



Standard Practice for Evaluating the Performance of Release Detection Systems for Underground Storage Tank Systems¹

This standard is issued under the fixed designation E 1526; 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.

INTRODUCTION

This practice provides the general procedure for evaluating and reporting the evaluation results of a system designed to detect releases from underground storage tanks containing regulated substances. It includes release detection systems that are designed to detect leaks from tanks, pipelines, and leaks into the interstitial area of double-walled tanks and secondary containment systems, and releases and spills in the backfill and native soil outside of the tank system. Internal release detection systems include but are not limited to volumetric leak detection systems (also known as precision test and tank integrity tests), automatic tank gaging systems, and pipeline leak detectors. External release detection systems include but are not limited to vapor monitors and liquid monitors.

Intended Use—This practice is intended to provide minimum requirements for evaluating all types of release detection systems, and a standard reporting procedure for the results. The procedure is general so that all types of systems and applications of these systems will be included.

Two Levels of Evaluation—A procedure is provided in this practice for evaluating performance characteristics of the release detection systems, and the performance of the systems under actual field test conditions. This practice requires that the performance characteristics of all systems be evaluated, and that an estimate be made of the capability of all interstitial and in-tank release detection systems to detect leaks in the tank walls, piping, or connections in the field.

Disclosure of Experimental Conditions—The evaluation of the release detection method must be done experimentally, and a full disclosure must be made of the experimental conditions under which the evaluation was performed, and the method was recommended for use.

ASTM Designation or Marking—In accordance with Section 6, the manufacturer may mark on its literature and the detection system, that the system was evaluated and the evaluation data reported in accordance with this practice.

1. Scope

1.1 This practice covers a uniform protocol for evaluating the performance of systems used to detect releases of regulated substances from underground storage tank systems or facilities. This practice applies to users, manufacturers, vendors, government regulators, and others using or concerned with release detection systems.

1.2 This practice covers release detection systems that are used internally, externally, or within the interstitial area of an underground storage tank system that has secondary containment.

1.3 This practice does not specify minimum performance standards.

1.4 The release detection system may consist of an individual or multiple tests. The release detection system may

operate in a continuous or intermittent mode, and may produce either quantitative-output (measured value) or qualitative-output (on/off) results.

1.5 The release detection system may be applicable to any part of a storage tank system, a single storage tank system, or combination of systems. The manufacturer may further limit the use of a release detection system to specific test conditions (for example, tank sizes, geographical regions, etc.).

1.6 The evaluation given in this practice provides two separate performance descriptions: an estimate of the performance characteristics of the release detection system, and an estimate of probability of release detection and probability of false alarm.

1.6.1 This practice requires that the system performance characteristics must be determined for all release detection systems as described in 1.2.

1.6.2 Further, this practice currently requires the determination of an estimate of probability of false alarm.

1.6.3 Estimates of probability of detecting releases and false

¹ This practice is under the jurisdiction of ASTM Committee E-50 on Environmental Assessment and is the direct responsibility of Subcommittee E50.01 on Storage Tanks.

Current edition approved March 15, 1993. Published May 1993.

alarms for external release detection systems are not required.

1.7 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

1.8 *This standard does not purport to address all of the safety problems, 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.* A full disclosure is required if hazardous materials are released into the environment as part of the test procedure.

1.9 The sections and subsections in this practice are arranged in the following order:

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2. Terminology

2.1 Definitions:

2.1.1 Definitions of pertinent terms are presented in Appendix X1 of this practice.

3. Release Detection System Description

3.1 The manufacturer must briefly describe the release detection system, its intended use, application, operational conditions, recommended calibration schedule, expected lifetime, and safety considerations.

3.1.1 *General Description*—A brief description of the release detection system must include the following:

3.1.1.1 The type of release detection system (internal, interstitial, or external) must be stated.

3.1.1.2 A clear statement of what the release detection system is designed to detect must be given.

3.1.1.3 A brief description of the scientific principle of operation of the release detection system must be given.

3.1.1.4 The frequency of the measurement (that is, continuous, periodic, or discrete) must be given.

3.1.1.5 A brief description of the apparatus and materials, test protocol, data analysis, and detection criteria must be given.

3.2 *Intended Use*—The intended use of the system must be given.

3.2.1 The applicability of the release detection system with different types and sizes of underground storage tank systems must be stated.

3.2.2 The part of the underground storage tank system to which the release detection system is applicable must be specified.

3.2.3 The applicability of the release detection system with specific stored products must be stated.

3.3 *Operational Conditions*—The range of applicable environmental conditions under which the release detection system is expected to operate successfully must be stated, and the conditions, practices, and materials for which the system is not expected to operate successfully should also be stated.

3.4 *Recommended Calibration Schedule*—Calibration procedures and recommended frequency for calibration of the release detection system or system components must be clearly stated.

3.5 *Expected Lifetime*—The expected lifetime (under specified conditions) of the release detection system and its components must be stated.

3.6 *Safety Considerations*—Known safety considerations, including compliance with OSHA regulations, special chemical concerns, and specific safety procedures must be documented.

4. Development of Performance Data

4.1 The performance evaluation in this practice requires the determination of performance characteristics for all release detection systems; it further requires an estimate of probability to detect release and false alarm for internal and interstitial release detection systems.

4.1.1 *Performance Characteristics*—An evaluation of the performance characteristics of all release detection systems, at a minimum, requires determination of the specificity of the release detection system to the chemical substance or physical property to be detected (that is, signal); measurement of the detection limit, dynamic range, precision and bias, response time for the signal; and quantification of those physical properties that significantly affect the magnitude of the signal; and identification and quantification of those chemical substances or physical properties that the system also responds to and that interferes with the detection of the signal (that is, interferences or ambient noise).

4.1.2 The performance results will be summarized in tables. Technical guidance on how to make the calculations is presented in Appendix X2 of this practice. This technical guidance is taken from reports that are intended to estimate these quantities for external release detection systems. Any standard engineering estimate of these quantities will suffice.

4.2 *Estimate of Probability to Detect a Release and False Alarm:*

4.2.1 The performance of internal and interstitial release detection systems to detect releases is specified in terms of the probability of detection and the probability of false alarm for a

given release. The performance estimate includes an estimate of the uncertainty (that is, confidence intervals) on the probability of detection and probability of false alarm, and a statement of the experimental conditions used to generate the performance estimate (that is, the noise and the signal-plus-noise).

4.2.2 The performance results will be presented as specified in 4.2.2.1-4.2.2.3. Technical guidance on how to calculate these results is presented in Appendix X3 of this practice.

4.2.2.1 The manufacturer must specify the probability of false alarm of the release detection system using the manufacturer's detection criterion. In addition, the manufacturer must tabulate the release detection thresholds that are associated with the following: 0.1, 0.075, and 0.05. If the data are sufficient, estimates can also be reported for any of the following probabilities: 0.01, 0.005, or 0.001.

4.2.2.2 The manufacturer must specify and tabulate the release measurements associated with the following probabilities of detection using the manufacturer's detection threshold: 0.95, 0.90, 0.80, and 0.50.

4.2.2.3 For comparison to other release detection systems, the manufacturer must specify the release that can be detected with the release detection system for the combinations of probabilities of detection and false alarm given in Table 1.

5. Evaluation of Performance Data

5.1 The manufacturer's performance claim must be supported and documented by an engineering evaluation that can be made available for review upon request by the purchaser or user of the release detection system. The evaluation must contain at a minimum the information specified below.

5.1.1 *General*—All performance evaluations will contain the following general information:

5.1.1.1 The manufacturer will briefly describe the important features of the release detection system that will be evaluated. The description will include the measurement systems, sensor geometry, test protocol, data analysis, and detection criterion of the system that will be evaluated.

5.1.1.2 The manufacturer will describe the protocol that will be used to evaluate the release detection system. The protocol should be specified and include the theoretical calculations, experiments, data to be collected, test conditions, and analyses to be performed.

5.2 Performance Characteristics:

5.2.1 *System Response to the Signal*—Under this practice, system response to a signal (the chemical substance or physical property to be detected) must be experimentally determined for the release detection system performance parameters of speci-

ficity, lower detection limit, the dynamic range of detection, accuracy and bias, precision, and response time for the signal. Evaluation of system response to the signal also requires an estimation of the effects of physical properties that significantly affect the magnitude of the signal.

5.2.2 Specificity:

5.2.2.1 The specificity of the release detection system must be experimentally estimated for each chemical substance or physical property to be detected by the system. Determination of specificity is dependent on the type of output that a release detection system produces.

5.2.2.2 For quantitative-output systems, specificity is reported as a response factor. For these systems, specificity is mathematically defined as the system response factor and reported as the ratio of the chemical substance or physical property measured at the output of the release detection system to the actual test value expressed as a percentage.

5.2.2.3 For qualitative-output systems, specificity is determined by whether the system activates or not in response to a known signal level (that is, a true or false response).

5.2.3 *Lower Detection Limit*—The mean and standard deviation of the lower detection limit for the designated signal sources as determined in 5.2.2 must be experimentally estimated.

5.2.4 *Dynamic Range*—An experimental estimate of the operating range of the release detection system must be made for the designated signal sources as determined in 5.2.2.

5.2.5 Precision and Bias:

5.2.5.1 The precision and bias of the release detection system must be made experimentally over the operating range for the designated signal sources as determined in 5.2.2.

5.2.5.2 For quantitative-output detectors, the precision and bias are estimated from the standard deviation and mean obtained from respective measurements at multiple representative known signal levels within the operating range of the release detection system.

5.2.5.3 For a qualitative-output system the precision is calculated as the number of positive responses expressed as a percentage of the total number of tests at a known signal level. An estimate of bias cannot be made for qualitative-output systems.

5.2.6 Response Time:

5.2.6.1 The response time of the release detection system must be experimentally determined for the signal sources designated in 5.2.2. Response time is a general term that refers to the more specific terms of lag time and rise time, that together constitute detection time and fall time of a release detection system.

5.2.6.2 The lag time is the elapsed time from a detector's first contact with the measured signal (chemical substance or physical property) to the first detectable signal.

5.2.6.3 The rise time is the elapsed time from a detector's first detectable signal in response to a product or measured physical property to an output that is 95 % of full scale.

5.2.6.4 The fall time is the elapsed time after a signal is displaced by a total absence of signal until its output returns to 95 % of its original baseline level or there is no detectable signal output.

TABLE 1 Performance of the Release Detection System is Required at the Specified Probability of Detection and Probability of False Alarm

Probability of Detection	Probability of False Alarm
0.95	0.10
0.95	0.075
0.95	0.05
0.90	0.05
0.80	0.05
0.50	0.05