

ACCEPTANCE CRITERIA FOR GLASS GLAZED UNIT SKYLIGHTS AND SLOPED GLASS GLAZING

AC17

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PREFACE

Evaluation reports issued by ICC Evaluation Service, LLC (ICC-ES), are based upon performance features of the International family of codes. (Some reports may also reference older code families such as the BOCA National Codes, the Standard Codes, and the Uniform Codes.) Section 104.11 of the *International Building Code*® reads as follows:

The provisions of this code are not intended to prevent the installation of any materials or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.

This acceptance criteria has been issued to provide interested parties with guidelines for demonstrating compliance with performance features of the codes referenced in the criteria. The criteria was developed through a transparent process involving public hearings of the ICC-ES Evaluation Committee, and/or on-line postings where public comment was solicited.

New acceptance criteria will only have an “approved” date, which is the date the document was approved by the Evaluation Committee. When existing acceptance criteria are revised, the Evaluation Committee will decide whether the revised document should carry only an “approved” date, or an “approved” date combined with a “compliance” date. The compliance date is the date by which relevant evaluation reports must comply with the requirements of the criteria. See the ICC-ES web site for more information on compliance dates.

If this criteria is a revised edition, a solid vertical line (|) in the margin within the criteria indicates a technical change from the previous edition. A deletion indicator (→) is provided in the margin where wording has been deleted if the deletion involved a technical change.

ICC-ES may consider alternate criteria for report approval, provided the report applicant submits data demonstrating that the alternate criteria are at least equivalent to the criteria set forth in this document, and otherwise demonstrate compliance with the performance features of the codes. ICC-ES retains the right to refuse to issue or renew any evaluation report, if the applicable product, material, or method of construction is such that either unusual care with its installation or use must be exercised for satisfactory performance, or if malfunctioning is apt to cause injury or unreasonable damage.

NOTE: The Preface for ICC-ES acceptance criteria was revised in July 2011 to reflect changes in policy.

Acceptance criteria are developed for use solely by ICC-ES for purposes of issuing ICC-ES evaluation reports

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PART A

INTERNATIONAL BUILDING CODE AND INTERNATIONAL RESIDENTIAL CODE

A1.0 INTRODUCTION

A1.1 Purpose: The purpose of Part A of this acceptance criteria is to establish requirements for glass glazed unit skylights to be recognized in an ICC Evaluation Service, LLC (ICC-ES), evaluation report under the 2009 and 2006 International Building Code® (IBC) and the 2009 and 2006 *International Residential Code*® (IRC). Bases of recognition are IBC Sections 2403 and 2405 and IRC Section R308.6.

The reason for development of this criteria is to establish guidelines for the evaluation of glass glazed skylights and to provide additional information to clarify the requirements of the IBC, IRC and documents referenced by those codes.

A1.2 Scope: This criteria is applicable to the evaluation of factory-fabricated, fixed or operable, curb-mounted or deck-mounted unit skylights having glass glazing and homogeneous (non-poured-and-debridged) aluminum, polyvinyl chloride (PVC) plastic, steel or wood frame and curb construction.

A1.3 Codes and Reference Standards:

A1.3.1 2009 and 2006 *International Building Code*® (IBC), International Code Council.

A1.3.2 2009 and 2006 *International Residential Code*®, (IRC) International Code Council.

A1.3.3 AAMA/WDMA/CSA 101/I.S.2/A440-08 (A440), North American Fenestration Standard/Specification for Windows, Doors, and Skylights, American Architectural Manufacturer Association, Window and Door Manufacturers Association and Canadian Standards Association (2009 codes).

A1.3.4 AAMA/WDMA/CSA 101/I.S.2/A440-05 (A440), Standard/Specification for Windows, Doors, and Unit Skylights, American Architectural Manufacturer Association, Window and Door Manufacturers Association and Canadian Standard Association (2006 codes).

A1.3.5 ASTM D 638-03, Standard Test Method for Tensile Properties of Plastics, ASTM International.

A1.3.6 ASTM D 790-03, Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials, ASTM International.

A1.3.7 ASTM D 1435-05, Standard Practice for Outdoor Weathering of Plastics, ASTM International.

A1.3.8 ASTM D 2559-04, Standard Specification for Adhesives for Structural Laminated Wood Products for Use under Exterior (Wet Use) Exposure Conditions, ASTM International.

A1.3.9 ASTM D 2565-99, Standard Practice for Xenon Arc Exposure of Plastics Intended for Outdoor Applications, ASTM International.

A1.3.10 ASTM D 4226-05, Standard Test Method for Impact Resistance of Rigid Poly Vinyl Chloride (PVC) Building Products, ASTM International.

A1.3.11 ASTM D 4329-99, Practice for Fluorescent UV Exposure of Plastics, ASTM International.

A1.3.12 ASTM D 4364-94, Practice for Performing Accelerated Outdoor Weathering of Plastics Using Concentrated Natural Sunlight, ASTM International.

A1.3.13 ASTM D 4803-97, Standard Test Method for Predicting Heat Buildup in PVC Building Products, ASTM International.

A1.3.14 ASTM E 283-04, Standard Test Method for Determining Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen.

A1.3.15 ASTM E 330-02, Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference, ASTM International.

A1.3.16 ASTM E 547-00, Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Difference, ASTM International.

A1.3.17 ASTM E 2190-02, Standard Specification for Insulating Glass Unit Performance and Evaluation, ASTM International.

A1.3.18 ASTM G 153-04, Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials, ASTM International.

A1.4 Definitions:

A1.4.1 Unit Skylight: A factory-assembled, glazed fenestration unit, containing one panel of glazing material, that allows natural daylight through an opening in the roof assembly while preserving the weather-resistant barrier of the roof. Under this criteria roof windows, as defined in A440, are classified as unit skylights.

A1.4.2 Operable Unit Skylight: A unit skylight which is intended to be opened and closed.

A1.4.3 Structural Test Pressure: The test pressure (load) that is applied to the test specimen to determine structural load capacity. The structural test pressure (load) shall be a minimum of the allowable load multiplied by a safety factor. See Section A3.1.4.4 for applicable safety factors.

A2.0 BASIC INFORMATION

A2.1 General: The following information shall be submitted:

A2.1.1 Product Description: Complete information concerning the unit skylights shall be in the quality documentation required in Section A5.0, and shall include dimensions, configuration, component specifications (including glazing type and thickness), and manufacturing process. The information shall include the following:

A2.1.1.1 Generic or trade name.

A2.1.1.2 Manufacturer's catalog or model number.

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A2.1.1.3 Outside curb dimensions.

A2.1.1.4 Inside curb dimensions.

A2.1.1.5 Curb mounting details, including description of whether the curbs are an integral part of the unit skylight, or furnished by others. Additionally, details shall be provided as to whether the bottom of the curb is mounted completely at roof level, completely inside the roof opening, or a combination of both.

A2.1.1.6 Glass type and thickness

A2.1.1.7 Description of interlayer of laminated glass. See IBC Section 2405.2.

A2.1.1.8 Specification(s) of insulated glass units. Insulated glass units shall comply with ASTM E 2190 or ASTM E 774 (Specification for Sealed Insulating Glass) with a minimum Class A rating when tested in accordance with ASTM E 773 (Test Method for Seal Durability of Sealed Insulating Glass Units).

A2.1.1.9 Description of adhesive(s) used, if any, to adhere wood components, including a description of the curing method. Adhesive for structural applications shall comply with ASTM D 2559. Adhesive for all other applications shall comply with A440 Section 6.3.2.2.

A2.1.1.10 Description of basic materials, including physical properties of gasketing, frame, curb, corrosion-resistant fasteners, flashing, etc. Fasteners in contact with aluminum components shall comply with IBC Chapter 20, and aluminum components shall be separated from dissimilar materials in accordance with IBC Chapter 20.

A2.1.1.11 Scaled drawings of glazing details indicating clearances, edge engagement, sealing, etc.

A2.1.1.12 Scaled drawings of mounting details, including curb profiles, clearances, seals, drainage, adjacent components, frame connections, etc.

A2.1.2 Manner of Field Identification:

A2.1.2.1 General: A permanent label conspicuously located on the unit skylight shall bear the manufacturer's name and address, model number, evaluation report number, a design pressure rating and the name or logo of the inspection agency. When regulation is under the IBC or IRC, glass shall be labeled in accordance with IBC Section 2403.1.

A2.1.2.2 Safety Labeling: Unit skylights shall bear a warning label similar to the following, with signal and key words at least 1/4 inch (6.4 mm) high.



A2.1.3 Installation Instructions: Installation details and limitations, fastening methods, and location of fasteners.

A2.2 Engineering Calculations: Calculations required by Section A3.2 shall be signed and sealed by a registered design professional.

A2.3 Testing Laboratories: Testing laboratories shall comply with Section 2.0 of the ICC-ES Acceptance Criteria for Test Reports (AC85) and Section 4.2 of the ICC-ES Rules of Procedure for Evaluation Reports.

A2.4 Test Reports: Test reports shall comply with AC85, and shall include the information specified in A440 Section 5.4, modified as follows:

A2.4.1 Statements regarding sampling of the test specimens consistent with Section A.2.5.

A2.4.2 Ambient temperature and relative humidity during tests.

A2.4.3 Description of test equipment and test procedures.

A2.4.4 Verification that a qualified representative of the testing laboratory determined that specimens comply with drawings and descriptions set forth in the report of tests.

A2.4.5 Detailed drawings of the unit, showing dimensioned profiles, material specifications for retaining frame and curb, and any other pertinent construction details. Any modification of standard specimens shall be noted on drawings.

A2.4.6 Pertinent data such as fastener size, type and spacing, maximum gap between the skylight frame and wood framing on curb-mounted units, etc.

A2.4.7 Verification that a qualified representative of the testing laboratory witnessed installation of the test specimens and that the installation complied with the manufacturer's published installation instructions.

A2.4.8 Duration of test loads.

A2.4.9 Written account of visual observations during and after tests.

A2.4.10 Mode of failure for each specimen.

A2.4.11 Statement from the testing laboratory indicating that tests were conducted in accordance with this criteria, or with a full description of deviations.

A2.4.12 Reports of water penetration tests shall also include:

A2.4.12.1 Water application rates.

A2.4.12.2 Record of all points of water penetration on the interior face of the specimen.

A2.4.12.3 Statement from the testing laboratory indicating success or failure of the test specimen.

A2.5 Product Sampling: Sampling of the unit skylights for tests under Part A of this criteria shall comply with the independent sampling requirements of Section 3.1 of AC85.

A3.0 TEST AND PERFORMANCE REQUIREMENTS

A3.1 General: Testing shall be conducted on one unit skylight of each skylight model in the sequence indicated

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in Sections A3.1.1 through A3.1.4. (See Section 5.1. 2 of A440-08 or Section 5.1.1. of A440-05) The uniform load test outlined in Section A3.1.4 shall be performed on a minimum of two additional, identical unit skylights. Previously tested skylights shall not be reglazed and used as the additional test specimens. Unit skylight test specimens shall be mounted in a manner consistent with the submitted installation instructions. (See Section A2.1.3). The air infiltration, water penetration and uniform load tests on operable skylights shall be performed with the skylights in the closed, latched position. Testing shall be performed on the largest unit skylight for which recognition is sought. Recognition of smaller unit skylights with the same allowable load is dependent on construction and installation methods, provided the geometric shape of the smaller units fits within the rectangular shape of the tested units. Higher allowable loads can be recognized for smaller units, provided uniform load tests are conducted on the maximum size unit for the intended higher allowable load. For consideration of recognition of allowable loads that are interpolated between tested unit sizes, the uniform load test described in Section A3.1.4 shall be conducted on at least three sizes of units, three specimens per size.

A3.1.1 Operating Force for Operable Unit Skylights:

A3.1.1.1 Procedure: If the skylight is an operable skylight, the unit skylight shall be tested in accordance with A440 Section 5.3.1, with excessive operating force as defined in Section 5.3.1 of A440 deemed to be failure. The A440 permission to adjust the tested specimen prior to retesting and permission to select a new test specimen if the unit skylight has excessive operating force is not allowed under this acceptance criteria.

A3.1.1.2 Conditions of Acceptance: The unit skylight shall comply with the requirements for roof windows, as outlined in A440 Table 5.

A3.1.2 Air Infiltration:

A3.1.2.1 Procedure: The unit skylight shall be tested in accordance with A440 Section 5.3.2. The test pressure shall be 1.57 psf (75 Pa).

A3.1.2.2 Conditions of Acceptance: The unit skylight shall comply with the requirements outlined in Table 8 of A440-08 or Table 6 of A440-05. The maximum allowable air leakage shall be 0.3 cfm/ft² (1.5 L/s•m²).

A3.1.3 Water Penetration:

A3.1.3.1 Procedure: The unit skylight shall be tested in accordance with A440 Section 5.3.3 except as amended by this criteria. The unit skylight shall be tested at the lowest slope for which recognition is sought. Testing shall be in accordance with ASTM E 547, with an air pressure differential of 2.92 psf (140 Pa) or 15 percent of the design load, whichever is greater. The water penetration test shall consist of four test cycles, with each cycle consisting of five minutes with the pressure applied and one minute with the pressure released, during which the water spray is continuously applied for a total test duration of 24 minutes, minimum.

Where the manufacturer offers or specifies an interior insect screen, the water penetration resistance test shall be performed with the insect screen removed.

A3.1.3.2 Conditions of Acceptance: There shall be no water leakage on the interior side of the tested skylight.

A3.1.4 Uniform Load Testing:

A3.1.4.1 General: As noted in Section A3.1, a total of three tests shall be conducted for each condition of testing (positive and negative). If the glass breaks during testing prior to achievement of the structural test pressure, a single replacement test may be conducted. This is contingent on glass breakage being of a random nature and not due to interaction with the frame such as glass-to-metal contact. Test equipment for superimposed loading shall be adequate to develop anticipated ultimate loads. If loading is not carried to failure, the highest value achieved will be considered the ultimate. Application of uniform loads shall be by differential air pressure [pounds per square foot (Pascals)] exerted with a vacuum or pressure pump. Deflection-measuring devices, as required by Section 11.2.2 of ASTM E 330, shall be installed to measure deflection of the edge of the glass, as required by IBC Section 2403.3, and shall consider curbs and/or frames that are not fully supported by the roof.

A3.1.4.2 Uniform Load Deflection Test:

A3.1.4.2.1 Procedure: Load test procedures shall comply with Procedure A of ASTM E 330 with the following modifications:

a. A load equal to one-half the anticipated allowable load shall be applied and held for one minute. Deflection readings shall be taken. The load shall then be released and deflection readings shall be taken after a recovery period of not less than one minute nor more than five minutes at zero load. The test specimen shall be evaluated for permanent damage.

b. The anticipated allowable load shall then be applied and held for one minute. Deflection readings shall be taken. The load shall then be released; deflection readings shall be taken after a recovery period of not less than one minute nor more than five minutes at zero load. The test specimen shall be evaluated for permanent damage.

c. The test loads shall be applied as positive pressures and then as negative pressures. The sequence of loading shall be permitted to be reversed at the option of the testing laboratory.

A3.1.4.2.2 Conditions of Acceptance: There shall be no permanent damage to the glazing, fasteners, hardware parts, support arms or actuating mechanisms, disengagement, or any other damage which causes the test specimen to become inoperable. While under load, the deflection of the edge of the glass perpendicular to the glass panel shall not exceed $1/175$ of the glass edge length or $3/4$ inch (19.1 mm), whichever is less.

A3.1.4.3 Uniform Load Structural Test:

A3.1.4.3.1 Procedure: Load test procedures shall comply with Procedure A of ASTM E 330 with the following modifications:

a. A load equal to one-half the structural test pressure (See Section A1.4.3) shall be applied and held for one minute. The load shall then be released and permanent deflection readings shall be taken after a recovery period of not less than one minute nor more than

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five minutes at zero load. The test specimen shall be evaluated for permanent damage.

b. The structural test pressure shall then be applied and held for one minute. The load shall then be released; permanent deflection readings shall be taken after a recovery period of not less than one minute nor more than five minutes at zero load. The test specimen shall be evaluated for permanent damage.

c. The test loads shall be applied as positive pressures and then as negative pressures. The sequence of loading shall be permitted to be reversed at the option of the testing laboratory.

d. As an option, tests may be carried to failure to gain more information on frame capacity by increasing loads in maximum increments of 10 psf (478 Pa), with each load held for one minute.

A3.1.4.3.2 Conditions of Acceptance: There shall be no glass breakage, deglazing of the skylight, or permanent damage to fasteners, hardware parts, support arms or actuating mechanisms, disengagement, or any other damage which causes operable skylights to become inoperable. There shall be no permanent deflection of any frame member in excess of $1/250$ of its span.

A3.1.4.4 Safety Factors: The safety factor which is applied to the allowable load to establish the structural test pressure shall be the greater value determined from the following items:

1. The safety factor shall be consistent with the applicable code for the materials composing the frames of the skylights. For units consisting of aluminum or steel frames, a minimum safety factor of 2.0 is necessary.

2. For units consisting of wood structural members and PVC plastic frames, a minimum safety factor of 3.0 is necessary.

A3.2 Design Calculations: Design calculations in accordance with Chapter 24 of the IBC shall be submitted for the glass.

Design calculations in accordance with the appropriate code-referenced standard shall be submitted for the fastener attachment to the support framing. The allowable load capacity of the fasteners attaching the skylight to the roof structure shall be equal to, or exceed, the allowable wind uplift pressure determined under Section A3.1. In the absence of code-recognized or nationally recognized allowable loads for fasteners, small-scale fastener tests are necessary. Prior to tests being conducted, a suggested test program should be submitted to ICC-ES for review.

A3.3 Additional Air Infiltration Tests: If the skylights tested under Section A3.1 do not have the largest perimeter length-to-glazing area ratio, then the largest skylight with the largest perimeter length-to-glazing area ratio shall be subjected to, and comply with, the air infiltration test of Section A3.1.2.

A3.4 Distributed Load Tests:

A3.4.1 Procedure: Operable skylights shall be tested in accordance with the distributed load test described in Section 5.3.6.6.2 of A440. The test shall be conducted on one of each of the operable skylight models

having the same size and design as the skylights tested under Section A3.1.

A3.4.2 Conditions of Acceptance: The specimens must comply with the conditions of acceptance in Section 5.3.6.6.2 of A440, resisting a minimum load of 5.0 psf.

A3.5 Weathering and strength tests of the PVC plastic material of skylight frames and glazing retainer caps shall be conducted in accordance with Section A4.1. These tests are not required if the plastic material is protected from exposure to ultraviolet light by metal cladding.

A3.6 Temperature cycling tests of the PVC plastic material of skylight frames and glazing retainer caps shall be conducted in accordance with Section A4.2.

A3.7 Deformation/Creep Tests: PVC plastic frames that do not directly transfer loads axially to the supporting sash are beyond the scope of this criteria. When PVC plastic frames transfer loads eccentrically to the supporting sash, flexural deflection of the frame can occur. The proponent must investigate and determine the effect on product performance of deformation under long-term loads or creep. The proponent must submit a proposed test program to ICC-ES for review prior to testing.

A4.0 TEST METHODS

A4.1 Weathering (Outdoor or Weatherometer) and Strength Tests: The following are required for the weathering and strength tests of PVC plastic frames and glazing retainer caps:

A4.1.1 Ten 1-inch-by-6-inch-by-10-inch (25.4 mm by 152 to 254 mm) samples are cut from the plastic. Cut edges may be protected. Half of the samples shall be treated as control.

A4.1.2 Five of the samples shall be subjected to one of the weathering conditions described below. The surface exposed in the test shall represent the surface exposed in the end use.

A4.1.2.1 Accelerated weathering tests for 2,000 hours in accordance with ASTM G 153. The operating schedule shall be Cycle 1 set forth in Table X1.1 of ASTM G 153.

A4.1.2.2 Accelerated weathering tests, in accordance with ASTM D 2565. Exposure shall be for 2,900 hours with exposure Cycle 1.

A4.1.2.3 Exposure to 36,805 Langleys of ultraviolet (UV) irradiance in accordance with Procedure B of ASTM D 4364 using Spray Cycle 1.

A4.1.2.4 Outdoor weathering per ASTM D 1435, with exposure for five years with a southern exposure at a 45-degree angle in a hot humid climate, a hot arid climate and a northern industrial climate.

A4.1.2.5 Accelerated weathering tests in accordance with ASTM D 4329. Exposure shall be for 2,000 hours with cycles of 8 hours UV at 158°F (70°C) followed by four hours of condensation at 104°F (40°C).

A4.1.3 Both the control and weathered samples shall be evaluated to assess retention of mechanical properties of the plastic after weathering by one of the following two methods:

A4.1.3.1 Procedure B of ASTM D 4226 for specimens subjected to outdoor weathering per Section

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A4.1.2.4. For acceptance, the minimum impact strength after two years of outdoor weathering shall be not less than 0.60 in.-lb./mil (2.67 Nm/mm). In addition, there shall be no visible signs of cracking or chipping after five years.

A4.1.3.2 ASTM D 638 and ASTM D 790. Any loss in mechanical properties shall be accounted for in the design of the plastic frame. The allowable load shall be determined according to Section A3.1 of this criteria, with reduction to accommodate any loss in mechanical properties of the PVC plastic frame material.

A4.2 Temperature Cycling Tests:

A4.2.1 Specimens: A representative sample PVC plastic skylight frame with glazing shall be subjected to 24 consecutive cycles of this test. The specimens shall be installed in a rigid wood frame simulating the field installation procedure recommended by the manufacturer. The test decks shall be installed at the minimum horizontal slope recommended for recognition. Test specimens shall be mounted in a compartment so one side of the specimens can be maintained at 73.4°F (23°C) throughout testing. The apparatus shall allow variable temperatures to the other side (weather side) of the specimen.

A4.2.2 Procedure: During the first hour, the weather side temperature shall be decreased from 73.4°F (23°C) to -22°F (-30°C) and then maintained at -22°F (-30°C) for one hour. During the third hour, the weather side temperature shall be increased to 73.4°F (23°C). In the next hour the weather side temperature shall be raised to 122°F (49°C) and then maintained for an additional hour. During the two-hour period, radiant heat shall be applied to the weather side of the specimens. The radiant heat must impose, and maintain for one hour, a temperature on the frame equivalent to the sum of the maximum heat buildup plus the ambient test temperature of 122°F (49°C).

Maximum heat buildup shall be determined in accordance with ASTM D 4803 using horizontal samples and using the darkest colors being recognized.

During the sixth hour, the radiant heat source shall be turned off and the temperature of the weather side

compartment lowered to 73.4°F (23°C). The exposures may be suspended between cycles, such as on weekends or holidays, provided the samples are maintained at 73.4°F (23°C).

A4.2.3 Conditions of Acceptance: At the conclusion of 24 cycles, the product shall have no crazing, cracking or other deleterious surface or joint changes. Additionally, there shall be no sign of failure or distress at fastener locations or at skylight frame corners.

A5.0 QUALITY CONTROL

A5.1 The unit skylights shall be manufactured under an approved quality control program with inspections by an inspection agency accredited by the International Accreditation Service (IAS), or otherwise acceptable to ICC-ES.

A5.2 Quality documentation complying with the ICC-ES Acceptance Criteria for Quality Documentation (AC10) shall be submitted.

A6.0 EVALUATION REPORT RECOGNITION

A6.1 The evaluation report shall include the maximum allowable positive and negative loads [pounds per square foot (Pascals)] on the unit skylights.

A6.2 The evaluation report shall indicate compliance with the air infiltration conditions of acceptance (see Section A3.1.2.2).

A6.3 The evaluation report shall reference the specific published installation instructions or installation drawings, including applicable dates and revision number of the installation instructions or drawings.

A6.4 The evaluation report shall indicate that the skylights are to be installed in accordance with IBC Section 2405 and IRC Section R308.6.

A6.5 Evaluation reports on plastic framed skylights shall include a statement that the skylights with plastic frames are limited to installations where a roof covering classification is not required.

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PART B UNIFORM BUILDING CODE, BOCA NATIONAL BUILDING CODE AND STANDARD BUILDING CODE

B1.0 INTRODUCTION

B1.1 Purpose: The purpose of Part B of this acceptance criteria is to establish requirements for predesigned and manufactured sloped glass glazing, including skylights, solarium roof panels and patio cover roof panels, under the 1997 *Uniform Building Code*™ (UBC); and prefabricated skylights under the BOCA® *National Building Code*/1999 (BNBC) and the 1999 *Standard Building Code*® (SBC). Bases of recognition are UBC Chapter 24, BNBC Chapter 24 and SBC Chapter 24.

The reason for development of this criteria is to establish guidelines for the evaluation of glass glazed skylights and sloped glass glazing and to provide additional information to clarify the requirements of the UBC, BNBC and SBC.

B1.2 Scope: Under the UBC, this criteria is limited to the evaluation of predesigned and manufactured sloped glass glazing, including skylights, solarium roof panels and patio cover roof panels, for gravity and wind uplift loading and weather-resistive performance. Under the BNBC and the SBC, this criteria is limited to the evaluation of prefabricated skylights for gravity and wind uplift loading and weather-resistive performance. Field-constructed sloped glazing systems consisting primarily of nonstandard components, garden windows, greenhouse windows or bay-type windows and greenhouses, are not included under this criteria.

B1.3 Codes and Reference Standards:

B1.3.1 1997 *Uniform Building Code*™ (UBC).

B1.3.2 BOCA® *National Building Code*/1999 (BNBC).

B1.3.3 1999 *Standard Building Code*® (SBC).

B1.3.4 ASTM D 2559-92, Specification for Adhesives for Structural Laminated Wood Products for Use Under Exterior (Wet Use) Exposure Conditions, ASTM International.

B1.3.5 ASTM E 330-90, Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference, ASTM International.

B1.3.6 ASTM E 331-93, Test Method for Water Penetration of Exterior Windows, Skylight, Doors and Curtain Walls by Uniform Static Air Pressure Difference, ASTM International.

B1.3.7 ASTM E 773-83 (1995), Standard Test Method for Accelerated Weathering of Sealed Insulating Glass Units, ASTM International.

B1.3.8 ASTM E 774-92, Standard Specification for the Classification of the Durability of Sealed Insulating Glass Units, ASTM International.

B1.4 Definitions:

B1.4.1 Annealed, Heat-Strengthened, Fully Tempered Glass and Wired Glass: Fully tempered glass

as used in Part B of this criteria is as defined for tempered glass in UBC Standard 24-1.

B1.4.2 Garden, Greenhouse and Bay-type Windows: Units consisting of glass and framework that are attached to the exterior wall as appendages and do not extend over the floor area.

B1.4.3 Glass Roof Panels: Sloped glass panels, other than skylights.

B1.4.4 Glass Skylight: A prefabricated unit consisting of glass, a supporting sash and a frame which is used to glaze a roof or ceiling opening. The glass and its supporting sash may be fixed or openable.

B1.4.5 Greenhouse: An agricultural building used for horticultural purposes and classified as a Group U, Division 3, Occupancy complying with UBC Appendix Chapter 3, Division II.

B1.4.6 Insulating Glass: Factory-fabricated glazing consisting of two panes of glass separated by an air space, with the periphery of the air space sealed.

B1.4.7 Patio Covers: Structures complying with UBC Appendix Chapter 31, Division III.

B1.4.8 Sloped Glass Glazing: Glass installed at a slope of 15 degrees or more from the vertical plane, including glazing in skylights and roof panels of solariums and patio covers. Glass edges shall be firmly supported. Sloped glass glazing shall comply with Part B of this criteria, and UBC Chapter 24, BNBC Chapter 24 or SBC Chapter 24, as applicable.

B1.4.9 Solarium: A building appendage enclosed by a glass roof with walls primarily of glass and standard components, designed for loads specified in UBC Chapter 16.

B2.0 BASIC INFORMATION

B2.1 General: The following information shall be submitted:

B2.1.1 Description of Glass Skylights and Roof Panels:

B2.1.1.1 Generic or trade name.

B2.1.1.2 Manufacturer's catalog or model number.

B2.1.1.3 Outside curb dimensions.

B2.1.1.4 Inside curb dimensions.

B2.1.1.5 Glass:

B2.1.1.5.1 Thickness(es).

B2.1.1.5.2 Type(s).

B2.1.1.5.3 Description of interlayer of laminated glass.

Specification(s) of insulated glass units. Insulated glass units shall comply with ASTM E 774, with a minimum Class C rating when tested in accordance with ASTM E 773.

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B2.1.1.6 Description of adhesive(s) used, if any, to adhere wood curb sections. Adhesive shall comply with ASTM D 2559.

B2.1.1.7 Description of basic materials, including physical properties of gasketing, frame, curb, corrosion-resistant fasteners, flashing, etc. Fasteners in contact with aluminum components shall comply with UBC Section 2004.2 or the Aluminum Design Manual (AA-97), as applicable. Aluminum components shall be separated from dissimilar materials in accordance with UBC Section 2004.3 or AA-97, as applicable.

B2.1.1.8 Dimensioned drawings of glazing details indicating clearances, edge engagement, sealing, etc.

B2.1.1.9 Dimensioned drawings of mounting details, including curb profiles, clearances, seals, drainage, adjacent components, frame connections, etc.

B2.1.2 Installation Instructions: Installation details and limitations, fastening methods, and location of fasteners shall be provided.

B2.1.3 Engineering Calculations: Calculations shall be signed and sealed by a registered design professional.

B2.1.4 Identification: A permanent label conspicuously located on skylight and roof panel frames shall bear the manufacturer's name and address, model number and evaluation report number. At least one conspicuously located permanent label shall be required on solariums and patio covers. Glass shall be labeled in accordance with UBC Section 2402, BNBC Section 2403.1 and SBC Section 2403, as applicable.

B2.1.4.1 Safety Labeling: Glass skylights shall bear a warning label similar to the following, with signal and key words at least 1/4 inch (6.4 mm) high.



B2.1.5 Testing Laboratories: Testing laboratories shall comply with the Section 2.0 of the ICC-ES Acceptance Criteria for Test Reports (AC85) and Section 4.2 of the ICC-ES Rules of Procedure for Evaluation Reports.

B2.1.6 Test Reports: Test reports shall comply with AC85.

B2.1.7 Product Sampling: Sampling of specimens for tests shall comply with Section 3.2 of AC85.

B2.1.8 The applicant shall specify whether he has investigated and determined that thermal stresses and movements are not detrimental to products under consideration.

B3.0 TEST AND PERFORMANCE REQUIREMENTS

B3.1 General: Test specimens shall be of standard manufacture and representative (as to dimensional specifications, materials, finish, etc.) of the product for which recognition is sought. The test specimens shall be mounted in a manner consistent with their intended field installation. Glass dead load is approximately 13 psf per inch (24.5 Pa/mm) of glass thickness.

B3.2 Gravity Loads: Allowable snow or live loads are derived from the data described below. Compliance with Sections B3.2.1 and B3.2.2 is needed for variations in frames and glass. See Section B3.3.6 for additional details:

B3.2.1 For purposes of determining the adequacy of glass, allowable load shall be based on the following:

B3.2.1.1 UBC: Application of a reduction factor of 2.67 to the uniform load derived from Graph No. I (single glass), II (insulating glass) or III (glass supported on two edges), as applicable, and then subtracting the glass weight.

B3.2.1.2 BNBC or SBC: In accordance with BNBC Section 2404.2 or SBC Section 2405.3.2, respectively.

B3.2.2 For purposes of determining the interaction of the frame with the glass and the adequacy of the frame, report is necessary of uniform positive transverse load tests conducted in accordance with Section B3.3.6. The minimum test load is the sum of the glass weight and allowable snow/live load from Section B3.2.1, the sum then being multiplied by the safety factor from Section B3.2.5. A reduced allowable load from that noted in Section B3.2.1 can be recognized in the event of premature failure not attributed to glass breakage. The allowable load will be the lower test result of two tests divided by the safety factor in Section B3.2.5, after which the glass weight is subtracted.

B3.2.3 Total load deflection of glass edge supports shall not exceed 1/175 of the glass edge length or 3/4 inch (19.1 mm), whichever is less.

B3.2.4 Engineering analysis is needed of structural framing members of solariums and patio covers in accordance with applicable code sections. Where framing members do not submit to an engineering analysis, the proponent should submit a test program proposal to justify compliance with the code, before the testing is conducted.

EXCEPTION: Engineering analysis and tests described in Section B3.2.4 are waived for skylights mounted directly to structural roof decks with or without curbs.

B3.2.5 Safety Factors: The safety factor which is applied to test results shall be the greater value determined from the following items:

1. Safety factor shall be consistent with the applicable code for the materials composing the frames of the skylights or roof panels. For units consisting of aluminum or steel frames, a minimum safety factor of 2.0 is necessary.

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2. For units consisting of wood structural members, a minimum safety factor of 3.0 is necessary. For gravity loads, a minimum safety factor of 2.6 is necessary.

3. For units consisting of PVC or thermally broken members, a minimum safety factor of 3.0 is necessary.

B3.3 Wind Uplift Load: Compliance with Sections B3.3.1 and B3.3.2 is needed for variations in frames and glass thicknesses and types. See Section B3.3.6 for additional details. Allowable wind uplift pressure shall be derived as follows:

B3.3.1 For purposes of determining the adequacy of glass, allowable load shall be based on the following:

B3.3.1.1 UBC: Application of a reduction factor of 2.67 to the uniform loads from Graph No. I (single glass), II (insulating glass) or III (glass supported on two edges) as applicable.

B3.3.1.2 BNBC or SBC: In accordance with BNBC Section 2404.2 or SBC Section 2405.3.2, respectively.

B3.3.2 For purposes of determining the interaction of the frame with the glass and the adequacy of the frame, report is necessary of uniform negative transverse load tests conducted in accordance with Section B3.3.6. The minimum test load shall be the allowable wind uplift pressure from Section B3.3.1 multiplied by the safety factor from Section B3.3.5 and then divided by 1.33. A reduced allowable load from that noted in Section B3.3.1 can be recognized in the event of premature failure not attributed to glass breakage. The allowable pressure will be the lower test result of two tests divided by the safety factor in Section B3.3.5 and then multiplied by 1.33.

B3.3.3 For purposes of determining the adequacy of connections, the allowable load shall be based on fasteners attaching skylights to curbs, skylights directly to roof framing and fasteners attaching glass retainers to frames of solariums and patio covers. In the absence of code or nationally recognized allowable loads for fasteners, small-scale fastener tests are necessary. A test program should be submitted to ICC-ES for review before testing is conducted.

B3.3.4 Allowable wind uplift pressures shall also be based on Sections B3.2.3 and B3.2.4.

B3.3.5 Safety Factors: The safety factor which is applied to test results shall be the greater value determined from the following items:

1. Safety factor shall be consistent with the applicable code for the materials composing the frames of the skylights or roof panels. For units consisting of aluminum or steel frames, a minimum safety factor of 2.0 is necessary.

2. For units consisting of wood structural members, a minimum safety factor of 3.0 is necessary.

3. For units consisting of PVC or thermally broken members, a minimum safety factor of 3.0 is necessary.

B3.3.6 Test Procedure: Load tests shall be performed on the largest unit. Glass roof panel specimens shall be the maximum intended size, and installed in glazing members as intended for recognition. Glazing members on each side of panel shall be supported in a manner that allows the members to deflect the same as in an actual installation. Recognition of smaller units with the

same allowable load is dependent on similar mullions, rafters, fastener spacing, and aspect ratios. Recognition of smaller units with greater allowable loads may require testing to establish maximum and minimum limits to allow interpolation between test results. Glass in test specimens shall be of the thickness and type intended for recognition.

When the applicant seeks recognition under the UBC of more than one type and/or thickness of glass, the glass in the test specimens shall be selected as determined from Glass Strength Graph No. I, II or III, and as required by the applicant. Glass thickness(es) of test specimens shall comply with Table 24-1-B of UBC Standard 24-1.

When the applicant seeks recognition under the BNBC and/or SBC of more than one type and/or thickness of glass, the glass in the test specimens shall be selected as determined from BNBC Section 2404.2 or SBC Section 2405.3.2, respectively, and as required by the applicant. Glass thickness(es) of test specimens shall comply with BNBC Chapter 24 or SBC Chapter 24, as applicable.

A minimum of two tests is necessary for each condition of testing. If the glass breaks during one of the two tests, prior to achieving the minimum test load, a third test may be conducted. This is contingent on glass breakage being of random nature and not due to interaction with the frame such as glass to metal contact. Test specimens shall be representative of the product on which recognition is sought. Previously tested prefabricated units shall not be reglazed and used as test specimens. Installation shall comply with manufacturer's instructions. Pertinent data such as fastener size, type and spacing, maximum gap between extruded curb and wood framing on curb mounted units, etc., shall be observed and noted in the test report. Openable skylights are tested in the closed latched position. Test equipment for superimposed loading shall be adequate to develop anticipated ultimate loads. If loading is not carried to failure, the highest value achieved will be considered the ultimate. Deflection measuring devices shall be located to measure the deflection of the support framing.

B3.3.6.1 Load Application: Application of uniform loads shall be by differential air pressure exerted with a vacuum or pressure pump. Load test procedures shall comply with Procedure A of ASTM E 330 with the following modifications:

B3.3.6.1.1 A load equal to one-half the anticipated allowable load is applied and held for one minute. The pressure is then released and readings taken after a recovery period of not more than five minutes at zero load. The anticipated allowable load is applied and held for one minute. Pertinent deflection readings and visual observations are then recorded. The pressure differential is reduced to zero. Deflection readings are recorded after a recovery period of not more than five minutes. The full test load, as noted in Sections B3.2.2 and B3.3.2 for positive and negative loads, respectively, is applied and held for one minute. As an option, tests may be carried to failure to gain more information on frame capacity by increasing loads in maximum increments of 10 psf (49 Pa) with each load held for one minute.

B3.3.7 Condition of Acceptance: The test specimen shall maintain the test load for the full one minute duration.

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B3.4 Roof Classification Tests: Reports of fire-retardant roof tests, conducted in accordance with UBC Standard 15-2, shall be provided.

EXCEPTIONS:

1. Glass Skylights.
2. Roof panels limited to structures with nonrated roof coverings under UBC Chapter 15.
3. Glass-roof panels on patio covers complying with UBC Appendix Chapter 31, Division III.

B3.5 Water Penetration Test: This test is not required for patio covers that comply with UBC Appendix Chapter 31, Division III.

B3.5.1 Test Procedure: One water-resistance test is conducted on the largest unit in each profile. Installation of the test specimen shall comply with published manufacturer's instructions, and be representative of actual construction conditions. Test unit shall be installed at the lowest slope for which recognition is being sought. Water-resistance test shall comply with ASTM E 331 using the standard pressure differential of 2.86 pounds per square foot (137 Pa) with a test duration of 15 minutes.

B3.5.2 Condition of Acceptance: There shall be no water leakage on the interior side of the unit.

EXCEPTION: Water penetration may occur in systems having an integral drainage and weep system, provided the water is evacuated by the drainage system.

B3.6 Reporting Requirements:

B3.6.1 Reports of load tests shall include the following information:

- B3.6.1.1** Dates of tests and the report.
- B3.6.1.2** Ambient temperature and relative humidity during tests.
- B3.6.1.3** Description of test equipment and test procedures.
- B3.6.1.4** Description of test sample (dimension, model types, materials, labeling, glass thickness and type and other pertinent information).
- B3.6.1.5** Verification that a qualified representative of the testing agency witnessed assembly and installation of the test specimens and determined that specimens comply with drawings and descriptions set forth in the report of tests.
- B3.6.1.6** Detailed drawings of the unit, showing dimensioned profiles, installation and spacing of anchorage, material specifications for retaining frame and curb, and any other pertinent construction details. Any

modification of standard specimens shall be noted on drawings.

B3.6.1.7 Duration of test loads.

B3.6.1.8 Written account of visual observations during and after tests.

B3.6.1.9 Mode of failure for each specimen.

B3.6.1.10 Statement from the testing agency indicating that tests were conducted in accordance with this criteria or with a full description of deviations.

B3.6.1.11 Pressures imposed on each test specimen, which in turn, are identified, particularly with respect to distinguishing features or differences from companion specimens.

B3.6.1.12 Extrapolation of test data is prohibited.

B3.6.2 Reports of water-resistance tests shall include the items noted in Sections B3.6.1.1 through B3.6.1.6, and B3.6.1.8. Additionally, the following items shall be provided:

B3.6.2.1 Water application rates.

B3.6.2.2 Record of all points of water penetration on the interior face of the test specimen.

B3.6.2.3 Drainage of condensation and infiltrated water shall be addressed.

B3.6.2.4 Statement from the testing agency indicating success or failure of the test specimen.

B4.0 QUALITY CONTROL

B4.1 A quality control manual complying with the ICC-ES Acceptance Criteria for Quality Control Manuals (AC10) shall be submitted. The quality control manual shall include classification of defects, inspection methods for glass surfaces and edges, installation of gasketing and proper setting of glazing.

B4.2 Third-party follow-up inspections are not required under Part B of this criteria.

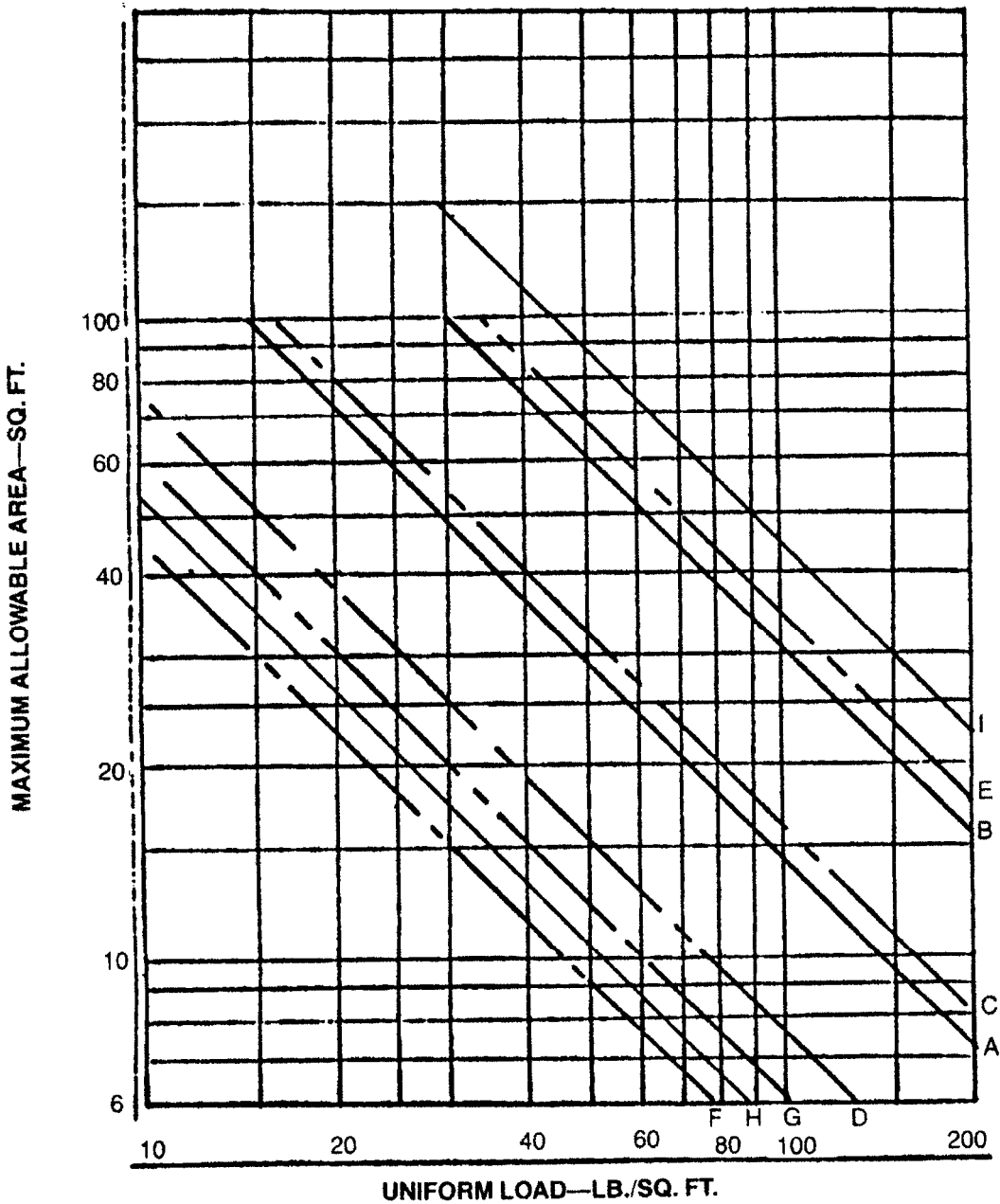
B5.0 EVALUATION REPORT RECOGNITION

B5.1 The evaluation report shall include the maximum allowable positive and negative loads [pounds per square foot (Pascals)].

B5.2 The evaluation report shall reference the specific published installation instructions or installation drawings, including applicable dates and revision number of the installation instructions or drawings.

B5.3 Field-assembled glass roof panels of solariums or patio covers shall be assembled and installed by installers approved by the solarium or patio cover manufacturer. ■

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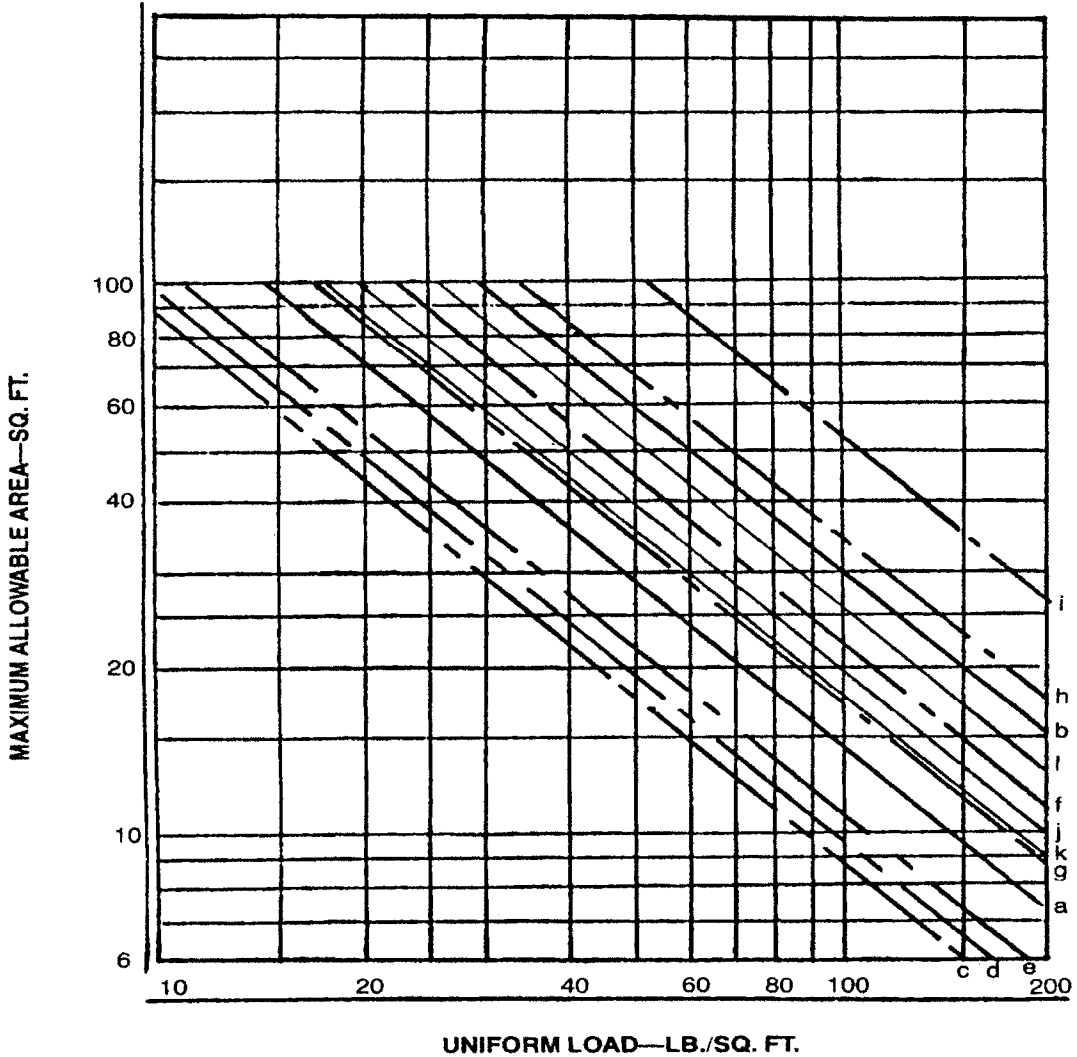


GRAPH NO. 1—GLASS IN SLOPED GLAZING—SINGLE GLASS¹

- A— $\frac{1}{8}$ " fully tempered glass
- B— $\frac{3}{16}$ " fully tempered glass
- C—lamination of 2 pieces of $\frac{1}{8}$ " heat-strengthened glass
- D—lamination of 2 pieces of $\frac{1}{8}$ " annealed glass
- E—lamination of 2 pieces of $\frac{1}{8}$ " fully tempered glass
- F—lamination of 2 pieces of SS annealed glass
- G—lamination of 2 pieces of lami thickness annealed glass
- H— $\frac{1}{4}$ " wired glass
- I— $\frac{1}{4}$ " fully tempered glass

¹Graph curves are based on rectangular glass firmly supported on all four edges, a design factor of 2.5 and aspect ratios of 1:1 to 1:5.

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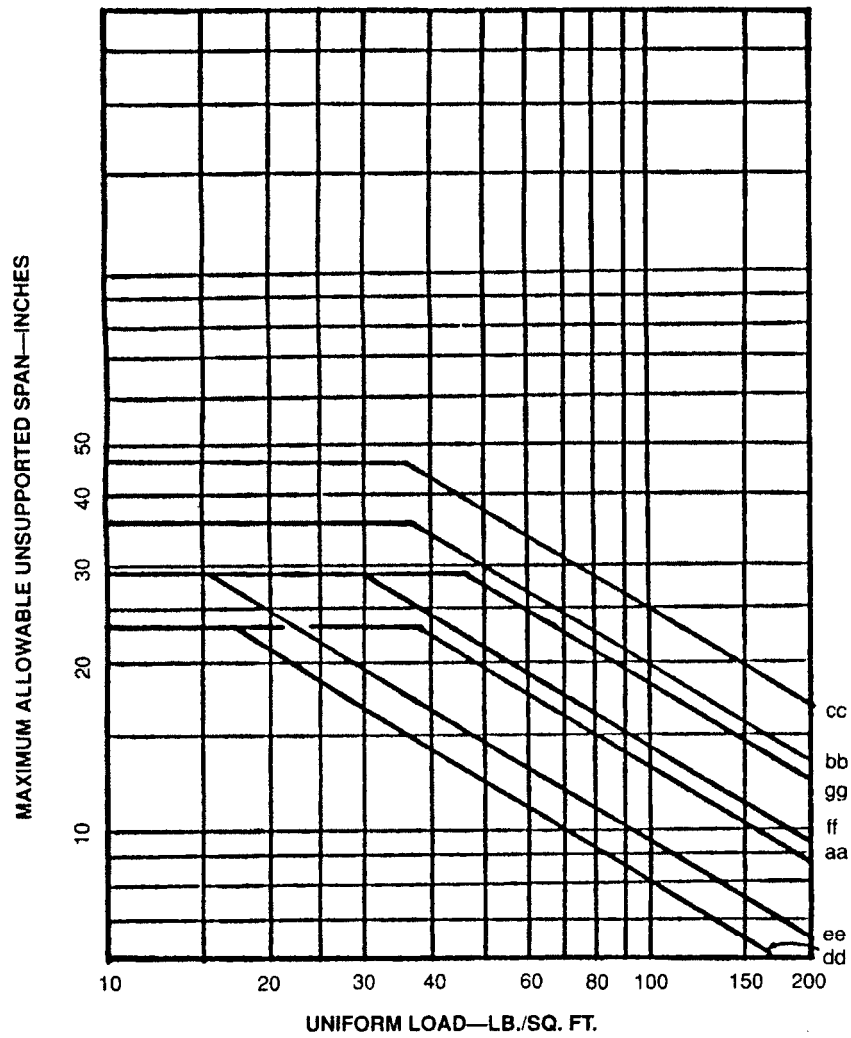


GRAPH NO. II—GLASS IN SLOPED GLAZING—INSULATING GLASS¹

- a— Outboard: 1/8" fully tempered
Inboard: 1/8" fully tempered
- b— Outboard: 3/16" fully tempered
Inboard: 3/16" fully tempered
- c— Outboard: 1/8" fully tempered or heat-strengthened
Inboard: lamination of 2 plies of SS annealed
- d— Outboard: 1/8" fully tempered or heat-strengthened
Inboard: lamination of 2 plies of lami thickness annealed
- e— Outboard: 1/8" fully tempered or heat-strengthened
Inboard: lamination of 2 plies of 1/8" annealed
- f— Outboard: 1/8" fully tempered or heat-strengthened
Inboard: lamination of 2 plies of 1/8" heat-strengthened
- g— Outboard: 3/16" heat-strengthened
Inboard: lamination of 2 plies of 1/8" heat-strengthened
- h— Outboard: 3/16" fully tempered
Inboard: lamination of 2 plies of 1/8" heat-strengthened
- i— Outboard: 3/16" fully tempered
Inboard: lamination of 2 plies of 1/8" fully tempered
- j— Outboard: 3/16" fully tempered
Inboard: lamination of 2 plies of 1/8" annealed
- k— Outboard: 3/16" fully tempered
Inboard: 2 plies of lami (0.102") annealed
- l— Outboard: 1/4" fully tempered
Inboard: lamination of 2 plies of 1/8" annealed

¹Graph curves are based on rectangular glass firmly supported on all four edges, a design factor of 2.5, and aspect ratios of 1:1 to 1:5.

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GRAPH NO. III—GLASS IN SLOPED GLAZING—
SINGLE GLASS SUPPORTED ON TWO OPPOSITE EDGES¹

- aa— 1/8" fully tempered glass
- bb— 3/16" fully tempered glass
- cc— 1/4" fully tempered glass
- dd— lamination of 2 plies of lami thickness annealed glass
- ee— lamination of 2 plies of 1/8" annealed glass
- ff— lamination of 2 plies of 1/8" heat-strengthened glass
- gg— lamination of 2 plies of 1/8" fully tempered glass

¹Graph curves are based on glass supported on two opposite edges and a design factor of 2.5.