Designation: D 7032 – 06a

Standard Specification for Establishing Performance Ratings for Wood-Plastic Composite Deck Boards and Guardrail Systems (Guards or Handrails)[1]

This standard is issued under the fixed designation D 7032; 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 the procedures to establish a performance rating for wood-plastic composite (WPC) deck boards. This specification also defines the procedures to establish a performance rating for WPC guards and handrails. The purpose of this specification is to establish the basis for code recognition of these products or systems in exterior applications where combustible construction is allowed (see X1.1).

1.2 Deck boards, guards, and handrails covered by this specification are permitted to be of any code compliant shape and thickness (solid or non-solid).

NOTE 1—While WPCs are produced in a broad range of ratios of fiber to resin it is recognized that the performance requirements in this specification are valid for any material or combination of materials used as deck boards, guards, or handrails. For products made primarily from resin, or for products that exhibit highly plastic properties (for example, more than 3 % strain without rupture in a standard flexural test under ambient conditions), users are directed to Specification D 6662 for additional guidance.

1.3 A deck board, and a deck board used as a stair tread, are assigned a span rating indicating its ability to comply with model code specified functions identified for its specific end use. A guard or handrail is recognized for its ability to meet minimum code requirements specified in the appropriate model building code.

1.4 Details of manufacturing processes may be proprietary and are beyond the scope of this specification.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units, which are provided for information only.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.*

1.7 *Table of Contents*:

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 9 Terminology Relating to Wood and Wood-Based Products

D 198 Test Methods of Static Tests of Lumber in Structural Sizes

[1] This specification is under the jurisdiction of ASTM Committee D07 on Wood and is the direct responsibility of Subcommittee D07.02 on Lumber and Engineered Wood Products.

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

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
D 883 Terminology Relating to Plastics
D 1037 Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
D 1413 Test Method for Wood Preservatives by Laboratory Soil-Block Cultures
D 1554 Terminology Relating to Wood-Base Fiber and Particle Panel Materials
D 1761 Test Methods for Mechanical Fasteners in Wood
D 1929 Test Method for Determining Ignition Temperature of Plastics
D 1972 Practice for Generic Marking of Plastic Products
D 2017 Test Method of Accelerated Laboratory Test of Natural Decay Resistance of Woods
D 2047 Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine
D 2394 Test Methods for Simulated Service Testing of Wood and Wood-Base Finish Flooring
D 2565 Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications
D 2915 Practice for Evaluating Allowable Properties for Grades of Structural Lumber
D 3345 Test Method for Laboratory Evaluation of Wood and Other Cellulosic Materials for Resistance to Termites
D 4000 Classification System for Specifying Plastic Materials
D 4092 Terminology for Plastics: Dynamic Mechanical Properties
D 4761 Test Methods for Mechanical Properties of Lumber and Wood-Base Structural Material
D 5764 Test Method for Evaluating Dowel-Bearing Strength of Wood and Wood-Based Products
D 6109 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastic Lumber and Related Products
D 6662 Specification for Polyolefin-Based Plastic Lumber Decking Boards
E 84 Test Method for Surface Burning Characteristics of Building Materials
E 108 Test Methods for Fire Tests of Roof Coverings
E 1354 Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter
F 1679 Test Method for Using a Variable Incidence Tribometer (VIT)[3]
G 154 Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

2.2 *Other References:*

AWPA Standard E1 Standard Method for Laboratory Evaluation for Determination of Resistance to Subterranean Termites[4]
2006 International Building Code International Code Council, Inc.[5]
2006 International Residential Code International Code Council, Inc.[5]

3. Terminology

3.1 *Definitions*—Terminology used to describe WPCs are defined in Terminologies D 9, D 883, D 1554, and D 4092, Practice D 1972, and Classification D 4000.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *center-point load*—a flexure test where the load comes in contact with the test specimen at a location that is ½ the test span.

3.2.2 *guard*—a building component or a system of building components located at or near the open sides of elevated walking surfaces that minimizes the possibility of a fall from the walking surface to a lower level.

3.2.3 *handrail*—a rail intended for grasping by the hand for guidance or support.

3.2.4 *quarter-point loading*—a flexure test where the load comes in contact with the test specimen at two locations, each of which is located at ¼ the span from the specimen load support. For example, quarter-point loading for a test specimen on a 24-in. (610-mm) span would have two equal loads contact the test specimen each located 6 in. in from the test specimen load support. The distance between the two points of load would be 12 in. (305 mm).

3.2.5 *span rating*—an index number that identifies the test span used in all structural load testing, which is the maximum center-to-center support spacing for the specified end use, and allowable design capacity, in pounds per square foot (lbf/ft^2 (kN/m^2)), determined in accordance with this specification. For example, a deck span rating of 16⁄100 recognizes the deck board for installation perpendicular to the floor joists spaced a maximum of 16 in. (406 mm) on center, and for supporting the load combinations required by the applicable code, which in this case cannot exceed 100 lbf/ft^2 (4.79 kN/m^2).

3.2.6 *third-point loading*—a flexure test where the load comes in contact with the test specimen at two locations, each of which is located at ⅓ the span from the specimen load support. For example, third-point loading for a test specimen on a 24-in. (610-mm) span would have two equal loads contact the test specimen each located 8 in. in from the test specimen load support. The distance between the two points of load would also be 8 in. (205 mm).

3.2.7 *wood-plastic composite (WPC)*—a composite made primarily from wood- or cellulose-based materials and plastic(s).

4. General Requirements

4.1 *Sampling*—Samples for testing shall be representative of the population being evaluated. Sampling shall be representative of the possible variations due to changes in raw materials and process variables over time. It is essential to consider batch-to-batch and shift-to-shift variability when sampling

[3] Withdrawn.
[4] Available from American Wood-Preservers' Association (AWPA), P.O. Box 388, Selma, AL 36702-0388, http://www.awpa.com.
[5] Available from International Code Council (ICC), 5203 Leesburg Pike, Suite 600, Falls Church, VA 22041.

actual production. Test specimens shall be selected from several production runs of a given item. Products shall be sampled at the manufacturing site by an accredited third party inspection agency or testing laboratory. Exceptions to sampling at the manufacturing site, such as at a warehouse or distribution center, shall be documented in the test report.

4.2 *Sample Size*—Selection of a sample size depends upon the property to be estimated, the actual variation in the property occurring in the population, and the precision with which the property is to be estimated. The principles of Practice D 2915 shall be followed. The minimum sample size shall provide estimation of mean values within 5 % in accordance with 3.4.2 of Practice D 2915.

4.3 *Conditioning*—Prior to testing, all specimens shall be conditioned to environmental conditions appropriate for the intended end use of the product. Alternatively, test specimens shall be conditioned for a minimum of 40 h at 68°F (20°C) and 50 ± 5 % RH. If data show that product properties are not affected by extreme moisture conditions, such as submersion, the material shall be permitted to be tested without special conditioning. When the product is to be subjected to a water soak environment, the test specimens shall be tested within 30 min upon removal from the treatment.

4.4 *Flexural Tests*—Flexural strength and stiffness shall be determined in accordance with principles of Test Methods D 4761 or D 6109. Alternatively, to assess compliance with performance requirements in its intended installed configuration, the deck boards shall be tested according to the two-span method defined in Annex A1. The test specimen cross section shall be the minimum anticipated structural size for the intended end use. The test span shall be that for which code recognition is desired. The specimens shall be loaded at a constant strain rate of 1 % per minute (±10 %). Average time to failure for each test configuration shall be recorded (see Commentary, X1.2). A constant strain rate of 1 % per minute is achieved by using a constant rate of test machine crosshead motion, R, (inches/minute) computed in terms of the test span, L, and the member depth, d, by the following equation:

$$R = 0.00185 \times L^2/d \quad (1)$$

For members in which the depth (vertical dimension) is varying along the member length, the depth (d) shall be taken as the gross member depth at the point of maximum moment.

NOTE 2—Eq 1 is based on the maximum extreme fiber strain at midspan of a horizontally symmetric simple span member. For a product that is symmetric about its horizontal axis, Eq 1 yields the target strain rate at both the extreme tensile and extreme compressive faces. For a product that is not symmetric about its horizontal axis, the Eq 1 strain rate is the average of the strains at these faces. See Commentary for additional information.

NOTE 3—Some WPCs exhibit exceptionally large deformations prior to failure in bending. Users are cautioned to take particular care in test machine set-up to accommodate large deflections, both in terms of deflection-measuring devices and support conditions.

4.4.1 *Flexural Strength*—Modulus of rupture (*MOR*) or moment capacity shall be reported for each specimen. Flexural strength shall be calculated from the maximum load achieved or the load at 3 % strain, whichever occurs first.

4.4.2 *Flexural Stiffness*—Apparent modulus of elasticity (*MOE*) or *EI* shall be reported for each specimen. Flexural stiffness shall be calculated from a linear least squares fit of the stress-strain curve over the range of 10 to 40 % of ultimate stress. The flexural strength and stiffness for deck board, guard, and handrail materials shall be determined in accordance with 4.4 and shall be used to establish a standard baseline performance level for comparison with future production during the required quality control audits.

4.5 *Temperature and Moisture Effects*:

4.5.1 *Temperature Effect*—Testing shall be conducted to verify that allowable span and load ratings are applicable at a range of temperatures expected in service. For purposes of this specification, the lower and upper temperatures shall be -20°F (-29°C) and 125°F (52°C), respectively. Flexure tests shall be conducted to failure at the desired span. A minimum of 10 specimens shall be tested at each temperature. The flexural strength and stiffness shall be determined in accordance with 4.4 and the average change in properties between the flexural strength and stiffness of the control flexural specimens and the specimens tested at low and high temperatures shall be calculated as a percentage and reported.

4.5.2 *Moisture Effect*—Testing shall be conducted to verify that allowable span and load ratings are applicable at moisture conditions expected in service. Flexure tests shall be conducted to failure at the desired span. A minimum of 10 specimens shall be tested at moisture conditions anticipated in service (for example, high humidity, submerged). The average maximum flexural strength and stiffness shall be determined in accordance with 4.4. The average change in properties between the control specimens and those tested at the in-service moisture condition of interest shall be calculated as a percentage and reported.

4.5.3 *Criteria*—The most restrictive effect (either temperature or moisture) shall be used to adjust the performance rating of deck boards, guardrails, and handrails. For deck boards, the deck board span (or load rating) shall be reduced by the most restrictive effect determined from 4.5.1 or 4.5.2. For guards and handrails, if the most restrictive effect exceeds 25 %, the test loads for the guards or handrails shall be increased by the amount in excess of 25 %.

4.6 *Ultraviolet (UV) Resistance Test*—To determine the mechanical property degrade after UV exposure, a minimum of five (5) full-size or full-thickness specimens shall be exposed to a minimum of 2000 h accelerated weathering in accordance with Specification D 6662 using Practice G 154 or D 2565.

4.6.1 When testing equipment does not allow either full-size or full-thickness test specimens, coupon specimens removed from the surface of the full-size cross section shall be used. However, when using data generated from coupon specimens, the user must justify the estimation of the impact on the full-size product (see X1.2).

4.6.2 A minimum of five (5) exposed and five (5) unexposed test specimens shall be tested in accordance with 4.4. The surface expected to receive UV exposure in service shall be exposed to the UV light source. The flexure test shall be conducted with the exposed surface in tension. If more than one component is being evaluated (for example, deck boards

and guard rail components) and all materials are manufactured from the same materials, then UV testing of only one component is required.

4.6.3 *Criteria*—The average change in properties between the exposed and unexposed specimens shall be calculated as a percentage and reported. Condition of acceptance is the average flexural strength of exposed test specimens and shall be within 10 % of the average flexural strength of unexposed specimens. For deck boards, if the decrease exceeds 10 %, the deck board span (or load rating) shall be reduced by the amount in excess of 10 %. For guards or handrails, if the decrease exceeds 10 %, the test loads for the guards or handrails shall be increased by the amount in excess of 10 % (see X1.3).

4.7 *Freeze-Thaw Resistance Test*—To determine the mechanical property degrade after freeze-thaw exposure, a minimum of five (5) specimens shall be subjected to the following exposure cycle. Whenever possible the test specimens shall be prepared using the full cross section of the as-manufactured product. Test specimens shall be submerged underwater (using weights to hold them down, if necessary) for a period of 24 h. The specimens shall then be placed in a freezer at −20°F (−292°C) for 24 h. After being subjected to freezing, the specimens shall be returned to room temperature for a period of 24 h. This process comprises one hygrothermal cycle. The above procedure shall be repeated two more times, for a total of three cycles of water submersion, freezing, and thawing.

4.7.1 A minimum of five (5) exposed and five (5) unexposed specimens shall be tested in accordance with 4.4. If more than one component is being evaluated (for example, deck boards and guard rail components) and all materials are manufactured from the same materials, then freeze-thaw testing of only one component is required.

4.7.2 *Criteria*—The average change in properties between the exposed and unexposed specimens shall be calculated as a percentage and reported. Condition of acceptance is the average flexural strength of exposed test specimens and shall be within 10 % of the average flexural strength of unexposed specimens. For deck boards, if the decrease exceeds 10 %, the deck board span (or load rating) shall be reduced by the amount in excess of 10 %. For guards or handrails, if the decrease exceeds 10 %, the test loads for the guards or handrails shall be increased by the amount in excess of 10 % (see X1.3).

4.8 *Biodeterioration Tests*—Termite and decay testing shall be required for deck board, guard, and handrail products containing wood, cellulosic, or other biodegradable materials.

4.8.1 *Fungal Decay Resistance Test*—Resistance to fungal decay shall be determined in accordance with Test Methods D 2017, D 1413, or APWA E1.

4.8.1.1 *Criteria*—Examination of test blocks shall reveal decay resistance equivalent to that of preservative-treated or the heartwood of naturally durable wood used in identical applications, as measured by visual inspection, and average weight loss.

NOTE 4—This is an accelerated laboratory decay test. Results are subjective and comparisons between tests and materials should be used with caution. However, mean specimen weight losses greater than 5 %, or significantly greater than controls, should be cause for concern.

4.8.2 *Termites*—Test Method D 3345 or AWPA E1 shall be used for evaluation of resistance to termite attack.

4.8.2.1 *Criteria*—Visual inspection of the test specimens shall demonstrate resistance to termite attack equivalent to that of preservative-treated or the heartwood of naturally durable wood used in identical applications.

4.9 *Fire Performance Tests*—The flame-spread rating of materials used to fabricate deck boards, guards, and handrails shall be determined by testing in accordance with Test Method E 84.

4.9.1 *Criterion*—Materials shall have a flame-spread index no greater than 200 when tested in accordance with Test Method E 84.

NOTE 5—Other test procedures may be permitted for determining a flame-spread rating for the material. Depending upon material formulation, other fire performance tests may be required. Additionally, fire performance properties other than flame spread may be important. Test Methods E 1354 or D 1929, or procedures in Annex A2 may be used to provide an assessment of one or more of the following properties: smoke release rate, mass loss rate, heat release rate, ignition temperatures, and spread of flame.

5. Deck Board Performance Requirements

5.1 *General*—Deck boards are a structural element and shall be tested in flexure to establish a deck board span rating. Because deck board products are often subject to a variety of outdoor environments, the effect of moisture and temperature shall be determined and used in the determination of the span (or load) rating. In addition to the structural assessments, several other performance measures shall be evaluated, which include tests to determine creep-recovery (5.4), mechanical fastener capacity (5.5), and slip resistance (5.6).

5.1.1 The unadjusted load derived in 5.3.1 shall be reduced by the adjustment factors derived in 4.5, 4.6, and 4.7.

5.1.2 The test loads specified in 5.3.2 shall be increased by the end-use adjustment factors derived in 4.5, 4.6, and 4.7. When the adjustment factors from 4.5 are required, the adjustment factor for MOR (or moment capacity) shall be used for strength criteria, and the adjustment factor for MOE (or EI) shall be used for deflection criteria.

5.2 *Flexural Performance Tests*—Flexural strength can be recorded as either modulus of rupture (*MOR*) or moment capacity. Flexural stiffness can be recorded either as apparent modulus of elasticity (*MOE*) or flexural stiffness (*EI*).

5.2.1 Flexural tests to failure at the span desired shall be conducted in accordance with 4.4. Sample size shall be a minimum of 15 specimens representative of normal production and be of the actual cross-section size for the intended end use. When a stair tread performance rating is desired, a center-point load test shall be also performed.

NOTE 6—Multiple-support conditions may be used for the flexural tests (for example, two-span continuous).

5.2.2 The maximum load, the load at the deflection at $1/180^{th}$ of the test span, and a description of the failure mode for each test specimen shall be recorded. The average flexural strength and average apparent stiffness shall be calculated and reported in accordance with 4.4.

NOTE 7—When determining the desired span, it is important to consider whether the boards will be installed perpendicular to or at an angle to the supports (joists).

5.3 *Determination of the Unadjusted Allowable Load*:

5.3.1 The unadjusted allowable load for the test span selected shall be the lesser of the following: *(1)* the average ultimate load applied divided by a factor of safety of 2.5, and *(2)* the average load that causes a deflection of $1/180^{th}$ of the test span.

5.3.2 Additionally, when deck boards are to be recognized as stair treads, the boards shall also sustain a minimum concentrated load of 750 lbf (3338 N) applied over a 2- by 2-in. (51- by 51-mm) area at midspan, adjacent to the edge of the deck board. The average stair thread deflection at 300 lbf (1335 N) load shall be 0.125 in. (3.1 mm) or less.

5.3.3 *Two-Span Adjustment*—When flexural testing is conducted to failure using a simple-span condition as described in Test Methods D 4761 or D 6109 and the failure mode is flexure, two-span adjustments for flexural strength and stiffness shall be permitted. If the user intends to take the strength increases for hollow or thin-walled products, a confirming test using the two-span protocol is required to verify that the failure mode is not buckling or crushing at the support. For flexural strength (MOR or moment capacity) the increase is 23%, and for flexural stiffness (MOR or EI) the increase is 39%. The strength increase (MOR or moment capacity) is applicable to stair treads only.

NOTE 8—The increases for flexural strength and stiffness in 5.3.3 are based on engineering mechanics for a continuous beam over two spans, where the support conditions are assumed to be pinned connections. Therefore, for these increases to apply, the actual installation of the stair tread should be such that the deck board remains in contact with its supports throughout its intended lifetime.

5.4 *Creep-Recovery Test*—A minimum of three (3) specimens representative of the population being sampled shall be loaded in flexure in accordance with 4.4 to twice the design load for which code recognition is desired. Prior to loading, the test specimens shall be allowed to equilibrate to the test temperature conditions (for example, 68 ± 4°F (20 ± 2 °C)) and be maintained throughout the experiment. The load is applied for 24 h and the specimens are then allowed to recover with no superimposed load for 24 h. Deflection at mid-span is measured a minimum of four times: *(1)* prior to the application of load, *(2)* at 24 h with load on, *(3)* immediately after the load is removed, and *(4)* after the 24-h recovery period. Total deflection is the deflection that occurs between time zero and the end of the first 24-h loading period. The recovered deflection is the deflection at the end of the 24-h recovery period minus the total deflection. The percent recovery for each test specimen shall be defined as the recovered deflection divided by the total deflection times 100. The average percent recovery, rounded to the nearest percent, shall be reported. For product where the total deflection is less than ⅛ in. (3.2 mm), the unrecovered deflection shall be less than 1/16 in. (1.6 mm).

5.5 *Mechanical Fastener Holding Tests*—Conditioning of the deck boards prior to test specimen preparation shall be conducted in accordance with 4.3. Testing of a minimum of five (5) test specimens with each fastener and load direction that the connection must resist, such as lateral, withdrawal, or pull-through, when used to fasten deck boards to the supporting structure, shall be conducted according to Test Methods D 1761 or D 1037 with nails, screws, or staples, and in accordance with Test Method D 5764 for bolts. Connections using proprietary fasteners, which include hidden fastener systems, shall be tested in accordance with Test Methods D 1761, D 5764, D 1037, or any other test procedure approved by the code organization that is appropriate for determining the allowable capacity of the connection. The allowable capacities of the fasteners shall be the average ultimate load divided by a factor of safety of three (3.0). Fastener application density for deck boards shall be based on allowable capacities of the fasteners and wind uplift pressures sought for recognition in the evaluation report.

5.6 *Slip Resistance Test*—When required, the slip resistance (coefficient of friction) shall be determined in accordance with Test Method F 1679. Alternatively, Methods D 2394 has long been used as a historical benchmark. Wet and dry slip resistance both parallel and perpendicular to the *L* direction shall be evaluated. A minimum of five (5) tests shall be conducted in each orientation.

NOTE 9—Other slip resistance test methods have historically been used, such as Test Method D 2047, and may be justified. However, Test Method F 1679 has been shown to be the most appropriate for measuring ambulatory slip performance. Test Method F 1679 is usable both in the laboratory and under a range of field conditions, and is believed to provide more reliable slip resistance property estimates than historical methods. ASTM is currently coordinating slip resistance specification issues at the Society level. The results of this effort, when available, will be incorporated into this specification. See X1.4, for additional discussion.

6. Guard and Handrail Performance Requirements

6.1 *General*—Structural load testing in accordance with 6.2 shall be required to establish guard acceptability, and testing in accordance with 6.3 shall be required to establish handrail acceptability.

NOTE 10—These requirements are based on minimum code-prescribed load requirements specified in IBC Section 1607.7.1 multiplied by a factor of safety of two and one-half (2.5), except for the deflection measurement load of 6.2.4.

6.1.1 The test loads specified in 6.2 and 6.3 shall be increased by the end-use adjustment factors derived in 4.5-4.7. When the adjustment factors from 4.5 are required, the adjustment factor for *MOR* (or moment capacity) shall be used for strength criteria, and the adjustment factor for *MOE* (or *EI*) shall be used for deflection criteria.

6.1.2 When required, the minimum test loads specified in 6.2 and 6.3 shall be increased by the end-use adjustment factors shown in 4.6 and 4.7.

NOTE 11—It is recommended that the load increase factors determined in 4.6 and 4.7 be established prior to guard or handrail testing.

6.2 *Guardrail System Test Requirements*:

6.2.1 One complete guardrail system shall be constructed according to the manufacturer's installation instructions. Each guard configuration, for which recognition is desired, shall be tested. However, testing a "worst-case" configuration is permitted to gain acceptance of more substantial configurations,

without testing the more substantial system, provided acceptable data are submitted justifying the selection of the "worst-case" configuration. A guard test specimen shall be defined as two posts at maximum spacing, all components, and all connections used in the test specimen. The specimen shall be subjected to the in-fill load test (6.2.2), the uniform load test (6.2.3), and the concentrated-load test (6.2.4), in that order. If a component(s) or connection(s) fails in any of the tests defined in 6.2.2, 6.2.3, or 6.2.4, a retest test may be performed after the failed component or connection is removed and replaced. The test series continues as defined in this section.

6.2.1.1 *One- and Two-Family Dwelling Requirements*—For compliance with the IBC and IRC, guards and handrails intended for use for one- and two-family dwellings shall satisfactorily pass only the load tests in 6.2.2 and 6.2.4.

6.2.2 *In-Fill Load Test*—The test specimen shall be tested and shall be capable of satisfactorily resisting a load of 125 lbf (556 N) applied over a one-square foot (0.0929-m^2) area normal to the in-fill. The in-fill is considered to be the load resisting elements between posts (vertical supports), such as balusters or panel fillers. The load shall be applied at a position on the in-fill that will represent the "worst-case" loading scenario. The guard is considered to satisfactorily pass if there is no failure, nor evidence of disengagement of any component, nor visible cracks in any component.

6.2.3 *Uniform Load Test*—The top rail of the guard system test specimen shall be separately subjected to a maximum uniform load of 125 plf (1825 N/m) applied vertically and horizontally. Alternatively, a single vector load shall be applied to the top rail where the *x* and *y* components of the vector load are equal to or greater than 125 plf (1825 N). For purposes of this test, quarter-point loading shall be deemed to be equivalent to uniform loading. The guard system is considered to satisfactorily pass if there is no failure, nor any evidence of disengagement of any component, nor visible cracks in any component.

6.2.4 *Concentrated Load Test for Guards*—A 500-lbf load (2224 N) shall be applied to the guardrail system at the maximum guardrail height. The load shall be applied at critical locations (for example, top rail midspan between posts, top rail adjacent to a post, top of a single post). In each case, when the applied load reaches 200 lbf (890 N), the deflection at the point of loading shall be recorded. The allowable deflection for the system at 200 lbf (890 N) shall not exceed either one of the following allowable deflection limits:

6.2.4.1 The sum of the rail height, *h* (in inches), divided by 24 plus the effective rail (guard) length, *l* (in inches), between the vertical supports divided by 96, or (h/24 + l/96), where the effective rail length is the distance between the edges of the posts. The deflection at the midspan of the top rail is measured relative to the center of the two posts (that is, it does not include post deflection).

6.2.4.2 The effective post height (vertical support) divided by 12, or (h/12). Where the effective post (vertical support) height is the distance from top-of-post to first point of support or first connector of the post to the supporting rim joist (in inches).

6.3 *Handrail Test Requirements (Concentrated Load)*—One handrail test specimen shall be constructed in the same manner as described in the manufacturer's installation instructions. Each handrail configuration, for which recognition is desired, shall be tested.

6.3.1 The mounting of handrails shall be such that the completed handrail and supporting structure are capable of withstanding a load of at least 200 lbf (890 N) when calculated using accepted engineering principles or 500 lbf (7300 N) when determined by test. The applied load shall be applied in any direction at any point on the handrail.

6.3.2 The handrail is considered to satisfactorily pass if there is no failure, nor any evidence of disengagement of any component, nor visible cracks in any component.

7. Report

7.1 Report the sampling plan and testing in accordance with the applicable standard used. Report the sample size and data used to make the calculations. For development of adjustment factors or other performance measures provide plots of the data and any curves fitted to the data.

7.2 *Product Description*—Report information concerning material specifications, thickness, size, and non-proprietary manufacturing process parameters.

7.3 *Installation Instructions*—Installation details and fastening methods. Where applicable, provide a description of the methods of field cutting, application, and finishing.

8. Independent Inspection

8.1 When building code listing is the objective of the investigation, the manufacturer shall employ a qualified agency for the purpose of monitoring the quality assurance process. The qualified independent agency shall establish or approve and monitor, or both, procedures for quality assurance.

8.2 *Qualified Agency*—A qualified agency is defined to be one that:

8.2.1 Is recognized by the appropriate building code organization,

8.2.2 Has trained technical personnel to verify that the workmanship and other characteristics of the products as determined by inspection, sampling, and testing comply with all applicable requirements specified in this specification,

8.2.3 Has written procedures to be followed by its personnel in performance of the inspection and testing,

8.2.4 Has no financial interest in, or is not financially dependent upon, any single company manufacturing the product being inspected or tested, and

8.2.5 Is not owned, operated, or controlled by any such company.

9. Manufacturing Standard

9.1 A manufacturing standard for each facility shall be written and maintained by the manufacturer. The manufacturing standard shall be approved by the qualified agency, and shall include specific provisions for each product. The standard shall specify all required quality assurance procedures.

9.2 The quality assurance program shall be designed to effectively monitor daily changes in material properties of the