NATIONAL
STANDARD
OF CANADA

CAN/ULC-S675.1-14

STANDARD FOR VOLUMETRIC LEAK DETECTION DEVICES FOR UNDERGROUND AND ABOVEGROUND STORAGE TANKS FOR FLAMMABLE AND COMBUSTIBLE LIQUIDS

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NATIONAL STANDARD OF CANADA

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STANDARD FOR VOLUMETRIC LEAK DETECTION DEVICES FOR UNDERGROUND AND ABOVEGROUND STORAGE TANKS FOR FLAMMABLE AND COMBUSTIBLE LIQUIDS

PREFACE

This is the First Edition of the Standard for Volumetric Leak Detection Devices for Underground and Aboveground Storage Tanks for Flammable and Combustible Liquids, CAN/ULC-S675.1.

This Edition of the Standard has been formally approved by the ULC Standards Committee on Fittings for Flammable and Combustible Liquids.

Only metric SI units of measurement are used in this Standard. If a value for measurement is followed by a value in other units in parentheses, the second value may be approximate. The first stated value is the requirement.

Appendices A and B, identified as Informative, are for information purposes only.

In Canada, there are two official languages, English and French. All safety warnings must be in French and English. Attention is drawn to the possibility that some Canadian authorities may require additional markings and/or installation instructions to be in both official languages.

This First Edition National Standard of Canada is based on, and now supersedes, ULC/ORD-C58.12.

Attention is drawn to the possibility that some of the elements of this Canadian standard may be the subject of patent rights. ULC Standards shall not be held responsible for identifying any or all such patent rights.

Requests for interpretation of this Standard should be sent to ULC Standards. The requests should be worded in such a manner as to permit a “yes” or “no” answer based on the literal text of the requirement concerned.

The initiation of the review of this Standard will commence within 5 years of the date of publication, unless the Standard is identified as fitting within a stabilized category, whereby the review will commence within the appropriate time frame set out by ULC Standards.

This Standard is intended to be used for conformity assessment.

1 SCOPE

1.1 This Standard provides minimum requirements for primary containment leak detection that uses quantitative assessment of physical characteristics to detect leaks in the primary containment.

1.2 These requirements do not cover qualitative nonvolumetric leak detection devices.

1.3 The requirements of this Standard apply to newly-manufactured products. The requirements of this Standard do not apply to installation and monitoring procedures.

NOTE: The identifier “leak detection device” used throughout this document applies to the sensor, plus any cables, connected equipment, software, and display necessary to detect and declare a leak. Since the elements of a particular product may range from all of these items, to a sensor with an integrated display alone, the requirements for marking permit the product elements to be marked “leak detection device” or “leak detection equipment” as appropriate.

2 REFERENCE PUBLICATIONS

2.1 The documents shown below are referenced in the text of this Standard. Unless otherwise stated elsewhere in this Standard such reference shall be considered to indicate the edition and/or revisions of the document available at the date on which the Committee approved this ULC Standard.

Documents Published by the American Society for Testing and Materials (ASTM)
100 Barr Harbour Drive, PO Box C700, West Conshohocken, PA 19428-2959 U.S.A.
Telephone: (610) 832-9585
www.astm.org

• ASTM D56-05 (R 2010), Standard Test Method for Flash Point by Tag Closed Cup Tester

• ASTM D93-13, Standard Test Method for Flash Point by Pensky-Martens Closed Cup Tester

• ASTM D471-12 (Rev A), Standard Test Method for Rubber Property - Effect of Liquids

• ASTM D3828-12, Standard Test Method for Flash Point by Small Scale Closed Cup Tester

• ASTM E1003-95 (R 2006), Standard Practice for Hydrostatic Leak Testing

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Documents Published by CSA Group
5060 Spectrum Way, Suite 100, Mississauga, Ontario L4W 5N6 Canada
Telephone: 1-800-463-6727, Fax: (416) 747-2473
www.csagroup.org

• CSA C22.1-12, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations

• CSA C22.2 No. 0.15-01, Adhesive Labels

• CSA C22.2 No. 22-86 (R2013), Electrical Equipment for Flammable and Combustible Fuel Dispensers

• CSA C22.2 No. 30-86 (R2012), Explosion-Proof Enclosures for Use in Class I Hazardous Locations

• CSA C22.2 No. 142-87 (R2009), Process Control Equipment Industrial Products

• CSA C22.2 No. 157-92 (R2012), Intrinsically Safe and Non-Incendive Equipment for Use in Hazardous Locations

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Documents Published by the Environmental Protection Agency (EPA)
1200 Pennsylvania Ave N.W., Washington, DC 20460 U.S.A.
Telephone: (703) 603-8399
www.epa.gov

• EPA/350/UST-90-006, March 1990, Standard Test Procedures For Evaluating Leak Detection Methods - Automatic Tank Gauging Systems

• EPA/530/UST-90-004, March 1990, Standard Test Procedures For Evaluating Leak Detection Methods - Volumetric Tank Tightness Testing Methods

• EPA/530/UST-90-007, June 1990, Standard Test Procedures For Evaluating Leak Detection Methods - Statistical Inventory Reconciliation Methods

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Document Published by the National Research Council of Canada (NRC)
1200 Montreal Road, Bldg. M58, Ottawa, ON, K1A 0R6, Canada
Telephone: 1-800-672-7990
www.nrc-cnrc.gc.ca

• National Fire Code of Canada, 2010

Documents Published by the National Working Group on Leak Detection Evaluations (NWGLDE)
www.nwglde.org

• Alternative Test procedures for Evaluating Leak Detection Methods - Volumetric Leak Detection Systems for Aboveground Storage Tanks, December, 2009, Ken Wilcox Associates

• Amendment to EPA ATG and Non Volumetric TTT Protocols for Water Sensor Testing, December 17, 2008, Jairus D. Flora Jr. Ph.D.

• ATG/CITLDS Water Detection Testing In Ethanol or Blends Greater Than 10% Ethanol, NWGLDE addendum to EPA/350/UST-90/006, December 2007, Jairus D. Flora, Jr. Ph.D

• Evaluation Protocol for Continuous In-Tank Leak Detection Systems, April 7, 1995, Midwest Research Institute.

• Evaluation Protocol for Continuous In-Tank Leak Detection Systems, January 7, 2000, Jairus D. Flora, Jr. Ph.D.

• Protocol for Determining Applicability of a SIR Method for Manifolded Tanks and Determining Size Limitation, November 1996, Developed under coordination by the SIR team of the National Work Group on Leak Detection Evaluations

• Test Procedures for Comparison of Different ATG Probes, March 27, 2000, Ken Wilcox Associates

• Test Procedures for Comparison of Different Automatic Tank Gauge Consoles, October 4, 2010, Ken Wilcox Associates

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Documents Published by Underwriters Laboratories Inc.
Available from COMM 2000, 1414 Brook Drive, Downers Grove, IL, U.S.A 60515
Telephone: 1-888-853-3503
www.comm-2000.com

• UL 913:2011, Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations

• UL 969:1995 (R2008), Standard for Marking and Labelling Systems

• ANSI/UL 1238:2013, Standard for Control Equipment for Use with Flammable Liquid Dispensing Devices

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3 GLOSSARY

NOTE: Terms used in this Standard that are in *italic* print are defined as follows:

3.1 *ACCURACY* — The degree to which the *measured leak rate* agrees with the *induced leak rate* on the average. If a leak detection device is accurate, it has a very small or zero *bias*.

3.2 *AUTHORITY HAVING JURISDICTION (AHJ)* — The governmental body responsible for the enforcement of any part of this Standard or the official or agency designated by that body to exercise such a function.

3.3 *BIAS (DEVICE BIAS), B* — The average difference between measured and *induced leak rates*, in litres per hour (L/h). It is an indication of whether the leak detection device being evaluated consistently overestimates (positive *bias*) or underestimates (negative *bias*) the *induced leak rate*.

3.4 *COMBUSTIBLE LIQUID* — Any liquid having a flash point at or above 37.8 °C and below 93.3 °C and as defined in the National Fire Code of Canada.

NOTE: Sentence 4.1.3 of the 2010 Edition of the National Fire Code of Canada specifies the following test methods: ASTM D56, Standard Test Method for Flash Point by Closed Cup Tester, for liquids with a kinematic viscosity less than 6 cSt; ASTM D93, Standard Test Method for Flash Point by Pensky-Martens Closed Cup Tester, for liquids with a kinematic viscosity of 6 cSt or more; ASTM D3828, Standard Test Methods for Flash Point by Small-Scale Closed Cup Tester, as an optional alternative for aviation turbine fuels.

3.5 *FALSE ALARM* — An indication that a tank is *leaking* when it is not.

3.6 *FLAMMABLE LIQUID* — Any liquid having a flash point below 37.8 °C and vapour pressure not exceeding 276 kPa (absolute) at 37.8 °C and as defined in the National Fire Code of Canada.

3.7 *INDUCED LEAK RATE* — The *leak rate*, expressed in litres per hour, used during testing, against which the results from a given leak detection device under test will be compared.

3.8 *LEAKAGE, LEAK OR LEAKING* — Any unplanned flow of fluid in or out of the primary containment.

3.9 *LEAK MONITORING DEVICE* — A surveillance device to detect *leaks (leakage)* of *flammable liquids* or *combustible liquids* from a primary containment.

3.10 *LEAK RATE (R)* — The amount of product loss per unit of time, expressed in litres per hour.

3.11 *MEASURED LEAK RATE* — A number, in litres per hour, measured by the leak detection device under test and indicating the amount of product *leaking* out of the tank. A negative *leak rate* would indicate that a liquid is *leaking* into the tank.

3.12 *PRECISION LEAK DETECTION DEVICE* — A leak detection device that is designed for short-term measurement for potential *leaks* from an installed tank.

3.13 *PROBABILITY OF DETECTION, P(D)* — The probability of detecting a *leak* in a primary containment of a given size, stated as a decimal, fraction or percentage.

3.14 *PROBABILITY OF FALSE ALARM, P(FA)* — The probability of declaring a *leak* in a non-leaking primary containment of a given size stated as a decimal, fraction or percentage.

4 MATERIALS, WORKMANSHIP AND CONSTRUCTION

4.1 GENERAL

4.1.1 The manufacturer shall state the limiting operating and service conditions, such as humidity, temperature, jarring and vibration, for which the leak detection device meets the requirements of this Standard.

4.1.2 The manufacturer shall define the *flammable liquids* and *combustible liquids* with which the leak detection devices are compatible.

4.2 ELECTRICAL FEATURES

4.2.1 General

4.2.1.1 The electrical features of unenclosed leak detection devices shall meet the applicable requirements of:

A CSA C22.1, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations;

B CSA C22.2 No. 142, Process Control Equipment, or ANSI/UL 1238, Standard for Control Equipment for Use with Flammable Liquid Dispensing Devices;

C CSA C22.2 No. 22, Electrical Equipment for Flammable and Combustible Fuel Dispensers;

D UL 913, Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations; or

E CSA C22.2 No. 157, Intrinsically Safe and Non-Incendive Equipment for Use in Hazardous Locations.

4.2.1.2 Leak detection devices not meeting the requirements of Clause 4.2.1.1, and which are to be used in a hazardous area, shall be protected in enclosures meeting the requirements of CSA C22.2 No. 30, Explosion-Proof Enclosures for Use in Class I Hazardous Locations. Such electrical devices or equipment shall meet the requirements of the appropriate CSA Standards for electrical safety and performance.

4.3 NONMETALLIC MATERIALS

4.3.1 Nonmetallic materials which are immersed in, or exposed to, *flammable liquids* or *combustible liquids* or vapours, shall not be affected by such liquids or vapours in a manner as to cause a failure of the leak detection devices or to cause a hazardous condition to occur. The manufacturer shall specify the *flammable liquids* or *combustible liquids* for which their product meets this requirement.

5 PERFORMANCE REQUIREMENTS

NOTE: Products meeting the applicable requirements as defined in this Standard may be identified by a manufacturer as *precision leak detection devices*, continuous *leak monitoring devices*, precision leak monitoring devices or any applicable combination.

5.1 PRECISION LEAK DETECTION

5.1.1 The leak detection device shall be capable of detecting a *leak rate* of 0.38 L/h within a period of 24 hours with a *probability of detection* equal to or greater than 0.95 and a *probability of false alarm* equal to or less than 0.05.

5.2 CONTINUOUS LEAK MONITORING

5.2.1 The leak detection device shall be capable of detecting a *leak rate* of 0.76 L/h within a period of 30 d with a *probability of detection* equal to or greater than 0.95 and a *probability of false alarm* equal to or less than 0.05. For the purposes of this requirement, “leak detection device” shall include Statistical Inventory Reconciliation (SIR) software, if applicable.

5.3 PRECISION LEAK MONITORING

5.3.1 The leak detection device shall be capable of detecting a *leak rate* of 0.38 L/h within a period of 30 d with a *probability of detection* equal to or greater than 0.95 and a *probability of false alarm* equal to or less than 0.05. For the purposes of this requirement, “leak detection device” shall include Statistical Inventory Reconciliation (SIR) software, if applicable.

5.4 TANK PRODUCT LEVEL MEASUREMENT CRITERIA

5.4.1 The leak detection device shall be capable of measuring the tank liquid level to within 3 mm with a probability of 0.99.

5.5 TANK WATER LEVEL MEASUREMENT CRITERIA

5.5.1 The leak detection device shall be capable of measuring the level of water in the tank to within 3 mm with a probability of 0.95.

NOTE: The impact on the capability of the leak detection device to meet this requirement for tanks containing ethanol blend fuels should be considered during certification testing.

6 PERFORMANCE TESTS

6.1 GENERAL

6.1.1 Samples that are fully representative of the leak detection devices shall be submitted for test.

6.1.2 Tests as described under Subsection 6.2, Accelerated Aging Test, shall be performed where the failure, or change in characteristics, of the materials would affect the safety or operation of the leak detection device, as determined by a Failure Modes and Effects Analysis performed by the proponent.

6.2 ACCELERATED AGING TEST

6.2.1 Representative samples of elastomers shall be subjected to an accelerated oxygen pressure aging test for a minimum of 96 h in oxygen at a temperature of 70 ± 2 °C and at a pressure of 200 ± 10 kPa. The samples shall be subjected to tensile and hardness determination before and after the aging.

6.2.2 The samples shall retain not less than 75 % of their original properties after the aging.

6.3 EXTERNAL LEAKAGE TEST

6.3.1 Samples of the assemblies or components subject to liquid or vapour pressure shall be leak tested at a pressure of 35 ± 2 kPa.

6.3.2 The samples shall withstand the applied pressure for 5 min without *leakage* or measurable permanent distortion.

NOTE: Proponents and testing laboratories are referred to the Visual Inspection Method of ASTM E1003, Standard Practice for Hydrostatic Leak Testing.

6.4 REPORTING REQUIREMENTS, EXCLUDING LEAK DETECTION

6.4.1 General

6.4.1.1 In addition to the information specified in the individual test methods, all reports describing the testing of the leak detection devices according to this Standard shall include the following information:

A The proponent's name and address;

B The general description, drawings and schematics of the leak detection devices;

C The descriptions of test apparatus, calibration standards and their source(s);

D The name and location of the laboratory performing the tests and, if applicable, the accreditation agency for the laboratory;

E A summary of measured results (preferably in a table) compared to the requirements of this Standard with indication that the leak detection devices have passed/failed for each requirement; and

F An appendix to the report containing the test data used to generate the above items.

6.5 LEAK DETECTION PERFORMANCE TESTS

6.5.1 Leak Detection Performance Test Requirements

6.5.1.1 The leak detection device shall conform to the requirements of one or more of the following documents:

A Aboveground Storage Tank Leak Detection Method

(i) Alternative Test procedures for Evaluating Leak Detection Methods - Volumetric Leak Detection Systems for Aboveground Storage Tanks, Ken Wilcox Associates;

B Automatic Tank Gauging Method

(i) EPA/350/UST-90-006, Standard Test Procedures For Evaluating Leak Detection Methods - Automatic Tank Gauging Systems,

(ii) Test Procedures for Comparison of Different ATG Probes, Ken Wilcox Associates

(With acceptable modification, this method is also applicable to comparisons of different ATG controllers.)

(iii) ATG/CITLDS Water Detection Testing In Ethanol or Blends Greater Than 10% Ethanol, NWGLDE addendum to EPA/350/UST-90/006, Jairus D. Flora, Jr. Ph.D,

(iv) Test Procedures for Comparison of Different Automatic Tank Gauge Consoles, Ken Wilcox Associates;

C Continuous In-Tank Leak Detection Method

(i) Evaluation Protocol for Continuous In-Tank Leak Detection Systems, Midwest Research Institute.,

(ii) Evaluation Protocol for Continuous In-Tank Leak Detection Systems, Jairus D. Flora, Jr. Ph.D.,

(iii) ATG/CITLDS Water Detection Testing In Ethanol or Blends Greater Than 10% Ethanol, NWGLDE addendum to EPA/350/UST-90/006, Jairus D. Flora, Jr. Ph.D,

(iv) Amendment to EPA ATG and Non Volumetric TTT Protocols for Water Sensor Testing, Jairus D. Flora Jr. Ph.D.;

D Secondary and Spill Containment Test Methods

(i) EPA/350/UST-90-006, Standard Test Procedures For Evaluating Leak Detection Methods - Automatic Tank Gauging Systems;

E Statistical Inventory Reconciliation Test Method (Quantitative)

(i) EPA/530/UST-90-007, Standard Test Procedures For Evaluating Leak Detection Methods - Statistical Inventory Reconciliation Methods,

(ii) Protocol for Determining Applicability of a SIR Method for Manifolded Tanks and Determining Size Limitation;

F Volumetric Tank Tightness Test Method (Overfill, Underfill)

(i) EPA/530/UST-90-004, Standard Test Procedures For Evaluating Leak Detection Methods - Volumetric Tank Tightness Testing Methods;

NOTE 1: Some of these documents describe alternative methods that *authorities having jurisdiction (AHJs)* may regard as equally applicable to a given leak detection device or installation. The proponent, the testing laboratory and the *AHJ* are to agree on the applicable document(s) for any leak detection device proposed for certification.

NOTE 2: *AHJs* may determine that the sizes of the test equipment tanks used to evaluate leak detection devices place limits on the applicability of the testing and related certification of the devices with respect to the size of tanks in actual installations.

6.5.2 Reporting Requirements for Leak Detection Tests

6.5.2.1 In addition to the information specified in the individual test methods, all reports describing the testing of the leak detection devices according to this Standard shall include the following information:

A The proponent's name and address;

B The general description, drawings and schematics of the leak detection devices;

C The name and location of the laboratory performing the tests and, if applicable, the accreditation agency for the laboratory;

D A summary of measured results (preferably in a table) compared to the requirements of this Standard with indication that the property has passed or failed; and

E An appendix to the report containing the test data in accordance with specific EPA/NWGLDE test procedures used to generate the above items, including the volume of the test tank(s), if applicable.

7 INSTALLATION AND OPERATING INSTRUCTIONS

7.1 The manufacturer's installation and operating instructions shall accompany each device or equipment.

7.2 The instructions shall include such directions and information as deemed by the manufacturer to be adequate for attaining proper and safe installation, maintenance, and use of the product and shall include as a minimum the following information:

A Safety requirements;

B Calibration techniques and frequency;

C Maintenance/cleaning methods and frequency;

D Best practices to promote measurement *accuracy*; and

E Notification that *authority having jurisdiction (AHJ)* requirements may specify that a leak from an installed tank be reported within a defined time limit after occurrence/detection.

8 MARKING

8.1 Each leak detection device shall be legibly marked with the following information:

A The manufacturer's name or logo;

B The model number;

C A date code or serial number;

D Electrical ratings, where applicable;

E The designation:

“Precision Leak Detection Device” or “Precision Leak Detection Equipment”

or

“Leak Monitoring Device” or “Leak Monitoring Equipment”

or

“Precision Leak Monitoring Device” or “Precision Leak Monitoring Equipment”;

F The rating stated as:

“Capability of Detection - 0.38* L/h”

* or 0.76 L/h for *leak monitoring* devices;

G The statement:

“Refer to operating instructions for compatibility with stored products”;

H “CAN/ULC-S675.1”. and

I Identification of the model number for associated hardware to which the device or equipment must be connected so as to match the leak detection performance verified by the testing laboratory.

NOTE 1: For smaller leak detection devices, it is acceptable to mark a tag attached to the leak detection device. In this case the tests of Section 6, Performance Tests, and Appendix A should be performed with the tag attached. Any machine-readable method acceptable to the *authority having kurisdiction (AHJ)* may be used as an alternative to physical marking.

NOTE 2: Manufacturers should be aware that the *AHJ* may also require that the mark of the certifying agency be included on each leak detection device. All marking is to be accessible for inspection subsequent to installation.

8.2 The markings shall be distinct, legible and shall be engraved or stamped on a metal label or other material of equivalent durability permanently attached to the leak detection device.

8.3 Alternate methods of attachment are permissible provided that the label is affixed to the leak detection device in a manner that will destroy the label if it is removed. If a pressure sensitive label, ink, paint-stencilling or other method is used, it shall comply with the requirements of CSA 22.2 No. 015, Adhesive Labels, or UL 969, Standard for Marking and Labelling Systems.

APPENDIX A - PROBABILITY OF DETECTION AND PROBABILITY OF FALSE ALARM (INFORMATIVE)

(Reference: Clause N/A)

A1 GENERAL

A1.1 In this document, *leaks* are viewed as product lost from the tank. As a convention, *leak rates* are positive numbers, representing the amount of product loss per unit time. Thus a larger *leak* represents a greater product loss. Parts of the *leak* detection industry report volume changes per unit time with the sign indicating whether product is lost from the tank (negative sign) or is coming into the tank (positive sign). We emphasize that here, *leaks* refer to the direction out of the tank and the rate to the magnitude of the flow.

A1.2 The performance of a leak detection device is expressed in terms of the *probability of false alarm, P(FA)*, and the probability of detecting a *leak* of specified size, P(D). In order to understand these concepts, some explanation is helpful. Generally, for volumetric leak detection devices, either a precision tank test or the *leak* test function of an automatic tank gauging system (ATCS), estimates a *leak rate*. This calculated rate is compared to a criterion or threshold, C, determined by the manufacturer. If the calculated rate is in excess of the criterion, the tank is declared to be *leaking*, otherwise, the tank is called tight.

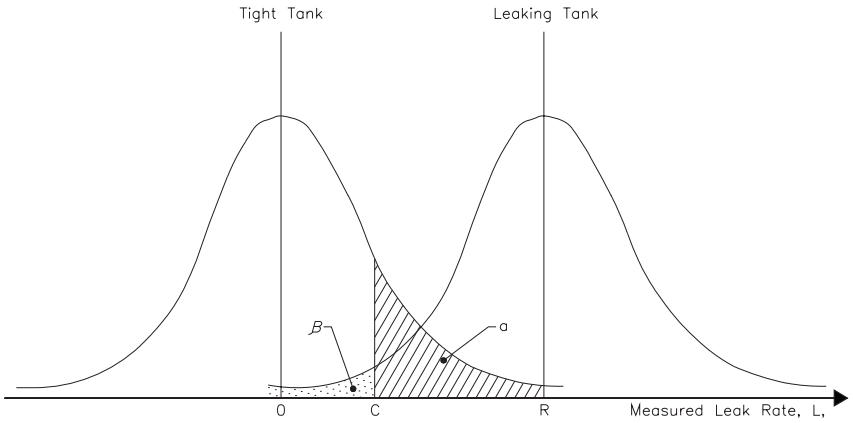
A1.3 Figure A1 represents the process of determining whether a tank is *leaking* or not. The curve on the left represents the inherent variability of the *measured leak rate* on a tight tank (with zero *leak rate*). If the *measured leak rate* exceeds C, the tank is declared to *leak*, a *false alarm*. The chance that this happens is represented by the shaded area under the curve to the right of C, denoted α (alpha).

A1.4 The variability of the *measured leak rates* for a tank that is actually *leaking* at the rate R is represented by the curve on the right in Figure A1. Again, a *leak* is declared if the measured rate exceeds the threshold, C. The probability that the *leaking* tank is correctly identified as *leaking* is the area under the right hand curve to the right of C. The probability of mistakenly declaring the *leaking* tank tight is denoted by β (beta), the area of the left of C under the *leaking* tank curve.

A1.5 Changing the criterion, C, changes both α and β for a fixed *leak rate*. If the *leak rate* is increased, the curve on the right shifts further to the right, decreasing β and increasing the *probability of detection* for a fixed criterion, C. If the precision of a leak detection device is increased, the curve becomes taller and narrower, decreasing both α and β, resulting in improved performance.

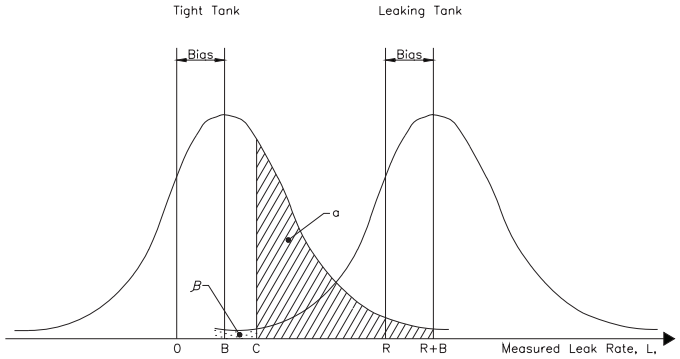
A1.6 A *bias* is a consistent error in one direction. This is illustrated in Figure A2. In it, both curves have been shifted to the right by an amount of *bias, B*. In this illustration, the *bias* indicates a greater *leak rate* than is actually present (the *bias* is positive in this case). This has the effect of increasing the probability of a *false alarm*, while reducing the probability of failing to detect a *leak*. That is, the probability of detecting a *leak* of size R is increased, but so is the chance of a *false alarm*. A *bias* toward underestimating the *leak rate* would have the opposite effect. That is, it would decrease both the *probability of false alarm* and the probability of detecting a *leak*.

FIGURE A1
DISTRIBUTION OF MEASUREMENT ERROR ON A TIGHT AND LEAKING TANK



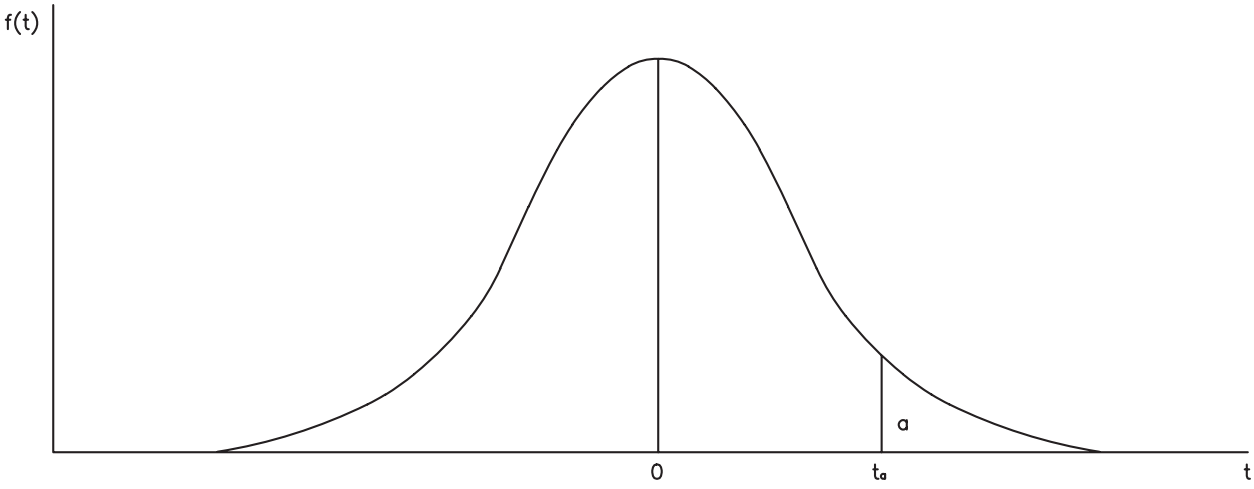
C Criterion or Threshold for declaring a leak (a leak is declared if the measured rate exceeds C).
α Probability of False Alarm, P(FA).
β Probability of not detecting a leak rate R.
1 - β Probability of detecting a leak rate R, P(D).
R Leak Rate.

FIGURE A2
DISTRIBUTION OF MEASUREMENT ERROR ON A TIGHT AND LEAKING TANK IN THE CASE OF A POSITIVE BIAS



C Criterion or Threshold for declaring a leak (a leak is declared if the measured rate exceeds C).
α Probability of False Alarm, P(FA).
β Probability of not detecting a leak rate R.
1 - β Probability of detecting a leak rate R, P(D).
B Bias.

TABLE A1
PERCENTAGE POINTS OF STUDENT'S t-DISTRIBUTION



df	a = 0.10	a = 0.05	a = 0.025	a = 0.010	a = 0.005
1	3.078	6.314	12.706	31.821	63.657
2	1.886	2.920	4.303	6.965	9.925
3	1.638	2.353	3.182	4.541	5.841
4	1.333	2.132	2.776	3.747	4.604
5	1.476	2.015	2.571	3.365	4.032
6	1.440	1.943	2.447	3.143	3.707
7	1.415	1.895	2.365	2.998	3.499
8	1.397	1.860	2.306	2.896	3.355
9	1.383	1.833	2.262	2.821	3.250
10	1.372	1.812	2.228	2.764	3.169
11	1.363	1.796	2.201	2.718	3.106
12	1.356	1.782	2.179	2.681	3.055
13	1.350	1.771	2.160	2.650	3.012
14	1.345	1.761	2.145	2.624	2.977
15	1.341	1.753	2.131	2.602	2.947
16	1.337	1.746	2.120	2.583	2.921
17	1.333	1.740	2.110	2.567	2.898
18	1.330	1.734	2.101	2.552	2.878
19	1.328	1.729	2.093	2.539	2.861
20	1.325	1.725	2.086	2.528	2.845
21	1.323	1.721	2.080	2.518	2.831

Table (Continued)

22	1.321	1.717	2.074	2.508	2.819
23	1.319	1.714	2.069	2.500	2.807
24	1.318	1.711	2.064	2.492	2.797
25	1.316	1.708	2.060	2.485	2.787
26	1.315	1.706	2.056	2.479	2.779
27	1.314	1.703	2.052	2.473	2.771
28	1.313	1.701	2.048	2.467	2.763
29	1.311	1.699	2.045	2.462	2.756
30	1.310	1.697	2.042	2.457	2.750
40	1.303	1.684	2.021	2.423	2.704
60	1.296	1.671	2.000	2.390	2.660
120	1.289	1.658	1.980	2.358	2.617
inf.	1.282	1.645	1.960	2.326	2.576

APPENDIX B - PROCESS OF CERTIFICATION AGAINST THE STANDARD (INFORMATIVE)

(Reference: Clause N/A)

B1 INTRODUCTION

B1.1 As of the 2014 publication date of the First Edition of this Standard, there has not been a formal product certification and listing service for leak detection products for *flammable liquids* or *combustible liquids* by an accredited certification organization in North America for many years. In the USA, an independent organization comprising representatives of the regulatory bodies of 10 States and the Federal Government, the National Working Group on Leak Detection Evaluations (NWGLDE), have operated a *de facto* listing service based on third-party testing to published protocols, and most *AHJs* in the USA have verified conformance of products to regulatory requirements by reference to the NWGLDE lists. In Canada, some jurisdictions verify product conformance in an identical fashion, whilst others operate a case-by-case evaluation process that also includes reference to the NWGLDE lists.

B2 PRODUCT DURABILITY, SAFETY AND PERFORMANCE RELIABILITY

B2.1 The partial certification processes identified in Clause B1.1, whilst not ideal, have nevertheless met the needs of the stakeholders to date in that, combined with safety regulations, they have ensured that newly-installed products are operating safely and determining the occurrences of *leaks* within acceptable error levels. Given that most of the products currently operating in the North American market have a proven track record of operating safety and reliability, and given that electrical products apply 'intrinsically safe' design methods, there is currently little concern that the lack of durability testing in the protocols applied by NWGLDE for listing products may result in safety hazards or increasing leak detection error levels as a result of in-service failures of these mature products.

B2.2 Some stakeholders have expressed concerns, however, that products from new manufacturers, or products that apply entirely new measurement or detection methods or technologies, may be evaluated, listed and put into service under the current partial system without the same, in effect, assurance of durability as are provided by the current mature product technologies and/or manufacturers, with consequent risks to life, property and environmental safety. The counter-argument has also been advanced that these concerns should not result in new durability requirements included in this Standard being imposed on mature products where no such concern exists, with the corresponding increase in product costs ultimately being born by the consumer. A need has also been identified to determine what types and levels of exposure testing provide adequate assurance of durability against actual leak detection service conditions, without imposing excessive stress levels that may result in failures of samples of existing products that are, in fact, adequately durable for actual service.

B2.3 Users of this Standard are recommended to develop verification and maintenance schedules for leak detection devices placed into service that include identified end-of-life dates for replacement of the leak detection devices, taking into account the service conditions in each case.

B2.4 In considering the foregoing points, the Task Group developed the material that follows in the rest of this Appendix.

B3 CERTIFICATION PROCESS APPLYING NWGLDE LISTINGS

B3.1 For mature product technologies, it is suggested that the certification organization determine that a specific leak detection device is acceptable by assembling and verifying the following:

A The information identified in Section 7 of this Standard;

B The protocol(s) against which the product was tested (selected from the NWGLDE list of protocols);

C All of the results of the protocol tests;

D A list of all the operating limitations, including those noted in the third party protocol test;

E Confirmation that the device/equipment is listed on the NWGLDE website;

F A field procedure and operating manual for the device/equipment;

G Testing and certification documentation for hazardous location installation, or intrinsic safety, of any electrical elements of the product.

B3.2 For products from new manufacturers, or products that apply entirely new measurement or detection methods or technologies, in addition to the material identified in Clause B3.1, it is recommended that the certification organization determine whether there is a need to address the issue of safety hazards or increasing leak detection error levels as a result of in-service failures and, if so, propose additional durability testing to be carried out on the product prior to completion of the certification and listing service.

B4 CERTIFICATION OF SOFTWARE INCLUDED IN LEAK DETECTION PRODUCTS

B4.1 It is recommended that software be addressed in the same fashion as the hardware components of a product. Control by the manufacturer of consistent software function despite changes in version numbers, etc., may be addressed in the same fashion as control of ongoing hardware component quality and reliability despite changes in part numbers or suppliers by periodic testing of the product for operation within the established control parameters.