Explosives Trace Detectors (ETDs)

Market Survey Report

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FOREWORD

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions. Located within the DHS Science and Technology Directorate (S&T), the SAVER Program conducts objective assessments and validations on commercially available equipment and systems and develops knowledge products that provide relevant equipment information to the emergency responder community. The SAVER Program mission includes:

- Conducting impartial, practitioner-relevant, operationally oriented assessments and validations of emergency response equipment.
- Providing information, in the form of knowledge products, that enables decision-makers and responders to better select, procure, use and maintain emergency response equipment.

SAVER Program knowledge products provide information on equipment that falls under the categories listed in the DHS Authorized Equipment List (AEL), focusing primarily on two main questions for the responder community: "What equipment is available?" and "How does it perform?" These knowledge products are shared nationally with the responder community, providing a life- and cost-saving asset to DHS, as well as to Federal, state and local responders

The SAVER Program is managed by the National Urban Security Technology Laboratory (NUSTL). NUSTL is responsible for all SAVER activities, including selecting and prioritizing program topics, developing SAVER knowledge products, coordinating with other organizations and ensuring flexibility and responsiveness to first responder requirements.

NUSTL provides expertise and analysis on a wide range of key subject areas, including chemical, biological, radiological, nuclear and explosive hazard detection; emergency response and recovery; and related equipment, instrumentation and technologies. For this report, NUSTL conducted a market survey of commercially available vehicle tracking technology systems. These systems fall under AEL reference numbers 07ED-03-SWPE – Swipe System, Trace Explosive Detection, and 07ED-01-IMOB – Trace Detector, Explosive, Handheld.

For more information on NUSTL's SAVER Program or to view additional reports on vehicle tracking technology systems or other technologies, visit www.dhs.gov/science-and-technology/SAVER.

U.S. Department of Homeland Security

SAVER

System Assessment and Validation for Emergency Responders

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EXECUTIVE SUMMARY

Explosives trace detectors (ETDs) are used by public safety organizations to screen packages, vehicles, luggage and other items for minute residues of explosives left on them by people who have recently handled explosives. Instrument users wipe the surface of the item to be screened with a swab and insert the swab into the instrument. Analysis results are produced in less than a minute and often in less than ten seconds. Desktop-sized ETDs are used at fixed checkpoints where their relatively large size, weight, and need to operate on alternating current power can be accommodated. Alternatively, handheld ETDs used for screening activities that are mobile in nature require an easily-carried instrument that can operate on battery power.

Between June 2020 and January 2021, the National Urban Security Technology Laboratory (NUSTL) conducted a market survey of commercially available ETDs for the Systems Assessment and Validation for Emergency Responders (SAVER) program. This report provides information on handheld and desktop ETDs that were identified through that market survey effort: 21 instruments and model variants produced by 12 instrument manufacturers are included.

The analytical capabilities of ETDs currently available on the commercial market vary. Some instruments indicate that an explosives compound has been detected, while others also identify the classes of compounds or specific explosives compounds detected. Some instruments detect a wide range of explosives compound types while others detect a narrow range. Many instruments can also detect narcotics compounds, and a few can detect toxic industrial chemicals and chemical warfare agents. These differences are largely due to the type of detector technologies employed in these instruments. Features important to the use of the instruments in the field, such as instrument size and weight, water and dust resistance, ability to withstand mechanical shock and vibrations, ability to operate on battery power, and data storage and exportability, also vary among commercially available ETDs. Instrument-specific considerations include supplies and parts needed for long term instrument operation and whether federal regulations on the disposal of instruments containing radioactive material apply. Summary tables in the report allow readers to compare instruments on many operationally relevant features and capabilities.

The purpose of this market survey is to provide information that will guide emergency response agencies in making operational and procurement decisions. When making procurement decisions, emergency response agencies should carefully research the overall capabilities, limitations, and technical specifications of each product in relation to their agency's operational needs.

Information included in this report has not been independently verified by NUSTL.

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1.0 INTRODUCTION

Explosives trace detector (ETDs) are used by public safety organizations to screen packages, vehicles, luggage and other items for minute residues of explosives. To provide these organizations with information helpful for selecting among and acquiring such an instrument, the System Assessment and Validation for Emergency Responders (SAVER) program conducted a market survey on commercially available products that fall under Authorized Equipment List (AEL) reference numbers 07ED-03-SWPE, “Swipe System, Trace Explosive Detection,” and 07ED-01-IMOB, “Trace Detector, Explosive, Handheld.”

This market survey report is based on information obtained from June 2020 to January 2021 through review of product literature obtained from company web sites, industry publications, government reports, and information provided by instrument manufacturers in response to a government-issued Request for Information (RFI) posted on the System for Award Management website in September 2020.

Instruments had to meet the following criteria for inclusion in this report:

- Swab samples can be analyzed for explosives compounds without any sample preparation.
- Analysis results are available in a minute or less.
- Less than a microgram of solid explosives compounds can be detected on swab samples.
- The device is ready to operate in 30 minutes or less from a cold start, i.e., after having been turned off for several hours
- The ETD is intended for use as an explosives screening tool rather than as a laboratory instrument.

Due diligence was performed to develop a report representative of products currently available in the marketplace.

2.0 TECHNOLOGY OVERVIEW

Explosives trace detectors (ETDs) are chemical detection instruments that security personnel use to quickly screen items such as baggage, packages and automobiles for trace residues of explosives. The premise underlying their use is that people who have handled explosives are likely to leave detectable traces of explosive material on themselves and on items they touch. A single fingerprint left by a person who has recently handled explosives may contain hundreds or thousands of microscopic particles of explosives having a combined mass on the order of 100 micrograms [1]. ETDs have sub-microgram level detection limits for explosive particles and therefore can detect a very small fraction of the residual explosives material present in such a fingerprint.

The analysis process is designed to be simple to perform and to rapidly produce results. The item to be screened is wiped with a swab to collect particles of explosives adhered to its surface, then the swab is inserted into the instrument for analysis without any sample preparation. Analysis results are produced in a minute or less, for many instruments in 10 seconds or less. Depending on the detector technology on which an ETD is based, analysis results may indicate the specific explosives compounds detected, the general types of explosives compounds detected, or simply that an explosive compound was detected, sometimes called a “go/no go” result. While ETDs are primarily used to analyze swab samples, some ETDs can also collect and analyze air drawn into the instrument via a sampling nozzle; this mode of operation is referred to as “vapor sniffing” mode.

Many ETDs can detect narcotics as well as explosives, and a few instruments can detect toxic industrial chemical (TICs) and chemical warfare agent (CWAs). Note that in this report the term “explosives” refers not only to energetic chemical compounds that can produce an explosion, but to indicators of the presence of explosives, such as taggant compounds that are deliberately added to some commercially produced explosives to make them more easily detectable with ETDs. Chemical compounds that are not by themselves explosive but can be mixed with other materials to construct an explosive device – for instance certain inorganic nitrogen, chlorate and perchlorate compounds – are considered explosives for the purpose of this report. The report language includes and refers to these as “explosives” because ETDs are designed to detect these chemicals as well as energetic compounds that are per se explosive.

ETDs currently available on the commercial market are based on several different measurement technologies. Some instruments incorporate more than one kind of detector technology. Operating principles and detection capabilities for each measurement technology are discussed in more detail below. Special considerations relating to use, ownership and maintenance of instruments based on these different technologies are also discussed.

2.1 VAPOR-BASED TRACE EXPLOSIVES DETECTION TECHNOLOGIES

Most commercially available ETDs use one of several different vapor measurement technologies to detect explosives compounds. For understanding vapor-based trace explosives detection technologies, the concept of vapor pressure is particularly important. The vapor pressure of a chemical compound is a measure of its tendency to evaporate. The higher the vapor pressure of a solid explosives compound, the higher its concentration will be in air saturated with the compound in its vapor form.

A rule of thumb is that the vapor pressures of an explosives compound doubles with every five-degree centigrade increase in its temperature. For this reason, the first step in the analysis of a swab using any vapor-based measurement technology is "thermal desorption." Upon insertion into the instrument, the swab is heated to increase the vapor pressure of the explosives compounds collected on it, thus making more explosives vapor available for detection. Detection sensitivities for explosives compounds tend to be poorer for compounds with relatively low vapor pressures. Due to their low vapor pressures, some explosives compounds may be undetectable by many ETDs, even when heated.

The analysis process for vaporized explosives compounds, whether released from swabs by thermal desorption or sampled in vapor sniffing mode, is briefly described below for each of the vapor-based detection technologies used by ETDs discussed in this report.

2.1.1 ION MOBILITY SPECTROMETRY (IMS)

In an IMS-based ETD, explosives compound vapors are directed into a section of the instrument where they are exposed to an ionization device that causes them to fragment into one or more chemically distinct ions. These ions then enter one end of the instrument's "drift tube" and are drawn by electrostatic forces to an ion collector at the other end. Different ion species travel through the drift tube at different speeds, so they arrive at the ion collector at different times. The measurement data obtained by the ion collector can be represented as an IMS spectrum, i.e., a plot of the number of ions collected versus drift time. When measured this way, many explosives compounds can be identified by the unique IMS spectra they produce. Onboard spectrum analysis software compares the sample's IMS spectrum against a library of IMS spectra to identify the explosives compounds present in the sample.

One ETD included in this report is based on an IMS variant that its manufacturer refers to as "ion trap mobility spectrometry" (ITMS™). The analysis process follows the same general steps but differs in the technique used to collect the ions created by the ionization device and transfer them into the drift tube.

Some IMS-based instruments are also able to detect narcotics compounds, toxic industrial chemicals (TICs), and chemical warfare agents (CWAs). These additional capabilities have to do with how the ETDs make ion measurements. Explosives compounds are identified by the negative ions they produce when ionized, therefore all IMS–based ETDs make negative ion measurements. Some IMS-based instruments can also make positive ion measurements, which enables them to better detect and identify some explosives compounds such as peroxides that produce characteristic positive ions. Narcotics compounds, too, produce characteristic positive ions when ionized, hence many ETDs that can measure positive ions are also able to detect and identify narcotics compounds. Depending on the design of such an ETD, it may analyze a single sample for both explosives and narcotics or two separate samples, one for explosives and the other for narcotics. TICs and CWAs can also be identified by measuring positive ions, therefore some ETDs with positive ion measurement capability are also able to detect and identify such compounds.

Items needed for continuous, proper instrument operation of IMS-based ETDs typically include desiccants, dopants, and calibrant materials. How often these materials will require replacement depends upon details of the instrument's design and on the number of samples the instrument has analyzed. This is also true of ionization device components.

IMS-based ETDs may contain one of the following three kinds of ionization devices. Special considerations related to ownership of ETDs using each of these ionization devices are briefly discussed below.

- Radioactive ionization devices – These devices contain a radioactive source consisting of a small quantity of Ni-63, a radioactive isotope of the chemical element nickel. Beta radiation emitted by the Ni-63 source ionizes vaporized explosives compounds as they pass by the source. Ni-63 ionization devices require no electrical power to operate and have no components that might fail or wear out.

  The beta radiation produced by the Ni-63 source is completely retained within the ionization device, so it poses no risk to the user. Nevertheless, the quantity of Ni-63 contained in these sources makes them subject to U.S. Nuclear Regulatory Commission (NRC) regulations regarding use and disposal of radioactive material. ETDs that contain Ni-63 radiation sources cannot be discarded as municipal waste when they reach the end of their operational lifetime: they must be disposed of in accordance with NRC regulations on disposal of radioactive material. Typically, disposal is handled by the instrument's manufacturer. Organizations purchasing ETDs that contain a Ni-63 ionization source may wish to consult with the instrument manufacturer about whether a fee is charged for instrument disposal.

  Organizations should also ask the manufacturer to identify other regulations that may impact the ownership and use of the instrument, e.g., whether the Ni-63 must be periodically checked for leakage or whether transport of the instrument on public highways requires documentation in accordance with U.S. Department of Transportation (USDOT) materials transport regulations. Some organizations may have a radiation safety officer (RSO) on staff to manage radioactive sources; if so, the organization's RSO should be consulted about these issues as well as the instrument manufacturer.

- Photoionization devices – Photoionization devices use a lamp that produces ultraviolet radiation to ionize explosive compound vapors as they pass through the device.

  Components of the photoionization device may need to be periodically replaced over the likely multi-year operational lifetime of the instrument. How often component replacement will be necessary will depend upon the specific design of the photoionization device and how many sample analyses an instrument has performed.

- Corona discharge and spark ionization – Corona discharge and spark ionization devices contain electrodes to which a high voltage is applied. As explosives compound vapors pass between these electrodes, they are ionized.

  The electrodes degrade with use and may need to be replaced periodically. How often replacement is necessary depends on the specific design of the ionization device and on how many analyses the ETD has performed.

2.1.2 GAS CHROMATOGRAPHY-ION MOBILITY SPECTROMETRY (GC-IMS)

One instrument in this report uses gas chromatography, a widely used laboratory analysis technique, combined with IMS spectrometry to detect and identify explosives compounds. Vaporized explosives compounds first enter the GC segment of the instrument, where they pass through a chromatographic column, a narrow metal tube containing material that binds to chemical compounds passing through it. Within that column, chemical compounds are separated based upon their volatility: more volatile compounds, that is, those that boil at a lower temperature, pass through the column more quickly than less volatile compounds. As the separated explosives compounds leave the column, they enter the IMS spectrometer segment of the instrument and their IMS spectra are determined as described above. Explosives compounds are identified on the dual basis of their retention times on the chromatographic column and their IMS spectra.

The additional compound identification data provided by the column retention times allows the instrument's analysis software to discriminate between compounds that have similar IMS spectra and may allow the instrument to more accurately detect and identify the explosives compounds present in the sample. The GC also provides the IMS spectrometer with separate compounds to measure, rather than a mix of compounds. This may allow samples containing mixtures of compounds to be more easily identified. From an instrument design standpoint, adding a GC column "front end" to an ETD may improve its analytical capabilities but it also significantly increases its weight, size, and electrical power consumption.

2.1.3 HIGH PRESSURE MASS SPECTROMETRY™ (HPMS)

High pressure mass spectrometry, like IMS, is an ion measurement technique. One instrument included in this report is based on this technology. While the analysis process parallels that of an IMS instrument, consumables such as dopants and desiccants are not needed in an HPMS-based ETD.

An HPMS-based ETD is essentially a miniature version of a benchtop laboratory mass spectrometer. Benchtop mass spectrometers require heavy, power-intensive turbopumps to achieve a sufficiently low pressure to make ion measurements. The design of the HPMS-based ETD, however, allows it to make ion measurements at a pressure that, while still quite low, can be obtained using a small, battery-powered vacuum pump. Sample ionization is achieved using a corona discharge device and the ions produced enter the low-pressure portion of the instrument. From there the ions are guided by electrostatic forces to a device where they are measured, which is called a "mass analyzer." The mass analyzer sequentially samples and counts the stream of ions arriving according to their masses. Measurement data can be represented as a mass spectrum, i.e., plot of the number of ions counted versus mass.[1] The HPMS instrument's analysis software automatically compares the measured mass spectrum against a mass spectrum library of chemical compounds. When matches are found, those explosives compounds are indicated as having been detected.

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[1] To clarify, it's actually the mass to charge ratio against which the ion count is plotted. Because the ions are singly charged, effectively the X-axis is mass.

The HPMS-based instrument included in this report can make both negative and positive ion measurements, which allows it to detect and identify narcotics, TICs, and CWAs, as well as explosives compounds.

2.1.4 CHEMILUMINESCENCE

"Chemiluminescence" refers to chemical reactions that produce light. In an ETD based on chemiluminescence detector technology, explosives compound vapors enter a section of the instrument in which they are heated to a temperature that causes them to degrade into simple gaseous chemical compounds. The thermal degradation products pass on to the detector section of the instrument. There, a sensor material contained in the detector cartridge undergoes chemiluminescent reactions with the thermal degradation products of nitrogen- and peroxide- based explosives compounds. The light output of the detector cartridge is monitored during sample analysis and, when light is detected, the instrument's operating software indicates that an explosives compound has been detected. Analysis results are "go/no go," indicating that an explosives compound has been detected without specifying its type or identity.

Chemiluminescence-based ETDs are typically limited to the detection of nitrogen- and peroxide-based explosives because other explosives compound types cannot be thermally degraded into chemical compounds that undergo chemiluminescent reactions with the detector cartridge sensor material.

Detector cartridges must be replaced periodically over the lifetime of the instrument. How often this is necessary depends upon the cartridge design and how many sample analyses the ETD has performed.

2.1.5 THERMO-REDOX

One ETD included in this report is based on proprietary thermo-redox detector technology about which only limited information is available. Explosive vapor enters a section of the instrument where they are trapped in a concentrator tube that is coated with a proprietary material designed to selectively adsorb explosive compounds. The adsorbed explosive compounds are then heated to thermally degrade into simple gaseous chemical compounds. These thermal degradation products then pass on to an electrochemical sensor designed to detect nitrogen dioxide (NO_2) gas, a thermal degradation product of nitro-based explosives compounds, which are a subset of the larger class of nitrogen-based explosives compounds. The electrochemical sensor contains electrodes that cause NO_2 gas to undergo a chemical reaction that causes an electrical current to flow through a measurement circuit attached to the electrodes. A flow of an electrical current through this circuit indicates that a nitro-based explosives compound has been detected. Analysis results are "go/no go."

The electrochemical sensor component must be periodically replaced over an instrument's lifetime. The manufacturer of the instrument employing this technology recommends that it be replaced approximately every two years.

2.1.6 AMPLIFYING FLUORESCENT POLYMER (AFP)

Fluorescence is the phenomenon by which a substance emits light of a certain wavelength when illuminated with light of a different wavelength. The intensity of light emission of a fluorescent material can be reduced or "quenched" in the presence of certain chemical compounds. One instrument included in this report detects explosives compounds by measuring the quenching of sensor materials – referred to as amplifying fluorescent polymers (AFPs) – by explosives compounds.

The key detector component is a glass detector tube, the inner surface of which has been coated with an array of different AFP materials that are quenched by different kinds of explosives compounds. During sample analysis, the AFP sensors are stimulated to fluoresce by a light source. As an explosives compound's vapors pass through the detector tube, they quench the fluorescent light emission of one or more of the AFP sensors in the tube. The pattern of quench responses exhibited by the full array of AFP sensors is measured and the instrument's analysis software uses this data to determine which of eight general explosives compound classes were in the sample.

The manufacturer of the ETD that uses AFP detection technology indicates that in typical use, detector tubes need to be replaced daily. Users in the field can quickly accomplish detector tube replacement without need of any tools.

2.1.7 HIGH FREQUENCY QUARTZ CRYSTAL MICROBALANCE (HF-QCM)

In an HF-QCM-based ETD, the detector consists of an array of quartz crystal sensors coated with materials that have affinities for different chemical compounds. Vaporized explosive compounds are directed through the sensor array and bind to specific sensors, which changes the frequency at which they vibrate. During sample analysis, the change in vibrational frequency of each sensor in the array is monitored. Onboard analysis software then identifies specific explosives compounds in the sample based upon the pattern of vibrational frequency changes in the sensor array.

HF-QCM instruments can be equipped with different sensor arrays to give them different detection capabilities, for instance the ability to detect narcotics as well as explosives compounds. The quartz crystal sensor array may need to be replaced periodically, with the frequency of replacement dependent on how many samples have been analyzed.

2.1.8 METAL OXIDE SENSORS (MOS)

Metal oxide sensor arrays are used in conjunction with other explosives detection technologies in just two of the ETDs included in this report, an instrument with a chemiluminescence detector and an instrument with an IMS. As with some of the previously discussed detection technologies, MOS sensor arrays detect explosive compounds by detecting their thermal degradation products (see section 2.1.5). Sensors in the array are made of metal oxide semiconductor materials, the electrical conductivity of which changes when exposed to certain gaseous chemical compounds. During sample analysis, the conductivity of each sensor in the array is monitored. The pattern of changes in conductivity exhibited by the MOS sensor array is used by the instrument's analysis software to determine whether an explosives compound is present in the sample. The data obtained from the sensor array does not allow specific explosives compounds to be identified.

In this report's MOS-equipped ETD that also contains a chemiluminescence detector, a portion of the thermal degradation products generated for analysis by the chemiluminescence detector is diverted to the MOS array. The analysis results obtained by the MOS sensor array and the chemiluminescence detector are used jointly by the instrument's analysis software to determine whether an explosives compound is present in the sample.

In the ETD that also contains an IMS, most of the sample's explosive vapors are directed into the spectrometer and a small fraction of the sample is diverted to the MOS array. That smaller portion enters a segment of the instrument where it is heated to produce gaseous, thermally degraded products that the MOS sensor array can detect. The analysis result produced by the MOS sensor array is used as a check on certain compound identification results provided by the IMS spectrometer: these compounds are reported as being present in the sample only if the IMS spectrometer has detected them and the MOS sensor array also detected the presence of an explosives compound.

The MOS sensor array may need to be periodically replaced over the operational lifetime of an ETD. How often replacement will be necessary depends upon the specific design of the MOS sensors and on the number of samples analyzed.

2.2 OTHER TRACE EXPLOSIVES DETECTION TECHNOLOGIES

Some commercially available ETDs are based on technologies that do not involve sample vaporization. Two such technologies, which are used in some of the products included in this report, are discussed below.

2.2.1 CAPILLARY ZONE ELECTROPHORESIS (CZE)

One ETD included in this report is based on capillary zone electrophoresis (CZE), and focuses solely on the detection of inorganic nitrate, chlorate, and perchlorate compounds. Due to the extremely low vapor pressures of these compounds, they cannot be detected by many ETDs that use a vapor-based detection technique.

Inserting a swab initiates an automated analysis process in which the swab is rinsed with a water-based chemical solution to dissolve and remove inorganic explosives compounds. Dissolved inorganic explosives dissociate into positively and negatively charged ions; the analysis process involves the separation and measurement of the negatively charged ions in the swab rinse solution. A voltage applied to the solution causes the anions to move towards a conductivity meter, where they are detected. Different ion species move through the solution at different speeds, so they arrive at the conductivity detector at different times. The instrument's analysis software identifies nitrate, chlorate and perchlorate compounds based on the arrival times of their anions at the conductivity detector. Analysis results indicate that an inorganic nitrate, chlorate or perchlorate compound was present in the sample, but do not identify the specific compound that has been detected.

The primary item that must be replaced periodically is the reagent cartridge containing the chemical solution that's used in the swab analysis process. These cartridges are designed to be easily replaced by the instrument owner without the need for any special tools.

2.2.2 AUTOMATED COLORIMETRY

Colorimetric detection kits are widely used to detect and identify explosives, narcotics, and toxic chemical compounds. Users observe color changes when a sample containing compounds of interest reacts with the reagent chemicals supplied with the test kit. The color change occurs after drops of reagent chemicals are added to a sample, or by mixing the sample with reagent chemicals in a small container.

Colorimetric kits that require manual processing and the user's visual observations of collected samples fall outside the scope of this report. However, one instrument included in this report provides an automated version of the manual colorimetric analysis procedure. The item to be screened is wiped with a manufacturer-provided detector card that contains the reagent chemicals that undergo a color-changing chemical reaction with explosives compounds. Inserting the detector card into the instrument causes the reagent chemicals to mix with any explosives compounds collected on the detector card. The color of the detector card is monitored by a built-in optical sensor and the sensor data is processed by analysis software. Results indicate which of several different classes of explosives compounds (if any) were collected on the detector card. The manufacturer of this instrument produces a model variant that can analyze samples for narcotics as well as explosives by using detector cards designed to detect both compound types.

Automated colorimetric analysis provides users with a less cumbersome way to analyze samples compared to traditional manual explosives test kits and may reduce user error in interpreting color changes. It is not possible to operate this type of instrument in vapor-sniffing mode since the detection technique does not involve vapor measurements. Detection limits are not as low as for vapor-based ETDs, however, compounds with extremely low vapor pressures, such as chlorate and perchlorate compounds and which many vapor-based ETDs cannot detect, can be detected.

2.3 GENERAL USE CONSIDERATIONS

Desktop ETDs may be the preferred choice for screening activities taking place at locations where their size, weight, and need for alternating current (ac) power can be accommodated. U.S. airport passenger screening is carried out using desktop ETDs. Security personnel use handheld ETDs to screen for explosives at locations where ac power is unavailable for operating a desktop system or when user mobility is necessary to conduct screening operations. For example, in large cities, security personnel use handheld ETDs to screen passengers entering mass transit stations at temporary checkpoints at station entrances. Ac power is often unavailable at these locations, and personnel may screen passengers at multiple transit stations during the course of the day. The engineering trade-offs necessary to make ETDs small enough and light enough to be carried and operated by hand, however, may make them less effective than desktop-sized instruments at detecting trace explosives.

As with any detection system, ETDs can produce false negatives, false positives, and nuisance alarms. False negative alarms occur when the instrument fails to detect an explosive compound when one is present. This might occur, for example, when harmless ambient chemical compounds collected on a swab suppress the instrument's normal detection sensitivity.

False positive alarms can occur when an ETD indicates that an explosive is present when it is not; this can occur when the instrument's detector technology misidentifies a harmless ambient chemical collected on a swab as an explosive compound. Nuisance alarms arise from the correct detection of compounds such as inorganic nitrate, chlorate, or perchlorate compounds in situations where they do not pose a threat. For instance, ammonium nitrate can be mixed with other ingredients to make a bomb, but it also is a widely used and transported agricultural fertilizer.

Sample analysis times typically permit users to screen several swab samples per minute, however, when explosives compounds are resent on a swab it may take much longer for the explosives compound to fully clear the instrument so that the next sample can be analyzed. Some compounds take longer to clear than others, and the greater the quantity of the compound introduced into the instrument, the longer it will take for the compound to clear. Cleardown delays can also occur when screening for narcotics, CWA and TIC compounds.

No single ETD can detect every chemical compound that could possibly be used to make an explosive device. The concept of orthogonality – that there is a greater confidence that an analysis result is correct when it can be verified by instruments based on different measurement techniques – applies to ETDs, as it does to all other kinds of measurement instruments. Deploying instruments based on more than one detection technology, when feasible, may provide responder organizations with the ability to detect explosives compounds more reliably.

Information on the analytical performance of currently available ETDs, that is, how well they perform at detecting and identifying trace explosives based upon independent testing, would be of great value to responder organizations making equipment acquisition and deployment decisions. Unfortunately, comparative data on the analytical performance of currently available ETDs is not publicly available.

2.3.1 SAMPLING CONSIDERATIONS

Swabs – ETDs are designed to be used with instrument-specific swabs available from the instrument's manufacturer. Swabs are not simply a consumable; they are an important component of the overall trace detection process. Swabs may have a "sweet spot" where collected explosives compounds will be most sensitively detected when inserted into the instrument for analysis. Users should follow the instrument manufacturer's guidance on how to most effectively sample surfaces with swabs made for their instruments.

Some ETD manufacturers offer a sampling wand, i.e., a swab holder, as a standard or optional accessory. Using a sampling wand reduces the possibility of contact with hazards such as concealed needles or dangerous narcotics; when used to screen a person's skin or clothing, they may also prevent conflicts related to cultural issues or gender differences. Some sampling wands are extendable, which allows users to more easily sample hard-to-reach surfaces.

Vapor Sampling – While ETDs are primarily used to analyze swab samples, some ETDs can collect and analyze air drawn into the instrument via a sampling nozzle; this mode of operation is commonly referred to as “vapor sniffing” mode. A limitation of this sampling approach is that fewer explosive compounds can be detected in vapor sniffing mode than in swab analysis mode. This is because in the first case, the vapor source is an explosive compound at ambient temperature, while in the latter case the vapor source is a heated swab and, as discussed in Section 2.1, the vapor pressure of explosives compounds greatly increases when heated.

A few ETD manufacturers provide an air sampling accessory that draws air through a sorbent with a high affinity for explosives compounds. The sorbent is then removed from the sampler and analyzed as if it were swab. Sorbent sampling provides improved detection sensitivity over vapor sniffing mode because it allows a greater volume of air to be analyzed for explosives compounds.

2.4 RECURRING COSTS

Over and ETD’s operational lifetime, the cost of supplies and instrument components needed to operate a detector may amount to a significant portion of the lifecycle cost compared to its purchase price. These costs depend upon the detection technology on which the ETD is based, the specific design of the instrument, and how heavily the instrument is used. One should not assume that similar operating costs for different instruments, even if they are based on the same detection technology.

An operating cost common to all ETDs is the cost of swabs. The price of swabs used in currently available instruments range from less than ten cents to nearly two dollars each. Some manufacturers indicate that the swabs used in their instruments can be reused a certain number of times if undamaged, not visibly soiled, and no explosives compounds have been detected during prior analyses. Other manufacturers state their swabs are single-use or make no claim about reusability. Swab reuse, if permitted under an organization’s screening procedures, may provide significant operational cost savings when screening large numbers of items. Swabs and other consumables for some ETDs can be purchased from third-party suppliers. The Transportation Security Agency (TSA) has a qualification testing program for aviation security equipment (see Section 2.4.2) that identifies third-party suppliers of swabs and other consumables that offer similar performance to those available from ETD manufacturers.

Section 2.1 identifies instrument components and supplies that may need to be replaced periodically over the lifetime of ETDs, based on the different detector technologies. Some relatively inexpensive items, such as desiccants used in IMS instruments, may need to be replaced on a daily or weekly basis. Other items, such as ionization devices used in IMS and HPMS-based instruments or the detector cartridges used in chemiluminescence-based instruments, are relatively more expensive than other consumables. These may provide months to years of service, however, or may not ever need to be replaced over the life of an instrument.

Replacement of components and supplies will generally need to occur more frequently the more often an instrument is operated. Some items, though, have a fixed lifetime and, therefore, will need to be replaced periodically regardless of how often the instrument is used.

Instrument components and supplies can be easily replaced by the instrument owner, but in some instruments, component replacement may need to be performed by the instrument manufacturer or by a person who has received maintenance training from the manufacturer.

All new ETDs come with a warranty covering repair costs and technical support for the first year or two of instrument ownership, after which warranty renewal becomes another recurring cost. The cost of disposal of an ETD that contains a radioactive ionization source may or may not be included in the purchase price of an instrument.

Organizations wishing to factor ownership costs into acquisition decisions should consult with instrument manufacturers to obtain realistic ownership cost estimates that account for the instrument's anticipated level of use.

2.5 RELEVANT TEST STANDARDS AND TESTING PROGRAMS

2.5.1 AMERICAN SOCIETY FOR THE TESTING OF MATERIALS: ASTM E2520-15 AND E2677-20

Two published ASTM standards assess the performance of trace explosives detection instruments for analysis of swab samples. These are ASTM E2520, "Standard Practice for Measuring and Scoring Performance of Trace Explosive Chemical Detectors" [2], and ASTM E2677 "Standard Test Method for Estimating Limits of Detection in Trace Detectors for Explosives and Drugs of Interest" [3]. The current versions of these two standards are ASTM E2520-15, published in 2015, and ASTM E2677-20, published in 2020. ASTM E2520 provides an assessment process that results in a numerical score reflecting instrument performance. This score is based on limits of detection determined according to ASTM E2677 and on an "effective detection throughput rate" that factors in sample throughput rate, swab area, and maintenance requirements during a typical eight-hour shift.

ASTM E2520 does not require, but places extra value on, specific identification of explosives compounds. An instrument is considered to have minimum acceptable performance if it receives a test score of 80 or greater, as calculated according to the standard. There is no fixed maximum score, but ASTM E2520 states that a test score of 800 would be considered "extraordinary—perhaps beyond the capabilities of current ETDs." Some ETD manufacturers indicate that their instruments have been tested to ASTM E2520 and that test results are available for review.

Note that ASTM E2520 cautions against using only these test scores to compare different ETDs in making procurement or deployment decisions. ASTM E2520 further states these test scores signify general detection performance, but do not necessarily reflect capabilities for specific analytes or for all likely natural matrix materials that may affect detection capabilities.

2.5.2 AIR CARGO SCREENING TECHNOLOGY LIST (ACSTL): QUALIFIED, APPROVED, GRANDFATHERED

The ACSTL serves as the TSA's official guidance to regulated parties such as air cargo handlers for procuring screening equipment for their aviation security programs [4]. Products included in the ACSTL are listed in one of three sections: "Qualified," "Approved," or "Grandfathered Technology."

The "Qualified Technology" section specifies products that have undergone a formal TSA-sponsored testing process and have been deemed qualified for screening operations. The "Approved Technology" section specifies products that have passed the first stage of the qualification testing process and have been conditionally approved for screening operations while undergoing additional suitability-based field testing. Products listed as "approved" have up to 36 months from the date of their addition to this section to pass TSA's additional field testing. Products unable to pass field testing within that time period are removed from the Approved Technology section. The "Grandfathered Technology" section specifies products that are qualified for screening operations until a stated expiration date.

An ETD may be listed as "qualified," "approved," or "grandfathered" equipment with specific hardware or software configurations or when used with a hand wand to collect swab samples for analysis. The ACSTL includes an appendix that lists model-specific ETD consumables such as swabs, verification samples, and maintenance supplies available from third-party suppliers that provide comparable performance to manufacturer-supplied consumables based on TSA testing.

The ACSTL is updated periodically, typically more than once in a calendar year. The current version of the ACSTL can be found at: www.tsa.gov/for-industry/cargo-screening-program.

2.5.3 EUROPEAN CIVIL AVIATION CONFERENCE (ECAC)

The ECAC is an intergovernmental organization that promotes the harmonization of civil aviation practices and policies among its 44 European member states. Under its Common Evaluation Process (CEP), aviation security equipment including ETDs are tested against performance standards established by ECAC member states [5]. Test results provide a common reference point that aviation authorities in each member state use to certify and approve equipment deployed at airports under their responsibility.

An up-to-date list of ETDs that meet ECAC standards can be found at: www.ecac-ceac.org/activities/security/common-evaluation-process-cep-of-security-equipment. This list specifies the specific hardware and software configuration employed during testing and indicates whether the instrument meets ECAC standards for use in passenger screening, cargo screening, hand and wand swabbing applications. Default hardware and software configurations for instrument supplied for generalized explosives screening use may differ from those used to achieve ECAC certification.

2.5.4 UNITED STATES DEPARTMENT OF DEFENSE: MIL-STD-810

MIL-STD-810 is a United States Department of Defense standard that provides testing procedures for assessing whether equipment can withstand conditions that may be encountered during military use [6]. Equipment is tested to operationally relevant portions of this standard rather than to every test method included in this 1100-page standard.

While MIL-STD-810 is specifically intended for testing military equipment, several ETD instrument manufacturers indicate that their products have been tested to MIL-STD-810 procedures for resistance to the elements (e.g., rain, dust, salt fog, or extreme temperatures) or harsh use (e.g., transit drop or transit vibration).

These testing procedures may provide several options for how the test is be performed; for instance, transit drop testing may be performed with the item to be tested either stored in, or removed from, its carrying case. A copy of the current version of this standard, MIL-STD-810-H, can be downloaded at www.iest.org/Standards-RPs/MIL-STD-810H. Information about individual laboratory test methods as outlined by the standard are included in Appendix B.

2.5.5 INTERNATIONAL ELECTROTECHNICAL COMMISSION: IEC 60068

Standard IEC 60068, developed by the International Electrotechnical Commission, is a collection of methods for testing whether electronic equipment remains functional when subjected to potentially damaging conditions that could be encountered during use. It includes test methods for mechanical shock, vibration, and exposure to the elements among many others. A copy of IEC 60068 can be purchased at the IEC web store [7]. Brief descriptions of some IEC 60068 test methods of potential relevance to field-deployed ETDs can be found at: www.desolutions.com/testing-services/test-standards/iec-60068-2/.

2.5.6 IEC: INGRESS PROTECTION RATINGS, IEC 60529

Ingress Protection (IP) ratings indicate the level of protection an electrical instrument's enclosure provides against intrusion by solid objects and water, as determined by test methods set forth in International Electrotechnical Commission (IEC) standard IEC 60529 [8]. An IP rating is expressed as a two-digit number. The first digit ranges from 0 to 6 and indicates the degree of protection against ingress by solids. The second digit, which ranges from 0 to 9, indicates the degree of protection provided against ingress by water.

IP ratings of products included in this report, and the level of protection they indicate are as follows:

IP 21 – Instrument case prevents entry of fingers and similarly sized objects. No harmful effect from vertically dripping water.

IP 42 – Penetration by wires and screws or by large insects is prevented. No harmful effect from dripping water when instrument is tilted up to 15 degrees from vertical.

IP 43 – Penetration by wires and screws is prevented. No harmful effect from water spray when instrument is tilted up to 60 degrees from vertical.

IP 54 – Dust ingress not entirely prevented but does not interfere with operations. No harmful effect from splashing water from any direction.

IP 65 – Dust ingress is prevented. No harmful effect of water projected against instrument from any direction.

IP 66 – Dust ingress is prevented. No harmful effect of jets of water powerfully projected against instrument from any direction.

More information on IP ratings and levels of solid and liquid ingress protection is provided in Appendix A.

3.0 PRODUCT INFORMATION

Information on 20 commercially available desktop and handheld ETDs, some of which are available in more than one variant, is provided in Sections 3.1 and 3.2. This report focuses on instrument features and capabilities identified as important to mission needs identified by experienced ETD users [9], [10].

The information provided in this report is based on product specifications obtained from questionnaire responses submitted by instrument manufacturers in response to an RFI, manufacturers' product literature, and correspondence with manufacturer representatives. NUSTL has not independently verified the accuracy of this information.

3.1 DESKTOP ETDS

All six desktop instruments herein and their variants analyze swab samples for trace residues of explosives compounds. Unless stated otherwise, they cannot analyze vapor samples. Product descriptions indicate instruments that, according to their manufacturers, have been tested to ASTM E2520. While the focus of this report is on trace explosives detection, most of the included desktop instruments can detect narcotics as well. The product descriptions state whether narcotics can be detected and, when this could be determined from available information, whether samples can be analyzed for explosives and narcotics simultaneously. Swab reusability is reported if that information was provided by the manufacturer. This report also notes whether stored data is overwritten when onboard memory is full so long as the manufacturer made that information available.

Detection limits for different explosives compounds vary; listed values should be considered typical values based on lab testing results obtained by the manufacturer. Detection limits for narcotics are similar to or within a factor of ten of those for explosives compounds. See product descriptions for details on specific instruments.

All instruments can operate on 110-240 volt (v), 50-60 Hertz (Hz) alternating current (ac) power sources. Unless otherwise noted, they cannot operate on battery power, do not have IP ratings greater than IP 21, and have not been tested to MIL-STD-810 or IEC 60068 standards. Also, all desktop EDTs in this report have color touch screens.

While these desktop instruments are not designed for handheld operation, some of them have features that enhance their portability, for example, being light enough to be carried by one person, having an integrated carrying handle, or operating for a limited time on battery power. Information about portability-enhancing features is provided, as applicable, in the product descriptions.

Products included in this section on desktop ETDs are listed in Tables 3-1 and 3-2, which summarize their key features and capabilities. Additional details about each product are provided in individual product descriptions following the tables below.

Product characteristics in Tables 3-1 and 3-2 ETDS are listed in column order and defined as follows:

Company indicates the manufacturer or vendor of the ETD.

Product indicates the name of the instrument model, including variant number if applicable.

Table 3-1

Detector Technology indicates the underlying technology the detector uses to perform sample analysis; either IMS, CZE, HF-QCM, ITMS, or GC-IMS.

Detectable Explosives Compounds indicates the general types of explosives compounds the device can determine are present in a sample.

Narcotics Detection indicates whether the ETD can also detect narcotics compounds. A ‘Y’ indicates it can detect narcotics; an ‘N’ indicates it cannot detect narcotics.

Analysis Result indicates the type of result generated by the instrument; either the identity of the specific compounds detected (“ID”), or the general types of chemical compounds detected (“Type”).

Detection Limit indicates the smallest mass of an explosives compound on a swab that can be reliably detected. When specific value was provided, for example “tens of nanograms,” that value appears in the table. The notation “ng” indicates a detection limit in the single-digit nanogram range. Check with product vendors about detection limits for specific explosives compounds.

Analysis Time indicates the number of seconds required to analyze a swab sample for explosives.

Table 3-2

Data Storage indicates how much analysis data can be saved to the ETD’s onboard memory.

Data Export indicates connection modes for exporting analysis data to other memory storage or computing devices.

Start-up Time indicates the time required for the instrument to be ready to operate when turn turned on after having been shut down for many hours.

Dimensions indicates the measurements of the instrument, in inches.

Weight indicates the weight of the instrument, including batteries, in pounds.

Temperature (Operating/Storage) indicates the temperature range within which the instrument can be operated and stored, in degrees Fahrenheit.

Screen Size indicates the diagonal length of the display screen, in inches.

Price indicates the manufacturer’s suggested retail price (MSRP) rounded to the nearest U.S. dollar and whether the instrument is listed on the GSA price schedule.

Table 3-1 Desktop ETD: Analysis Technology and Capabilities

Company	Product	Detector Technology	Detectable Explosives Compounds	Narcotics Detection	Analysis Result	Detection Limits	Analysis Time (seconds)
Bruker Detection	DE-tector flex	IMS	Nitrogen- and Peroxide- based	Y	ID	ng	<10
Greyscan Australia	ETD-100	CZE	Inorganic Nitrate- Inorganic Chlorate-, and Inorganic Perchlorate-based	N	Type	Tens of ng	~60
Leidos	QS-B220-003	IMS	Nitrogen- and Peroxide- based	Y	ID	ng	10
Leidos	QS-B220-005	IMS	Nitrogen- and Peroxide- based	Y	ID	ng	10
Rapiscan Systems	Itemiser 5x	ITMS	Nitrogen- and Peroxide- based	Y	ID	<1 ng	8
Scintrex	E5000	GC-IMS*	Nitrogen- and Peroxide- based	N	ID	ng	20-120†
Scintrex	EN5000	GC-IMS*	Nitrogen- and Peroxide- based	Y	ID	ng	20-120†
Smiths Detection	Ionscan 600 482400E-3	IMS	Nitrogen- and Peroxide- based	N	ID	ng	<8
Smiths Detection	Ionscan 600 482400E-P-2	IMS	Nitrogen- and Peroxide- based	N	ID	ng	<8
Smiths Detection	Ionscan 600 482400NE-3	IMS	Nitrogen- and Peroxide- based	Y	ID	ng	<8
Smiths Detection	Ionscan 600 482400NE-P-2	IMS	Nitrogen- and Peroxide- based	Y	ID	ng	<8
Smiths Detection	Ionscan 600 482400FNE-701	IMS	Nitrogen- and Peroxide- based	Y#	ID	ng	<8
Smiths Detection	Ionscan 600 482400FNE-701-P1	IMS	Nitrogen- and Peroxide- based	Y#	ID	ng	<8

Notes:
* indicates the detector uses a radioactive sample ionization device
† indicates the sample analysis time is user-settable
# indicates that narcotics analysis is optimized for detection of fentanyl and synthetic opioids.

Table 3-2 Desktop ETD: Data Capabilities and Operational Considerations

Company	Product	Data Storage (# of analyses)	Data Export	Startup Time (minutes)	Dimensions (inches)	Weight (pounds)	Temperature Operating Storage (°F)	Screen Size (inches)	Price
Bruker Detection	DE-tector flex	250,000	USB	15	13 x 16 x 12	23	14 to 131 -4 to 140	9.2	$31,000
Greyscan Australia	ETD-100	>50,000	USB Wi-Fi Ethernet	<15	15 x 19 x 9.0	37.7	40 to 130 40 to 130	7	$45,000
Leidos	QS-B220-003	>100,00	USB	30	17 x 16 x 16	34.6	14 to 131 -4 to 185	12.5	$25,000
Leidos	QS-B220-005	>100,000	USB	30	17 x 16 x 15	32.2	14 to 131 -4 to 185	12.5	$25,000
Rapiscan Systems	Itemiser 5x	~10,000	USB Ethernet	30	20 x 19 x 15	28.7	14 to 131 N/A	10.4	$39,900
Scintrex	E5000	~450,000	USB	30	17 x 22 x 11	72.3	59 to 95 23 to 149	12	$30,000†
Scintrex	EN5000	~450,000	USB	30	17 x 22 x 11	72.3	59 to 95 23 to 149	12	$39,000†
Smiths Detection	Ionscan 600 482400E-3	250,000	USB	<10	15 x 12 x 13	23.8	14 to 122 -4 to 122	9	$29,995
Smiths Detection	Ionscan 600 482400E-P-2	250,000	USB	<10	15 x 16 x 15	25.3	14 to 122 -4 to 122	9	$32,550
Smiths Detection	Ionscan 600 482400NE-3	250,000	USB	<10	15 x 12 x 13	23.8	14 to 122 -4 to 122	9	$33,500
Smiths Detection	Ionscan 600 482400NE-P-2	250,000	USB	<10	15 x 16 x 15	25.3	14 to 122 -4 to 122	9	$34,650
Smiths Detection	Ionscan 600 482400FNE-701	250,000	USB	<10	15 x 12 x 13	23.8	32 to 122 -4 to 122	9	$33,500
Smiths Detection	Ionscan 600 482400FNE-701-P1	250,000	USB	<10	15 x 16 x 15	25.3	32 to 122 -4 to 122	9	$34,650

Notes:
N/A indicates that no information was available from the manufacturer
* indicates the capability requires a component available at additional cost.
† indicates that the instrument is available on the GSA price schedule

3.1.1 BRUKER DETECTION, DE-TECTOR FLEX

The DE-tector flex can analyze swabs for explosives and narcotics by using an IMS spectrometer that measures negative and positive ions produced by a photoionization device. Samples are analyzed for either explosives only or narcotics -only. This ETD can detect a broad range of nitrogen- and peroxide- based explosives. It completes analyses in less than 10 seconds and has low nanogram detection limits for both explosives and narcotics compounds. Results identify the compounds that have been detected. Bruker indicates that swabs can be reused up to 30 times. A sampling wand is included in the purchase price of this instrument.

Figure 3-1 DE-tector flex
Image Credit: Bruker Detection

The DE-tector flex has a 9.2-inch color touch screen and a built-in thermal printer. Audio and visual alarms are produced when an explosives or narcotics compound is detected; audio alarms can be deactivated at the user's discretion. Data for up to 250,000 analyses can be saved to onboard memory; if memory is full, the instrument prompts the user to delete saved data. Sample analysis data can also be exported to a PC via a USB port.

The DE-tector flex can operate on two internal hot swappable batteries[2] so long as it is first started on ac power. Each battery provides approximately one hour of operating time and can be fully recharged in three hours. Battery level is indicated during instrument operation.

The DE-tector flex weighs 23 pounds and measures 13.2 x 16.3 x 12 inches. It has a built-in carrying handle. Its operating temperature range is 14 to 131 °F and its storage temperature range is -4 to 140 °F. It starts up in approximately 15 minutes.

The list price of the DE-tector flex is $31,000. Volume discounts are not available, and it is not listed on the GSA price schedule. The purchase price includes a one-year warranty covering parts and labor; extended warranties are available at an additional cost. Technical support is available during business hours on weekdays at a Bruker location on the U.S. East Coast. A one-hour user training course is provided with purchase of the instrument at no additional cost.

Online Resources:

De-tector flex product literature

De-tector flex product video

[2] An instrument's batteries are "hot swappable" if they can be replaced without turning the instrument off.

3.1.2 GREYSCAN AUSTRALIA, ETD-100

The ETD-100 is a specialized screening instrument that analyzes swabs for inorganic nitrate-, chlorate-, and perchlorate-based compounds that – due to their extremely low vapor pressures – are not detectable by many ETDs. Swabs are analyzed by capillary zone electrophoresis (CZE). Analyses take 40 seconds to complete and are followed by a 20 to 30 second clearing cycle. Detection limits are as low as 25 nanograms. Analysis results indicate whether an inorganic nitrate, chlorate, or perchlorate compound was detected. Smiths Detection Ionscan 600 swabs are used to collect samples. A sampling wand is available at additional cost.

Figure 3-2 ETD-100

Image Credit: Greyscan Australia

The ETD-100 is operated using a 7-inch color touch screen. Audio and visual alarms are produced when an inorganic nitrate, chlorate, or perchlorate compound is detected; the audio alarm can be deactivated. Results of over 50,000 sample analyses can be saved in onboard memory. Sample analysis data can be exported to an USB data storage device or to a PC via Ethernet or Wi-Fi connection.

The ETD-100 is equipped with an internal sealed, lead-acid gel cell battery that provides approximately one hour of operating time when an ac power source is unavailable. The battery is not removable and takes four to six hours to recharge. Battery level is displayed during instrument operation. An optional military grade battery can be connected externally to provide additional operating time; information on the recharge time of this battery, however, is not available. The ETD-100 can also operate on external 12-volt direct current (dc) power sources. The start-up time of the ETD-100 is less than 15 minutes.

The ETD-100 weighs 37.7 pounds. A Pelican case with a carrying handle and measuring 15.2 x 19.2 x 9-inches serves as its outer body. With its outer Pelican case closed, the ETD-100 has an IP 63 rating. Operating and storage temperature ranges are both 40 to 130 °F.

The list price of the ETD-100 is $45,000. Discounts are available for volume purchases, but it is not listed on the GSA price schedule. The purchase price includes a one-year warranty covering parts and labor. Extended warranties are available for an additional cost. Technical support is provided 24 hours a day, seven days a week, every day of the year. Greyscan offers customer-tailored training that can be delivered online or at the customer's location. Training costs are not included in the list price of this instrument.

Online Resources:

[ETD-100 product literature]

3.1.3 LEIDOS, B220

The B220 can analyze swabs for explosives and narcotics using an IMS spectrometer that employs separate drift tubes to make negative and positive ion measurements. A photoionization device produces negative ions and a corona discharge device produces positive ions. The B220 can be operated in explosives only, narcotics only, or simultaneous explosives and narcotics detection modes. It can detect a broad range of nitrogen- and peroxide-based explosives compounds.

Swab analyses are completed in 12 seconds when analyzing for both explosives and narcotics and in 10 seconds when analyzing for explosives only. Detection limits for explosives compounds are at the nanogram level and the tens of nanogram level for narcotics compounds. Analysis results identify detected compounds. The performance of the B220 has been assessed according to ASTM E2520 test standard. According to Leidos, swabs can be reused up to 25 times. A sampling wand is included with purchase of the instrument.

The B220 is operated using a 12.5-inch color touch screen. Audio and visual alarms are produced when explosives or narcotics are detected; the audio alarm can be deactivated at the user's discretion. Onboard memory can save data for over 100,000 swab analyses. When onboard memory is full, previously stored data is overwritten in "first-in, first-out" fashion. Alternatively, analysis data can be exported to an external memory device via a USB port but not directly to a PC.

The B220 can be purchased with or without a built-in printer. The version without the printer, designated the B220-005, weighs 32.2 pounds and measures 16.7 x 15.9 x 14.5 inches. The variant with the built-in printer, designated the B220-003, weighs 34.6 pounds and measures 16.7 x 15.9 x 15.7 inches. In either configuration, the B220 has a 14 to 131 °F operating temperature range and a 14 to 185 °F storage temperature range. The start-up time is 30 minutes.

The list price is $25,000, with or without the built-in printer. Discounts are available for volume purchases, but the B220 is not listed on the GSA price schedule. The purchase price includes a one-year warranty covering parts, labor and return shipping to the customer. Warranties of longer duration or that offer additional technical support are also available at an additional cost.

A variety of training courses are available at additional cost and can be provided online, at the user's location, or at a Leidos facility. Technical support is available 24 hours a day, seven days a week, every day of the year through Leidos's service call center.

Online Resources:

B220 product literature

3.1.4 RAPISCAN SYSTEMS, ITEMISER 5X

The Itemiser 5X analyzes swab samples for explosives and narcotics. Samples are analyzed with an ion trap mobility spectrometer (ITMS) that measures both negative and positive ions produced by a photoionization device. Swabs can be analyzed for explosives only, narcotics only or for both explosives and narcotics at the same time. A broad range of nitrogen- and peroxide-based explosives compounds can be detected. Analyses are completed in eight seconds. Detection limits are in the sub-nanogram range for explosives and in the nanogram range for narcotics. Analysis results indicate the identity of detected compounds. According to Rapiscan, swabs can be reused up to 20 times. A sampling wand is included with purchase of this instrument.

Figure 3-3 Itemiser 5X
Image Credit: Rapiscan Systems

The Itemiser 5X has a 10.4-inch color touch screen and a built-in printer. It produces audio and visual alarms when an explosives or narcotics compound is detected; it can be operated with audio alarms at the operator's preference.

Data for approximately 10,000 sample analyses can be saved to onboard memory. Sample analysis data can be exported to a USB memory device or to a PC via an Ethernet connection.

The Itemiser 5X is equipped with a removable, rechargeable battery that provides up to one hour of operating time when AC power is unavailable. Battery charge level is indicated while the instrument is operating. The start-up time of the Itemiser 5X is 30 minutes. Operating the Itemiser 5X on battery power when moving it to a new location prevents start-up delays: samples can be analyzed while operating on battery power.

The Itemiser 5X weighs 28.7 pounds and measures 19.8 x 18.9 x 14.9 inches. Its operating temperature range is 14 to 131 °F; information on its storage temperature range is not available.

The list price of the Itemiser 5X is $39,900. Discounts are available for volume purchases, but the ETD is not listed on the GSA price schedule. The purchase price includes a one-year warranty covering parts, labor, and return shipment of repaired instruments to the customer. Extended warranties are available at additional cost. Technical support is available 24 hours a day, seven days a week, every day of the year for instruments under warranty. In-person or online training is available at an additional cost.

Online Resources:

Itemiser 5x product literature

3.1.5 SCINTREX E5000/EN5000

Figure 3-4 EN5000

Image Credit: Scintrex

This instrument from Scintrex is available in two variants, the E5000 and the EN5000. The E5000 analyzes swabs for explosives compounds only, while the EN5000 analyzes swabs in either explosives only or narcotics only detection modes. Features and capabilities are the same for both variants except as noted.

Samples are analyzed using a gas chromatography-ion mobility spectrometry (GC-IMS) detector. The IMS spectrometer measure positive and negative ions produced by a nickel-63 radiation source. A broad range of nitrogen- and peroxide-based explosives compounds can be detected. Analysis times are adjustable between 20 to 120 seconds. Detection limits are in the picogram range for explosives and in the tens of nanogram range for narcotic compounds. Analysis results indicate the identity of detected compounds. A sampling wand is not included and is not available as an optional accessory.

Both model variants feature a 12-inch color touch screen and produce visual and audio alarms. Users can deactivate the audio alarm at their discretion. Onboard memory can store data for approximately 450,000 analyses. When memory is full, previously saved data is overwritten on a “first in-first out” basis. Analysis data can be exported via a USB port to an external memory device, but not directly to a PC.

Both variants weigh 72.3 pounds and measure of 16.5 x 21.5 x 11 inches. They have an operating temperature range of 59 to 95 °F and a storage temperature range of 23 to 149 °F. Start-up time is 30 minutes.

The list price for the E5000 and EN5000 are $30,000 and $38,000, respectively. Both model variants are listed on the GSA price schedule. The purchase price includes a one-year warranty covering parts, labor and return shipment of serviced instruments to the customer. Extended warrantees are available at additional cost. Technical support, included in the one-year warranty, is available on a 24-hour basis. On-site training is available at additional cost.

Online Resources:

E5000/EN5000 product literature

3.1.6 SMITHS DETECTION IONSCAN 600

Figure 3-5 Ionscan 600
Image Credit: Smiths Detection

The Ionscan 600 analyzes swabs using an ion mobility spectrometer that measures negative and positive ions produced by a corona discharge ionization device. It is available in three variants that have different analytical capabilities. Features and capabilities described below are the same for all three variants of the Ionscan 600 unless otherwise noted. All variants of the Ionscan 600 can detect a broad range of nitrogen- and peroxide- based explosives compounds.

The two variants that detect explosives and narcotics differ in that one also has enhanced capability for detection of fentanyl and synthetic cannabinoid compounds. This variant of the Ionscan 600 with enhanced fentanyl and synthetic cannabinoid detection capability can operate in either explosives only or narcotics only mode, while the other variant that detects both explosives and narcotics can also analyze swabs for both explosives and narcotics simultaneously. The ETD completes analyses in less than eight seconds with nanogram-level detection limits for explosives. Narcotics detection limits are also at the nanogram level for the two variants with narcotics capability. Analysis results indicate the identity of compounds detected. Swabs are single use only. A sampling wand is available at additional cost.

The Ionscan 600 has a 9-inch color touch screen. It produces visual and audio alarms; the audio alarm can be deactivated at the user's discretion. Onboard memory capacity can store up to 250,000 sample analyses. When the memory is full, stored data is deleted in "first-in, first-out" order. Analysis data can be exported via a USB cable to a personal computer or external printer. Each Ionscan 600 variant can be purchased with or without a built-in printer.

The Ionscan 600 operates on two hot swappable Li-ion batteries as well as on ac power. Each battery provides one hour of operating time and takes two and half hours to recharge. The start-up time of the Ionscan 600 is less than 10 minutes.

Ionscan 600 variants without a built-in printer weigh 23 pounds, measure 14.8 x 12.0 x 12.9 inches, and have a carrying handle. Variants with a built-in printer weigh 25.3 pounds, measure 15.1 x 15.6 x 14.8 inches and do not have a carrying handle. All Ionscan 600 variants have an operating temperature range of 14 to 122 °F and a storage temperature range of -4 to 122 °F. All Ionscan 600 variants have been tested to IEC 60068 standards for sinusoidal vibration, broadband random vibration, and mechanical shock.

List prices range from $29,995 to $34,650, depending on the model variant (see Table 3-2). Discounts are available for volume purchases but the Ionscan 600 is not listed on the GSA price schedule. Purchase price includes a one-year warranty covering parts, labor and return shipping of repaired instruments to the customer. Warranties providing additional levels of customer support are available at additional cost. Technical support is provided 24 hours a day, seven days a week, every day of the year. Training classes are provided at additional cost and are available online, at the customer's location, or at a Smiths Detection facility in Maryland.

Online Resources:

Ionscan 600 product literature

Ionscan 600 product video

3.2 HANDHELD ETDS

This section provides information on 14 handheld ETDs and their variants, products which range in price from $12,500 to $65,000. All handheld instruments listed herein analyze swab samples for explosives. Although the focus of this report is on explosives detection, many instruments can also detect narcotics compounds. Product descriptions indicate, based on available product information, whether instruments have that capability and, if so, whether explosives and narcotics can be detected in a single analysis. Unless otherwise stated, these handheld instruments cannot be operated in vapor sniffing mode or detect TICs and CWAs. Additional details about each instrument are provided in the tables and individual product descriptions below.

Detection limits for different explosives compounds vary; listed values should be considered typical values based on lab testing results obtained by the manufacturer. Detection limits for narcotics, TICs and CWAs compounds are similar to or within a factor of ten of those for explosives compounds; see product descriptions for details on specific instruments.

In accordance with information provided by manufacturers, product descriptions indicate those instruments that have been tested to ASTM E2520, whether stored data is overwritten when onboard memory is full, and swab reusability. As discussed in Section 2.2, swabs should only be reused if the ETD manufacturer indicates it is possible to do so.

None of these instruments operate on widely available battery types (e.g., AA batteries). Operating times on battery power and battery recharge times are estimates provided by the manufacturer. In actual use, battery operating times will vary depending on factors such as ambient temperature, display screen brightness, battery age, and number of sample analyses performed since the instrument was turned on. Battery recharge times are for fully recharging completely depleted batteries. Unless otherwise noted, instruments provide a battery level indication. Reported instrument weights are with batteries installed.

Products included in this section on handheld ETDs are listed in Tables 3-3 through 3-5, which summarize their key features and capabilities. Additional details about each product are provided in individual product descriptions following the tables. Categories of product information provided in Tables 3-3, 3-4 and 3-5 are defined as follows:

Company indicates the manufacturer or vendor of the ETD.

Product indicates the name of the instrument model, including variant number if applicable.

Table 3-3

Detector Technology indicates underlying technology (or technologies) the detector uses to perform sample analysis; either HPMS, IMS, IMS and MOS, Automated Colorimetry, AFP, HF-QCM, Chemiluminescence, ITMS, Chemiluminescence and MOS, or Thermo-Redox (listed here in order of appearance).

Analysis Modes indicates whether the instrument analyzes swabs, operates in vapor sniffing mode, or both.

Detectable Explosives Compounds indicates the general types of explosives compounds the device can determine are present.

Other Detectable Compounds indicates non-explosive compounds of potential interest that the ETD can also detect, narcotics, TICs, and CWAs.

Analysis Result indicates whether analysis results name specific compounds detected ("ID"), general types of chemical compounds detected ("Type"), or simply that an explosives compound is present ("go/no go") without identifying the compound(s) name or type.

Detection Limit indicates the smallest mass of an explosives compound on a swab that can be reliably detected. When a numerical value was provided by a product manufacturer, e.g., "~100 nanograms," it is reported in the table. The notation "ng" indicates detection limits in the single-digit nanogram range. Check with product vendors for information about detection limits for specific explosives compounds.

Analysis Time indicates the number of seconds required to analyze a swab sample for explosives.

Table 3-4

Display Screen indicates the diagonal length of the display screen, whether it is color or monochrome, and whether it functions as a touch screen.

Alarms indicates the type of alarms transmitted by the instrument when an explosive or other compound of interest has been detected; options are audio, visual, and vibrational.

Data Storage indicates how much analysis data can be saved to the ETD's onboard memory.

Data Export indicates connection modes available for exporting analysis data to other memory storage or computing devices.

Price indicates the manufacturer's suggested retail price rounded to the nearest U.S. dollar and whether the instrument is listed on the GSA price schedule.

Table 3-5

Dimensions indicates measurements of the instrument, in inches.

Weight indicates the weight of the instrument including batteries, in pounds.

Temperature (Operating/Storage) indicates temperature range within which the instrument can be operated and stored, in degrees Fahrenheit.

IP Rating indicates the two-digit ingress protection (IP) rating of the instrument. (See IP rating discussion in Section 2.5.6.)

MIL-STD indicates whether the instrument has been tested to any part of MIL-STD-810. A "Y" indicates it has been; an "N" indicates it has not. Where "Y" is listed, details are provided in the product descriptions.

Start-up Time indicates the time required for the instrument to be ready to operate when turned on after having been shut down for many hours, given in minutes unless otherwise noted.

Battery Life indicates operating time of the instrument on battery power, given in hours, assuming that the instrument is in continuous use and the batteries initially were fully charged.

Hot Swap indicates whether batteries can be replaced without turning off the instrument: "Y" indicates yes, "N" indicates batteries are removable but not hot swappable, and "F" for fixed, indicates that batteries are not readily removable in the field.

Battery Recharge Time indicates the manufacturer's best estimates of the time required to fully recharge a fully depleted battery.

Table 3-3 Handheld ETDs: Analysis Technology and Detection Capabilities

Company	Product	Detector Technology	Analysis Modes	Detectable Explosives Compounds	Other Detectable Compounds	Analysis Result	Detection Limits	Analysis Time (seconds)
908 Devices	MX908	HPMS	Swab Vapor	Nitrogen- and Peroxide-based	Narcotics TICs/CWAs	ID	ng	~60
Airsense Analytics	GDA-X	IMS* and MOS	Swab† Vapor	Nitrogen- and Peroxide-based	TICs/CWAs	ID	ng	20-40
Bruker Detection	RoadRunner	IMS	Swab Vapor	Nitrogen- and Peroxide-based	Narcotics	ID	ng	<25
DetectaChem	SEEKERe EDK	Automated Colorimetry	Swab	Nitrogen-, Peroxide- and, Inorganic Chlorate- based	—	Type	~500 ng	10-45
DetectaChem	SEEKERe MDK	Automated Colorimetry	Swab	Nitrogen-, Peroxide- and Inorganic Chlorate- based	Narcotics	Type	~500 ng	10-45
FLIR Detection	FIDO X4	AFP	Swab Vapor	Nitrogen- and Peroxide-based	—	Type	~100 ng	<25
Leidos	QS-H-150E	IMS	Swab	Nitrogen- and Peroxide-based	Narcotics	ID	ng.	10
MS Technologies	Duoscan	HF-QCM	Swab Vapor	Nitrogen- and Peroxide-based	Narcotics	ID	ng	7-15
MS Technologies	Exploscan	HF-QCM	Swab Vapor	Nitrogen- and Peroxide-based	—	ID	ng	7-15
RS Dynamics	miniEXPLONIX 3	CL	Swab Vapor	Nitrogen- and Peroxide-based	—	Go/No Go	ng	< 2
Rapiscan Systems	MobileTrace	ITMS*	Swab Vapor	Nitrogen- and Peroxide-based	Narcotics	ID	<1 ng	<12

Company	Product	Detector Technology	Analysis Modes	Detectable Explosives Compounds	Other Detectable Compounds	Analysis Result	Detection Limits	Analysis Time (seconds)
Rapiscan Systems	Hardened MobileTrace	ITMS*	Swab Vapor	Nitrogen- and Peroxide-based	Narcotics TICs/CWAs	ID	<1 ng	<12
Scintrex	CLX	CL and MOS	Swabs	Nitrogen- and Peroxide-based	—	Go/No Go	~10 ng	<15
Scintrex	E3500	CL	Swabs Vapor	Nitrogen- and Peroxide-based	—	Go/No Go	~10 ng	8
Scintrex	EN3300	IMS*	Swabs Vapor	Nitrogen- and Peroxide-based	Narcotics	ID	~10 ng	10
Scintrex	EVD3000+	Thermo-Redox	Swabs Vapor	Nitro- based	—	Go/No Go	~20 ng	10
Smiths Detection	Sabre 5000 4823750NEG-C	IMS*	Swabs Vapor	Nitrogen- and Peroxide-based	—	ID	ng	~20
Smiths Detection	Sabre 5000 4823750DUAL-C	IMS*	Swabs Vapor	Nitrogen- and Peroxide-based	Narcotics	ID	ng	~20
Smiths Detection	Sabre 5000 4823750TRI-C	IMS*	Swabs Vapor	Nitrogen- and Peroxide-based	Narcotics TICs/CWAs	ID	ng	~20
Smiths Detection	Sabre 5000 4822800TRI-FR	IMS*	Swabs Vapor	Nitrogen- and Peroxide-based	Narcotics TICs/CWAs	ID	ng	~20

Notes:
CL indicates chemiluminescence
* indicates the detectors uses a radioactive sample ionization device
† indicates that the capability requires an optional component included in the purchase price listed in Table 3-4.

Table 3-4 Handheld ETDs: User Interface and Data Capacities

Vendor	Product	Display Screen	Alarms			Data Storage (# of analyses)	Data Export	Price
			Audio	Visual	Vibration			
908 Devices	MX908	5" Color	✓	✓		>1,000	USB Bluetooth	$65,000*
Airsense Analytics	GDA-X	3" Color	✓	✓		N/A	SD card USB RS-232 Wi-Fi†	57,400 €
Bruker Detection	RoadRunner	4.3" Color	✓	✓		~13,000	USB Ethernet	$39,000*
DetectaChem	SEEKERe EDK	2.9" Color	✓	✓	✓	>100,000	USB	$12,950*
DetectaChem	SEEKERe MDK	2.9" Color	✓	✓	✓	>100,000	USB	$14,950*
FLIR Detection	FIDO X4	2.4" Color	✓	✓	✓	~60,000	USB, Bluetooth Wi-Fi	$22,500*
Leidos	QS-H150E	4.3" Color Touch screen	✓	✓		>100,000	USB	$25,556
MS Technologies	Exploscan	3.5" Color Touch screen	✓	✓		N/A	USB Micro USB Bluetooth† Wi-Fi†	$23,500
MS Technologies	Duoscan	3.5" Color Touch screen	✓	✓		N/A	USB Micro USB Bluetooth† Wi-Fi†	$26,500
RS Dynamics	miniExplonix3	1.7" Color	✓	✓		80,000	USB Wi-Fi†	$23,600
Rapiscan Systems	Hardened Mobile Trace	3.5" Color Touch screen	✓	✓		~5,000	USB Ethernet	$35,000

Vendor	Product	Display Screen	Alarms			Data Storage (# of analyses)	Data Export	Price
			Audio	Visual	Vibration			
Rapiscan Systems	Mobile Trace	3.5” color Touch screen	✓	✓		~5,000	USB Ethernet	$33,000
Scintrex	CLX	4.3” color	✓	✓	✓	1,000,000	USB	$22,000
Scintrex	E 3500	(size N/A) Monochrome	✓	✓		~1,000	USB RS-232	$17,000*
Scintrex	EN 3300	3.5” Color Touch screen	✓	✓		400	USB RS-232	$18,000*
Scintrex	EVD 3000+	(size N/A) Monochrome	✓	✓		~1,000	USB RS-232	$12,500
Smiths Detection	Sabre 5000 4823750NEG-C	3.5” Color Touch screen	✓	✓		~300	USB	$24,000
Smiths Detection	Sabre 5000 4823750DUAL-C	3.5” Color Touch screen	✓	✓		~300	USB	$24,000
Smiths Detection	Sabre 5000 4823750TRI-C	3.5” Color Touch screen	✓	✓		~300	USB	$27,000
Smiths Detection	Sabre 5000 4822800TRI-FR	3.5” Color Touch screen	✓	✓		~300	USB	$27,000

Notes:
* indicates that the instrument is available on the GSA price schedule
† indicates that the capability requires a component available at additional cost.
€ is the symbol for Euros
N/A indicates the information was not available from the product manufacturer

Table 3-5 Handheld ETDs: Operational Considerations and Standards

Vendor	Product	Dimensions (inches)	Weight (lbs.)	Temperature Operating / Storage (°F)	IP Rating	MIL-STD-810	Startup Time (in minutes)	Battery Life (hours)	Hot Swap	Battery Recharge Time (hours)
908 Devices	MX908	12 x 8.5 x 4.8	9.5	32 to 110 -4 to 140	IP 54	Y	~1	6*	Y	2
Airsense Analytics	GDA-X	20 x 6.9 x 13	11.3	-4 to 131 -4 to 160	IP 65	Y	6-10	4	F	4
Bruker Detection	RoadRunner	13 x 14 x 5	7.7	32 to 104 -4 to140	IP 42	N	25	3.5	Y	3
DetectaChem	SEEKERe EDK SEEKERe MDK	2.6 x 4.4 x 1.4	0.53	-20 to 120 -20 to 160	IP 66	Y	0.5	8	F	1.5
FLIR Detection	FIDO X4	14 x 4.5 x 2.8	3.2	32 to 104 -4 to140	IP 54	Y	<3	8	Y	4
Leidos	QS-H150E	18 x 6.0 x 8.4	11.8	14 to 131 14 to 185	IP 43	N	30	3 to 4	Y	1 in 3.5 2 in 6
MS Technologies	Exploscan Duoscan	7.8 x 3.5 x 2.8	1.87	-4 to 131 -22 to 140	–	N	<2	6 to 8	Y	2.5
RS Dynamics	miniExplonix3	9.8 x 2.5 x 4.8	1.5	-4 to 131 -22 to 140	IP 42	N	0.5	8	Y	1
Rapiscan Systems	Mobile Trace	16 x 6.0 x 12	9.4	-4 to 131 N/A	N/A	N	30	4	Y	N/A
Rapiscan Systems	Hardened Mobile Trace	17 x 6.3 x 13	12	-4 to 131 -22 to 140	IP 54	Y	30	3	Y	N/A
Scintrex	CLX	9.8 x 6.7 x 3.1	4.2	-4 to 122 -40 to 185	IP 54	Y	5	3	Y	2
Scintrex	E3500	20 x 5.5 x 4.3	6.6	-4 to 130 -22 to 140	–	N	<1	4	N	2

Vendor	Product	Dimensions (inches)	Weight (lbs.)	Temperature Operating / Storage (°F)	IP Rating	MIL-STD-810	Startup Time (in minutes)	Battery Life (hours)	Hot Swap	Battery Recharge Time (hours)
Scintrex	EN3300	18 x 6.2 x 7.5	6.1	-4 to 130 -22 to140	—	N	20	3.5	N	2
Scintrex	EVD3000+	20 x 5.5 x 4.3	6.2	32 to 131 -23 to 149	—	N	1	4	N	2
Smiths Detection	Sabre 5000 (all variants)	14 x 4 x 4.5	7.0	-4 to 130 -22 to 140	—	N	15	4	N	2

Notes:
* denotes that the instrument holds two batteries, time given here is for depletion of both batteries.
N/A indicates that information was not available from the product manufacturer

3.2.1 908 DEVICES, MX908

Figure 3-6 MX908
Image Credit: 908 Device

The MX908 detects and identifies explosives, narcotics, TICs and CWAs. It can analyze swabs and operate in vapor sniffing mode. Samples are analyzed using a high-pressure mass spectrometer (HPMS) that measures negative and positive ions produced by a corona discharge device. A broad range of nitrogen- and peroxide-based explosives compounds can be detected. Swab sample analyses are completed in approximately 60 seconds with low nanogram-level detection limits for explosives compounds. Analysis results indicate the identity of detected compounds. In certain explosives applications, trace swabs can be reused following manufacturer-recommended protocols.

The MX908 is operated using a 5-inch display screen and multi-button keypad. The screen guides users through sample analysis steps. This ETD offers mission-specific “target hunter” modes for detection of explosives, narcotics, TICs and CWAs, as well as a general hazard survey detection mode. Both audio and visual alarms are produced when a compound in the instrument’s library has been detected. Data for more than 1,000 sample analyses can be saved to onboard memory. Users are notified of remaining storage capacity once onboard memory is half full. Data can be exported to a PC via USB port or Bluetooth connection.

The MX908 operates on hot swappable batteries. The battery compartment holds two batteries, each providing three or more hours of operating time (for a total estimated battery life of about six hours). Batteries can be fully recharged in two hours; four batteries are included with purchase. The MX908 can also operate on ac power. Its start-up time is about one minute.

The MX908 weighs 9.5 pounds and measures are 11.5 x 8.5 x 4.8 inches. It has an operating temperature range of 32 to 110 °F, and a storage temperature range of -4 to 140 °F. It has an IP 54 rating and has been tested to MIL-STD-810G standards for high temperature, low temperature, rain, humidity, sand & dust, salt fog, vibration, and shock.

The list price of the MX908 S1 is $65,000 and includes on-site training, a one-year parts and labor warranty, and technical support. Warranty and support coverage beyond the first year are available at additional cost with package prices ranging from $65,000 to $91,000. Volume purchase discounts are offered on a case-by-case basis. GSA pricing for a MX908 S1 is $64,836.27.

In addition to the on-site training provided with instrument purchase, users can attend a live virtual refresher training that occurs monthly. For additional cost, the manufacturer offers online mission- and scenario-specific tutorials and can develop mission-specific training per customer request.

Online Resources:

MX-908 product literature

MX-908 product overview video

MX-908 swab analysis video

MX-908 vapor sniffing mode video

3.2.2 AIRSENSE ANALYTICS GDA-X

The standard version of the GDA-X detects and identifies explosives, TICs and CWAs in vapor sniffing mode. Fitted with an optional sample introduction attachment that clips onto the front of the instrument, it can also analyze swabs for explosives.

Figure 3-7 GDA-X

Image Credit: Airsense Analytics

Samples are analyzed by an IMS spectrometer that measures negative and positive ions produced by a nickel-63 radiation source. Measurement data from two MOS sensors are used to verify analysis results for several explosives compounds. A broad range of nitrogen- and peroxide-based explosives compounds can be detected. Vapor sample analyses are completed in 5 to 20 seconds, and swab sample analyses in 20 to 40 seconds. Detection limits are in the ppm to ppb range (parts per million and per billion, respectively) for explosives sampled in vapor analysis mode and at the nanogram level for explosives compounds collected on swabs. Analysis results indicate the identity of compounds detected. A sampling wand is included in the purchase price of this instrument.

The user interface includes a 3-inch diagonal display screen and two control buttons. Audio and visual alarms are produced when an explosives compound is detected; the GDA-X can be operated without audio alarms at the user's preference. Analysis data is saved to a removable 30 Gigabyte SD card. Data can be exported by using the SD card, by connecting a USB or RS-232 cable to a personal computer, or wirelessly, if the owner purchased the optional Wi-Fi capability.

The GDA-X operates on removable (but not-hot swappable) Li-ion batteries that provide four hours of operating time and take four hours to recharge. The instrument does not have a battery level indicator. The GDA-X can also operate on external 12-volt DC and AC power sources. Its start-up time is six to 10 minutes.

Without the swab sample introduction accessory attached, the GDA-X weighs 9.3 pounds and measures 15.5 x 4.4 x 8.3 inches. The swab sample introduction attachment adds an additional 2.0 pounds and has dimensions of 4.3 x 2.5 x 4.4 inches. The operating temperature range of the GDA-X is -4 to 131 °F and its storage temperature range is -4 to 160 °F. It has an IP 65 rating and has been tested to MIL-STD-810G drop and shock standards.

The list price of the GDA-X is 57,400 Euros, with volume discounts available. It is not listed on the GSA schedule. The purchase price includes a one-year warranty covering parts and labor. A two-year warranty is available at additional cost. Technical support is available by telephone or email on weekdays during business hours at Airsense's offices in Germany. Training for up to five people at the user's location is available for additional cost.

Online Resources:

GDA-X product literature

3.2.3 BRUKER ROADRUNNER

Figure 3-8 RoadRunner
Image Credit: Bruker Detection

The RoadRunner analyzes swabs for explosives and narcotics, and can also operate in vapor sniffing mode. Samples are analyzed by an IMS spectrometer that measures both positive and negative ions produced by a photoionization device. A range of nitrogen- and peroxide-based explosives compounds can be detected. Swab samples can be analyzed for explosives only, for narcotics only, or for both explosives and narcotics simultaneously. Analysis results indicate the identity of compounds detected. The combined explosives/narcotics library is limited to a select group of compounds, so operation in either explosives only or narcotics only mode is recommended. Swab sample analyses are typically completed in less than 25 seconds with nanogram-level detection limits. According to Bruker, swabs can be reused up to 15 times. A telescoping sampling wand is available at an additional cost.

The RoadRunner's user interface includes a 4.3-inch color screen and a LED status indicator. Audio and visual alarms are produced when an explosives or narcotics compound is detected; however, the audio alarm can be deactivated by the user. Data for approximately 13,000 sample analyses can be stored in onboard memory. Saved data is overwritten in "first in-first out" order; users are warned when the onboard memory is approaching its limit. Analysis data can be exported to a PC by connecting a USB or Ethernet cable.

The Roadrunner uses a hot swappable Li-ion battery that provides approximately three and a half hours of operating time and can be fully recharged in three hours. It can also operate on 12-volt dc or ac power sources. The start-up time for the RoadRunner is 25 minutes.

This handheld ETD weighs 7.7 pounds and measures 13 x 13.5 x 5 inches. Its operating temperature range is 32 to 104 °F and its storage temperature range from -4 to 140 °F. It has an IP 42 rating. Information about whether it has been tested to the MIL-STD-810 standard is unavailable.

The list price of the RoadRunner is $39,000; it is listed on the GSA price schedule. The purchase price includes a one-year limited warranty covering parts and labor. Technical support is available during business hours at a Bruker location in Massachusetts. A one-hour user training course is provided at no cost with purchase of the instrument; more detailed in-person training courses are available for an additional fee.

Online Resources:

Roadrunner product literature

RoadRunner product video

3.2.4 DETECTACHEM SEEKERE EDK/MDK

Figure 3-9 SEEKERe EDK
Image Credit: Detectachem

The SEEKERe detects explosives on swab samples and is available in two model variants: the SEEKERe EDK, which detects only explosive compounds, and the SEEKERe MDK, which simultaneously detects both explosives and narcotics compounds. Features and capabilities of the Seeker EDK are described below; the SEEKERe MDK's features and capabilities are the same unless otherwise noted.

Swabs are analyzed using an automated colorimetric detector. Detection limits are approximately 500 nanograms for both explosives and narcotics. Sample analyses are completed in 10 to 45 seconds. Analysis results for explosives indicate which if any of several general classes of explosives compounds were detected. Detectable compound classes are nitroaromatics, nitrate esters and nitramines, inorganic nitrates, inorganic chlorates, and peroxides. A sampling wand is not included, nor available.

The user interface consists of a 2.9-inch color display screen and a menu navigation button. Audio, visual, and vibration alarms are produced when an explosives compound is detected; the instrument's audio and vibration alarms can be deactivated by the user. Onboard memory can store over 100,000 sample analyses. Data can be exported to a USB flash storage device provided with purchase.

The SEEKERe EDK operates on a non-removable Li-ion battery that provides eight hours of operating time and can be fully recharged in 90 minutes. It can also operate on ac power sources. Its start-up time is 30 seconds.

The SEEKERe EDK weighs 0.53 pounds and measures 2.6 x 4.4 x 1.4 inches. It operates within a temperature range of -20 to 120 °F, can be stored between -20 to 160 °F, and has an IP rating of 66. It has been tested to the ASTM E2520 standard and to MIL-STD-810G for transit drop, shock, and vibration.

The manufacturer's suggested retail price for the SEEKERe EDK and SEEKERe MDK is $12,950 and $14,950, respectively. Volume discounts are available for both, and both model variants can be purchased from instrument resellers at GSA schedule prices. Purchase prices include a 1-year warranty covering parts, labor, and return shipping of repaired instruments to the customer. Extended warranties are available at additional cost. Access to an online video training course is also included with purchase. Training at the customer's location or at a Detectachem facility is available for an additional fee. Technical support is provided weekdays during business hours at DetectaChem Stafford, Texas office location.

Online Resources:

SEEKERe EDK/MDK product literature SEEKERe EDK/MDK product video

3.2.5 FLIR FIDO X4

Figure 3-10 FLIR FIDO X4
Image Credit: FLIR Detection

The FIDO X4 analyzes swabs for explosives and can also operate in vapor sniffing mode. Samples are analyzed with an AFP detector. Swab sample analyses are completed within 25 seconds with detection limits of about 100 ng. Analysis results indicate which of several general categories of explosives compounds have been detected: nitroaromatics, nitramines, nitrate esters, nitrosamines, inorganic nitrates, smokeless powders, organic peroxides, and black powder. According to FLIR, swabs can be reused up to 10 times. A sampling wand is available at additional cost.

The FIDO X4's user interface includes a 2.4-inch color touch screen and keypad. Audio, visual, and vibration alarms are produced when an explosives compound is detected; the audio alarm can be deactivated by the user. Onboard memory offers capacity to store approximately 60,000 sample analysis results. The user interface indicates available data storage capacity. Stored data is overwritten in "first in-first out" order when memory is full. Analysis results and summary reports for a user-selected date range are available. Data can be exported to a PC via a USB cable, Wi-Fi and Bluetooth connections.

The FIDO X4 operates on one hot swappable Li-ion battery that provides approximately eight hours of operating time and can be fully recharged in four hours. Two batteries are included with purchase. The FIDO X4 can also operate on ac power sources. Its start-up time is less than three minutes.

The FIDO X4 weighs 3.2 pounds and measures 14.4 x 4.5 x 2.8 inches. It has an operating temperature range of 32 to 104 °F and a storage temperature range of 14 to 122 °F. This ETD has an IP 54 rating and has been tested to the ASTM E2520 standard. It has also been tested to MIL-STD-810G for high temperature, low temperature, salt fog, vibration, and shock.

The list price of the FIDO X4 is $22,500, with discounts available for volume purchases. It is also listed on the GSA price schedule. The purchase price includes a one-year warranty covering parts, labor and return shipping. Extended warranties are available at additional cost. Technical support is provided during business hours on weekdays at a FLIR location in the central United States.

Online or in-person training at FLIR's Stillwater, Oklahoma facility is included in the purchase price of the FIDO X4. Training at the customer's location can also be arranged at additional cost. The Fido X4 also has instrument operation tutorials stored in its onboard memory, which can be viewed on the instrument's display screen before or during use.

Online Resources:

[FIDO X4 product literature]   [FIDO X4 product video]

3.2.6 LEIDOS, QS-H150E

The QS-H150E analyzes swabs for narcotics compounds as well as explosives compounds. Samples are analyzed by an IMS spectrometer that measures positive and negative ions produced by a spark ionization device. Analyses are performed in either explosives only or narcotics only mode. (Samples cannot be simultaneously analyzed for explosives and narcotics.) A broad range of nitrogen- and peroxide-based explosives compounds can be detected. Analysis results indicate the identity of detected explosives or narcotics compounds. Swab analyses are completed in 10 seconds and within nanogram-level detection limits for explosives compounds. Swabs are reusable up to 25 times, according to Leidos. A sampling wand is not included, but two types of sampling wands are available for purchase at additional cost.

The user interface includes a 4.3-inch touch screen and a joystick button for navigation. Audio and visual alarms are produced when an explosives or narcotics compound is detected. The audio alarm can be deactivated at the user's discretion. An optional external keyboard and monitor can be connected via a USB port to access IMS spectrum display and analysis tools and administrative controls. Internal memory can save data for over 100,000 sample analyses. When the onboard storage capacity is reached, data is overwritten on a "first in-first out" basis. Analysis data can be exported to an external USB memory device or printed, receipt style by a small USB-connected printer that can be purchased at additional cost. Despite this ETD's having a USB port, data cannot be exported directly to a PC via USB cable.

The QS-H150E operates on two hot swappable Li-ion batteries that each provide three to four hours of operating time, allowing for six to eight hours of operation on battery power. Two batteries are included with purchase. Recharge times are three and a half hours for one battery and six hours for recharging two batteries. It can also operate on ac power sources. The start-up time of the QSH-150E is 30 minutes.

This handheld ETD weighs 11.8 pounds and measures 18 x 6 x 8.4 inches. It has an operating temperature range of 14 to 131 °F and a storage temperature range of 14 to 185 °F. It has an IP 43 rating but has not been tested to any part of the MIL-STD-810 standard.

The list price of the QS-H150E is $25,555.56. Volume discounts are available. It is not listed on the GSA schedule. Purchase price includes a one-year warranty covering parts, labor and return shipping to the customer. Warranties of longer duration or providing additional technical support are available at additional cost. Technical support is available 24 hours a day, seven days a week, every day of the year through Leidos' service call center.

A variety of training courses are available online, at the user's location, or at a Leidos facility for an additional fee.

Online Resources:

QS-H150E product literature

3.2.7 MS TECHNOLOGIES, EXPLOSCAN AND DUOSCAN

The Exploscan and Duoscan are variants of the same core instrument. The Exploscan and Duoscan can both detect a range of nitrogen- and peroxide based explosives compounds. The Duoscan can additionally detect narcotics compounds and can be operated to analyze samples for explosives only, narcotics only, or simultaneously for both explosives and narcotics. Both instruments can operate in vapor sniffing mode as well as analyze swab samples. A sampling wand is included with purchase of either instrument. Features and capabilities described below are the same for both instrument variants unless otherwise noted.

Figure 3-11 Exploscan
Image Credit: MS Technologies

Sample analysis is based on high frequency quartz crystal microbalance (HF-QCM) detection technology. Swab analyses take 7 to 15 seconds to complete and provide low-nanogram detection limits for both explosives and (in the case of the Duoscan) narcotics compounds. Swabs can be reused 30 times or more according to MS Technologies. An optional battery-powered sampling accessory can be used to collect vapor on a sorbent that is then analyzed as a swab sample. This sampling and analysis method offers a higher detection sensitivity compared to vapor sniffing mode because the sorbent sampling collects vaporized compounds from a greater volume of air.

Both instruments have a 3.5-inch color touch screen, produce audio and visual alarms when a target compound is detected, and can operate with the audio alarm muted at the user's discretion. Analysis data can be exported to a PC via a micro-USB port. Results can also be sent to a USB printer, which is available as an optional accessory. Instruments also can be configured with Bluetooth and Wi-Fi communication capabilities at additional cost. An adjustable workstation with lockable wheels is available at extra cost for users who wish to use these instruments as desktop ETDs at fixed locations.

They operate on hot swappable Li-ion batteries that provide 6 to 8 hours of operating time and take two and a half hours or less to recharge. They can also operate on ac power sources. The start-up time is under two minutes. Both instruments weigh 1.87 pounds including batteries and measure 7.8 x 3.5 x 2.8 inches. They have an operating temperature range of -4 to 131 °F and a storage temperature range of -22 to 140 °F. These systems do not have IP ratings nor have they been tested to any part of the MIL-STD-810 standard.

List prices of the Exploscan and Duoscan are $23,500 and $26,500, respectively. They are not listed on the GSA price schedule. A two-year warranty covering parts, labor and a technical support package is included in the purchase price for all three instruments. Technical support is available weekdays during business hours through an MS Detection location in Virginia. Additional levels of technical support, such as extended technical support hours or remote instrument diagnostics, can be provided at additional cost. MS Detection offers operator, technical, and specialized training courses that can be provided online or in person. Training courses are not included in the purchase price of the instrument; their cost is dependent on course content and training venue.

Online Resources:

Exploscan product literature

Duoscan product literature

3.2.8 RS DYNAMICS, MINIEXPLONIX3

Figure 3-12 miniExplonix3
Image Credit: RS Dynamics

The miniExplonix3 analyzes swab samples for explosives and can also operate in vapor sniffing mode. Samples are analyzed using a chemiluminescence detector that can be fitted with either a standard or an advanced detector cartridge. The standard cartridge detects a wide range of nitro- and peroxide-based explosives, while the advanced cartridge detects a narrower range of compounds but provides better detection sensitivity for them. The manufacturer offers standard and advanced swabs for use with this instrument. Standard swabs are intended for use when the standard detector cartridge is installed and are reusable. Advanced swabs are recommended for use with the advanced detection cartridge. Advanced swabs can only be reused if carefully cleaned by reanalyzing them several times to ensure all volatile explosive residues have been desorbed. Swab analyses are completed in two seconds or less with low nanogram level detection limits. Analysis results are "go/no go."

The miniExplonix3 has a 1.7-inch diagonal color LCD display screen that is navigated using a single control button. Audio and visual alarms are produced when an explosives compound is detected; the audio alarm can be deactivated at the user's discretion. Onboard memory can store 80,000 sample analyses; data is overwritten when memory is full. Users can download measurement data to a computer via USB cable or wirelessly, if the optional Wi-Fi capability has also been purchased. Also available is an optional advanced software suite that enables a Wi-Fi-equipped miniExplonix3 to be operated remotely, for example, while mounted on a robot.

The miniExplonix3 operates on hot-swappable lithium polymer (Li-Poly) batteries that provide eight hours of operating time and can be fully recharged in one hour. It can also operate on 12-volt dc or ac power sources. Its start-up time is 30 seconds or less.

The miniExplonix3 weighs 1.5 pounds and measures 9.8 x 2.5 x 4.8 inches. It has an operating temperature range of -4 to 130 °F and a storage temperature range of -22 to 140 °F. It has an IP 42 rating. It has not been tested to any part of the MIL-STD-810 standard.

The list price of the miniExplonix3 is $23,600; volume discounts are available. It is not listed on the GSA price schedule. The purchase price includes a one-year parts and labor warranty; extended warranties are available at additional cost. Technical support is offered from 9 a.m. to 5 p.m. Central European Standard Time. Training on instrument operation (not including travel costs) is included in the purchase price and can be provided online or in-person at a U.S. distributor's location.

Online Resources:

MiniExplonix3 product video

MiniExplonix3 product page

3.2.9 RAPISCAN SYSTEMS, MOBILETRACE AND HARDENED MOBILETRACE

Figure 3-13 Hardened MobileTrace
Image Credit: Rapiscan Systems

The MobileTrace and Hardened MobileTrace are two variants of the same core instrument. Features and capabilities of both variants are identical except as noted. Both variants analyze swabs samples and can also operate in vapor sniffing mode. Samples are analyzed by an Ion Trap Mass Spectrometer (ITMS) that measures negative and positive ions produced by a nickel-63 radiation source. Both model variants can analyze samples for explosives and narcotics, either separately or simultaneously. The Hardened MobileTrace can also analyze samples for TICs and CWAs. A broad range of nitrogen- and peroxide-based explosives compounds can be detected. Swab analyses are completed in less than 12 seconds. Detection limits are at the picogram-level limits for explosives and at the nanogram-level for narcotics. Analysis results indicate the identity of detected compounds. Swabs are not reusable. A swab sampling wand is an included accessory.

Both variants are operated using a 3.5-inch color touch screen and a soft key navigation pad. Audio and visual alarms are produced when a target compound is detected; the audio alarm can be deactivated during operation at the user's discretion. Data for approximately 5,000 analyses can be stored in onboard memory. Analysis data can be exported to an external USB storage device or to a PC via Ethernet connection.

Both model variants operate on hot swappable Li-ion batteries; two batteries are provided with purchase. Each battery provides four hours of operating time for the MobileTrace or three hours of operating time for the Hardened MobileTrace. Both model variants also can operate on 12-volt dc or ac power sources. The start-up time of both variants is 30 minutes.

The MobileTrace weighs 9.4 pounds and measures 16.1 x 6 x 12.4 inches. It has an operating temperature range of -4 to 131 °F. No information about its storage temperature range or IP rating was available. Performance of this instrument has been tested to the ASTM E2520 standard. It has not been tested for any part of the MIL-STD-810 standard. The Hardened MobileTrace weighs 12 pounds and its dimensions are 17.3 x 6.3 x 12.8 inches. It has an operating temperature range of -4 to 131°F and a storage temperature range of -4 to 267°F. It has an IP 54 rating and has been tested to the ASTM E2520 standard. It has also been tested to MIL-STD-810G for resistance to blowing dust and sand, resistance to rain/blowing rain, and salt fog resistance.

The manufacturer's suggested retail price for the MobileTrace and Hardened MobileTrace is $33,000 and $35,000, respectively. Volume purchase discounts are available. The ETDs are not listed on the GSA schedule. Purchase price includes a one-year warranty covering parts and labor and shipment of repaired instruments back to the customer; extended warranties are available at additional cost. Technical support is available 24 hours a day, seven days a week, every day of the year for instruments under warranty. Training is offered at an extra cost and can be provided in person or online.

Online Resources:

MobileTrace product literature

Hardened MobileTrace product literature

3.2.10 SCINTREX, CLX

The CLX detects trace explosives on swabs using a chemiluminescence detector and an MOS sensor array. Vapor samples can be collected using a sampling accessory that draws air through a sorbent that is then analyzed like a swab sample. A broad range of nitrogen- and peroxide-based explosives compounds can be detected, as well as inorganic chlorate and perchlorate compounds that, due to their very low vapor pressures, many ETDs cannot detect. Samples are analyzed in 15 seconds or less with detection limits in the 10 nanogram range. Analysis results are “go/no go.” A sampling wand is neither included, nor available.

Figure 3-14 Scintrex CLX with Vapor Sampling Accessory
Image Credit: Scintrex

The CLX’s user interface includes a 4.3-inch diagonal color display screen and several menu navigation buttons. Audio, visual, and vibration alarms are produced when an explosives compound is detected; the audio and vibration alarms can be deactivated at the user’s discretion. The CLX has a built-in digital camera to photograph inspected items for documentation purposes. Onboard memory is sufficient to store data for over 1,000,000 sample analyses. Analysis data can be exported to a USB flash drive.

The CLX operates on hot swappable Li-ion batteries that provide three hours of operating time and can be fully recharged in two hours. It can also operate on ac power. The start-up time of the CLX is five minutes.

This handheld ETD weighs 4.2 pounds and measures 9.8 x 6.7 x 3.1 inches. It has an operating temperature range of -4 to 122 °F and a storage temperature range of -40 to 185 °F. The CLX has an IP 54 rating but has not been tested to any part of the MIL-STD-810 standard.

The list price of the CLX is $22,000; volume purchase discounts are available. It is not listed on the GSA price schedule. The purchase price includes a one-year warranty covering parts, labor and return shipment of repaired instruments to the customer; extended warrantees are available at additional cost. Technical support is available 24 hours a day. On-site instrument training is available but is not included in the purchase price.

Online Resources:

Scintrex CLX product literature

Scintrex CLX product video

3.2.11 SCINTREX, E3500

The E3500 analyzes swabs for explosives and can also operate in vapor sniffing mode. Samples are analyzed using a chemiluminescence detector. A broad range of nitrogen- and peroxide-based explosives compounds can be detected. Swab analyses are typically completed in eight seconds with detection limits of approximately 10 nanograms. Analysis results are “go/no go.” A sampling wand is neither included, nor available.

Figure 3-15 Scintrex E3500

Image Credit: Scintrex

The E3500’s user interface includes a monochrome display screen and a four-button keypad. Audio and visual alarms are produced when an explosives compound is detected; the audio alarm can be deactivated at the user’s discretion. Onboard memory can store up to 1,000 sample analyses; older data is overwritten when memory is full. Analysis data can be exported to a personal computer via a USB or RS-232 cable connection. Analyses can also be sent to a printer via RS-232 cable connection.

The E3500 operates on nickel metal hydride (NiMH) batteries that provide four hours of operating time and can be fully recharged in two hours. The batteries are readily removable but are not hot swappable. An externally connected battery that provides eight hours of operating time can be purchased at additional cost. The E3500 can also operate with 12-volt dc or ac power sources. Its start-up time is less than one minute.

The E3500 weighs 6.6 pounds, and its dimensions are 20 x 5.5 x 4.3 inches. It has an operating temperature range of 32 to 131 °F and a storage temperature range of 23 to 149 °F. It does not have an IP rating and has not been tested to any part of the MIL-STD-810 standard.

The list price of the E3500 is $17,000; volume purchase discounts are available. It is listed on the GSA price schedule. The purchase price includes a one-year warranty covering parts, labor and return shipment of repaired instruments to the customer; extended warrantees are available at additional cost. Technical support is available 24 hours a day. On-site instrument training is available but is not included in the manufacturer’s list price.

Online Resources:

[Scintrex E3500 product literature]

3.2.12 SCINTREX EN3300

Figure 3-16 Scintrex EN3300

Image Credit: Scintrex

The EN3300 analyzes swabs for explosives and narcotics, and can also operate in vapor sniffing mode. It is equipped with an IMS spectrometer that measures both negative and positive ions produced by a nickel-63 radiation source. Nine different nitrogen-based explosives compounds can be detected. Sampling surfaces for solid residues is done in a way that is distinct from other instruments: the item to be screened is wiped with a disposable glove and the residue collected is transferred to a reusable metallic swab for analysis. Swab analyses are typically completed in 10 seconds. Detection limits in the 10 nanogram range for explosives and the 50 nanogram range for narcotics. Analysis results indicate the identity of compounds detected. A sampling wand is neither included, nor available as an optional accessory.

The EN3300 is operated using a 3.5-inch color touch screen. Audio and visual alarms are produced when an explosives or narcotics compound is detected; the audio alarm can be muted at the user's discretion. Onboard memory can store analysis data for 400 samples. Data can be exported to a PC via a USB or RS-232 cable. Analyses can also be sent to a printer via an RS-232 cable connection.

The EN3300 operates on Li-ion batteries that are removable but not hot swappable; a spare battery is provided with purchase of the instrument. Each battery provides three and half hours of operating time and can be fully recharged in two hours. The EN3300 can also operate on ac power. Its start-up time is 20 minutes.

The EN3300 weighs 6.1 pounds and measures 17.7 x 6.2 x 7.5 inches. It has an operating temperature range of 32 to 131 °F and a storage temperature range of 23 to 149°F. It does not have an IP rating, nor has it been tested to any part of the MIL-STD-810 standard.

The list price of the EN3300 is $18,000; discounts are available for volume purchases. It is listed on the GSA price schedule. The purchase price includes a one-year warranty covering parts, labor and return shipment of repaired instruments to the customer; extended warranties are available at additional cost. Technical support is available 24 hours a day. On-site instrument training is available but is not included in the manufacturer's list price of this instrument.

Online Resources:

[Scintrex EN3300 product literature]

3.2.13 SCINTREX EVD 3000+

Figure 3-17 Scintrex EVD 3000+

Image Credit: Scintrex

The EVD 3000+ detects a variety of nitro-based explosives compounds on swabs and can also operate in vapor sniffing mode. Sample analysis is based on thermo redox detector technology and provides a "go/no-go" response. Swab sample analyses are completed in 10 seconds at detection limits of about 20 nanograms. In vapor sniffing mode the analysis time can be set between seven and 15 seconds.

The EVD 3000+ user interface includes a monochrome display screen, LED indicator lights, and four-button keypad. Audio and visual alarms are produced when an explosives compound is detected; the audio alarm can be muted at the user's discretion. Data for up to 1,000 analyses can be saved to onboard memory. Stored data files are overwritten when memory is full. Analysis data can be exported to a PC via a USB or RS-232 cable connection. Analysis results can also be sent directly to a printer via RS-232 cable connection.

The EVD3000+ operates on rechargeable NiMH batteries that provide four hours of operating time each and can be fully recharged in two hours. Batteries are removable but are not hot swappable. An optional externally connected battery providing eight hours of operating time is also available. The EVD3000+ can also operate on 12-volt dc or ac power sources. Its start-up time is one minute.

The EVD3000+ weighs 6.2 pounds and measures 20 x 5.5 x 4.3 inches. It has an operating temperature range of 32 to 131 °F and a storage temperature range of 23 to 149 °F. It does not have an IP rating, nor has it been tested to any part of the MIL-STD-810 standard.

The list price of the EVD3000+ is $12,500; discounts are available for volume purchases. It is listed on the GSA price schedule. The purchase price includes a one-year warranty covering parts, labor and return shipment of repaired instruments to the customer; extended warranties are available at additional cost. Technical support is available 24 hours a day. On-site instrument training is available, but is not included in the manufacturer's list price.

Online Resources:

[Scintrex EVD-3000+ product literature]

3.2.14 SMITHS DETECTION, SABRE 5000

The Sabre 5000 can analyze swab samples and can also operate in vapor sniffing mode. It is available in four variants that have different measurement capabilities. All variants analyze samples using an IMS spectrometer that measures ions produced by a nickel-63 radiation source and can detect a broad range of nitrogen- and peroxide-based explosives compounds.

Figure 3-18 Sabre 5000

Image Credit: Smiths Detection

One variant of the Sabre 5000 can analyze samples only for explosives compounds; a second "dual mode"' variant can analyze samples for both explosives and narcotics; two "tri mode" variants can analyze samples for explosives, narcotics, TICs and CWAs. What differentiates the two tri-mode variants from one another is their capabilities when operating in vapor sniffing mode. One tri-mode variant can operate in "ASV-Explosives" vapor sniffing mode to optimize ion measurements for explosives analysis, while the other tri-mode variant can operate in "ASV-CWA/TIC" vapor sniffing mode to optimize ion measurements for CWA and TIC analysis. The two other Sabre 5000 variants can also operate in ASV-Explosives mode. Swab sample analyses across the model variants are typically completed within 30 seconds: 10 seconds for detection and 20 seconds for compound identification. Detection limits are in the nanogram range for solid explosives compounds on swabs and in the low ppm range for vapors. Swabs can be re-used up to 10 times.

The user interface includes and a 3.5-inch color touch screen and four function buttons. The display screen can be rotated when the Sabre 5000 is operated at a fixed location. Both audio and visual alarms are produced when a target compound is detected. Data for approximately 300 analyses can be stored in the instrument's onboard memory. Analysis data files are overwritten on a "first-in first-out" basis when memory is full; users are warned when data storage is nearing full capacity. Data can be exported to a PC via a USB port. Included software also allows the Sabre 5000 to be operated by a personal computer connected via a USB cable.

The Sabre 5000 operates on Li-ion batteries that provide up to four hours of operating time and can be fully recharged in two hours. The batteries are removable but not hot swappable. The Sabre 5000 can also operate connected to an ac power source. Its start-up time is less than 15 minutes. The Sabre 5000 weighs 7 pounds, and measures 14 x 4.0 x 4.5 inches. It has an operating temperature range of 32 to 104 °F and a storage temperature range of -4 to 131 °F. It does not have an IP rating, nor has it been tested to any part of the MIL-STD-810 standard.

The list price of the Sabre 5000 ranges from $24,000 to $27,000 depending on the variant purchased. Volume discounts are available. All Sabre 5000 model variants are listed on the GSA price schedule. Purchase price includes a one-year warranty covering parts, labor and return shipping of repaired instruments to the customer. Warranties providing additional levels of customer support are available at additional cost. Technical support is provided 24 hours a day, seven days a week, every day of the year. Training is available at an additional cost. Training options include a self-paced online course, an interactive online course with a Smiths Detection instructor, and in-person courses with a Smiths Detection instructor.

Online Resources:

SABRE 5000 product literature

4.0 VENDOR CONTACT INFORMATION

Additional information on the instruments included in this market survey report can be obtained from the companies listed below.

Table 4-1 Contact Information

Company Name	Address	Phone	Website
908 Devices	908 Devices 645 Sumer Street Boston, MA 02120	857-254-1500	www.908devices.com
Airsense Analytics	Airsense Analytics Hagenower Strasse 73 Schwerin D-19061 Germany U.S. Distributor: Wilbur Technical Services 97 South Main St. Mont Vernon, NH 03057	Germany: +49 38 3993-276 USA: 603-880-7100	www.airsense.com
Bruker Detection	Bruker Detection 40 Manning Road Billerica, MA 01821	978-633-3660	www.bruker.com/products/cbrne-detection.html
Detectachem	Detectachem, Inc. Greenbrier Drive Suite 180 Stafford, TX 77477	855-573-3537	www.detectachem.com
FLIR Detection	FLIR Detection, Inc. 1024 S. Innovation Way Stillwater, OK 74074	405-880-3444	www.flirdetection.com
Greyscan Australia	Greyscan Australia 9/435 Williamstown Road Port Melbourne VIC 3207 Australia U.S. Distributor: GreyScan USA 5950 Symphony Woods Road Suite 250 Columbia, MD 21044	Australia: +61 3 9112 0333 USA: 410-997-3923	www.greyscandetection.com
Leidos	Leidos Security Detection & Automation, Inc. One Radcliff Road Tewksbury, MA 01876	781-939-3800	www.leidos.com/security-detection
MS Technologies	MS Technologies, Inc. 1655 Fort North Myer Drive Suite 700 Arlington, VA 22209	703-465-5101	www.ms-technologies.com

Company Name	Address	Phone	Website
Rapiscan Systems	Rapiscan Systems 23 Frontage Road Andover, MA 01810	978-262-8700	www.rapiscansystems.com
RS Dynamics	RS Dynamics LLC Baarerstrasse 57 Zug 6304 Switzerland	+4 17893770	www.rsdynamics.com
Scintrex	Scintrex Trace Corporation 300 Parkdale Avenue Ottawa, Ontario K1Y1G2 Canada	613-617-7000	www.autoclear.com
Smiths Detection	Smiths Detection, Inc. 2202 Lakeside Boulevard Edgewood, MD 21040	410-612-4000	www.smithsdetection.com

5.0 CONCLUSIONS

Desktop ETDs are primarily intended for use at fixed locations, while handheld ETDs are intended for scenarios when user mobility and the ability to operate the instrument on battery power are essential to conduct screening. Some of the ETDs described are available in more than one variant.

The kinds of explosives compounds that an ETD can detect depends upon the underlying technology it uses. Some ETDs can detect a broad range of explosives compound types, while others detect a relatively narrow range of explosive compound types, e.g., only nitro-based explosives or inorganic explosives compounds. Instruments that are based on IMS, HPMS and HF-QCM detector technology identify the specific explosives compounds that have been detected, while ETDs based on AFP and automated colorimetry indicate only the general classes of detected explosives compounds. ETDs based on chemiluminescence and thermo-redox detector technologies are “go/no go” screening devices; they indicate that explosives compounds have been detected but do not provide compound identification information. No single ETD can detect every chemical compound that could potentially be used to make an explosive device.

This market survey provides information on 21 different desktop and handheld ETD models. All instruments included in this report analyze swab samples for explosives. Many handheld ETDs can also operate in vapor sniffing mode; however, swab sample analysis is the primary way these instruments are used. Many desktop and handheld ETDs can also be used to screen for narcotics compounds, and some handheld ETDs can also detect and identify TICs and CWAs.

Features related to ETD deployment and operation in the field, such as start-up time, size, weight, water and dust resistance, ruggedness, ability to operate on battery power, battery operating and recharge times, data storage capacity, and consumables needed for operation vary significantly among the instruments included in this report.

Long-term ownership considerations also differ depending upon factors such as the detector technology the instrument is based on, instrument design details, and how much the instrument is used. Instrument components such as ionization devices and chemical sensors may need to be replaced periodically, while ETDs that contain radioactive ionization sources may be subject to Nuclear Regulatory Commission and US DOT regulations governing the use, transport and disposal of radioactive material. The cost of items needed to operate an ETD over its usable lifetime may amount to a significant fraction of its initial cost. Prices of the desktop ETDs included in this report range from about $25,000 to $40,000, and prices of the handheld ETDs range from about $12,500 to $65,000.

The product information provided in this market survey has not been independently verified by NUSTL and should not be the sole source of information that an organization uses to make acquisition decisions. Organizations should engage with instrument manufacturers to further understand the potential suitability of their products.

6.0 REFERENCES

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Appendix A. Ingress Protection Codes

Table A-1 IP Rating First Digit: Protection Against Ingress of Solids

Digit	Object Size Effective Against	General Description
0	No Protection	No protection against contact and ingress of solids.
1	> 50 mm	Large surfaces, e.g., back of hand, but no protection against deliberate contact with body part.
2	> 12.5 mm	Prevents entry of fingers and similarly sized objects.
3	> 2.5 mm	Prevents entry of tools, thick wires, etc.
4	> 1 mm	Prevents entry of most wires, screws, large ants etc.
5	Dust Protected	Dust ingress not entirely prevented but does not enter in sufficient quantity to interfere with satisfactory operation of equipment.
6	Dust Tight	No ingress of dust.

Table A-2 IP Rating Second Digit: Protection Against Ingress of Water

Digit	Water Exposure Protection	Description
0	No Protection	No protection.
1	Vertically dripping water	Vertically dripping water has no harmful effects.
2	Dripping water, enclosure tilted up to 15 degrees	Vertically dripping water has no harmful effects when enclosure is tilted at an angle up to 15 degrees of normal vertical position.
3	Spraying water	Water sprayed at angles up to sixty degrees from the vertical has no harmful effects.
4	Splashing water	Water splashed against the enclosure from any direction has no harmful effect.
5	Water jets	Water projected by a nozzle (6.3 mm) against enclosure from any direction has no harmful effects.
6	Powerful water jets	Water projected in powerful jets against the enclosure from any direction has no harmful effects.
7	Temporary immersion in water	Ingress of water in harmful quantity is not possible when the enclosure is temporarily immersed in water under standard conditions or pressure and time.
8	Continuous immersion in water	The equipment is suitable for continuous immersion in water under conditions more severe than for numeral 7.
9	High Pressure and Temporary Water Jets	Water projected at high pressure and high temperature against the enclosure from any direction will not have harmful effects.

Appendix B. MIL-STD-810 Test Methods

The table below provides information about the title and purpose of each test method specified by MIL-STD-810.

Table B-1 MIL-STD-810 Test Methods

Method Number	Title	Purpose
500	Low Pressure (Altitude)	Use low pressure (altitude) tests to determine if materiel can withstand and/or operate in a low-pressure environment and/or withstand rapid pressure changes.
501	High Temperature	Use high temperature tests to obtain data to help evaluate effects of high-temperature conditions on material safety, integrity, and performance.
502	Low Temperature	Use low temperature tests to obtain data to help evaluate effects of low temperature conditions on materiel safety, integrity, and performance during storage, operation, and manipulation.
503	Temperature Shock	Use the temperature shock test to determine if materiel can withstand sudden changes in the temperature of the surrounding atmosphere without experiencing physical damage or deterioration in performance.
504	Contamination by Fluids	Use contamination by fluids test to determine if materiel (or material samples) is affected by temporary exposure to contaminating fluids (liquids) such as may be encountered and applied during its life cycle, either occasionally, intermittently, or over extended periods.
505	Solar Radiation (Sunshine)	This method has two purposes, (1) to determine the heating effects of direct solar radiation on materiel, and (2) to help identify the actinic (photodegradation) effects of direct solar radiation.
506	Rain	Determine the following with respect to rain, water spray, or dripping water: (1) The effectiveness of protective covers, cases, and seals in preventing the penetration of water into the materiel; (2) The capability of the materiel to satisfy its performance requirements during and after exposure to water; (3) Any physical deterioration of the materiel caused by the rain; (4) The effectiveness of any water removal system; and (5) The effectiveness of protection offered to a packaged materiel.
507	Humidity	Determine the resistance of materiel to the effects of a warm, humid atmosphere.
508	Fungus	Assess the extent to which materiel will support fungal growth and how any fungal growth may affect performance or use of the materiel.
509	Salt Fog	Determine the effectiveness of protective coatings and finishes on materials. It may also be applied to determine the effects of salt deposits on the physical and electrical aspects of materiel.
510	Sand and Dust	Dust (< 150μm) procedure – evaluate the ability of materiel to resist the effects of dust that may obstruct openings, penetrate into cracks, crevices, bearings, and joints, and to evaluate the effectiveness of filters. Sand (150 to 850μm particle size) procedure–performed to help evaluate the ability of materiel to be stored and operated in blowing sand conditions without degrading performance, effectiveness, reliability, and maintainability due to abrasion (erosion) or clogging effects of large, sharp-edged particles.
511	Explosives Atmosphere	Demonstrate the ability of materiel to operate in fuel-air explosive atmospheres without causing ignition or demonstrate that an explosive or burning reaction occurring within encased materiel will be contained and will not propagate outside the test item

Method Number	Title	Purpose
512	Immersion	Determine if materiel can withstand immersion or partial immersion in water (e.g., fording), and operate as required during or following immersion.
513	Acceleration	Assure that materiel can structurally withstand the steady state inertia loads that are induced by platform acceleration, deceleration, and maneuver in the service environment, and function without degradation during and following exposure to these forces. Acceleration tests are also used to assure that materiel does not become hazardous after exposure to crash inertia loads.
514	Vibration	Performed to (1) develop materiel to function in and withstand the vibration exposures of a life cycle including synergistic effects of other environmental factors, materiel duty cycle, and maintenance. This method is limited to consideration of one mechanical degree-of-freedom at a time. Refer to Method 527 for further guidance on multiple exciter testing. Combine the guidance of this method with the guidance of Part One and other methods herein to account for environmental synergism. (2) Verify that materiel will function in and withstand the vibration exposures of a life cycle.
515	Acoustic Noise	Determine the adequacy of materiel to resist the specified acoustic environment without unacceptable degradation of its functional performance and/or structural integrity.
516	Shock	Performed to provide a degree of confidence that materiel can physically and functionally withstand the relatively infrequent, non-repetitive shocks encountered in handling, transportation, and service environments. This may include an assessment of the overall materiel system integrity for safety purposes in any one or all of the handling, transportation, and service environments; determine the materiel's fragility level, in order that packaging may be designed to protect the materiel's physical and functional integrity; and test the strength of devices that attach materiel to platforms that can crash.
517	Pyroshock	Performed to provide a degree of confidence that materiel can structurally and functionally withstand the infrequent shock effects caused by the detonation of a pyrotechnic device on a structural configuration to which the materiel is mounted; and experimentally estimate the materiel's fragility level in relation to pyroshock in order that shock mitigation procedures may be employed to protect the materiel’s structural and functional integrity.
518	Acidic Atmosphere	Determine the resistance of materials and protective coatings to corrosive atmospheres, and when necessary, to determine its effect on operational capabilities.
519	Gunfire Shock	Performed to provide a degree of confidence that materiel can structurally and functionally withstand the relatively infrequent, short duration, transient, high rate repetitive shock-input encounter in operational environments during the firing of guns.
520	Temperature, Humidity, Vibration, and Altitude	Determine the combined effects of temperature, humidity, vibration, and altitude on airborne electronic and electro-mechanical materiel with regard to safety, integrity, and performance during ground and flight operations. Some portions of this test may apply to ground vehicles, as well. In such cases, references to altitude considerations do not apply.
521	Icing/Freezing Rain	Evaluate the effect of icing on the operational capability of materiel. This method also provides tests for evaluating the effectiveness of de-icing equipment and techniques, including prescribed means to be used in the field.

Method Number	Title	Purpose
522	Ballistic Shock	This method includes a set of ballistic shock tests generally involving momentum exchange between two or more bodies, or momentum exchange between a liquid or gas and a solid, performed to provide a degree of confidence that materiel can structurally and functionally withstand the infrequent shock effects caused by high levels of momentum exchange on a structural configuration to which the materiel is mounted; and experimentally estimate the materiel's fragility level relative to ballistic shock in order that shock-mitigation procedures may be employed to protect the materiel's structural and functional integrity.
523	Vibro-Acoustic/ Temperature	Performed to determine the synergistic effects of vibration, acoustic noise, and temperature on externally carried aircraft stores during captive carry flight. Such determination may be useful for, but not restricted to, the following purposes: (1) To reveal and correct design weaknesses (Test, Analyze, and Fix (TAAF) test); (2) To determine whether a design meets a specified reliability requirement (Reliability Demonstration test); (3) To reveal workmanship or component defects before a production unit leaves the place of assembly (Screening test); (4) To estimate the Mean Time Between Failure (MTBF) of a lot of units based upon the test item's time to failure of a small sample of the units (Lot Acceptance test); and (5) To determine the relative reliability among units based upon the test item's time to failure of a small sample of the units (Source Comparison test).
524	Freeze-Thaw	Determine the ability of materiel to withstand the effects of moisture phase changes between liquid and solid, in or on materiel, as the ambient temperature cycles through the freeze point; and the effects of moisture induced by transfer from a cold-to-warm or warm-to-cold environment.
525	Time Waveform Replication	Performed to provide a degree of confidence that the materiel can structurally and functionally withstand the measured or analytically specified test time trace(s) to which the materiel is likely to be exposed in the operational field environment; and experimentally estimate the materiel's fragility level in relation to form, level, duration, or repeated application of the test time trace(s).
526	Rail Impact	Replicate the railroad car impact conditions that occur during the life of transport of systems, subsystems, and units, hereafter called materiel, and the tiedown arrangements during the specified logistic conditions.
527	Multi-Exciter Testing	Performed to provide a degree of confidence that the materiel can structurally and functionally withstand a specified environment, e.g., stationary, non-stationary, or of a shock nature, that must be replicated on the test item in the laboratory with more than one motion degree-of-freedom consideration.
528	Mechanical Vibrations of Shipboard Materials	Specifies procedures and establishes requirements for environmental and internally excited vibration testing of naval shipboard equipment installed on ships