UL 1784

STANDARD FOR SAFETY

Air Leakage Tests of Door Assemblies and Other Opening Protectives

UL Standard for Safety for Air Leakage Tests of Door Assemblies and Other Opening Protectives, UL 1784

Fourth Edition, Dated February 17, 2015

Summary of Topics

This reaffirmation of ANSI/UL 1784 dated January 16, 2025 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin

The requirements are substantially in accordance with Proposal(s) on this subject dated November 29, 2024.

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Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives

The First, Second, and Third editions were titled Standard for Air Leakage Tests of Door Assemblies.

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Second Edition – December, 1995
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Fourth Edition

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This ANSI/UL Standard for Safety consists of the Fourth Edition including revisions through January 16, 2025.

The most recent designation of ANSI/UL 1784 as a Reaffirmed American National Standard (ANS) occurred on January 16, 2025. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover the investigation of air leakage through door assemblies and other opening protectives (hereafter also referred to as test sample) installed in wall openings where air leakage is intended to be controlled.

1.2 The purpose of the test is to determine only the resistance of a test sample, in the closed position, to air leakage resulting from a specified air pressure difference applied across the surface of the entire opening protective.

1.3 These requirements apply to complete door assemblies, opening protectives, or to gasketing systems intended for use with specific door or other protective assemblies.

1.4 The test method includes air leakage tests and cycling tests to determine the rate of air leakage through a test sample in an as-installed condition.

1.5 The results obtained by use of this test method are expressed in cubic feet per minute per square foot (m^3/s per m^2) of opening and are intended to develop data to assist authorities having jurisdiction, and others, in determining acceptability of a door assembly, opening protective, or gasketing system with reference to control of air movement through an assembly.

1.6 A door assembly, opening protective, or gasketing system investigated by this test method is intended for installation and use in accordance with the Standard for the Installation of Smoke Door Assemblies, NFPA 105.

1.7 This test method shall not be used for such opening protectives that include an air leakage test method within the test standard. For example, the Standard for Fire Tests of Through-Penetration Firestops, UL 1479, contains an air leakage test method for firestop systems and therefore shall not be substituted with this test method.

2 General

2.1 Units of measurement

2.1.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

2.2 Undated references

2.2.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

3 Glossary

3.1 For the purpose of this test method the following definitions apply.

3.2 AIR-FLOW METERING SYSTEM – A device used to measure the air flow within the limitations of error specified in 7.4.

3.3 AIR LEAKAGE (Q) – The volume of air flowing, per unit of time, through the openings around a closed test sample under a test pressure difference, expressed as cubic feet per minute (m^3/s). This air leakage volume is to be reported normalized to an ambient air temperature of 75°F (24°C).

3.4 AIR SYSTEM – A controllable blower, compressed air supply, exhaust system, or reversible blower designed to provide a constant required air flow at the specified fixed test pressure difference for the period required to obtain readings of air leakage.

3.5 AMBIENT TEMPERATURE EXPOSURE – The temperature at the exposed face of the test sample is to be 75 ±20°F (24 ±11°C).

3.6 ELEVATED TEMPERATURE EXPOSURE – The temperature at the exposed face of the test sample is to be 400 ±10°F (204 ±5°C).

3.7 EXTRANEOUS LEAKAGE (Q_L) – The difference between the metered air flow (Q_m) and the air leakage (Q).

3.8 METERED AIR FLOW (Q_m) – The volume of air flowing per unit of time through the air flow metering system, expressed as cubic feet per minute (m^3/s).

3.9 OPENING – The clear area within the test sample boundaries, which may include the floor, header, and other edges that allows the passage of people or materials, determined by the overall dimensions of the test sample expressed as square feet (m^2). The floor shall be considered as part of the opening when the frame is not continuous and terminates at the floor slab.

3.10 OPENING PROTECTIVE – A device or assembly such as a curtain used to protect openings in walls against the spread of smoke within, into or out of a building.

3.11 RATE OF AIR LEAKAGE – The air leakage per unit of opening, expressed as cubic feet per minute per square feet (m^3/s per m^2) of the test sample.

3.12 REPLACEMENT AIR – The volume of air, at ambient temperature, added to the test chamber, to replace the air leakage (Q) volume of air in either the ambient or elevated temperature exposure tests.

3.13 TEST CHAMBER – A sealed chamber or box with an opening, a removable mounting panel, or one open side in which or against which the test sample is installed and sealed.

3.14 TEST PRESSURE DIFFERENCE – The specified difference in static air pressure across the closed and latched or fixed test sample expressed as inch of water column (Pa).

3.15 TEST SAMPLE – The entire assembly of the opening system, which may include the frame, operable panel, gasketing, hardware, or any combination thereof. The test sample shall also consist of the specific type of supporting construction for which the opening is installed.

INSTALLATION AND OPERATING INSTRUCTIONS

4 General

4.1 Installation and operating instructions shall be made available with each test sample by the manufacturer. Instructions shall be illustrated and shall include detailed directions and information for the intended installation and operation of the test sample. Instructions shall cover mounting, sealing, opening and closing requirements, maximum and minimum size of the test sample, and shall be in accordance with the Standard for the Installation of Smoke Door Assemblies, NFPA 105.

4.2 The instructions shall be used as a guide in the examination and test of the opening assembly. For this purpose, a published edition is not required. A published edition will be required upon successful completion of the test program.

4.3 The evaluated sample size shall be as defined in the Standard for the Installation of Smoke Door Assemblies, NFPA 105. In instances where the test sample or size is not defined in NFPA 105, the construction and size of the tested sample shall be representative of that for which the rating is being evaluated. For test sample sizes not defined in NFPA 105, critical factors including the aspect ratio (ratio of door perimeter to area) and the length of linear gaps or clearances where leakage could occur is to be considered in determining the sample size for testing. The instructions shall be used as a guide in the examination and test of the opening assembly. For this purpose, a published edition is not required. A published edition will be required upon successful completion of the test program.

PERFORMANCE

5 General

5.1 Test sample

5.1.1 A representative test sample for each specific design desired for evaluation shall be subjected to the Cycling Test, Section 6, followed by the Air Leakage Tests, Section 7.

5.1.2 Each test sample shall be tested from both directions with respect to the opening of the test chamber. The testing can either be conducted on one test sample that is removed and repositioned in the mounting panel or on two separate, identical test samples.

5.1.3 The test laboratory has the authority to identify and evaluate representative test installations that shall be subjected to the tests described within this standard. When a test sample and assembly is entirely symmetrical about the center plane of the test sample and assembly, a single representative direction can be tested. If testing is conducted from one side only, the justification shall be stated within the report.

Exception: For those test samples not defined within the Standard for the Installation of Smoke Door Assemblies, NFPA 105, each size and aspect ratio shall be considered for testing as the performance of the assembly is directly related to its size and construction.

5.2 Conditioning

5.2.1 A test sample containing hygroscopic materials or other materials that can be affected by moisture is to be conditioned in an environment having a dry bulb temperature of 77 ±5°F (25 ±3°C) and a relative humidity of 40 – 65 percent until the moisture content within the test sample reaches equilibrium. The equilibrium shall be based on measurements taken by no less than 3 days apart.

5.3 Test chamber

5.3.1 The air leakage test chamber is to consist of a well-sealed chamber or box with an opening, a removable mounting panel, or one open side in or against which the test sample is installed and sealed. A means of access into the chamber may be provided to facilitate adjustments and observations of the installed test sample.

5.3.2 At least one static pressure tap is to be provided to measure the chamber pressure and is to be located so that the reading is unaffected by the velocity of the air supplied to or exiting from the chamber.

5.3.3 The temperature of the chamber shall be deemed the average temperature obtained by a minimum of three thermocouples and no fewer than one thermocouple per 15 square feet (1.4 m^2) of test assembly exposed to the furnace symmetrically disposed and distributed to measure the temperature near all parts of the test sample. The end of the thermocouple assembly shall be 6 inches (152 mm) from the exposed face of the test sample or from the wall in which the test sample is installed. The temperatures shall be measured and recorded at intervals not exceeding 5 minutes and at the time each pressure differential is recorded.

5.3.4 The air supply opening into the chamber is to be arranged so that air does not impinge directly on the test sample with any non-uniform velocity.

5.4 Test setup

5.4.1 The test sample is to be installed in or against the test chamber. The same test sample is to be used for the Cycling Test, Section 6, and the Air Leakage Tests, Section 7.

5.4.2 Sealing material or construction that is not intended as a part of the assembly as installed in a building is to be removed. The test sample is to be fitted into or against the chamber opening. The outer perimeter of the test sample is to be sealed to only one face of the chamber wall. Non-hardening mastic-compounds or pressure-sensitive tape can be used effectively to seal the test sample at the chamber opening, to seal the access door to the chamber, and to achieve air tightness in the construction of the chamber. These materials can also be used to seal a separate mounting panel to the chamber. Rubber gaskets with clamping devices may also be used for this purpose, if the gasket is highly flexible and has a narrow contact edge.

5.4.3 Without disturbing the seal between the test sample and test chamber, the clearances between each side of the door or opening protective and frame, and between the meeting edges of pairs of doors; and between top and bottom are to be adjusted to the lesser of the maximum clearances specified in the installation instructions provided with the test sample, or the maximum clearances permitted by subtracting the difference between the maximum width and height of the frame, including maximum positive tolerances, and the minimum width of the door(s) or opening protective, including the maximum negative tolerances.

5.4.4 The closing forces necessary to operate a test sample incorporating a positive means of latching shall be measured and recorded. For opening protectives other than swinging doors, the closing force measurement method shall also be recorded.

5.4.5 In order to obtain information on the extent of air leakage at the ungasketed bottom gap of a test sample, an artificial seal may be applied to the bottom 6 inches (152.4 mm) of the test sample. The artificial seal may be any material, such as an impermeable sheet or tape. The artificial seal is to be used at the test sponsor's request to isolate the perimeter of the opening protective or door assembly to allow for measuring leakage through the assembly without any influence from the clearance between the bottom of the assembly and the top of the floor surface.

6 Cycling Test

6.1 The cycling test requirements are only applicable for test samples that include movable parts. This section may be omitted for test samples that are non-operable.

6.2 Prior to conducting the Air Leakage Tests, Section 7, the operable panel of the test sample shall function as intended after being operated for five full-stroke close and reopen operations. The closing force necessary to close and latch the door or opening protective incorporating a positive means of latching before and after the cycling test shall be measured and recorded. The test sample is to be cycled while mounted as intended.

6.3 The full stroke noted in 6.2 is the distance that an opening travels from fully closed to fully open when subjecting it to the cycling test. For swinging type door assemblies the amount of opening is the lesser of 90 ±5 degrees or the maximum permitted by the design of the assembly. For sliding or rolling type door assemblies the amount of opening is to be the lesser of the maximum permitted by the design of the assembly or of a sufficient amount to disturb the installed position of all gasketing materials.

6.4 The same test sample to be subjected to the Air Leakage Tests, Section 7, shall be used for this test. The interface between the test sample and the test chamber may be resealed after the cycling test. The test sample may be provided with reinforcing parts to accommodate an actuator and a closer; that is, an electric, pneumatic, or hydraulic device, if used to operate the test sample.

6.5 To determine the closing force for swinging doors, the test door is to be placed in the open position and the closing force is to be measured along a base line perpendicular to the closed test door and 30 inches (762 mm) from the test door pivot center with two marks provided, one at 3 inches (76.2 mm) and the other 1/2 inch (12.7 mm) from the door face.

6.6 The door closer is to be adjusted to provide the minimum closing force necessary to close and latch the door, within 3 seconds after being opened to 90 ±5 degrees or the maximum permitted by the design of the assembly.

6.7 The test door is to be opened beyond the 3 inch (76.2 mm) mark. Holding the door open with a mechanical force gauge, the door is to be allowed to close slowly under the power of the door closer. The greatest force developed during closing is to be recorded as the door travels between the 3 inch and 1/2 inch (12.7 mm) marks.

6.8 After the closing force is measure, the door closer shall be disabled so that it does not assist in sealing the door to the frame.

6.9 After cycling, no additional adjustments are to be made to the test sample while measuring the air leakage.

7 Air Leakage Tests

7.1 General

7.1.1 Prior to the air leakage tests, all clearances shall be measured at three points on each horizontal and vertical edge. The extraneous chamber leakage (Q_L) is to be measured after the conduct of the cycling tests using an air-impermeable sheet to cover the entire test sample. The extraneous chamber leakage (Q_L) shall be measured prior to the ambient temperature exposure tests specified in 7.2.1 and after the elevated temperature exposure tests specified in 7.3.1. (See 7.4.4). The extraneous chamber leakage measured after the elevated temperature exposure tests shall be measured after the temperatures at the faces of the door assembly have returned to within 20°F (13°C) of their temperatures prior to the elevated exposure tests. Any measurable chamber leakage determined prior to the ambient temperature exposure tests or after the elevated temperature exposure tests is to be subtracted from the measured test sample leakage.

7.2 Ambient temperature exposure tests

7.2.1 The temperature of the exposed face of the test sample is to be 75 ±20°F (24 ±11°C), and each operable panel face is to be within ±5°F (±3°C) of each other prior to the conduct of the test. The air flow is to be adjusted in the test chamber to provide a positive test pressure differential of 0.05 inch water (12.5 Pa) between the test chamber and the area immediately outside the chamber. The test pressure difference is to be measured within a tolerance of ±0.005 inch water (1.25 Pa). After the test conditions are stabilized, the air flow through the air flow metering system and the test pressure difference are to be

measured and recorded. This measured air flow is designated the total metered air flow (Q_m). The total metered air flow (Q_m) is then determined at test pressure differentials of 0.10 inch water (25 Pa), 0.20 inch water (50 Pa), and 0.30 inch water (75 Pa) and recorded. If required, other test pressure differentials may be employed.

7.3 Elevated temperature exposure tests

7.3.1 The temperature of the exposed face of the test sample is to be 75 ±20°F (24 ±11°C), and each operable panel face is to be within ±5°F (±3°C) of each other prior to the conduct of the test. The tests to determine total metered air flow (Q_m) at ambient temperature as specified in 7.2.1 are to be repeated at a test chamber temperature of 400 ±10°F (204 ±5°C). The chamber air temperature is to be increased so that it reaches 350°F (177°C) within 15 minutes and 400°F (204°C) within 30 minutes. When stabilized at the prescribed air temperature of 400 ±10°F (204 ±5°C), the leakage rates are to be measured at the three pressure differentials specified in 7.2.1 in sequence, during a period not to exceed 30 minutes.

7.4 Recorded test data

7.4.1 The air flow through the test sample is to be determined with an error not greater than ±5 percent when the air flow equals or exceeds 2 cubic feet per minute (9.44×10^{-4} m^3/s) or 10 percent when the air flow is less than 2 cubic feet per minute, but more than 0.5 cubic feet per minute (2.36×10^{-4} m^3/s). At lower flow rates, a greater percentage of error is acceptable. If higher precision is required, special flow-measuring techniques are necessary. The accuracy of the test sample leakage flow measurement is affected by the accuracy of the flowmeter and the amount of extraneous leakage of the apparatus. See Appendix A.

7.4.2 As the air leakage through the test sample may be affected by the density of the air passing through the test sample, the barometric pressure, temperature, and relative humidity of the supply air are to be measured at the test sample and recorded. The air supply flow values are to be corrected to normal temperature and pressure standard conditions for reporting purposes.

7.4.3 Extraneous chamber leakage (Q_L) is to be eliminated or, if this is impractical, the amount of such leakage is to be determined with the test sample sealed and tested at ambient air temperatures and the air pressure differences to be exerted during the air leakage test. The metering equipment used for the measurement of air leakage may be used for measuring the extraneous leakage, or it may be necessary to provide additional air metering equipment for this purpose. Any measured chamber leakage is to be subtracted from the measured test sample leakage. See Appendix A.

7.4.4 The extraneous chamber leakage (Q_L) shall be remeasured after the conduct of the elevated temperature exposure tests and the assembly has reached ambient temperature conditions of 75 ±20°F (24 ±11°C). Any measurable chamber leakage is to be subtracted from the measured sample leakage. See Appendix A.

7.4.5 There shall be no extrapolations above the maximum test pressures or beyond the test sample sizes.

8 Report of Results

8.1 The report of the performance of the test samples during these tests shall include the following:

a) A description of the test sample and materials, including drawings depicting geometry and exact size (length, width, and thickness) and clearances between the panel(s) and frame/sill. The size shall be reported to the nearest 1/16 inch (1.6 mm). This also includes the test sample supporting construction;