Designation: ~~E1996 – 12a~~ E1996 – 14

Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes[1]

This standard is issued under the fixed designation E1996; 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 This specification covers exterior windows, glazed curtain walls, doors, and impact protective systems used in buildings located in geographic regions that are prone to hurricanes.

1.1.1 *Exception*—Exterior garage doors and rolling doors are governed by ANSI/DASMA 115 and are beyond the scope of this specification.

1.2 This specification provides the information required to conduct Test Method E1886.

1.3 Qualification under this specification provides a basis for judgment of the ability of applicable elements of the building envelope to remain unbreached during a hurricane; thereby minimizing the damaging effects of hurricanes on the building interior and reducing the magnitude of internal pressurization. While this standard was developed for hurricanes, it may be used for other types of similar windstorms capable of generating windborne debris.

1.4 This specification provides a uniform set of guidelines based upon currently available information and research.[2] As new information and research becomes available it will be considered.

1.5 All values are stated in SI units and are to be regarded as standard. Values given in parentheses are for information only. Where certain values contained in reference documents cited and quoted herein are stated in inch-pound units they must be converted by the user.

1.6 The following precautionary statement pertains only to the test method portion, Section 5, of this specification:*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.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

C719 Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)

C1135 Test Method for Determining Tensile Adhesion Properties of Structural Sealants

D3575 Test Methods for Flexible Cellular Materials Made From Olefin Polymers

E631 Terminology of Building Constructions

E1886 Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials

2.2 *~~ASCE~~ASCE/SEI Standard:*[4]

~~ASCE~~ASCE/SEI 7 American Society of Civil Engineers Minimum Design Loads for Buildings and Other Structures

2.3 *ANSI/DASMA Standard:*[5]

ANSI/DASMA 115 Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure

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[1] This specification is under the jurisdiction of ASTM Committee E06 on Performance of Buildingsand is the direct responsibility of Subcommittee E06.51 on Performance of Windows, Doors, Skylights and Curtain Walls.

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[2] See the Significance and Use Section of Test Method E1886.

[3] 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.

[4] Available from American Society of Civil Engineers (ASCE), 1801 Alexander Bell Dr., Reston, VA 20191, http://www.asce.org.

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

2.4 *Other Standards:*[6]
International Residential Code ~~2000~~

3. Terminology

3.1 *Definitions:*
3.1.1 General terms used in this specification are defined in Terminology E631.
3.1.2 Terms common to this specification and Test Method E1886 are defined in Test Method E1886, unless defined herein.

3.2 *Definitions of Terms Specific to This Standard:*
3.2.1 *assembly elevation*—vertical dimension above adjacent mean ground level at which fenestration or impact protective system assembly is to be installed, measured to the lowest point of the assembly.

3.2.2 *basic wind speed*—three-second gust speeds as defined in the latest edition of ~~ASCE~~ASCE/SEI 7.

3.2.3 *combination mullion*—a horizontal or vertical member formed by joining two or more individual fenestration units together without a mullion stiffener.

3.2.4 *impact protective system*—construction applied, attached, or locked over an exterior glazed opening system to protect that system from windborne debris during high wind events.

[6] Available from International Code Council (ICC), 500 New Jersey Ave., NW, 6th Floor, Washington, DC 20001-2070, http://www.iccsafe.org.

3.2.4.1 *Discussion*—

Impact protective systems include types that are fixed, operable, or removable.

3.2.5 *infill*—glazing in a fenestration assembly or curtain wall.

3.2.6 *integral mullion*—a horizontal or vertical member which is bounded at both ends by crossing frame members.

3.2.7 *maximum deflection*—Greatest deformation of an element or component under the application of an applied force.

3.2.8 *maximum dynamic deflection*—greatest deformation of an element or component during the missile impact.

3.2.9 *meeting rail or check rail*—one of the two horizontal members of a sliding sash that come together when in the closed position.

3.2.10 *meeting stile*—one of the two vertical members of a sliding sash that come together when in the closed position.

3.2.11 *porous impact protective system*—an assembly whose aggregate open area exceeds ten percent of its projected surface area.

3.2.12 *valley*—a pivoting axis of an impact protective system designed to rotate adjacent slats or panels outward.

4. Test Specimens

4.1 *Number of Test Specimens:*
4.1.1 *Fenestration Assemblies:*
4.1.1.1 Three test specimens shall be submitted for the large missile test.
4.1.1.2 Three test specimens shall be submitted for the small missile test.
4.1.1.3 One additional test specimen may be submitted for each of the tests should no more than one of the original three specimens fail any portion of the testing.
4.1.2 *Impact Protective Systems:*
4.1.2.1 A minimum of three test specimens shall be submitted for the large missile test for the largest span to be qualified.
4.1.2.2 A minimum of three test specimens shall be submitted for the small missile test.
4.1.2.3 One additional test specimen may be submitted for each of the tests should no more than one of the original specimens fail any portion of the testing.
4.1.2.4 For porous impact protective systems, the large and small missile tests shall be allowed to be performed on the same specimens, or on separate specimens. If the large and small missile tests are performed on the same specimens, the small missile impacts shall be performed first, followed by the large missile impacts.

4.2 Test specimens shall be prepared as specified in Test Method E1886.

4.3 The size of the test specimen shall be determined by the specifying authority. All components of each test specimen shall be full size.

4.4 Where it is impractical to test the entire fenestration assembly such as curtain wall and heavy commercial assemblies, test the largest size of each type of panel as required by the specifying authority to qualify the entire assembly.

4.5 Fenestration assemblies and impact protective systems intended to be mulled together shall be tested separately or tested by combining three specimens into one mounting frame separated only by the mullions.

5. Test Methods

5.1 Test specimens shall be tested according to Test Method E1886.

5.2 Determine the missile based upon building classification, wind speed, and assembly elevation according to Section 6.

5.3 *Location of Impact:*

5.3.1 *Large Missile Test*—Impact each impact protective system specimen and each fenestration assembly infill type once as shown in Fig. 1~~, except for additional impacts specified in 5.3.2~~.

5.3.1.1 Impact one specimen with the center of the missile within a 65-mm (2½-in.) radius circle and with the center of the circle located at the center of each type of infill.

5.3.1.2 Impact a different specimen with the center of the missile within a 65-mm (2½-in.) radius circle and with the center of the circle located 150 mm (6 in.) from supporting members at a corner.

5.3.1.3 Impact the remaining specimen with the center of the missile within a 65-mm (2½-in.) radius circle and with the center of the circle located 150 mm (6 in.) from supporting members at a diagonally opposite corner.

~~5.3.2 *Additional Impact Locations in Wind Zone 4 (See Fig. 1):*~~

~~5.3.2.1 Impact the same specimen specified in 5.3.1.1 a second time with the center of the second missile within a 65-mm (2½-in.) radius circle and with the center of the circle located 150 mm (6 in.) from supporting member at a corner.~~

~~5.3.2.2 Impact the same specimen specified in 5.3.1.2 a second time with the center of the second missile within a 65-mm (2½-in.) radius circle and with the center of the circle located at the center of each type of infill.~~

~~5.3.2.3 Impact the same specimen specified in 5.3.1.3 a second time with the center of the second missile within a 65-mm (2½-in.) radius circle and with the center of the circle located at the center of each type of infill except as specified in 5.3.3.6.~~

~~5.3.2.4 For test specimens with bracing at the specified impact location(s), the impact location(s) shall be relocated to the nearest area with no bracing.~~

~~5.3.2.5 If the specimens are sufficiently small to cause the 65-mm (2½-in.) radius circle to overlap, two separate specimens shall be impacted one time each.~~

5.3.2 *Special Considerations:*

5.3.2.1 For test specimens containing multiple panels, impact the exterior glazing surface innermost from the exterior plane of the fenestration assembly or impact protective system panel innermost from the exterior.

5.3.2.2 For test specimens containing fixed and operable panels of the same type of infill, impact the operable portion.

5.3.2.3 For operable test specimens, a corner impact location shall be nearest a locking device and the other corner impact location shall be at a corner diagonally opposite.

5.3.2.4 For test specimens with bracing at the specified impact location(s), the impact location(s) shall be relocated to the nearest area with no bracing.

5.3.2.5 The impacts on accordion impact protective systems shall be at the valleys located closest to the impact locations shown in Fig. 1.

~~5.3.3.6 In Wind Zone 4, impact the integral mullion and other intermediate members such as a meeting rail, check rail, or meeting stile mid-span in lieu of the impact specified in 5.3.2.3 if applicable. (See Fig. 2, Fig. 3, and Fig. 4.)~~

~~5.3.3.7 In Wind Zone 4, for each type of mullion impact one vertical or horizontal combination mullion with the longest span at mid span in addition to impacts specified in 5.3. (See Fig. 3.)~~

5.3.3 *Small Missile Test*—Impact each impact protective system specimen and each fenestration assembly infill type three times with ten steel balls each as shown in Fig. 52.

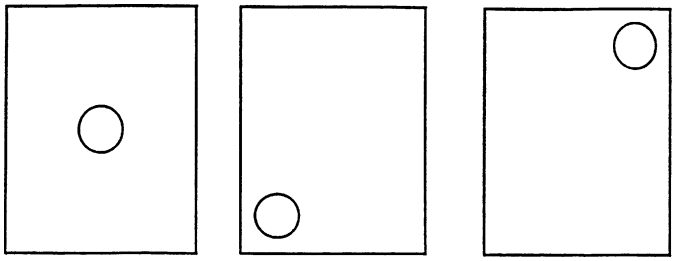

FIG. 21 ~~Integral Mullion~~Impact Locations for Large Missile Test (Each Type of Infill)

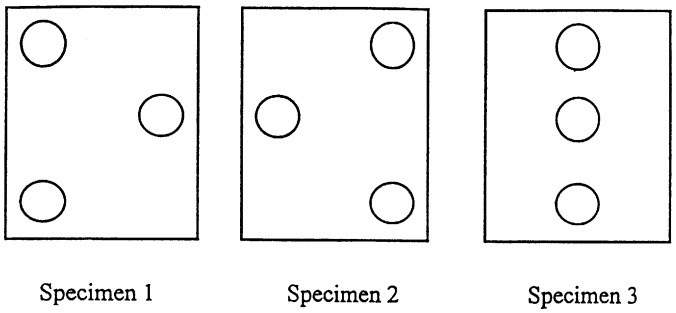

FIG. 52 Impact Locations for Small Missile Test (Each Type of Infill)

5.3.3.1 Each impact location shall receive distributed impacts simultaneously from ten steel balls. The impact shall be described in the test report.

5.3.3.2 The corner impact locations shall be entirely within a 250-mm (10-in.) radius circle having its center located at 275 mm (11 in.) from the edges.

5.3.3.3 The edge impact locations shall be entirely within a 250-mm (10-in.) radius circle at the centerline between two corners having its center located at 275 mm (11 in.) from the edge.

5.3.3.4 The center impact location shall be entirely within a 250-mm (10-in.) radius circle having its center located at the horizontal and vertical centerline of the infill.

NOTE 1—Impact locations for small missile test may overlap depending on the size of the specimen.

5.4 *Air Pressure Cycling:*

5.4.1 *Air Pressure Differential:*

5.4.1.1 The air pressure portion of the test shall use the test loading program in Table 1. Select P_{pos} and P_{neg} for the maximum inward (positive) and maximum outward (negative) air pressure differential for which qualification is sought.

5.4.1.2 The air pressure differential to be used for porous impact protective systems shall be F (the design wind force for other structures as specified in ~~ASCE~~ASCE/SEI 7) divided by the horizontally projected area of the entire assembly.

5.4.2 ~~Except in Wind Zone 4, porous~~ Porous impact protective systems whose aggregate open area exceeds 50 % of their projected surface area that pass the small missile test and that are not subject to the large missile test need not be tested for the air pressure portion of the test described in this section.

5.5 For impact protective system specimens that are tested independently of the fenestration assemblies they are intended to protect, measure, and record both the maximum dynamic deflection and the residual deflection following the impact test and measure and record the maximum positive deflection in combination with the residual deflection during the air pressure cycling test. Measure all deflections to the nearest 2 mm (0.1 in.).

6. Missiles

6.1 The specifying authority shall select an applicable missile by defining a level of protection, a wind zone, and an assembly elevation above the ground.

6.2 The applicable missile from Table 2 shall be chosen using Table 3 or Table 4, unless otherwise specified.

6.2.1 Unless otherwise specified, select the appropriate level of building protection from 6.2.1.1 – 6.2.1.3 and enter Table 3 or Table 4 at the appropriate column.

6.2.1.1 *Enhanced Protection (Essential Facilities)*—Buildings and other structures designated as essential facilities, including, but not limited to, hospitals; other health care facilities having emergency treatment facilities; jails and detention facilities; fire, rescue and police stations, and emergency vehicle garages; designated emergency shelters; communications centers and other

TABLE 1 Cyclic Static Air Pressure Loading

Loading Sequence	Loading Direction	Air Pressure Cycles	Number of Air Pressure Cycles
1	Positive	0.2 to 0.5 P_{pos}	3500
2	Positive	0.0 to 0.6 P_{pos}	300
3	Positive	0.5 to 0.8 P_{pos}	600
4	Positive	0.3 to 1.0 P_{pos}	100
5	Negative	0.3 to 1.0 P_{neg}	50
6	Negative	0.5 to 0.8 P_{neg}	1050
7	Negative	0.0 to 0.6 P_{neg}	50
8	Negative	0.2 to 0.5 P_{neg}	3350

TABLE 2 Applicable Missiles

Missile Level	Missile	Impact Speed (m/s)
~~Missile Level~~	~~Missile~~	~~Impact Speed (m/s)~~
A	2 g (31 grains) ± 5 % steel ball	39.62 (130 f/s)
B	910 g ± 100 g (2.0 lb ± 0.25 lb) 2 × 4 in. 52.5 cm ± 100 mm (1 ft – 9 in. ± 4 in.) lumber	15.25 (50 f/s)
C	2050 g ± 100 g (4.5 lb ± 0.25 lb) 2 × 4 in. 1.2 m ± 100 mm (4 ft ± 4 in.) lumber	12.19 (40 f/s)
D	4100 g ± 100 g (9.0 lb ± 0.25 lb) 2 × 4 in. 2.4 m ± 100 mm (8 ft ± 4 in.) lumber	15.25 (50 f/s)
E	4100 g ± 100 g (9.0 lb ± 0.25 lb) 2 × 4 in. 2.4 m ± 100 mm (8 ft ± 4 in.) lumber	24.38 (80 f/s)

TABLE 3 Description Levels

NOTE 1—For Missiles B, C, D, and E, also use Missile A for porous impact protective systems (see 8.5).

Level of Protection	Enhanced Protection (Essential Facilities)		Basic Protection		Unprotected	
~~Level of Protection~~	~~Enhanced Protection (Essential Facilities)~~		~~Basic Protection~~		~~Unprotected~~	
~~Assembly elevation~~	~~≤9.1 m (30 ft)~~	~~>9.1 m (30 ft)~~	~~≤9.1 m (30 ft)~~	~~>9.1 m (30 ft)~~	~~≤9.1 m (30 ft)~~	~~>9.1 m (30 ft)~~
Assembly Elevation	≤9.1 m (30 ft)	>9.1 m (30 ft)	≤9.1 m (30 ft)	>9.1 m (30 ft)	≤9.1 m (30 ft)	>9.1 m (30 ft)
Wind Zone 1	D	D	C	A	None	None
Wind Zone 2	D	D	C	A	None	None
Wind Zone 3	E	D	D	A	None	None
~~Wind Zone 4~~	~~E~~	~~D~~	~~D~~	~~A~~	~~None~~	~~None~~

TABLE 4 Description of Levels for Rooftop Skylights in One- and Two-Family Dwellings

NOTE 1—The term "One- and Two-Family Dwellings" includes all buildings included under the scope of the International Residential ~~Code 2000.~~Code.

Level of Protection	Basic Protection	
~~Level of Protection~~	~~Basic Protection~~	
~~Assembly elevation~~	~~≤9.1 m (30 ft)~~	~~>9.1 m (30 ft)~~
Assembly Elevation	≤9.1 m (30 ft)	>9.1 m (30 ft)
Wind Zone 1	A	A
Wind Zone 2	B	A
Wind Zone 3	C	A
~~Wind Zone 4~~	~~D~~	~~A~~

facilities required for emergency response; power generating stations; other public utility facilities required in an emergency; and buildings and other structures having critical national defense functions.

6.2.1.2 *Basic Protection*—All buildings and structures except those listed in 6.2.1.1 and 6.2.1.3.

6.2.1.3 *Unprotected*—Buildings and other structures that represent a low hazard to human life in a windstorm including, but not limited to: agricultural facilities, production greenhouses, certain temporary facilities, and storage facilities.

6.2.2 Unless otherwise specified, select the wind zone based on the basic wind speed as ~~follows:~~specified in 6.2.2.1 – 6.2.2.3. For Basic Protection buildings use the ASCE/SEI 7 V_{ULT} map for risk category II. For Enhanced Protection buildings use the ASCE/SEI 7 V_{ULT} map for risk categories III and IV.

6.2.2.1 *Wind Zone 1*—~~110~~130 mph (~~49~~58 m/s) ≤ basic wind speed ~~<120~~<140 mph (~~54~~63 m/s), and Hawaii.

6.2.2.2 *Wind Zone 2*—~~120~~140 mph (~~54~~63 m/s) ≤ basic wind speed ~~<130~~<150 mph (~~58~~67 m/s) at greater than 1.6 km (one mile) from the coastline. The coastline shall be measured from the mean high water mark.

6.2.2.3 *Wind Zone 3*—~~130 mph (58 m/s) ≤ basic~~ Basic wind speed ~~≤140 mph (63 m/s), or 120 mph (54 m/s) ≤ basic wind speed ≤140 ≥~~150 mph (67 m/s) or ≥140 mph (63 m/s) and within 1.6 km (one mile) of the coastline. The coastline shall be measured from the mean high water mark.

6.2.2.4 ~~*Wind Zone 4*—basic wind speed >140 mph (63 m/s).~~Specifiers using ASCE/SEI 7–05 or earlier shall use Annex A3, Allowable Stress Design Wind Zones, in lieu of 6.2.2.

6.2.2.5 A specifying authority who wishes to specify additional protection from hurricane damage may use the information in Appendix X4, Additional Protection, to define Wind Zone 4.

7. Pass/Fail Criteria

7.1 In Wind Zones 1, 2, ~~3,~~ and ~~4,~~3, the specifying authority shall select an applicable pass/fail criterion based on 7.1.1 and 7.1.2.

7.1.1 *Fenestration Assemblies and Non-Porous Impact Protective Systems:*

7.1.1.1 The test specimen shall resist the large or small missile impacts, or both, with no tear formed longer than 130 mm (5 in.) and wider than 1 mm (1⁄16 in.) through which air can pass, or with no opening formed through which a 76 mm (3 in.) diameter solid sphere can freely pass when evaluated upon completion of missile impacts and test loading program.

7.1.1.2 All test specimens meeting the enhanced protection impact levels shall resist the large or small missile impacts, or both, without penetration of the inner plane of the infill or impact protective system, and resist the cyclic pressure loading specified in Table 1 with no tear formed longer than 130 mm (5 in.) and wider than 1 mm (1⁄16 in.) through which air can pass.

7.1.2 *Porous Impact Protective Systems Tested Independently of the Fenestration Assemblies They are Protecting:*

7.1.2.1 There shall be no penetration of the innermost plane of the test specimen by the applicable missile(s) during the impact test(s).

7.1.2.2 Upon completion of the missile impact(s) and test loading program, there shall be no horizontally projected opening formed through which a 76 mm (3 in.) diameter solid sphere can pass.

~~7.2 In Wind Zone 4, the specifying authority shall be permitted to select an optional applicable pass/fail criterion based on 7.2.1, 7.2.2, and 7.2.3.~~

~~7.2.1 All test specimens shall resist the large or small missile impacts, or both, without penetration of the inner plane of the infill or impact protective system, and resist the cyclic pressure loading specified in Table 1 with no tear formed longer than 130 mm (5 in.) and wider than 1 mm (1⁄16 in.) through which air can pass.~~

~~7.2.2 The overlap seams of an impact protective system shall not have a separation greater than 1⁄180 of the span or 13 mm (½ in), whichever is less, after impact. The length of the separation shall not be greater than 900 mm (36 in.) or 40 % of the span whichever is less.~~

~~7.2.3 Fasteners, when used, shall not become disengaged during the test procedure.~~

8. Product Qualification

8.1 When all test specimens submitted have met the requirements of this specification based on the pass/fail criteria described in Section 7, except in the case of 8.2, the set of test specimens shall be accepted according to the designated building classification, wind speed, and assembly elevation.

8.2 If any test specimen fails to meet the requirements of this specification based on the pass/fail criteria described in Section 7, it shall be rejected and one additional identical test shall be performed on the additional specimen specified in 4.1.1.3 or 4.1.2.3. Any additional failures shall constitute failure of the entire set of test specimens and it shall be rejected.

8.3 Impact protective system offset requirements:

8.3.1 Porous impact protective systems that are tested independently of the fenestration assembly shall be accepted for installations in which they are offset from the fenestration assemblies by the greater of the following:

8.3.1.1 The maximum dynamic deflection, as measured in 5.5 plus 25 %; or

8.3.1.2 The sum of the maximum positive deflection and the residual deflection, as measured in 5.5 plus 25 %.

8.3.2 Non-porous impact protective systems in essential facilities in all wind zones that are tested independently of the fenestration assembly shall be accepted for installations in which they are offset from the fenestration assemblies by the greater of the following:

8.3.2.1 The maximum dynamic deflection, as measured in 5.5 + 2 mm (0.1 in.); or

8.3.2.2 The sum of the maximum positive deflection and the residual deflection, as measured in 5.5 + 2 mm (0.1 in.).

~~8.4 Where the specifying authority has specified optional additional pass/fail criteria in accordance with 7.2, non-porous impact protective systems that are tested independently of the fenestration assembly shall be accepted for installations only in which they are offset from the fenestration assemblies as specified in 8.3.2.~~

8.4 Fenestration and non-porous impact protective systems that have passed the large missile impact test are not required to pass the small missile test.

8.5 *Substitutions:*

8.5.1 Substitutions within fenestration assemblies with successful tests shall be in accordance with Annex A1.

8.5.2 Substitutions within impact protection systems with successful tests shall be in accordance with Annex A2.

8.6 Manufactured assemblies successfully tested shall not be combined unless the structural supports and connections between assemblies have been designed for the wind loads.

8.7 Qualification at any load level automatically includes qualification for all lower load levels.

9. Compliance Statement

9.1 Report the following information:

9.1.1 Detailed description of test specimen(s) and test results in accordance with the report section of Test Method E1886.

9.1.2 Missile type and cyclic loading pressure(s) for which the test specimen qualified.

9.2 Attach a copy of the test report from Test Method E1886, to the compliance statement for this specification.

10. Keywords

10.1 building envelope; curtain walls; cyclic pressure loading; doors; fenestration; hurricanes; impact protective systems; missile impact; windborne debris; windows; windstorms

ANNEXES

(Mandatory Information)

A1. FENESTRATION SUBSTITUTIONS

A1.1 Introduction

A1.1.1 Substitution allowances are presented in the following text. There are two types of substitutions for fenestration assemblies qualified under this standard: *(1)* substitutions of infill elements and *(2)* substitutions of all other elements.

A1.1.2 The substitution criteria in Annex A1 are related to impact and cycling performance only as found in this specification and in Test Method E1886 and does not qualify systems for other performance attributes.

A1.1.3 The substitution language applies to the following fenestration types (representative diagrams of these fenestration types are located in Fig. A1.1):

Sliding windows
Sliding doors
Storefront framing
Fixed windows
Mullions
Projected or hinged windows
Dual action windows and doors
Hinged doors
Curtain wall
Skylights and roof windows

A1.1.3.1 Specialty windows and greenhouse windows are not covered in these substitution allowances.

A1.2 Substitution Categories

A1.2.1 *Automatic*—No additional testing or analysis necessary.

A1.2.2 *Engineering Analysis*—Demonstrated or documented performance through a review of materials that predicates a minimum of equivalent performance.

A1.2.3 *Single Specimen*—One specimen, identical to the original specimens qualified with the only difference being the element to be substituted.

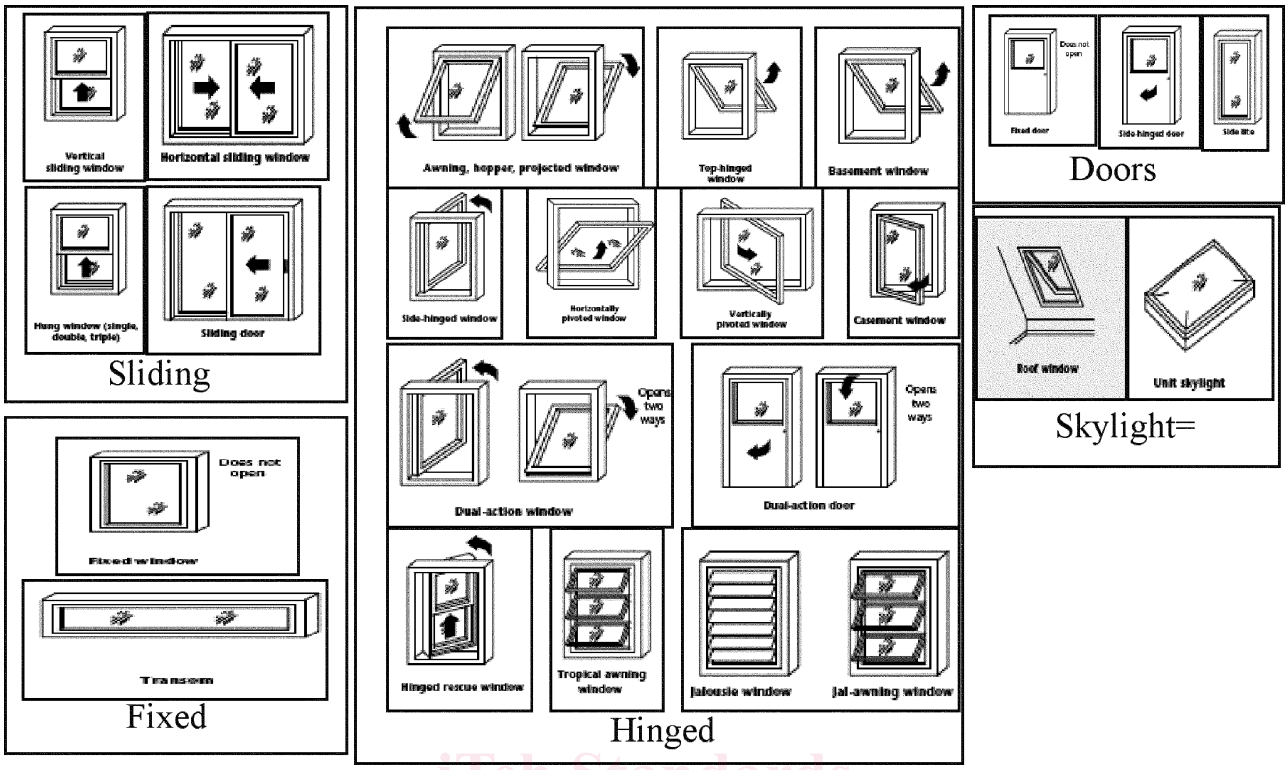

FIG. A1.1 Visual Grouping of Window Types in This Specification

A1.2.4 *Not Allowed*—Three identical specimens out of four are required to qualify the substitution, as for a new product.

A1.3 General Premises for Substitution

A1.3.1 For products qualified under ~~5.3.4~~5.3.3, Small Missile Test, substitutions of all elements that are not infill elements shall be allowed automatically.

A1.3.2 Any substitution shall be allowed for materials and components only after three initial specimens out of four have passed all the prescribed performance requirements and are identical in every way including anchorage and mounting.

A1.3.3 Any substitution of an assembly of the same type as the three initial specimens that contains smaller sash, panels, or lites at equal or lower design pressures shall be allowed automatically provided the same methods of fabrication are used and the anchorage is unchanged. Smaller assemblies shall not exceed dimensions of the tested width or height.

A1.3.4 Any substitution within the fenestration assembly shall be equal to or stronger than the components originally tested.

A1.3.5 Any substitution shall be qualified at a pressure equal to the design pressure at which the three initial specimens were qualified.

A1.3.6 Any substitution of an element shall not be allowed if a failure occurs for any reason during a single specimen test of that substitution.

A1.3.7 Automatically substituted elements shall be allowed to be combined into a system without requiring engineering analysis or testing.

A1.3.8 No more than three substituted elements that are individually qualified by a single test shall be combined into a system.

A1.3.9 *Anchorage:*

A1.3.9.1 Any substitution of the anchorage method shall require the testing of one additional specimen with the only difference being in the anchorage method.

A1.3.9.2 Any substitution of the fastener, supported by engineering analysis to be equal to or stronger than the initial three qualified fasteners shall be allowed automatically provided the original spacing is not exceeded.

A1.3.9.3 Any substitution of weaker anchorage method or fasteners shall not be allowed.

A1.3.10 *Insect Screens*—If the initial specimens were tested without screens the addition of screens shall be allowed automatically. If the initial specimens were tested with screens, substitution of the screen shall require the testing of one additional specimen.

PREMISES FOR SUBSTITUTION—GLAZED PRODUCTS

A1.4 General

A1.4.1 When substituting an element on the basis of a single specimen test refer to Fig. A1.2 and select the worst case for impact locations for large missile or small missile. Order of impact is immaterial.

A1.5 Glazing Sealants, Adhesives, and Backbedding

A1.5.1 Substitution of glazing sealants, insulating glass primary or secondary sealants, adhesives, or backbedding color shall require the testing of one additional specimen, or shall be allowed by engineering analysis provided the only change from the initial three qualified specimens is a change in the sealant color and documentation is provided that the nominal specific gravity of the substituted material is ±0.06 from that used in the initial three specimens or historic data/documentation is provided showing that different colors perform to the same performance properties that are either within or outside the allowable specific gravity range.

A1.5.2 Any substitution within the fenestration glazing sealant, insulating glass primary or secondary sealants, adhesives or backbedding demonstrated to be equal to or stronger in ultimate tensile strength as shown in Test Method C1135 than the initial three qualified specimens shall require the testing of one additional specimen with the only difference being in the sealant. Substitution of a sealant, adhesive or backbedding material with a lower movement capability as shown in Test Method C719 shall not be allowed.

A1.6 Glazing Tapes

A1.6.1 Substitution of glazing tape color shall require the testing of one additional specimen, or shall be allowed by engineering analysis provided the only change from the initial three qualified specimens is a change in the tape color, as follows:

A1.6.1.1 For preformed tapes, documentation is provided that the nominal specific gravity of the substituted material is ±0.06

FIG. A1.2 Single Specimen Impact Locations

from that used in the initial three specimens or historic data/documentation is provided showing that different colors perform to the same performance properties that are either within or outside the allowable specific gravity range.

A1.6.1.2 For foam tapes, documentation is provided that the specific gravity, as determined by Test Methods D3575 does not differ by more than ±20 % from that used in the initial three specimens.

A1.6.2 Any substitution within the fenestration glazing tapes demonstrated by an applicable reference standard to be equal to or stronger than the initial three qualified specimens shall require the testing of one additional specimen with the only difference being in the glazing tapes.

A1.7 Glass Plies

A1.7.1 Glass color change shall be allowed automatically without additional testing.

A1.7.2 Substitution or adding of glass coating (reflective, coated, low-e, frit, and so forth) shall be allowed without additional testing as determined by engineering analysis of the durability and compatibility of the treatment with glazing infill, interlayer, and sealant, adhesives or back-bedding materials.

A1.7.3 Individual glass ply thickness increase shall require the testing of one additional specimen that is identical to the three initial specimens with the only change being limited to glass ply thickness. A substitution with a decrease in glass ply thickness shall not be allowed.

A1.7.4 Glass type change from annealed to heat-strengthened or chemically-strengthened shall require the testing of one additional specimen. Glass must be of the same thickness and must not exceed any size of the three initial specimens. This applies to any and all glass plies of a unit under a single change.

A1.7.5 Glass type change from heat-strengthened to annealed or heat-strengthened to chemically-strengthened shall not be allowed.

A1.7.6 Glass type change to or from fully tempered shall not be allowed.

A1.7.7 Glass decorative surface (sandblasted, acid etched, and so forth) substitution shall not be allowed.

A1.8 Insulating Glass Units

A1.8.1 *Preconditions for Insulating Glass Unit Substitutions:*

A1.8.1.1 The impact resisting lite (monolithic or laminated) of an insulating glass unit shall be composed of the same glass type and treatment with equal thickness or thicknesses of glass, and thicker or equal interlayer of the same manufacturer and type as originally tested and approved.

A1.8.1.2 The glazing detail (glazing sealants, adhesives, stops, etc.) shall be unchanged other than to accommodate any variations in overall glazing thickness.

A1.8.1.3 Substitutions for insulating glass shall only be made for systems with the glazing structurally adhered to the frame or sash. In addition, the impact resisting lite (monolithic or laminated) shall be structurally adhered to the glazing leg or bed in the same manner and position as originally tested and approved.

A1.8.1.4 In an insulating glass unit, typically one lite provides the impact resistance (usually a laminated lite) and the other lite is considered to be “sacrificial.” This sacrificial lite can fracture without detriment to the impact resistant lite which is providing the actual building envelope protection.

A1.8.1.5 Glazing systems typically have a stationary glazing stop that is a permanent part of the frame or sash, or a removable