Designation: ~~D6662 – 17~~ D6662 – 22

Standard Specification for Polyolefin-Based Plastic Lumber Decking Boards[1]

This standard is issued under the fixed designation D6662; 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 polyolefin-based plastic lumber products for use as exterior residential decking boards.

1.2 Plastic lumber products are currently made predominantly with recycled polyolefin plastics (in particular high-density polyethylene) where the products are more or less non-homogenous in the cross-section. However, this specification is also potentially applicable to similar manufactured plastic products made from other plastic and plastic composite materials that have non-homogenous cross-sections.

1.3 This specification details a procedure to calculate recommended span lengths for spacing of support joists. This procedure was developed using experimental data from a typical unreinforced plastic lumber made predominantly from recycled high-density polyethylene. The methodology to develop span lengths for other types and compositions of plastic lumber is detailed in Appendix X1 of this standard.

1.4 The values are stated in inch-pound units, as these are currently the most common units used by the construction industry. Equivalent SI units are indicated in parentheses. However, the units stated for irradiance exposure in the weatherability section (6.3) are in SI units as these are the units commonly used for testing of this type.

1.5 *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~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—There is no similar or equivalent ISO Standard.

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

2. Referenced Documents

2.1 The following documents of the issue in effect on the date of material purchase form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards:*[2]

[1] This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.20 on Plastic Lumber.

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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.

***A Summary of Changes section appears at the end of this standard**

D883 Terminology Relating to Plastics
D2565 Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications
D2898 Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
D2915 Practice for Sampling and Data-Analysis for Structural Wood and Wood-Based Products
D4329 Practice for Fluorescent Ultraviolet (UV) Lamp Apparatus Exposure of Plastics
D5033 Guide for Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics (Withdrawn 2007)[3]
D6109 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastic Lumber and Related Products
D6112 Test Methods for Compressive and Flexural Creep and Creep-Rupture of Plastic Lumber and Shapes
D6341 Test Method for Determination of the Linear Coefficient of Thermal Expansion of Plastic Lumber and Plastic Lumber Shapes Between –30 and 140°F (–34.4 and 60°C)
E84 Test Method for Surface Burning Characteristics of Building Materials
E108 Test Methods for Fire Tests of Roof Coverings
G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources
G154 Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials
G155 Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials

3. Terminology

3.1 *Definitions:*

3.1.1 *plastic lumber, n*—a manufactured product made primarily from plastic materials (filled or unfilled), typically used as a building material for purposes similar to those of traditional lumber, which is usually rectangular in cross-section. (Terminology D883)

3.1.1.1 *Discussion*—
Plastic lumber is typically supplied in sizes similar to those of traditional lumber board, timber and dimension lumber; however the tolerances for plastic lumber and for traditional lumber are not necessarily the same. (Terminology D883)

3.1.2 *resin, n*—a solid or pseudo solid organic material often of high molecular weight, which exhibits a tendency to flow when subjected to stress, usually has a softening or melting range, and usually fractures conchoidally. (Terminology D883)

3.1.2.1 *Discussion*—
In a broad sense, the term is used to designate any polymer that is a basic material for plastics. (1982)

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *bulge*—convex distortion (away from the center of the cross-section) of the face of the board from a straight line drawn from edge to edge across the width of the board.

3.2.2 *crook*—distortion of the board in which there is a deviation in a direction perpendicular to the edge from a straight line from end to end of the board.

3.2.3 *cup*—concave distortion (towards the center of the cross-section) of the face of the board from a straight line drawn from edge to edge across the width of the board.

3.2.4 *edge*—the side of a rectangular-shaped board corresponding to the thickness of the board.

3.2.5 *face*—the side of a rectangular-shaped board corresponding to the width of the board.

3.2.6 *thickness*—the lesser dimension of the cross-sectional profile of a rectangular-shaped board.

3.2.7 *width*—the greater dimension of the cross-sectional profile of a rectangular-shaped board.

3.3 Additional definition of terms applying to this specification appear in Terminology D883 and D5033.

4. Ordering Information

4.1 The information contained in this specification is intended to be helpful to producers, distributors, regulatory agencies and

[3] The last approved version of this historical standard is referenced on www.astm.org.

users. The information can also promote understanding between purchasers and sellers. The purchaser shall state whether this specification is to be used, select the preferred options permitted herein, and include the allowable design information in the invitation to bid and purchase order from the following:

4.1.1 Title, number and date of this specification,

4.1.2 Minimum allowable bending strength and allowable bending stiffness,

4.1.3 Percent recycled content (if requested),

4.1.4 Flame spread index,

4.1.5 Color,

4.1.6 Quantity in lineal feet,

4.1.7 Cut length,

4.1.8 Cross-sectional dimensions,

4.1.9 Packing requirements,

4.1.10 Palletization, if required,

4.1.11 Marking, if other than specified.

4.2 If specific mechanical property values are not required by the purchaser (for example, when purchasing materials for general retail sales distribution and not for a specific project), the manufacturer shall provide minimum allowable design information, as would be determined under this specification, to aid in the application of the decking board material by the end user.

5. Dimensions and Permissible Variations

It is permissible to produce decking boards either in sizes that are similar to the standard dimensions of the wood industry, or to proprietary dimensions designed by manufacturers. This specification does not limit the dimensional range of production. For reference, the standards of the wood industry are as follows:

5.1 *Thickness*—Unless otherwise specified in 4.1.8, boards shall be:

Nominal (in.)	Actual (in.)	Tolerance (in.)
1	¾	± 1⁄16
5⁄4	1	± 1⁄16
2	1-½	± 1⁄16

Tolerance on thickness of boards thicker than 2 inches (nominal) shall be ± 1⁄16 inch.

5.2 *Width of Boards*—Unless otherwise specified in paragraph 4.1.8, board widths shall be:

Nominal (in.)	Actual (in.)	Tolerance (in.)
3	2-½	± 1⁄16
4	3-½	± 1⁄16
6	5-½	± 1⁄16
8	7-¼	± 1⁄16
10	9-¼	± 1⁄16
12	11-¼	± 1⁄16

Tolerance on width of boards wider than 12 inches (nominal) shall be ± 1⁄16 inch.

5.3 *Length of Boards*—unless otherwise specified in 4.1.7, boards up to 20 feet shall have tolerances of +½ inch or -1⁄16 inch. Over 20 feet, the tolerances will be +½-inch or -1⁄16 inch per 20-ft of length or fraction thereof. Measurement of lengths to be made at 73 ± 2 °F and relative humidity of 50 ± 5 %.

5.4 *Flatness Tolerance*—Board shall be flat with maximum cup or bulge in the board face limited to the tolerances in Table 1. Linear interpolation of the values is acceptable for dimensions other than listed.

5.5 *Squareness*—Unless a specially shaped member is specified, the cross-section of all boards shall be visually rectangular (that is, the face and edge of the board are perpendicular to each other) and suited for the intended purpose.

5.6 *Crook*—Crook shall conform to the tolerances in Table 2. Linear interpolation of the values is acceptable for dimensions other than listed.

5.7 *Tongue and Groove*—Boards shall be without tongue and groove unless otherwise specified in 4.1.8. Because of load transfer between adjacent boards, the methodology and equations presented in section 6.1.4 for determining recommended maximum span lengths are not applicable to tongue and groove boards. Manufacturers of tongue and groove decking boards shall provide recommended span lengths based on sound engineering practice, taking into account some of the issues described in 6.1.4 below, as well as previous, in-service performance history.

6. Performance Requirements

6.1 *Flexural Properties:*

6.1.1 *Test Procedure*—D6109.

6.1.2 *Specimens Tested*—A minimum of 15 specimens shall be tested.

6.1.3 *Criteria*—(*1*) The mean value of the secant flexural modulus at 1 % outer fiber strain estimated statistically to within 5 % with 75 % confidence shall equal or exceed 50 000 psi. Table 3 shows the number of specimens required to establish the mean value at 75 % confidence interval with ± 5 % error using Practice D2915. (*2*) The 5 % lower tolerance limit at 75 % confidence flexural stress at 3 % outer fiber strain shall equal or exceed 1000 psi. If any specimen fails prior to reaching 3 % strain, then the flexural strength at failure for that specimen shall equal or exceed 1000 psi. The 5 % lower tolerance limit at 75 % confidence is computed by subtracting K-times the standard deviation from the mean value, where K is tabulated in statistics handbooks (and in Table 3 of Practice D2915) as a factor for a one-sided tolerance limit for the distribution. Table 4 shows the value of K for several sample sizes.

NOTE 2—Many standards require a minimum sample size of approximately 30 to balance testing costs against the large reductions in the allowable values for very small sample sizes.

NOTE 3—A16 in. on center joist spacing is considered typical standard spacing for residential deck construction. While 50 000 psi is given as a minimum flexural modulus, a modulus greater than 50 000 psi is potentially required for some decking board sizes in order to meet this spacing when determining span lengths per the guidance presented in 6.1.4 below. Alternatively, use span lengths less than 16 in. on center as needed.

NOTE 4—Concurrent to the development of this specification for Plastic Lumber Decking, a Standard Guide for the Design and Construction of Plastic Lumber Decking is being developed by Section D20.20.01 (under the Subcommittee D20.20 on Plastic Products). This Standard Guide is expected to be available sometime after this Specification has been approved and in use.

6.1.4 *Span Lengths*—Recommended maximum span lengths shall be determined using the following equations:

For concentrated loads on boards which are continuous over a minimum of two spans (such as decking boards) as shown in Fig. 1, the maximum recommended span shall be limited by either the stress or the deflection formula as follow, whichever provides the lesser span:

Stress Formula:

$$L = (64S\, F_b')/(13P) \quad (1)$$

Deflection Formula:

TABLE 1 Cup or Bulge Tolerances Relative to Nominal Width of the Board Face

Face Width, in.	≤4 in.	6 in.	8 in.	10 in.	12 in.
Tolerance	1⁄32 in.	1⁄16 in.	1⁄8 in.	3⁄16 in.	1⁄4 in.

TABLE 2 Crook Tolerances Relative to Nominal Length and Width of the Board

Length in Feet	≤4 in. Width	6 in. Width	8 in. Width	10 in. Width	12 in. Width
4–6	3/8 in.	1/4 in.	3/16 in.	1/8 in.	1/8 in.
8	1/2 in.	1/2 in.	3/8 in.	1/4 in.	3/16 in.
10	3/4 in.	5/8 in.	1/2 in.	7/16 in.	3/8 in.
12	1 in.	7/8 in.	13/16 in.	3/4 in.	9/16 in.
14	1-1/4 in.	1-1/8 in.	1 in.	7/8 in.	3/4 in.
16	1-1/2 in.	1-3/8 in.	1-1/8 in.	1 in.	7/8 in.

TABLE 3 Number of Specimens Required to Establish the Mean Value with an Error of ± 5 % with 75 % Confidence for Various Coefficients of Variation (COV) in the Data Set

COV Range, %	10–15	>15–20	>20–25	>25
No. of Specimens, N	15	23	34	~60

TABLE 4 Value of K for Establishing the Lower 5 % Lower Tolerance Limit with 75 % Confidence for Various Sample Sizes

No. of Specimens, N	15	30	Infinite
Value of K	1.991	1.869	1.645

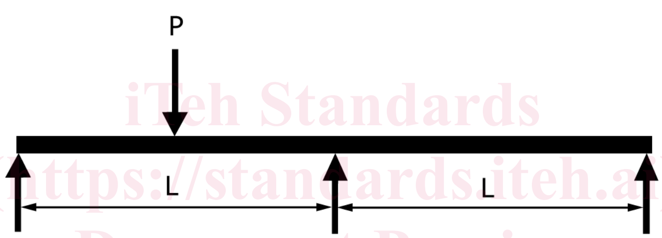

FIG. 1 Schematic of Concentrated Load on Boards that are Continuous Over Two Spans

$$L = [(67E'I)/(P\,k\alpha)]^{\frac{1}{2}} \quad (2)$$

For distributed (or uniform) loads on boards which are continuous over a minimum of two spans (such as decking boards) as shown in Fig. 2, the maximum span shall be limited by either the stress or the deflection formula as follow, whichever provides the lesser span:

Stress Formula:

$$L = [(8S\,F_b')(144)/(qb)]^{\frac{1}{2}} \quad (3)$$

Deflection Formula:

$$L = [(185E'I)(144)/(qb\,k\alpha)]^{\frac{1}{3}} \quad (4)$$

where:

L = computed span length, in.,
S = section modulus, in.^{3},
F_b' = allowable flexural stress as computed in 6.1.4.1, psi,
P = concentrated load, lb,
E' = effective modulus of elasticity as computed in 6.1.4.2, psi,

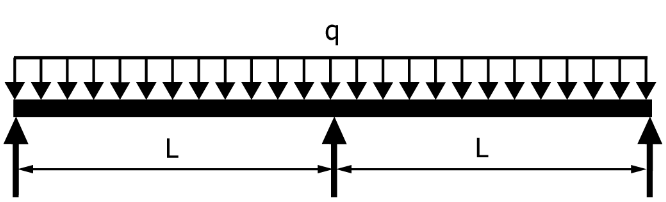

FIG. 2 Schematic of Distributed Load on Boards that are Continuous Over Two Spans

I = moment of inertia, in.^{4} ,
k = factor used to limit deflection to L/k (for example L/360 with k = 360; or L/120 with k = 120),
q = uniformly distributed load, lb/sq-ft,
b = actual board width, in., and
α = Creep Adjustment Factor = 1.5.

NOTE 5—The attached commentary in Appendix X1 provides a rationale for the Creep Adjustment Factor, α.

6.1.4.1 *Allowable Flexural Stress*—The allowable flexural stress, F_b', of the decking board is given as follows:

$$F_b' = (F_b/FS) \cdot C_D \cdot C_T \tag{5}$$

where:

F_b = the base flexural stress value for plastic lumber made of HDPE-type polyolefins for normal duration loading (10 yr. duration), psi,
FS = Factor of Safety = 1.5,
C_D = Load Duration Factor for flexural stress, presented in Fig. 3 and Table 5, depends on the shortest-duration load in combination, applied either cumulatively or continuously, and
C_T = Temperature Factor, Table 6.

F_b, the base flexural stress value for plastic lumber made of HDPE type polyolefins, is determined as follows:

$$F_b = F_{bt} \cdot 0.3 \tag{6}$$

where:

F_{bt} = the 5 % lower tolerance limit at 75 % confidence of the flexural stress at 3 % outer fiber strain determined from flexure tests conducted in accordance with Test Method D6109, and
0.3 = factor to convert the 3 minute test value to a ten year normal duration value (that is, a flexural stress equal to 30 % of F_{bt} will induce a 3 % outer fiber strain in ten years).

NOTE 6—The attached commentary in Appendix X1 provides a more detailed description of the development of C_D, C_T and 0.3 factors above, based on experimental data on typical plastic lumber. A general procedure to develop these factors for other types of plastic lumber is also provided in Appendix X1.

6.1.4.2 *Effective Modulus of Elasticity and Adjustment for Creep*—The effective modulus of elasticity, E', shall be determined as follows:

$$E' = (E \cdot C_T) \tag{7}$$

where:

E = the secant flexural modulus as defined in section 6.1, psi, and
C_T = Temperature Factor, Table 6.

The deflection, Δ_T, for the decking board can then be calculated as follows:

$$\Delta_T = \Delta_{e1} \cdot \alpha \tag{8}$$

TABLE 5 Load Duration Factor, C_D

Duration of Load	Load Duration Factor
Impact Load—1 s	4.81
1 min	3.62
3 min	3.34
Wind/Seismic Load—10 min	3.04
1 h	2.64
6 h	2.28
1 day	2.04
Construction Load—7 days	1.73
Snow Load—2 months	1.44
1 year	1.22
Floor Load—10 years	1.00
Permanent Load—30 years	0.91

Use linear interpolation to estimate C_D for any other duration of load, noting that the abscissa in Fig. 3 is on a logarithmic scale.

TABLE 6 Temperature Factor, C_T

Temperature, °F	C_T
32	1.71
63	1.14
73	1.00
100	0.63
122	0.43
140	0.30

Use linear interpolation to estimate C_T for any other temperature value.
The Load Duration Factors C_D and Temperature Factor C_T were developed using one typical unreinforced polyolefin-based plastic lumber. The methodology to obtain these factors for boards of other composition is outlined in Appendix X1.

where, Δ_{e1}, the instantaneous elastic deflection for the cases in Fig. 1 is given as

$$\Delta_{e1} = [PL^3]/[67E'I] \text{ for concentrated loads} \quad (9)$$

$$\Delta_{e1} = [qbL^4]/[(144)\cdot(185E'I)] \text{ for distributed loads} \quad (10)$$

For distributed loading at an average ambient temperature of 90°F the maximum creep deflection of the decking boards shall not exceed L/240.

NOTE 7—An example problem for the case of distributed loading is described in Appendix X2, Table X2.1.

6.2 *Dimensional Stability—Thermal Expansion:*

6.2.1 *Test Procedure*—D6341.

6.2.2 *Specimens Tested*—A minimum of 15 specimens shall be tested to establish the average value.

Report the measured coefficient of thermal expansion in the longitudinal direction to two significant figures for use in deck design calculations.

NOTE 8—This value has the potential to be of significant importance when the plastic lumber decking boards are used with other dissimilar materials involving differential thermal expansion under varying temperature conditions. For tongue and groove boards, the transverse thermal expansion coefficient is also occasionally needed to estimate required spacing between boards.

6.3 *Weatherability*

6.3.1 *Test Procedure for Surface Appearance Changes:*

6.3.1.1 *Exposure Conditions:* 6.3.1.1.1 Specimens to be tested shall be exposed to the xenon arc light source with daylight filters in accordance with Practices G151, G155 and D2565.

6.3.1.1.2 Use the following exposure conditions (control setpoints and control tolerances) for a total period of 2000 hours continuous light, cycling between:

2 hours light only	
Irradiance:	0.7 ± 0.02 W/(m²·nm) @340 nm or 77.0 ± 4.5 W/m² @300–400 nm or 736.0 ± 44.0 W/m² @300–800nm
Humidity (if used):	50 ± 5 % RH
Uninsulated Black Panel Temperature:	158 ± 4°F (70 ± 2.2°C)
2 hours light with water spray (on the exposed surface)	
Irradiance:	0.7 ± 0.02 W/(m²·nm) @340 nm or 77.0 ± 4.5 W/m² @300–400 nm or 736.0 ± 44.0 W/m² @300–800 nm
Humidity:	Not applicable
Uninsulated Black Panel Temperature:	Not applicable

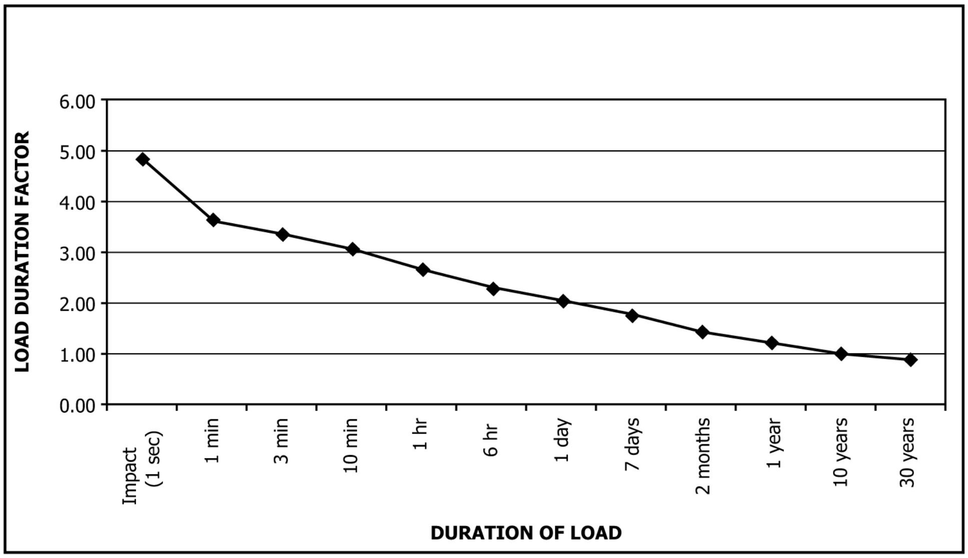

FIG. 3 Load Duration Factor for Plastic Lumber

NOTE 9—Immersion can be used as an alternative method to water spray to introduce moisture to the material surface.

6.3.1.2 *Specimens Tested:* 6.3.1.2.1 *Coupon Specimens*—Triplicate specimens of a size required to fit into the standard weathering chamber specimen holder.

6.3.1.3 *Period(s) of Exposure*—Specimens to be tested shall be exposed for a period of 2000 hours in accordance with section 6.3.1.1.

6.3.1.4 *Criteria of Degradation:* 6.3.1.4.1 Exposed samples shall be free of any visual surface changes such as peeling, chipping, cracking, flaking, pitting and non-uniform color changes.

6.3.2 *Test Procedure for Flexural Property Changes:*

6.3.2.1 *Exposure Conditions:* 6.3.2.1.1 Specimens to be tested shall be exposed to fluorescent UVA-340 radiation in accordance with Practices G151, G154 and D4329 Procedure 7.2.2 Cycle B.

6.3.2.1.2 Use the following exposure conditions (control setpoints and control tolerances) for a total period of 2000 hours, cycling between:

8 hours light only	
Irradiance:	0.72 ± 0.2 W/(m^2·nm) @340 nm
Uninsulated Black Panel Temperature:	158 ± 5°F (70 ± 2.8°C)
4 hours no light with condensation	
Irradiance:	Not applicable
Uninsulated Black Panel Temperature:	Not applicable

6.3.2.1.3 The surface of the plastic lumber specimens will need to be immersed in or sprayed with water in order to assure a wet surface during the no-light portion of the test cycle. The plastic lumber specimens are too thick and too great of an insulator to expect water to condense on the face of the specimen during the no light cycle.

6.3.2.2 *Specimens Tested:* 6.3.2.2.1 *Full Member Boards*—15 representative specimens shall be prepared and tested in flexure as described in Test Method D6109 with the loading noses on the unexposed side so that the exposed side is under tensile stress.

6.3.2.3 *Period of Exposure*—Specimens to be tested shall be exposed for a period of 2000 hours in accordance with section 6.3.2.1.

NOTE 10—The Building Officials and Code Administrators (BOCA) has accepted a screening test with Test Method D4329 at 1080 hour exposure in approving polyolefin based decking boards per BOCA International Evaluation Research Report 97-63, December 1999.

NOTE 11—As detailed in Appendix X3, there is experimental data that indicate that outdoor weathering over an 11 year period has negligible effect on the flexural strength and stiffness of polyolefin based plastic lumber decking boards. Thus, a 2000 hour screening test, such as that described above, can only be used to identify the products that are most susceptible to UV degradation and with the potential to deteriorate in two years or less under actual outdoor exposure.

6.3.2.4 *Criteria of Degradation*—The flexural secant modulus shall retain 90 % of the average value at 75 % confidence when tested without exposure.

6.3.3 *Hygrothermal Cycling:*

6.3.3.1 *Test Procedure*—Specimens shall also be prepared as described in Test Method D6109. Each specimen shall then be weighed to the nearest 0.00022 lb (0.1 g). Specimens shall then be totally submerged underwater (using weights to hold down, if necessary) for a period of 24 h. After removal from water, each specimen shall then be dried with a dry cloth on the outside surfaces and weighed again within 20 min. Specimens which exceed a 1 % weight gain shall be resoaked until such time as the weight changes less than 1 % per 24 hour period. Such specimens will then be considered to have reached moisture absorption equilibrium. Upon reaching this equilibrium the specimens shall be frozen to -20 °F (-29 °C) for 24 h, then returned to room temperature. This process comprises one hygrothermal cycle.

The above procedure shall be repeated two more times, for a total of three cycles of water submersion, moisture absorption equilibrium, and freezing. After completion of these steps, the specimens shall be returned to room temperature and tested as described in Test Method D6109.

6.3.3.2 *Specimens Tested*—A minimum of 15 specimens shall be prepared as per Test Method D6109 and tested.

6.3.3.3 *Criteria*—Note any obvious physical changes that occur as a result of the hygrothermal cycling. The flexural secant modulus and the greater of the stress level at 3 % strain or the stress at fracture as defined in Test Method D6109 shall retain 90 % of the average value at 75 % confidence when tested without hygrothermal cycling.

6.3.4 *Weathering for Code Applications:*

6.3.4.1 When plastic lumber materials are intended for use in applications where code requirements apply, materials shall meet the performance requirements for weathering (including exposure to temperature and moisture) contained in Method A from Practice D2898, as applicable to the materials and the conditions of use, except as indicated in 6.3.4.2.

6.3.4.2 When plastic lumber materials have no content of cellulosic materials, weathering in accordance with Practice D2898 is not required.

6.4 *Fire Properties:*

6.4.1 The flame spread index of plastic lumber decking boards shall be determined by testing in accordance with Test Method E84.

6.4.2 The test specimen shall either be self-supporting by its own structural characteristics or held in place by added supports along the test specimen surface. The test specimen shall remain in place throughout the test duration. Test results are invalid if one of the following occurs during the test: (a) the test specimen sags from its position in the ceiling to such an extent that it interferes with the effect of the gas flame on the test specimen or (b) portions of the test specimen melt or drop to the furnace floor to the extent that progression of the flame front on the test specimen is inhibited. Appendix X1 of Test Method E84 provides guidance on mounting methods.

6.4.3 Products shall have a flame spread index no greater than 200 when tested in accordance with Test Method E84.

NOTE 12—For combustible construction, codes often require fire performance at least equivalent to that of wood. A maximum flame spread index of 200 when tested in accordance with Test Method E84 is considered to be equivalent to that of wood. For outdoor applications, there is no requirement specified for smoke developed index.

NOTE 13—Fire retardants are available to increase the resistance to ignitability and flame spread of plastic lumber and shall be incorporated as needed.

6.4.4 The plastic lumber industry has developed a qualification fire test based on end-use of the material in decking. This method, a modification of Test Methods E108 originally intended for roofing materials, is presented in Appendix X4 along with a commentary for its use.

6.5 *Slip Resistance:*

6.5.1 There is currently no universal consensus of requirements for slip resistance for residential decking regardless of the material of construction. Over the years, a variety of ASTM test methods have been developed to measure the slip resistance or the coefficient of friction of various materials. However, the test results can be significantly influenced by climatic and interfacial conditions, which the different methods do not necessarily take into account. The existing ASTM test methods are, therefore, not considered sufficient to establish minimum slip resistance criteria for publication in this plastic lumber decking board standard.

NOTE 14—ASTM is currently coordinating slip resistance specification issues at a Society level. Committee Section D20.20.01 on Plastic Lumber will continue to look to the recommendations from this effort for guidance on this issue.

6.5.2 As with all types of decking materials, in some cases egress areas will require specific surface treatments in order to reduce the possibility of accidental slipping.

7. Specimen Conditioning

7.1 *Conditioning of Specimens for Tests*—Unless specifically stated otherwise, all specimens shall be conditioned and tested in accordance with the appropriate test method.

8. Workmanship, Finish, and Appearance

8.1 The decking furnished in accordance with this specification shall be an acceptable match to approved samples in pattern, color, and surface appearance. The product shall be free of defects that adversely affect performance or appearance. Such defects include blemishes, spots, indentations, cracks, blisters, and breaks in corners or edges.

9. Certification

9.1 When requested, a manufacturer's certification and any other documents required to substantiate certification shall be furnished stating that the material was manufactured to meet this specification.

10. Product Marking

10.1 Unless otherwise specified in the purchase order or contract, shipping containers shall be marked with the name of the material as defined by the contract under which the shipment is made, the size, thickness, length, color, quantity, lot number, date, location and name of the manufacturer shall be included.

11. Quality Assurance

11.1 This section presents a quality assurance program for the manufacturer to put into place to verify compliance with specific portions of this specification. The program shall include the following at a minimum:

11.1.1 *Material Specification,* including incoming material inspection and acceptance requirements.

11.1.2 Sampling and inspection frequencies shall be devised to encompass all variables that affect the quality of the finished product including lot-to-lot variations from different production runs. Increased frequencies shall be used in connection with new or revised facilities. A random sampling scheme shall generally be used for specimen selection. As a minimum, properties to be verified in the quality assurance program include: (*1*) Dimensions and Permissible Variations, per Section 5 and (*2*) Flexural Properties, per Section 6.

NOTE 15—Increased sampling and test frequencies shall be a useful procedure when investigating apparent data trends or adjustments in process. It is desirable at times to deviate from a random sampling scheme while investigating effects of specific variables.

11.1.3 Procedures to be followed upon failure to meet specifications or upon out of control conditions shall be specified. Included shall be re-examination criteria for suspect material and material rejection criteria.

11.1.4 Finished product marking, handling, protection, and shipping requirements as they relate to the performance of the finished product shall be defined.

11.2 *Inspection Personnel*—All manufacturing personnel responsible for quality control shall have knowledge of the inspection and test procedures used to control the process of the operation and calibration of the recording and test equipment used and of maintenance and interpretation of quality control records.

11.3 *Record Keeping*—All pertinent records shall be maintained on a current basis and be available for review. Records shall include:

11.3.1 Inspection reports and records of test equipment calibration, including identification of personnel conducting tests.

11.3.2 All test data, including retesting and data associated with rejection production and corrective actions taken.

11.4 *Testing Equipment*—Testing equipment shall be properly maintained, calibrated and evaluated for accuracy and adequacy at a reasonable frequency.

11.5 *Retest and Rejection*—If the results of any selected quality tests do not meet the requirements, conduct the test(s) again in accordance with statistically valid sampling techniques if agreed upon between the purchaser and the seller. There shall be no agreement to lower the minimum requirements or omitting tests that form a part of this specification, substituting or modifying a test method or by changing the specification limits. In retesting, the product requirements of this specification shall be met. If upon retest, failure occurs, the quantity of product represented by the test(s) shall be rejected.

12. Packaging and packing

12.1 The decking shall be packaged in accordance with normal commercial practice and packed to assure acceptance by common carrier and to provide protection against damage during normal shipping, handling, and storage.

13. Keywords

13.1 plastic lumber; plastic decking; recycled plastics; residential decks

APPENDIXES

(Nonmandatory Information)

X1. RATIONALE (COMMENTARY) REGARDING SECTION 6.1.4—RECOMMENDED SPAN LENGTHS

X1.1 The determination of span lengths is relatively straightforward and uses elementary analysis principles. The maximum recommended span is controlled by either the maximum permissible flexural stress or the deflection limit. The allowable flexural stress, F_b', and the effective modulus of elasticity E' are needed to compute the maximum recommended span lengths as detailed in section 6.1.4.1 for unreinforced polyolefin-based plastic lumber materials.

X1.2 Extensive experimental and analytical work conducted at Louisiana State University (LSU) over a four-year period ("Flexural Creep Analysis of Recycled Polymer Structural Elements," Ph.D. dissertation by Jose N. Martinez-Guerrero, Department of Civil and Environmental Engineering, LSU, Baton Rouge, LA, August 1999) has led to the development of an empirical creep model which predicts the strain, ε, as a function of time, t, the applied stress, σ, and the service temperature, T. These creep experiments were conducted per Test Methods D6112 under four point flexure. This model, given below, has been verified by creep tests conducted at different combinations of stress and temperature levels. The model below was chosen from several empirical and micro-mechanical models that were developed and evaluated:

$$\varepsilon = (a_1 + a_2 t^m) exp\left(\frac{T}{a_3}\right)(\sigma^n) \quad \text{(X1.1)}$$