Designation: E2342/E2342M – 10 (Reapproved 2015)ε1

Standard Test Method for Durability Testing of Duct Sealants[1]

This standard is issued under the fixed designation E2342/E2342M; 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.

ε[1] NOTE—Units statement was inserted in 1.4 and units information was corrected editorially in February 2015.

INTRODUCTION

Duct leakage has been identified as a major source of energy loss in residential buildings. Most duct leakage occurs at the connections to registers, plenums, or branches in the duct system. At each of these connections a method of sealing the duct system is required. Typical sealing methods include tapes or mastics applied around the joints in the system. Field examinations of duct systems have typically shown that these seals tend to fail over extended periods of time.

The proposed method evaluates the durability of duct sealants by blowing heated air into test sections, combined with a pressure difference between the test sections and their surroundings. The temperatures and pressures were chosen to expose the test sections to typical conditions that are found in residential duct systems. The duct leakage site geometry represents a leakage site commonly found in duct systems. The test sections are constructed from standard duct fittings.

1. Scope

1.1 This test method describes an accelerated aging test for evaluating the durability of duct sealants by exposure to temperatures and static pressures characteristic of residential duct systems.

1.2 This test method is intended to produce a relative measure of the durability of duct sealants. This standard does not measure durability under specific conditions of weather and building operation that might be experienced by an individual building and duct system. Instead it evaluates the sealant method under fixed conditions that do not include the manifold effects of installation practice.

1.3 This test method only addresses sealants not mechanical strength of the connections.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific hazard statements see Section 7.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E631 Terminology of Building Constructions

3. Terminology

3.1 Terminology E631 defines much of the terminology used in this test method.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *air-leakage rate*—the volume of air movement per unit time across the duct wall.

3.2.2 *duct sealant*—a method or material, or both, for sealing leaks in forced air thermal distribution duct systems.

3.2.3 *durability*—the capability of maintaining the serviceability of a product, component, or assembly over a specified time.

4. Summary of Test Method

4.1 To evaluate sealant durability this test method uses a standardized joint configuration with controlled temperature

[1] This test method is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.41 on Air Leakage and Ventilation Performance.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

and pressure differences. These temperatures and pressures are chosen to represent conditions found in residential duct systems. The test apparatus applies temperature and pressure conditions and measures how well the sealant performs over time.

5. Significance and Use

5.1 Residential duct systems are often field designed and assembled. There are many joints, often of dissimilar materials that require both mechanical connection and air sealing. Without this sealing, duct systems would be extremely leaky and hence inefficient. While some duct sealants are rated on their properties at the time of manufacture or during storage, none of these ratings adequately addresses the in-service lifetime. This test method has been developed to address this durability issue.

5.2 This standard applies to products which list duct sealing as one of their uses. This includes duct tape (cloth, metal foil, or plastic backed), mastics, and sprayed/aerosol sealants. It does not apply to caulks or plaster patches that are not intended to be permanent duct sealing methods.

5.3 The standard duct leak site is a collar to plenum connection for round duct that is 10 to 20 cm [4 to 8 in.] in diameter. This perpendicular connection was chosen because almost all residential duct systems have this type of connection and in field observations of duct systems, it is often this type of connection that has sealant failure.

6. Apparatus

6.1 The following is a general description of the required apparatus. Any arrangement of equipment using the same principles and capable of performing the test procedure within the allowable tolerances is permitted.

6.2 *Major Components*—There are two major components required to perform the testing: a test section leakage measurement device (Fig. 1) and a durability test apparatus (Fig. 2).

6.2.1 *Test Section Leakage Measuring Device*—A device for measuring the leakage of individual test sections. This device shall consist of a fan to blow air into the test section, a flow measurement device for measuring the flow rate in the test section, a pressure measuring device for measuring the pressure difference between the inside and outside of the test section, and a cap to seal the end of the test section. See Fig. 2. For these test section leakage measurements, the air flow measuring device shall have an accuracy of ± 0.085 m^3/h [0.05 cfm] or ± 1 % of the measured flow, whichever is greater.

6.2.2 *Durability Test Apparatus*—A device for blowing hot air through one or more test sections. This device is comprised of the following components.

6.2.2.1 *Air-Moving Equipment*—A fan that is capable of moving air through the test sections. The fan must be selected to provide the required flow rates and pressure differences. In addition, the fan must be selected to be capable of operating at the hot conditions existing in the test apparatus.

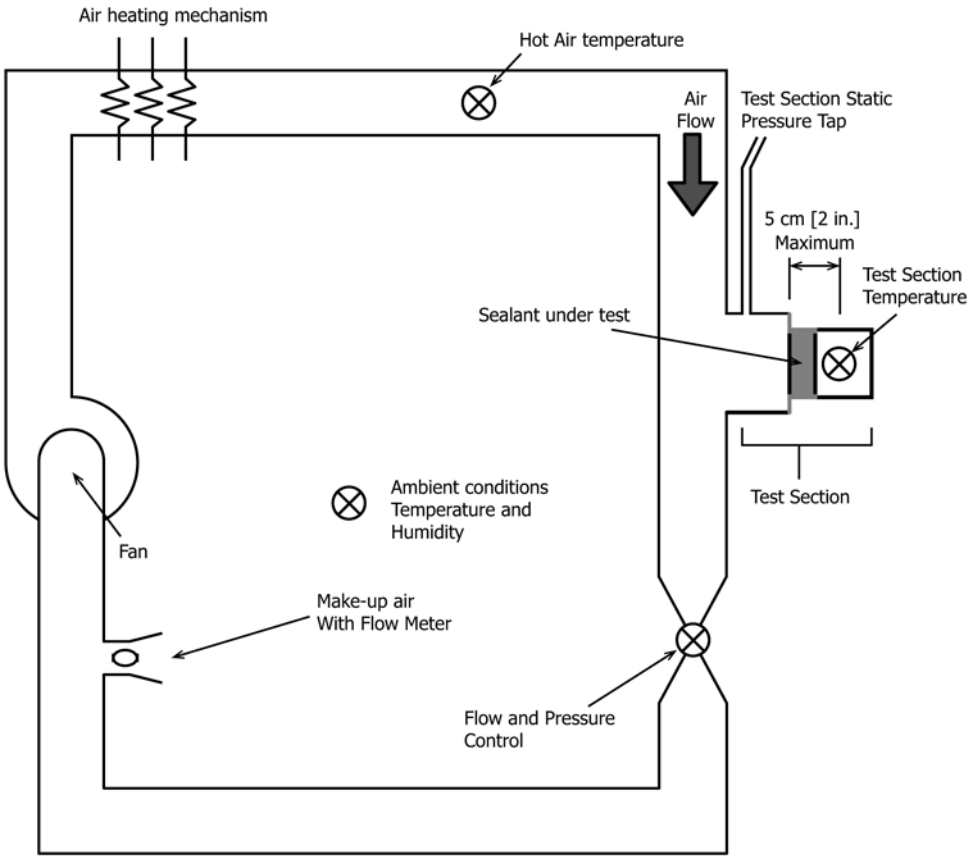

FIG. 1 Schematic of Durability Apparatus

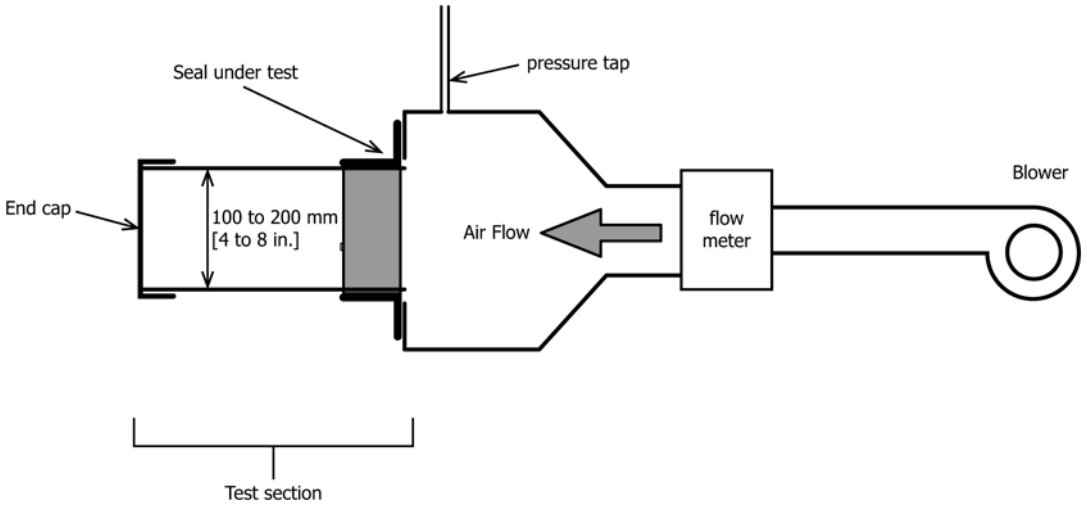

FIG. 2 Schematic of Apparatus for Measuring Leakage of Test Sections

6.2.2.2 *Pressure-Measuring Devices*—Manometers or pressure indicators to measure pressure difference with an accuracy of ±0.2 Pa [0.0008 in. of water] or ±1 % of the measured pressure, whichever is greater.

6.2.2.3 *Temperature-Measuring Devices*—Instruments to measure temperature with an accuracy of ±1°C [2°F]. The test section surface temperatures shall be measured using surface mount temperature sensors with heat transfer paste between the sensor and the test section.

6.3 *Test Section*—Sheet metal duct system components combined to create a plenum to collar connection. The test section consists of a flange and a collar with fingers to fold in and out of the hole in the flange. The gap between the flange and the collar shall be 6 mm [¼ in.] all the way around. The collar shall be centered in the flange. Sheet metal screws shall be used to mechanically connect the collar to the flange. See Fig. 3.

7. Hazards

7.1 *Eye Protection*—Ducts should not break at the pressure differences normally applied to the test structure. However, for added safety, adequate precautions such as the use of eye protection should be taken to protect the personnel.

7.2 *Safety Clothing*—Use safety equipment required for general laboratory work, including safety shoes, and work gloves.

7.3 *Equipment Guards*—The air-moving equipment shall have a proper guard or cage to house the fan, motor, and pulleys and to prevent accidental access to any moving parts of the equipment.

7.4 *Noise Protection*—Make hearing protection available for personnel who must be close to the noise that may be generated by the fan.

7.5 *Debris and Fumes*—Duct materials may decompose during the test releasing particles and fumes into the air. Adequate protection must be provided in the form of ventilation of the test space or other appropriate means.

8. Procedure

8.1 Construct test sections of the plenum to collar joint type shown in Fig. 3. The test sections shall use ducts of 100 to 200 mm [4 to 8 in.] diameter round sheet metal. The sheet metal sections shall be mechanically connected using sheet metal screws.

8.2 The test sections shall be tested for their air leakage before and after they are sealed. The temperature of air flowing through the test section and flowmeter shall be measured and the leakage tests for the test sections shall be performed with the temperature of air flowing through the test section and air flowmeter between 15 and 25°C [59 and 77°F]. All measured air flows shall be corrected to standard conditions using instructions provided by the air flowmeter manufacturer.

8.2.1 Connect the unsealed test section to the test section leakage measurement device as shown in Fig. 2. Ensure that the cap on the end of test section and all other connections are sealed. Pressurize the test section to 25 Pa [0.1 in. water] and record the flow through the flowmeter. This is the unsealed test section leakage $Q_{unsealed}$. The acceptable range for this unsealed leakage is 0.050 to 0.067 $m^3/(h{\cdot}mm)$ [0.75 to 1.0 cfm per in.] of perimeter of the test section plenum to collar connection. If the test section is outside this range it needs to be rebuilt and the hole size adjusted until it meet this criteria, or not used for testing.

8.2.2 Apply the sealant to the test section and perform the leakage test of 8.2.1 with the sealed section. The sealant shall be applied using manufacturers' instructions. If no instructions come with the sealant, then the sealant shall be applied as carefully as possible. This careful application includes ensuring that surfaces to be sealed are clean and free from dust, dirt, and excess lubricants used in the manufacture of many sheet metal duct fittings. To ensure removal of oil residue, the surfaces should be cleaned using an appropriate solvent. A good practice is to photograph each test section before testing to document how the sealant was originally applied. Record the initial leakage flow at 25 Pa [0.1 in. water], $Q_{initial}$. If $Q_{initial}$ is

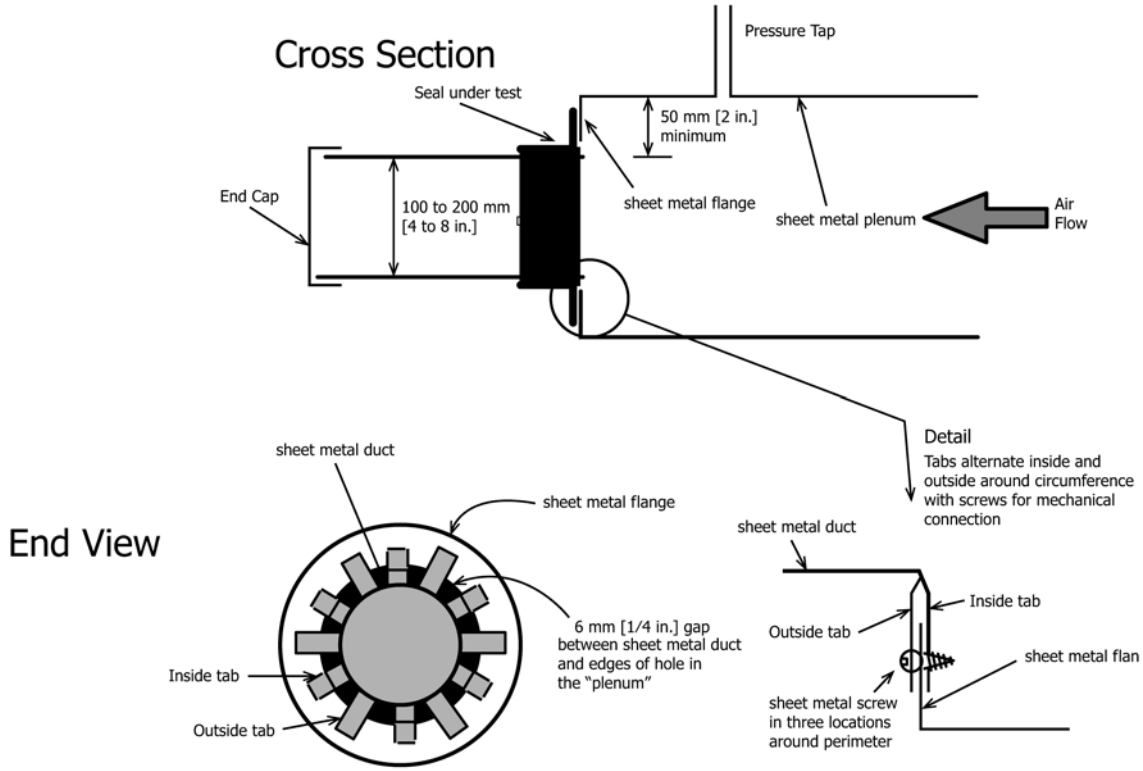

FIG. 3 Schematic of Typical Test Section Assembly

greater than 2 % of $Q_{unsealed}$ then the initial sealing is inadequate and the test section shall not be used. Record the date and time of the initial leakage test.

8.3 Place the test sections in the durability testing apparatus. Record the date and time of the placement of the test section in the apparatus.

8.4 The test sections shall be removed from the durability apparatus on a weekly basis to have the leakage test in 8.2.1 performed to measure Q_{leak}.

8.5 The durability test apparatus shall be constructed and operated to meet the following parameters:

8.5.1 The static pressure difference between the inside of the test section and its surroundings shall be 200 Pa ± 20 Pa [0.8 ± 0.08 in. of water], with the air inside the duct at a higher pressure than outside.

8.5.2 The test section surface temperature shall be controlled to be within the range of 82 to 93°C [180 to 200°F] measured on the outside surface of the test section within 5 cm [2 in.] of the gap between the flange and the collar.

8.5.3 The test sections shall be enclosed so that their exposure to ultraviolet radiation (for example, sunlight) is minimized.

8.5.4 The apparatus shall be as airtight as possible with an intentional hole added on the suction side of the air moving fan. The intentional hole shall be continuously monitored for make-up air flow rate. The monitored hole is for the purpose of admitting make-up air when leakage occurs at a test section. Some duct sealants fail suddenly with a complete loss of seal on the test section. This is called catastrophic failure. When catastrophic failure of the test seal occurs, an abrupt increase in make-up air flow will occur. This monitoring allows the time of catastrophic failures to be recorded.

8.5.5 The following parameters shall be continuously monitored at a sampling frequency of once every ten seconds (or more often if desired).

8.5.5.1 Surface temperature of each test section,

8.5.5.2 Pressure difference between inside each test section and its surroundings, and

8.5.5.3 Air flow through makeup air hole(s).

8.5.6 These parameters shall be recorded every hour of testing for each sample as follows:

8.5.6.1 Temperatures: the minimum, maximum, and average for each hour;

8.5.6.2 Pressures: the minimum, maximum, and average for each hour; and

8.5.6.3 Makeup air flow: maximum for the hour.

9. Data Analysis and Calculations

9.1 The weekly leakage measurement, Q_{leak}, for each test section shall be compared to the air leakage reduction provided by the seal; that is, the difference between unsealed leakage, $Q_{unsealed}$, and the initial leakage $Q_{initial}$. The sealant failure criterion is when the increase in leakage above $Q_{initial}$ reaches 10 % of this value, that is:

$$Q_{leak} > [0.1\,(Q_{unsealed} - Q_{initial}) + Q_{initial}] \quad (1)$$

9.1.1 The time to failure shall be the difference between the time the sample was placed in the durability test apparatus and the time at which it failed. This is typically measured in days.

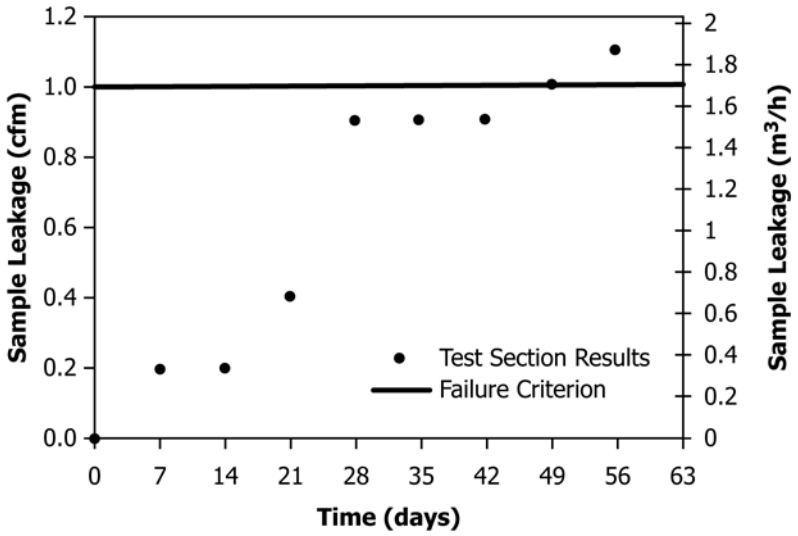

FIG. 4 Example Plot of Leakage Increase to Failure

9.2 When a catastrophic failure is detected by the monitoring system, the time of failure shall be recorded. The failed test section shall be identified and tested immediately upon failure.

9.3 A plot of weekly (and final) leakage versus time shall be made. An example is given in Fig. 4.

9.4 Obtain the mean, maximum, and minimum recorded surface temperatures and pressure differences for the test section during the test from the recorded data.

10. Reporting Requirements

10.1 Users of this test method shall provide the following information for each test section:

10.1.1 Test section description: type of sealant (mastic, tape etc.), manufacturer of sealant, manufacturers identifying code, or manufacturers description for sealant, lot, and batch numbers (if available);

10.1.2 Date and time of test start;

10.1.3 Date and time of failure;

10.1.4 Total time before failure (expressed in days and hours). The smallest unit of time used to express time before test section failure shall be one hour;

10.1.5 A plot of leakage versus time; and

10.1.6 Mean, maximum, and minimum surface temperatures and pressure differences for the test section during testing.

10.2 The following information shall be provided as on option for information and further analysis purposes:

10.2.1 Leakage flows at 25 Pa [0.1 in. water], $Q_{unsealed}$, Q_{sealed}, Q_{leak}.

11. Precision and Bias

11.1 *Precision*—The precision of the procedure in Test Method E2342/E2342M for durability testing of duct sealant methods is estimated from the accuracy specifications for the measurement equipment that indicate a precision error of less than 5 % of the leakage air flow. In addition, repeatability testing of the same sealants on a single test system has shown that the same sealants fail within seven days of each other. A more detailed precision statement will be available after the test has been performed in different laboratories.

11.2 *Bias*—No information can be presented on the bias of the procedure in this test method for durability testing of duct sealant methods because no material having an accepted reference value is available.

12. Keywords

12.1 accelerated aging; duct leakage; durability; sealant