is this offered and what level of expertise is anticipated to be fielding questions from operators of the instrument? • Available 24/7/365? • How does the user get the spectrum to the reachback support team? What type of communication capability is required to reach the support team and how responsive and knowledgeable are the experts provided? • What are the sustainment costs for accessing reachback support?
Vendor-provided Library Updates	• May add to sustainment costs.
Vendor-provided Software Updates	• May add to sustainment costs.

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