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Standard Practice for Evaluation of Explosives Vapor Detectors[1]

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1. Scope

1.1 This practice is for the laboratory evaluation and selection of explosives vapor detectors.

2. Terminology

2.1 *Definitions:*

2.1.1 *clear down time*—time required for the detector to produce no alarm at the IFMAL after an overload level.

2.1.2 *false negative ratio*—one minus the probability of detection.

2.1.3 *false positive ratio*—ratio of the number of positive alarms to the total number of challenges when no explosives vapor is present, where the number of challenges is large and the instrument is set at the IFMAL.

2.1.4 *interferent*—nonexplosive substance, other than the explosive being detected, that can mask the explosives and produce a false negative decision or is identified as an explosive, producing a false positive decision.

2.1.5 *interferent equivalent response*—positive or negative response caused by a substance other than the explosive being measured, and expressed in explosives equivalent concentration units.

2.1.6 *interferent free minimum alarm level (IFMAL)*—alarm level that provides a 95 % probability of detection at confidence level of 95 %, at that setpoint, and no greater than 5 % false positives, at confidence level of 95 %, when challenged with explosive free air at that setpoint.

2.1.7 *overload level*—that concentration that upon recycle of the detector in the absence of that mass, produces a signal above the minimum alarm level.

2.1.8 *probability of detection*—ratio of the number of alarms to the total number of challenges at a specified explosive vapor concentration, where the number of challenges is 60 or greater and the instrument is set at the IFMAL This probability takes into account other system variables that affect performance, such as sample losses in inlets and preconcentrators.

2.1.9 *response time*—the amount of time required for the detector to analyze the sample and produce a reading that is at least 95 % of the full response for that sample.

2.1.10 *sample throughput*—number of distinguished samples that can be obtained and processed by the detector system in a given time period.

2.1.11 *sample time*—amount of time it takes to obtain a sufficient sample for introduction into the explosives detector.

2.1.12 *span drift*—variance with time of the detector response to the upper calibration concentration level.

2.1.13 *temperature and humidity effects*—effect of temperature and humidity on the stability and drift of the zero and span calibration of the detector.

2.1.14 *total analysis time*—total elapsed time from the sampling start until the system outputs a result. It is the sum of the sample time and response time.

3. Significance and Use

3.1 This practice establishes a method for characterizing explosives vapor detectors in the laboratory. The practice does not set performance requirements.

3.2 This practice is intended for use by the manufacturers of explosives vapor detection equipment and any organization that has the facilities and expertise to perform vapor calibrations. This practice relies upon the use of an explosives vapor generator unit to determine the applicable performance levels of the explosives vapor detectors.

3.3 This practice provides a method for evaluation of the following parameters:

3.3.1 Interferent free minimum alarm level,
3.3.2 Probability of detection,
3.3.3 False positive ratio,
3.3.4 False negative ratio,
3.3.5 Interference equivalent,
3.3.6 Temperature and humidity effects,
3.3.7 Sample time,
3.3.8 Response time,
3.3.9 Total analysis time,
3.3.10 Sample throughput, and
3.3.11 Overload level.

3.4 Each user or evaluator may choose to evaluate a detector only for those parameters of interest to them.

4. Reference Vapor Generator

4.1 The reference calibrated explosives vapor generator shall be one of the following vapor calibration units: (*1*) the pulsed vapor calibration unit constructed by the Idaho National Engineering Laboratory, Idaho Falls, Idaho, described in detail

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in Ref **(1)**; [2] (*2*) the continuous vapor calibration unit constructed by Sandia National Laboratories, described in Ref **(2)**; or (*3*) the continuous vapor calibration unit for higher vapor pressure explosives constructed by the National Research Council Canada described in Ref **(3)**.

5. Detector Evaluation

5.1 A manufacturer of explosives vapor detectors may construct or purchase a secondary vapor generation device which can be used to measure the parameters of the explosives vapor detectors. Each secondary vapor generation device shall be traceable to one of the calibrated reference explosives vapor generation systems listed in Section 4. At least once a year, each manufacturer's secondary vapor generation source shall be compared to a calibrated reference vapor generator and a calibration curve shall be prepared for the output of the secondary vapor generator.

5.2 *Secondary Explosive Vapor Generator Unit*—Each manufacturer's secondary vapor generator shall have the following characteristics:

5.2.1 The output flow of the secondary vapor generator unit shall be at least equal to the required flow for the sampling device, but no greater than 1.25 times the flow of the sampling device. If the flow of the generator is greater than the flow of the sampling device, then the input diameter of the sampling device shall be no greater than one half the output diameter of the vapor generator. Additionally, the output of the generator and inlet of the sampling device should be coaxial, and at a distance not to exceed one-half the output diameter of the vapor generator.

5.2.2 The test atmosphere delivery system shall be designed and constructed so that no explosives vapor shall be allowed to collect on the walls of the delivery system.

5.2.3 The output of the test atmosphere generation system shall be sufficiently constant in flow and concentration to obtain a stable response during the required test measurements. The concentration of each test atmosphere shall be established by calibration of the secondary explosives vapor generator with the reference explosives vapor generator. This is accomplished by taking the secondary vapor generator to the reference vapor generator and measuring the output of the secondary generator using the same analytical techniques used to calibrate the reference vapor generator. The method used to calibrate the reference generator is to be used to measure the response of the secondary vapor generator.

5.2.4 All diluent air shall be free of explosives and potential interferents.

5.2.5 The accuracy of all flow measurements used to calculate the test atmosphere concentrations shall be documented.

5.2.6 The concentration output of a secondary vapor generator is determined by the calibration curve determined during the calibration of the reference vapor generation unit.

5.2.7 In order to obtain reproducible results when measuring the output concentration of a secondary vapor generator, a fixture shall be used to reproducibly hold the sampling device at the same position with respect to the output flow of the vapor generator. Additionally, for a batch type analyzer the sampling device shall be operated in a mode to ensure that for each analysis point, the sampling device is used the identical amount of time. All test performed in Section 6 are to be performed using the sampling device as the means of introducing the explosives and potential interferents into the sample analysis stream of the detector.

6. Measurement of Detector Parameters

6.1 Each explosives vapor detector shall be setup and adjusted to the manufacturers recommended specifications. Adjustments for "special" or unusual performance are not permitted. In conducting these measurements, the manufacturer shall take a random instrument from his production line and set it up according to the instructions in the detector's operating instruction booklet. No special research instruments or special instruments are to be used to determine these operating parameters.

6.2 *Equipment Required*:

6.2.1 Explosive vapor detector under test.

6.2.2 Environmental chamber capable of controlling temperature between the lowest and the highest operating temperature expected for the unit.

6.2.3 Secondary vapor generator capable of generating the required concentration levels of explosives for the performance testing.

6.2.4 Constant voltage transformer, sufficient for powering the unit followed by a variac, to allow for generation of constant voltages between the test voltages. The unit shall be operated in the voltage window specified by the manufacturer.

6.2.5 A power generator of the same frequency as specified for the unit tested.

6.2.6 The appropriate device to record the output, which may be manual recording.

6.3 *Test Conditions*:

6.3.1 Set-up and start-up shall be in strict accordance with the operating instruction manual supplied with the unit. Allow adequate warm-up or stabilization time as indicated in the manual before beginning any of the testing.

6.3.2 Evaluation of the detector shall be performed in strict accordance with the users manual. A response curve (see 6.4) shall be generated by introducing at least three different concentrations of explosives vapors and one free of explosives vapor for each explosive type tested, and noting the instant response for units with a quantitative output of signal strength. A plot shall be prepared of the output. The log of the concentration may be used.

6.3.3 *Recalibration and Maintenance*— No recalibration shall be performed once the test sequence has begun, unless the recalibration is explicitly called for in the users manual. Once the unit has been calibrated and set-up, and the tests started, manual adjustments or normal periodic maintenance are permitted only in accordance with the manufactures recommended schedule. Replacement of consumables are permitted in accordance with the manufacturers operation manual. Automatic adjustments which the unit performs by itself are permitted at any time. Records should be kept of all manual adjustments and periodic maintenance procedures.

[2] The boldface numbers in parentheses refer to the list of references at the end of this practice.

6.3.4 *Malfunctions*—If a malfunction occurs during the performance testing, that entire test shall be repeated. A detailed explanation of the malfunction and the remedial action taken shall be included in the test report. If more than one malfunction occurs, all performance test procedures for all parameters shall be repeated.

6.3.5 Tests for all performance parameters shall be completed on the same explosives vapor detector.

6.4 *Interferent Free Minimum Alarm Level*—Determine the lowest explosive vapor concentration that can be reliably detected. This would be the lowest concentration that would produce 60 responses out of 60 challenges. Each challenge with explosives vapor shall be followed by a successful challenge (that is, no alarm) with explosives free air. The resulting concentration is the interferent free minimum alarm level (IFMAL). The alarm level guarantees a 95 % probability of detection with a confidence level of 95 % at that setpoint and no greater than 5 % false positives with a confidence level of 95 % when challenged with explosive free air at that setpoint. Once the interferent free minimum alarm level has been determined, it is to be set at the beginning of the test protocol. Once the level is set, it is not to be changed during the test protocol.

6.5 *Detector Response Curve*—The detector response shall be determined according to the instructions in the users manual. This test can be performed with either a calibrated reference or a calibrated secondary vapor generator. If the test detector does not identify the explosive, then rigorous documentation shall be available to certify the purity of the materials used in the generator. Additionally, the test protocol shall ensure that cross contamination has not occurred. This shall be documented by independent analytical chemistry tests which check the purity of the generator output. This shall be carried out before, during, and at the end of each test. One simple test to ensure that the system has not been contaminated is to vary the temperature of the generator and ensure that the change in instrument response agrees with the known vapor pressure variation of the explosive with temperature.

6.5.1 Adjust the sample concentration of the secondary vapor generator to supply at least four concentrations of each of the different explosives. One point shall be zero, the second point shall be the expected interferent free minimum alarm level (IFMAL, see 6.4), the third point about 20-50 times the interferent free minimum alarm level, and the fourth point about 1 % of the equilibrium vapor pressure of the test explosive at 25 °C. For the case where the test instrument has an extremely low IFMAL, which is difficult to generate, the lower point for the calibration curve can lie at any convenient point between 20 times the IFMAL and 10 % of the higher calibration point. For the case where the detector has a high IFMAL where 20 to 50 times the IFMAL is close to 1 % of the equilibrium vapor pressure at 25 °C, only two points and zero need be taken.

6.5.2 Note the detector response for each explosive type. Plot the detector response versus concentration output (or log of concentration) for each explosive type using statistical methods to obtain the response curve. This plot shall be used for the rest of the testing protocol to translate the reported output of the detector into actual concentration units for each explosive. Include the instrument response curve as part of the test report.

6.6 *Interference Equivalent*—The following tests are designed to show interferences problems:

6.6.1 The test detector shall be tested for all substances likely to be encountered in typical use which may cause a detectable response. A list of interferents is contained in Table 1.

6.6.2 The test detector shall be challenged 20 times with each interferent agent specified in Table 1. The effect of the interference is positive if the test detector's response is increased or negative is the response is decreased by the presence of the interferent. The tests shall be performed in the following manner: The interferent compound shall be placed inside a 45 mm inside diameter, disposable aluminum weighing dish. If the interferent is a liquid, 1.0 mL of the liquid shall be placed onto a filter paper (Whatman 42.5 mm diameter) placed in the weighing dish. If the interferent is dissolved in a solvent, 1.0 mL of this solution shall be placed onto the filter paper. In this later case, 5 min shall be allowed for the solvent to evaporate before testing. One gram of the solid samples shall be placed directly onto the aluminum weighing dish. A new weighing dish and filter paper shall be used for each test.

6.6.3 Cigarette smoke shall be sampled by lighting a cigarette, placing it 5 cm from the detector inlet and sampling the

TABLE 1 Interferent Equivalent Levels

Interferent	Interferent Equivalent Level	Units
Dibutyl Phthalate Plasticizer		g/L
Formaldehyde		g/L
Cigarette Smoke		g/L
Dry Cleaning Solvent (Trichloroethylene)		g/L
Coty Wild Musk Perfume		g/L
Ethyl Alcohol		g/L
Skoal Wintergreen Smokeless Tobacco		g/L
McCormick Ground Cloves		g/L
Kiwi Black Shoe Polish		g/L
Lysol Spray Disinfectant		g/L
Pinesol Cleaner		g/L
Chloraseptic Mouthwash		g/L
Solarcaine Sunburn Spray		g/L
Mothballs, Naphthalene		g/L
Mothballs, p-Dichlorobenzene		g/L
WD-40 Penetrating Oil		g/L
Armorall Vinyl Cleaner		g/L

smoke for the normal sample time specified by the manufacturer of the explosives vapor detector being evaluated.

6.6.4 All test results shall be tabulated.

6.6.5 The interference equivalent shall be determined by taking the measured response of the detector to the interferent and determining the equivalent explosives response from the detector response curve of 6.5.

6.6.6 Next, the detector shall be tested for synergistic effects of the interferent on the detector response to explosives in the presence of the interferent. The test shall be conducted in the following manner: The explosive sample shall be placed on a filter paper in a clean aluminum weighing dish by any of the following methods. The explosive sample can be rubbed onto the filter paper or the explosive sample can be touched with the thumb and a thumbprint left on the surface of the filter paper. Alternatively, a solution of the explosive can be deposited onto a filter paper placed on the aluminum weighing dish. After allowing 5 min for the solvent to evaporate, the response of the explosives detector to the explosive is measured. Next, 0.1 mL of the liquid interferent or a 0.1 mL of solution of the interferent in a suitable solvent is placed onto the filter paper containing the explosive and the solvent is allowed to evaporate for 5 min. The aluminum weighing dish with the filter paper containing the explosive sample and interferent is sampled by the test instrument, and the response is noted and compared to the response obtained earlier for the explosive only. Any differences are noted and reported in the test report.

6.7 *False Negative Ratio*—The false negative ratio is one minus the probability of detection.

6.8 *Sample Time*—The sample time is the total time required to obtain an explosives vapor sample for presentation to the detector for analysis. It is the same sampling time used by the manufacturer in determining the IFMAL and is used in all the tests. If a remote sampling unit is used, the sample time is the time from the start of the sampling until the sample is removed from the sampling unit and the beginning of the analysis cycle of the detector. The sampling time may vary from a few seconds for those detectors with integral samplers to several minutes for those detectors requiring larger sample volumes.

6.9 *Response Time*—The response time can be determined during calibration, or by a dedicated test. The test procedure is different for a batch type detector, and a continuous type detector.

6.9.1 *Batch Type Detector*—Using a stopwatch, time the duration between the moment the sample is presented to the detector, and the completion of the analysis. The response time shall be reported as the average of at least ten measurements. Report the results in Table 3.

6.9.2 *Continuous Type Detector*—Record the output, preferably with a recording instrument. Using a stopwatch, the response time is the exact repetitive time interval, *t*, expected between 2 and 5 s.

TABLE 2 Voltage and Temperature Setting for Zero and Span Drift Tests

Test Day	Voltage (RMS)	Temperature
1	nominal	(25 °C)
2	nominal +10 %	(35 °C)
3	nominal –10 %	(35 °C)
4	nominal +10 %	(40 °C)

6.9.2.1 Sample the explosive-free air and wait for a stable reading.

6.9.2.2 Sample explosive vapor that is 20 to 50 times the IFMAL. Note and record the exact point where the sampling started and when the data are taken.

6.9.2.3 Wait for a stable reading.

6.9.2.4 Switch to an explosive free sample. Note the exact point where the switch occurred.

6.9.2.5 Wait for a stable reading.

6.9.2.6 Repeat 6.9.2.2-6.9.2.5 five times.

6.9.2.7 The response time for an explosive-free sample is defined as the time in seconds from when the switch occurred until the instrument response reaches 95 % of the final stable reading. If a recorder is not available, record the time for the analog or digital signal to reach a stable reading. The response time is 95 % of this value.

6.9.2.8 The response time from sample to explosives-free sample is defined as the time in seconds from when the switch occurred until the instrument response reaches 5 % of the stable response for the sample. If a recorder is not available, record the time for the analog or digital signal to decrease to a stable zero. This response time is 95 % of this value.

6.9.2.9 The response time reported for the instrument is the average of the response times determined in 6.9.2.7 and 6.9.2.8 above.

6.9.2.10 Repeat test for all explosives.

6.9.2.11 Report the results in Table 3.

6.10 *Alarm Time*—The alarm time is determined as the time between the response time and the time the results of the analysis and detection are revealed to the operator. This time may be as little as a few seconds or less.

6.11 *Total Analysis Time*—The total analysis time is the sum of the time required to obtain the explosives vapor sample, the response time of the detector, and the alarm time.

6.12 *Overload Recovery*—Overload recovery is determined differently for a batch operation instrument and for a continuous operation type instrument.

6.12.1 *Batch Operation Instrument Method*— Sample a known level of explosives, and then immediately upon completion of the analysis, run a reanalysis without resampling. Upon reanalysis the level of explosives found should be below 5 times the IFMAL. The concentration level of the explosives are then incremented until it is determined at what level of explosives one needs to be before reanalysis gives a signal above 5 times the IFMAL. The procedure is as follows:

6.12.1.1 Set the secondary explosives vapor generator to generate a sample about 20 times the IFMAL for each of the explosives. Sample using the sampling device:

6.12.1.2 Note the instrument response. Using the detector response curve determined in 6.5, convert these values to concentration units.

6.12.1.3 Immediately upon completion of 6.12.1.2, without resampling, rerun the sample. Note the instrument response on the alarm bars, the display and also the printer output. Using the detector response curve, convert these values to concentration units.

TABLE 3 Summary of Test Results

Parameter	Explosive							Units
	1	2	3	4	5	6	7	
IFMAL								g/L
Detection Probability								%
False Positive Ratio								%
False Negative Ratio								%
Zero Drift								g/L
Sample Drift								%
Precision								g/L
Sample Time								seconds
Response Time								seconds
Analysis Time								seconds
Sample Throughput								number per minute
Overload								g/L

6.12.1.4 If the concentration determined in 6.12.1.3 above is below 5 times the IFMAL for the explosive being tested increase the concentration by a factor of 2 to 10 depending upon the results determined in 6.12.1.3. Repeat 6.12.1.1-6.12.1.3.

6.12.1.5 Repeat 6.12.1.4 until either 5 times the IFMAL has been reached for that explosive, or until a concentration equal to the highest point used in the calibration is reached.

6.12.1.6 Report the results in Table 3. If the test point equal to the highest calibration point was reached before a result equal to 5 times the IFMAL was reached report the overload level as greater than the highest tested point.

6.12.2 *Continuous Sampling Device*—The overload level is the lowest concentration for which, when one switches to explosives-free air and waits exactly 5 times the analysis time, the instrument response is 5 times the IFMAL. The procedure is as follows:

6.12.2.1 Collect the data in an identical manner to the way one collected the data for the analysis time.

6.12.2.2 Set the secondary explosives vapor generator to generate a sample about 20 times the IFMAL for the different explosives. Sample using the sampling device. Wait for a stable reading.

6.12.2.3 Switch to explosives free air. Note the moment of switching on the hard copy of the data. Wait for a stable reading.

6.12.2.4 On the hard copy note the instrument reading at exactly 5 times the analysis time.

6.12.2.5 If the concentration determined in 6.12.2.4 above is below 5 times the IFMAL for the explosive being tested, increase the concentration by a factor of 2 to 10 depending upon the results of 6.12.2.4. Repeat 6.12.2.2-6.12.2.4.

6.12.2.6 Repeat 6.12.2.5 until either 5 times the IFMAL has been reached for that explosive, or until a concentration equal to highest point used in the calibration is reached.

6.12.2.7 Report the results in Table 3. If the test point equal to the highest calibration point was reached before a result equal to 5 times the IFMAL was reached report the overload level as greater than the highest tested point.

6.13 *Zero Drift, Span Drift, Precision, Voltage, Humidity and Temperature Effects*—The purpose of these tests is to determine the zero and span drifts over a period of time, as well as the precision of the measurements, and the effects of changing voltage, humidity, and temperature. It is possible, especially for some of the batch type units, that there is no real zero drift that can be measured. This is due to the effect that these units are digital and batch. Thus, if no signal is found in the batch sample that conforms to the preprogrammed results expected for the explosives being looked for, then a zero output (that is, no detected signal for a given explosive), is reported. In this case the zero drift shall be reported as zero. The purpose of these test is to determine repeatability, changes in response sensitivity as a function of time, and the effects of changing voltage and temperature on the analyzer's response. In some cases the effects of changing humidity on the unit's response would also be of interest. The protocol below also includes humidity testing as an option. It should be emphasized that the temperature and voltage effects reflect the perturbations in the sampling as well as analysis sections of the different analyzers, as well as potential perturbations of the vapor generator, and the vapor in the atmosphere. Thus while the amount of vapors leaving the secondary vapor generator may be independent of the parameters being varied here, there may be a secondary effect of the atmosphere on the vapor in the space between the output of the vapor generator and the sampling device.

6.13.1 Tests for these parameters shall be performed over a period of four days. Table 2 lists the temperature and voltage to be used for each day of testing. Test day one (that is, set-up) and day five shall be performed at 25 °C and nominal voltage. The analyzer shall be allowed to equilibrate for at least 4 h after the temperature and voltage has been changed prior to the beginning of a new test sequence.

6.13.2 All periodic maintenance and adjustments shall be performed prior to the beginning of the four day test sequence. Once the test sequence has begun, no adjustment or maintenance is allowed. If a recalibration is required as the result of an adjustment or maintenance procedure, the recalibration shall be performed prior to the beginning of the four day test procedure. If the analyzer is recalibrated, a new instrument response curve shall be generated. Automatic adjustments which the analyzer performs by itself are permitted at any time, as well as procedures specifically called out in the users manual.

6.13.3 All responses of the analyzer shall be reported in

concentration units using the instrument response curve.

6.13.4 The secondary explosives vapor generator shall be adjusted to produce a level of each explosive equal to ten times the typical concentration used for the alarm trigger point. (The minimum alarm trigger point is either equal to or greater than the interferent free minimum alarm level (IFMAL)). This concentration is referred to as E_1. It is important that E_1 be stable, and reproducible over the period of testing. The generating system also should be capable of producing explosive free sample, E_0.

6.13.5 Each of the tests reported for a particular day shall be performed on a different day. The tests should preferably be performed on sequential days, but days can be skipped for weekends, holidays, etc. For each test condition day, the tests can be performed for all of the explosives under evaluation, or a unique sequence of four days can be performed for each explosive under consideration. The following nomenclature shall be used for these data:

E_0 = measured level of explosives-free air,

E_1 = measured level of explosives 10 times the IFMAL,

j = number of individual measurement, j = 1 to 6,

M = day of the test, M = 1 to 4,

$E_0(M)j$ = jth measurement of level of explosives-free air on Day M, and

$E_1(M)j$ = jth measurement of level of explosives 10 times the IFMAL on Day M.

6.13.6 *Day One (Baseline)*:

6.13.6.1 Allow the unit to stabilize at 25 °C and nominal voltage for at least 4 h; recalibrate if necessary.

6.13.6.2 Sample E_0, note result as $E_0(1)1$. Sample E_1, note results as $E_1(1)1$. Determine $E_0(1)1$, and $E_1(1)1$ for each explosive.

6.13.6.3 Repeat 6.13.6.2, noting results as $E_0(1)2$, and $E_1(1)2$. Determine $E_0(1)2$ and $E_1(1)2$ for each explosive.

6.13.6.4 Repeat 6.13.6.2 four more times obtaining results $E_0(1)3$ through $E_0(1)6$, and $E_1(1)3$ through $E_1(1)6$.

6.13.6.5 Adjust temperature and voltage for the conditions for Test Day 2.

6.13.7 *Day Two*:

6.13.7.1 Allow at least 4 h for the unit to stabilize from tests of day one; overnight is preferable.

6.13.7.2 Sample E_0 and note result as $E_0(2)1$. Sample E_1 and note result as $E_1(2)1$.

6.13.7.3 Repeat 6.13.7.2, noting results as $E_0(2)2$, and $E_1(2)2$.

6.13.7.4 Repeat 6.13.7.2 four more times obtaining results $E_0(2)3$ through $E_0(2)6$, and $E_1(2)3$ through $E_1(2)6$.

6.13.7.5 Adjust the temperature and voltage for Day 3.

6.13.8 *Days Three and Four*—Repeat the test for Day 2 on Days 3 and 4, setting the temperature and voltage condition in the environmental chamber according to Table 2.

6.13.9 *Computation of Zero and Span Drift*—Compute the average response $E_0(M)$ and $E_1(N)$ for Day M as follows:

$$E_0(M) = \left(\frac{1}{6}\right) \sum_{j=1}^{6} E_0(M)j \quad M = 1....4 \tag{1}$$

$$E_1(M) = \left(\frac{1}{6}\right) \sum_{j=1}^{6} E_1(M)j \quad M = 1....4 \tag{2}$$

6.13.9.1 Compute the zero (Level 0) drifts, D_0, and span (sample level, E_1) drifts, D_1, for Day M as follows:

$$D_0(M) = \{[E_0(M) - E_0(M-1)] / E_0(M)\} \times 100\ \% \tag{3}$$

$$D_1(M) = \{[E_1(M) - E_1(M-1)] / E_1(M)\} \times 100\ \% \tag{4}$$

No zero or span drifts are determined for Day 1.

6.13.10 Compute the precision P (M) for each day, M, at sample level E_1 as follows:

$$P(M) = \left[\frac{1}{5}\sum_{j=1}^{6}\left[(E_1(M)j) - \left(\frac{1}{6}\right)\left(\sum_{j=1}^{6} E_1(M)j\right)\right]^2\right]^{\frac{1}{2}} \quad M = 1....4 \tag{5}$$

6.13.11 Note the results for the zero and span drifts, as well as the precision in Table 3.

6.13.12 *Humidity Effects*—If the explosives detector is to be evaluated in either high or low humidity conditions, repeat the test of day two for the condition of nominal voltage, 25 °C, and at the high humidity level, and on a different day at the low humidity conditions. Determine the zero and span drift as in 6.13.9 and the precision as in 6.13.10.

6.14 *Sample Throughput*—The number of samples that can be obtained and processed in a given time period.

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