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January 18, 2023
v0.01 02/06/23

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ASTM E783 AND ALL-GLASS FACADES

Improper Use and Misunderstanding of "The Air Test"

Fig. 01: Tare Sheet Removal – Framed Window Opening

Industry-wide, ASTM E783 test data is not providing a reliably accurate measurement of the envelope's air tightness on building envelopes comprised of window wall and/or curtain wall and therefore should not be utilized as the project team's sole means of predicting air changes or deriving energy usage.

ABSTRACT

ASTM E783 tests being performed on uncompartmentalized window wall and curtain wall systems are erroneous to the point of being invalid, and – on projects where the majority of the envelope is comprised of these glazed systems – the data gleaned from these tests as they are currently being and have historically been performed do not accurately assess that building envelope's air tightness. Consequently, project stakeholders that are relying on ASTM E783 field test data to anticipate their envelope's overall air tightness (and forecast derivative factors – e.g energy usage) are oblivious to that envelope's actual efficiency.

Accordingly, it is not uncommon for buildings with a portfolio of "passing" ASTM E783 test reports to nevertheless experience the effects of excessive air infiltration/exfiltration (e.g. extreme stack effect, occupant claims of howling ghosts residing in wall cavities, drafty units, unanticipated energy consumption, fenestration that sounds like the woodwind section of a forest gnome orchestra, and other tenant and management discontents).

To reiterate and further clarify: on buildings where glazed systems comprise the majority of the envelope, those relying solely on ASTM E783 tests performed on uncompartmentalized fenestration systems to evaluate their building envelope's air tightness are effectively blind to that envelope's actual performance. The conclusion here is not "*all buildings are leaking more air than code or contract allow.*" Rather, the conclusion here is that those relying solely on ASTM E783 test reports being issued on these projects do not know if their buildings are leaking more air than code or contract allow.

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2021 IECC
Notes from Table C402.5.4
Max. Air Leakage for Fenestration Assemblies

Assembly	Max. cfm/ft²
Windows	0.20
CurtainWalls	0.06
Storefront	0.06
Ent. Door	1.00
Revolving	1.00
Garage Door	0.40

2021 IECC
C402.5.4
Air Leakage of Fenestration

Exception 2:
"fenestration in buildings that comply with [C402.5 testing] are not required to meet the air leakage requirements in Table C402.5.4"

LATERAL AIR FLOW

The first area of concern relates to the continuous frame cavities provided by stack joints at curtain walls and the head/sill receptors at continuous runs of window walls. Unless some pre-test compartmentalization measures are implemented in the field, these cavities draw from a relatively infinite volume of air. An ASTM E783 test performed on such a specimen would pull air through those continuous cavities and the numerous paths from that cavity to other environments (interior and exterior) from which the receptor cavity might draw "infinite" air.

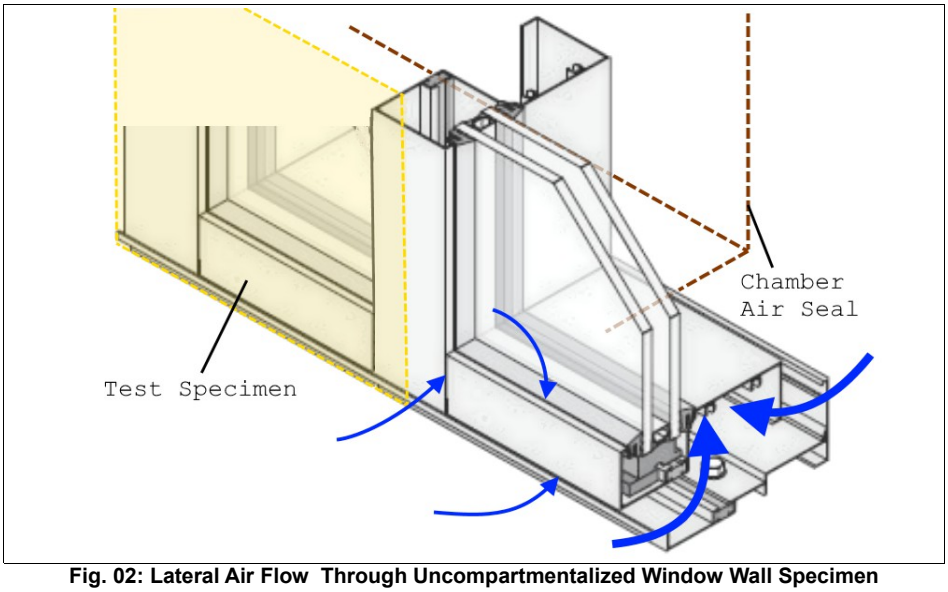


Fig. 02: Lateral Air Flow Through Uncompartmentalized Window Wall Specimen

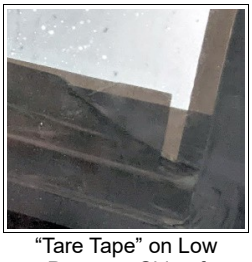
"I've been doing it this way for 20 years!"
- Person Doing it Wrong

Under these conditions, the test is not evaluating air flow through one vector (e.g from exterior to interior, for infiltration) of the specimen as intended.

Note: A specimen that passes a properly executed ASTM E783 test including extraneous air (without tare) may be reasonably presumed to meet that project's criteria because it "passes" despite the encumbrance of continuous receptor air flow and extraneous chamber/apparatus leakage.

For uncompartmentalized window wall and curtain wall specimens that do not pass the test *including extraneous air*, there is no accurate way to assess that specimen's air infiltration/exfiltration rate using ASTM E783 and, in our view, attempts to "work around" this limitation and perform the test should not be made.

ALTERNATE TARE METHOD - "TARE TAPE" ON LOW-PRESSURE SIDE



"Tare Tape" on Low Pressure Side of Specimen

One frequently utilized field test "work around" to this limitation includes isolating areas of the specimen's low pressure surface (typically the interior chamber side) with tape – the tape functioning as a "tare" that, in theory, restricts air flow through the isolated detailing and allows for pre- and post-tare readings to be taken. The "tare tape" is typically applied over the interior glazing gaskets, operable vent crack, etc. The application of this tape requires perfection – even pinholes in the tape's seal over the subject specimen will mis-allocate specimen air flow as extraneous air in the tare reading. The tape must hermetically seal the specimen's potential paths for air flow, sometimes contending with cutting oils and other residues, or frame coatings or glass with little "grip," all while its adhesive is being challenged by the direction of air flow.

Even if a perfect application could be assured and the low pressure side "tare tape" method was accurate and repeatable, it fails to measure the air flow through the un-taped sections of the fenestration.

"[specimen includes] all joints, cracks, or openings between such components and any panning, receptors, extenders, sills, mullions, or other parts or components used for assembly and installation"
ASTM E783 (2018)
3.2.6 *test specimen*

High-Rise Developments in Chicago as of March, 2020*

34

Of Those, Developments Utilizing Continuous Window Wall or Curtain Wall

27

* Curbed Chicago, "Mapping the 34 high-rises under construction in Chicago," Mar. 2, 2020 https://chicago.curbed.com/maps/high-rise-tower-skyscraper-construction-map

The ASTM E783 procedure does allow for alternative tare methods if the thin polyethylene film specified in 11.2.1 and 11.2.2 are unfeasible. Per 11.2.3: "*For applications where neither of these approaches is acceptable, other methods of measuring extraneous air leakage may be used provided such techniques are agreed upon by all parties involved.*" We recommend that "parties involved" reject offers to perform the "tare tape" method on uncompartmentalized segments of fenestration systems.

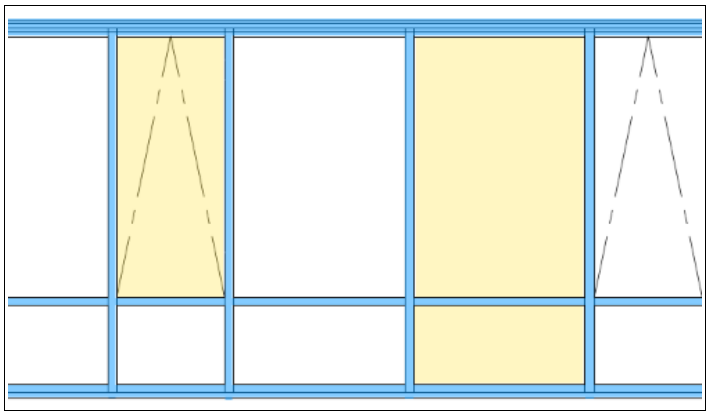


Fig. 03: Reported "Test Specimen" (Yellow) and Omitted Components (Blue)

A "tare tape" method that measures air flow through a single glazing infill or operable vent fails to capture elements that contribute heavily to a fenestration system's air tightness. This "tare tape" approach, as illustrated in *Fig. 03*, would deliver a test result for the yellow highlighted sections (e.g. fixed glazing, the surface area for which is probably not a major source of air infiltration), but not measure the blue highlighted portions. In terms of air performance, it is beneficial to look at building envelope systems in terms of linear footage of air seal joint (e.g. gasketed connections, for fenestration systems) in addition to overall square footage. The yellow highlighted portions may "pass" on a square foot basis, but these measurements completely omit frame and receptor elements on the blue highlighted portions - details that typically bear considerable impact on the envelope's air tightness, and would substantially impact cfm/ft² measurements of the total system.

On a square foot area basis, the "tare tape" report values might reflect a "passing" system (and be regularly misinterpreted by report readers as validation of the *complete* system). But, without knowing the performance of the blue-highlighted sections, the overall system's actual air tightness performance and thus, crucially, the air tightness of the overall building, is unknown.

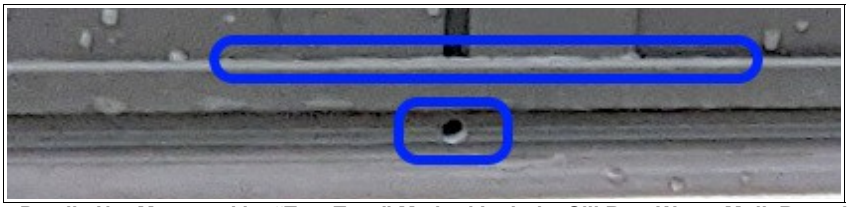


Fig. 04: Details Not Measured by "Tare Tape" Method Include: Sill Rec. Weep, Mull. Reveals, etc.

Consequently, ASTM E783 tests conducted with even a perfectly-executed "tare tape" method may appear to capture a substantial proportion of surface area of a (what should be) representative sample of the envelope, but this method will, in effect, neglect the system's most vulnerable (to air flow) details and, therefore, misrepresent the envelope's true air infiltration rates by orders of magnitude.

ADDL. CONCERNS
Even if the areas of concern highlighted herein were adequately addressed, there remains a list of other common deficiencies in this test's execution that might render evaluations of even true “punched” windows and doors invalid.

For example, conversion to standardized CFM (SCFM) via accurate measurement of air density at the point of air flow measurement – as required by the test standard – is infrequently performed. Air density at the point of measurement may be substantially different than that of air at the nearest airport or other source of weather readings printed to a website or app.

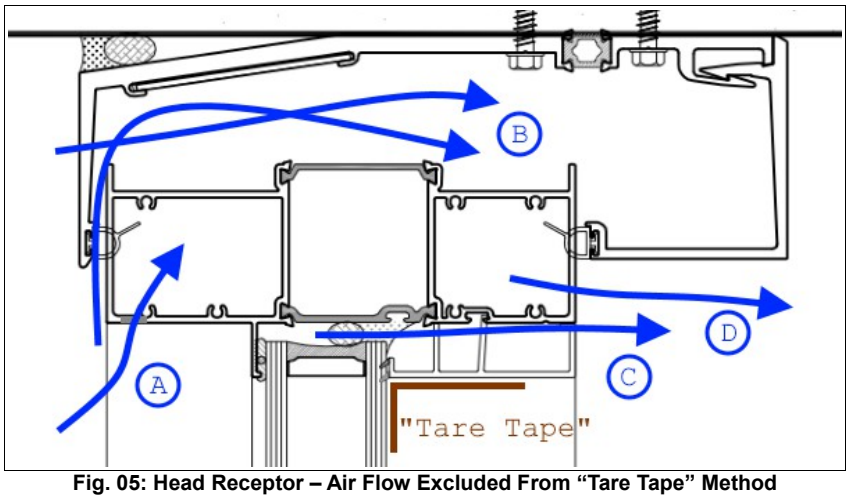


Fig. 05: Head Receptor – Air Flow Excluded From “Tare Tape” Method

Compared to glazing infill perimeters (particularly at relatively air-tight four-side structural glazing), details such as mullion stacks at unitized systems, frame joinery, receptors, weep paths, and other gasketed connections carry inherent potential for air flow. These details are not being measured by a “tare tape” applied solely to the glazing infill or operable vent crack perimeter.

At a head receptor detail alone, there are numerous opportunities for air flow. Examples highlighted on *Fig. 05* include weep paths (A), gaskets and splice joints (B), breaks in heel bead continuity (if a continuous four-side heel bead is provided) on captured systems (C), and frame joinery (D), though more exist (drive cleat splices, etc.). Air flow through these and other details is not being measured under the “tare tape” method.

Examples of frame joinery that are frequently omitted from attempts to use a low-pressure-side “tare tape method” and yet may impact a system's air tightness include the following:

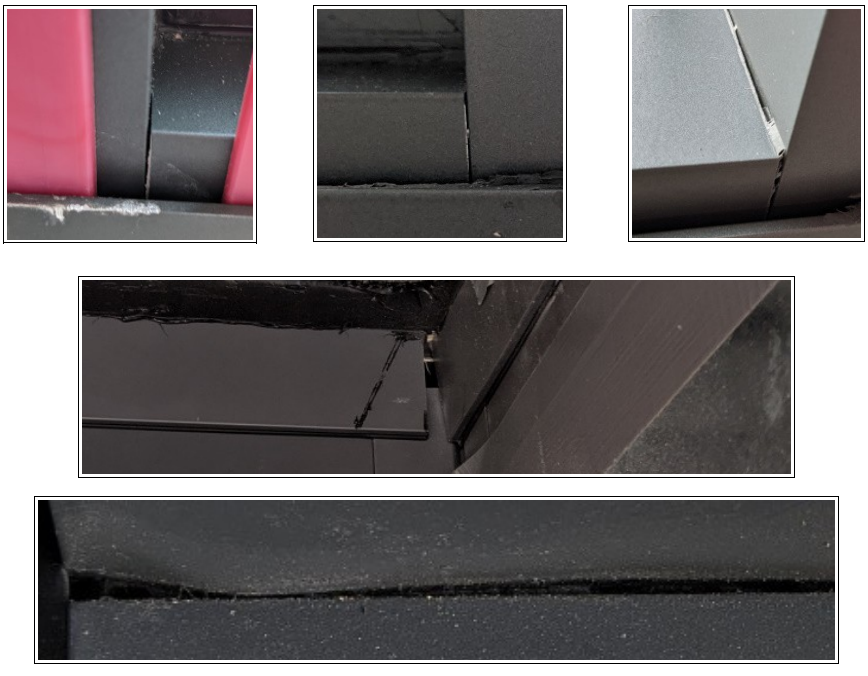


Fig. 06: Frame Joinery & Head Drive Voids that May Allow Air Infiltration

Q&A

Q: I have (4) ASTM E783 test reports that show our uncompartmentalized window wall specimen air infiltration performance meets contract requirements. Do I know our building envelope's air leakage rate?

A: No

Q: Can't I just rely on the manufacturer's published air infiltration values and PMU / other certification lab reports to predict the overall building envelope air tightness?

A: No

About This Article
The intent of this article (paper? memo? what is this document?) is to raise awareness of widespread misunderstanding of ASTM E783 testing data and, in many cases, outright misrepresentation of building envelope air tightness performance of fenestration systems delivered via ASTM E783 test reports. Concepts herein have been simplified so that even the median developer might be able to understand and act on the information.

These tests are being specified, performed, reported, and interpreted incorrectly. This general summary outlines some basic areas of concern.

Consequently, in our view, ASTM E783 should not be employed as the project team's sole means of evaluating the envelope's air tightness on enclosures comprised of majority window wall and/or curtain wall.

Inaccuracies of this test method, as it is frequently being employed, are often implied in the test data on reports issued for these tests. Purchasers of ASTM E783 tests commonly receive reports that reflect suspiciously perfect air tightness of systems:

Specimen	Test Criteria	Results	Allowable
Specimen #1	Differential Pressure (psf): 6.24 Wind Speed (mph) 50	**PASS** 0.00 cfm 0.00 cfm/ft²	6.22 cfm 0.06 cfm/ft²
Specimen #2	Differential Pressure (psf): 6.24 Wind Speed (mph) 50	**PASS** 0.00 cfm 0.00 cfm/ft²	2.67 cfm 0.10 cfm/ft²
Specimen #3	Differential Pressure (psf): 6.24 Wind Speed (mph) 50	**PASS** 0.00 cfm 0.00 cfm/ft²	15.45 cfm 0.45 cfm/ft²
Specimen #4	Differential Pressure (psf): 6.24 Wind Speed (mph) 50	**PASS** 0.00 cfm 0.00 cfm/ft²	3.40 cfm 0.10 cfm/ft²
Specimen #5	Differential Pressure (psf): 6.24 Wind Speed (mph) 50	**PASS** 0.00 cfm 0.00 cfm/ft²	9.38 cfm 0.06 cfm/ft²

Fig. 07: Sample Field Test Report Results

While it is *possible* that a tested fenestration specimen yields zero air leakage, it is far more likely that the system's air leakage was improperly mis-attributed to the tare reading, or directly omitted by selection of “tare tape” placement.

TEST METHOD GUIDANCE

The spirit (and letter – the title of this test method is “*Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior **Windows** and **Doors***”) of this test method is applicability to windows and doors, not window walls and curtain walls. The latter systems do not have defined perimeters that can be reasonably enclosed within and integrated into a test chamber and, for that reason, cannot be accurately evaluated under this method without compartmentalization.

Further clues as to this test's applicability are contained within the procedure's definition of test specimen, per 3.2.6: “the assembled window or door unit *as installed in the exterior wall of a building.*” Notable is the distinction between “window installed into the exterior wall,” as the test procedure dictates, and “window forming the exterior wall” as the test is frequently employed. For this, and other reasons noted herein, and other reasons omitted for brevity, the ASTM E783 test is not, in our view, applicable to uncompartmentalized window and curtain wall systems.

CONCLUSIONS

ASTM E783 is a useful tool for comparative analysis and for verifying contract compliance on installed windows and doors. The procedure also has a number of other valuable ancillary uses but, in our view, this test method in isolation is not appropriate for understanding a building's overall air tightness on window wall or curtain wall envelopes, despite the prevalence of this usage.

This article should more efficiently raise awareness of these systemic defects in execution of this field test method and limitations in test result applicability compared to our previous strategy of talking to incredulous AIA conference attendees looking for the latest in bathroom vanity faucet technology, and should be more effective than holding a sign that reads *“the construction industry is blind to whole building air tightness on a large supply of building stock due to widespread misunderstanding of an obscure test procedure”* in Daley Plaza. It is difficult to read, let alone to read long form writing on cardboard medium, which explains (in part) why widespread industry misunderstanding and misuse of this test procedure has persisted for over twenty years.

Fortunately, there are solutions to address the concerns raised herein. Unfortunately, there is not enough space remaining on this page to adequately summarize those solutions.

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