Designation: E1186 – 22

Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems[1]

This standard is issued under the fixed designation E1186; 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.

1. Scope

1.1 These practices cover standardized techniques for locating air leakage sites in building envelopes and air barrier systems.

1.2 Individual practices provide advantages for specific applications.

1.3 Some of the practices require a knowledge of infrared scanning, building and test chamber pressurization and depressurization, smoke and fog generation techniques, sound generation and detection, and tracer gas concentration measurement techniques.

1.4 The practices described are of a qualitative nature in determining the air leakage sites rather than determining quantitative leakage rates.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific hazard statements, see Section 6.

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E631 Terminology of Building Constructions

E741 Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution

E779 Test Method for Determining Air Leakage Rate by Fan Pressurization

2.2 *Entertainment Services and Technology Association (ESTA) Standards:*[3]

ANSI E1.5 Entertainment Technology–Theatrical Fog Made with Aqueous Solutions of Di- and Trihydric Alcohols

ANSI E1.23 Entertainment Technology–Design and Execution of Theatrical Fog Effects

2.3 *Other Standards:*[3]

ANSI-ASHRAE Standard 101 Application of Infrared Sensing Devices to the Assessment of Building Heat Loss Characteristics

ISO Standard 6781 Thermal Insulation—Qualitative Detection of Thermal Irregularities in Building Envelopes—Infrared Method

3. Terminology

3.1 *Definitions:*

3.1.1 *air barrier system, n*—a system in building construction that is designed and installed to reduce air leakage either into or through the building envelope.

3.1.2 *air exfiltration, n*—air leakage out of the building.

3.1.3 *air infiltration, n*—air leakage into the building.

3.1.4 *air leakage rate, n*—the volume of air movement per unit time across the building envelope or air barrier system,

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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.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

including flow through joints, cracks, and porous surfaces, or combinations thereof, in which the driving force for such air leakage in buildings is either mechanical pressurization or evacuation, natural wind pressures, or air temperature differences between the building interior and the outdoors, or combinations thereof.

3.1.5 *air leakage site, n*—a location on the building envelope or air barrier system where air can move between the building interior and the outdoors.

3.1.6 *building system, n*—the boundary or barrier separating the interior volume of a building from the outside environment.

3.1.6.1 *Discussion*—For the purpose of these practices, the interior volume is the deliberately conditioned space within a building generally not including the attic space, basement space, and attached structures, unless such spaces are connected to the heating and air conditioning system, such as a crawl space plenum. The actual building envelope may extend beyond these boundaries because of ducting or other construction features.

3.1.7 *test specimen, n*—the part of the air barrier system on the building to be tested that consists of materials comprising the primary resistance to airflow, joints between such materials and joints between the materials and structural, mechanical, or other penetrations through such materials, and excludes any material which does not form an integral part of the air barrier system.

3.1.8 *theatrical fog, n*—visible vapor generated by a fog generator, more commonly used in theatrical productions, and as supplied by the manufacturer of the fog generator. (See ANSI E1.5 and ANSI E1.23.)

3.1.9 *tracer gas, n*—a gas that is mixed with air and measured in very small concentrations in order to study air movement.

3.2 For other definitions, see Terminology E631.

4. Summary of Practices

4.1 This standard presents the following seven practices for detecting air leakage sites in building envelopes:

4.1.1 Combined building depressurization (or pressurization) and infrared scanning,

4.1.2 Building depressurization (or pressurization) and smoke tracers or theatrical fog,

4.1.3 Building depressurization (or pressurization) and airflow measuring devices,

4.1.4 Generated sound and sound detection,

4.1.5 Tracer gas detection,

4.1.6 Chamber depressurization (or pressurization) and smoke tracers or theatrical fog, and

4.1.7 Chamber depressurization and leak detection liquids.

4.2 These practices are described as follows:

4.2.1 *Building Depressurization (or Pressurization) with Infrared Scanning Techniques*—This practice relies on the existence of an indoor–outdoor temperature difference of at least 5 °C. Outdoor air is moved through the building envelope by depressurizing the building interior with a fan (see Test Method E779) or using the mechanical system in the building. Because the infiltrating air is at a different temperature than the interior surfaces of the building envelope, local interior surface temperature changes take place which can be detected by infrared scanning equipment. The infrared pattern resulting from air leakage is different from that associated with varied levels of thermal conductance in the envelope, allowing air leakage sites to be identified. This practice can also be performed by pressurizing the building and scanning the exterior of the building envelope.

NOTE 1—In most geographic locations, an indoor-outdoor temperature difference of at least 5 °C is met during some portion of the day over a large fraction of the year.

4.2.2 *Smoke Tracer or Theatrical Fog in Conjunction with Building Pressurization or Depressurization*—This practice consists of pressurizing or depressurizing the building using a fan or the mechanical system in the building and moving a smoke tracer source or theatrical fog over the interior or the exterior surface of the building envelope. If the building is pressurized and the smoke tracer source or theatrical fog is moved over the interior of the building envelope, air exfiltration through air leakage sites will draw smoke from the tracer source to the site, revealing its location visually. Alternatively, if the building is depressurized and the smoke tracer source or theatrical fog is moved over the interior of the building envelope surface, then air jets at each air leakage site will cause the smoke or fog to move rapidly inward. Similarly, the smoke tracer source or theatrical fog can be employed on the exterior of the building envelope.

4.2.3 *Building Depressurization (or Pressurization) in Conjunction with Airflow Measurement Devices, or Anemometers*—This practice consists of depressurizing or pressurizing the building using a fan or the building's mechanical systems and moving an anemometer over the interior building envelope surface. If the building is depressurized, air jets will be present within the building at each air leakage site. As the anemometer is moved over the building envelope surface, it will register an air velocity peak at the location of the air leakage site. If the building is pressurized, interior air will flow toward each air leakage site. In this case, the resulting measured air velocity peak will be less distinct.

4.2.4 *Generated Sound in Conjunction with Sound Detection*—This practice consists of locating a sound generator within the building and moving a sound detection device over the exterior of the building envelope. Increased sound intensity is indicative of an air leakage site. Alternatively, the sound generator is located outside the building and the interior surface of the building envelope is surveyed using the sound detection device.

4.2.5 *Tracer Gas*—This practice consists of releasing a tracer gas on one side of the building envelope and using a tracer gas detector to measure the concentration of the tracer gas on the other side. A measurable tracer gas concentration indicates the location of an air leakage site. Pressurizing or depressurizing the building envelope using a fan or the building's mechanical system improve the results obtained by this method.

4.2.6 *Chamber Pressurization or Depressurization in Conjunction with Smoke Tracer or Theatrical Fog*—This practice