Designation: E2520 – 07

StandardPractice for Verifying Minimum Acceptable Performance of Trace Explosive Detectors[1]

This standard is issued under the fixed designation E2520; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice is primarily intended to assist first responders and security screeners in verifying the minimum acceptable performance of detectors used to identify traces of high explosives such as cyclotrimethylene trinitramine (RDX), pentaerythritol tetranitrate (PETN), and trinitrotoluene (TNT). These explosive detectors may be based on, but are not limited to, ion mobility spectrometry (IMS).

1.2 This practice is used to evaluate the detector response to evaporated residues of low-concentration solutions of explosive compounds placed on test swipes. The solutions used for this evaluation are prepared in a suitable organic solvent and contain a single high explosive.

1.3 This practice does not address or use sampling procedures common to the use of trace explosive detectors. It only tests the response of the detector once a test swipe has been successfully introduced into the explosive detector.

1.4 This practice does not evaluate the effect of contaminants or interferences that may be encountered in sampling for trace explosives in the field.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Terminology

2.1 *Definitions of Terms Specific to This Standard:*

2.1.1 *blank solution, n*—semivolatile solvent that does not contain trace explosives to which the detector is sensitive.

2.1.2 *calibration, n*—act of providing the detector with a known substance so that it may be adjusted to identify explosive compounds correctly.

2.1.2.1 *Discussion*—Manufacturers of explosives detectors often provide calibration swipes. In an ion mobility spectrometry (IMS) instrument, calibration allows the instrument to adjust the present values of the mobility (or drift) time of the calibrant to the most current conditions. For explosives detectors based on mass spectrometry (MS), calibration is often called tuning. Some IMS and MS explosives detectors may have built-in materials and software to perform calibration automatically.

2.1.3 *instrument blank swipe, n*—unused swipe freshly removed from the container provided by the manufacturer.

2.1.4 *performance evaluation solution, n*—dilute solution of a single explosive compound dissolved in a semivolatile solvent.

2.1.5 *process blank swipe, n*—sample swipe that has been dosed with the blank solution.

2.1.6 *sample swipe, n*—pads that are made from various types of materials, including fabric and paper, that are offered by the equipment manufacturer to collect particle samples for use in trace explosives detectors.

2.1.6.1 *Discussion*—Also referred to as sample traps by some manufacturers of trace explosives detectors.

2.1.7 *swipe support, n*—holder for the sample swipe that suspends the swipe preventing contact of the back side of the sampling area with any surface that might wick away drops of solution.

2.1.8 *test kit, n*—set of individual solutions of the explosives and a blank solution to be used for the evaluation of explosives detector performance.

2.1.8.1 *Discussion*—The test kit may also include holders used for supporting the sample swipes for solution application.

2.1.9 *test swipe, n*—sample swipe that has been dosed with one of the performance evaluation solutions and dried.

2.1.10 *trace explosives detector, n*—an instrument designed to detect trace amounts (micrograms or less) of explosive compounds.

2.1.10.1 *Discussion*—In the context of this standard

[1] This practice is under the jurisdiction of ASTM Committee E54 on Homeland Security Applications and is the direct responsibility of Subcommittee E54.01 on CBRNE Sensors and Detectors.

Current edition approved Feb. 1, 2007. Published March 2007. DOI: 10.1520/E2520-07.

practice, a trace explosives detector will require the use of a swipe sample collector. These detectors are commonly based on, but not limited to, ion mobility spectrometry.

2.2 *Acronyms:*

2.2.1 *IMS, n*—ion mobility spectrometry

2.2.2 *MS, n*—mass spectrometry

2.2.3 *PETN, n*—pentaerythritol tetranitrate

2.2.4 *RDX, n*—cyclotrimethylene trinitramine

2.2.5 *TNT, n*—trinitrotoluene

3. Significance and Use

3.1 The practice may be used to accomplish several ends: to compare detectors before purchase; as a demonstration by the vendor that the equipment is performing properly to a minimal standard; or for a periodic verification of detector performance after purchase.

3.2 This practice establishes the minimum performance that is required for a detector to be considered effective in the detection of trace explosives. An explosives detector is considered to have "minimum acceptable performance" when it has passed all of the evaluation tests without a failure.

3.3 This practice uses three explosive compounds—RDX, PETN, and TNT—that are used to represent nitro-based compounds having a range of physical and chemical properties. The concentrations of the solutions of explosive have been determined to be sufficient to provide a positive detector alarm signal. In time, other compounds may be added or substituted into this practice as detection priorities dictate.

3.4 This practice was developed using IMS-based trace explosives detectors, but this practice should also be applicable to any explosives detector designed to analyze trace levels of high-explosive compounds collected on swipes.

3.5 This practice does not include procedures to test for compounds that may interfere with detector performance.

3.6 This practice does not test the minimum limit of detection or the dynamic range of the trace explosives detector.

3.7 This practice does not test for compounds other than high explosives.

3.8 This practice only evaluates the response of the detector to traces of pure explosive compounds.

4. Performance Evaluation Materials

4.1 *Test Kit*—One test kit contains:

4.1.1 Test solutions of the specified concentrations of the high explosives that may be in plastic squeeze dropper bottles in which each solution contains a single high explosive labeled with the contents in isobutyl alcohol (2-methyl-1-propanol) or another suitable solvent,

4.1.2 One blank solution containing only alcohol, and

4.1.3 Four swipe supports for holding the test and blank swipes for evaporation.

4.2 *Solution Concentrations*—Solution concentrations of the high explosives for the kit are: RDX concentration: 0.14 mg/L providing ≈3 ng per drop; TNT concentration: 1.0 mg/L or ≈23 ng per drop; and PETN concentration: 1.7 mg/L or ≈40 ng per drop. The volume of solution of explosive delivered by a single drop is based on an average drop volume of 23 µL dispensed by holding the bottle at approximately a 45° angle.[2] A volumetric pipette or syringe may also be used to deliver the 23-µL volume of the solution of explosives accurately.

5. Procedure

5.1 *Preparation of Workspace:*

5.1.1 Cover table of bench surface with clean, absorbent, disposable material.

5.1.2 Care should be taken not to contaminate sample swipes. Handling the swipes with either unused gloves or clean tweezers is recommended. It is particularly important not to touch the target area of the swipe.

5.1.3 Provide convenient and appropriate means of disposal of used test swipes and other consumables.

5.1.4 Four swipe supports are needed. Each support will provide a means for allowing the alcohol solutions to evaporate completely from the swipe without losses to other surfaces. Label each of the four swipe supports for the identity of the explosive or blank solution to be tested for exclusive use with that solution. This will prevent cross-contamination of the explosives on the holder.

5.1.5 In the case in which the sample and blank swipes are not used immediately, have labeled containers ready to hold the prepared test swipes that are of an appropriate size, are clean, and have covers. Glass or metal containers (including aluminum foil) are appropriate for this task.

5.1.6 The use of chemically resistant nitrile gloves is recommended for handling of test solutions.

5.2 *Preparation of Test Swipes:*

5.2.1 Place the test swipes properly on the labeled swipe supports.

5.2.2 Choose one of the solutions from the test kit, ensure the cap is closed tightly, and shake well to mix.

5.2.3 When the solutions are being dispensed from a squeeze bottle, sacrifice the first drop by opening the cap, holding the bottle at about a 45° angle from horizontal, and squeeze the bottle slowly to deposit one or two drops on a disposable tissue.

5.2.4 Deposit a drop at about a 45° angle from horizontal on the test swipe within the target area for sample deposition as indicated by the instructions provided with the detector. Examples of the target area are provided in NIST IR 7240.[2] If more than one drop is deposited on the swipe, discard it and begin again with a unused swipe. Alternatively, a 23-µL drop of the solution from the test kit can be delivered using a volumetric pipette or syringe.

5.2.5 Allow the solvent to evaporate. Wait until the solution is visibly dry on the test swipe and the alcohol smell has

[2] Verkouteren, J., Gillen, G., Verkouteren, R. M., Fletcher, R., Etz, E., et al., "IMS-Based Trace Explosives Detectors for First Responders," *NIST IR 7240, System Assessment and Validation for Emergency Responders*, U.S. Department of Homeland Security, Washington, DC 20528. This document is summarized on the web page http://saver.tamu.edu/documents.php?fl=336&c=7&s=3&pn=77.