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DEPARTMENT OF COMMERCE (DOC) VOLUNTARY PRODUCT STANDARDS

DOC Voluntary Product Standards are developed under procedures published by the Department of Commerce in Title 15 Code of Federal Regulations Part 10, *Procedures for the Development of Voluntary Product Standards.* The purpose of these standards is to establish nationally recognized requirements for products and to provide all concerned interests with a basis for common understanding of the characteristics of the products. The National Institute of Standards and Technology (NIST) administers the Voluntary Product Standards program on a reimbursable basis.

ROLE OF NIST

The role of NIST in the establishment of a DOC Voluntary Product Standard is to act as an unbiased coordinator in the development of the standard, provide editorial assistance in the preparation of the standard, supply such assistance and review as is required to assure the technical soundness of the standard, and seek satisfactory adjustment of valid points of disagreement. NIST also determines compliance with the criteria of the Department's procedures and publishes the standard as a public document.

Producers, distributors, users, consumers, and other interested groups contribute to the establishment of Voluntary Product Standards. These groups initiate and participate in the development of the standards, provide technical or other counsel as appropriate, promote the use of and support for the standards, and assist in keeping them current with respect to advancing technology and marketing practices.

USE OF VOLUNTARY PRODUCT STANDARDS

The use of DOC Voluntary Product Standards is voluntary. NIST has no regulatory power in the enforcement of their provisions; however, since the standards represent a consensus of interested groups, their provisions are likely to become established as trade customs.

The benefits derived from a DOC Voluntary Product Standard are in direct proportion to their general recognition and actual use. Producers and distributors whose products meet the requirements of a DOC Voluntary Product Standard may refer to the standard in advertising and on labels to promote greater public understanding for confidence in their products. At times, purchasers may order products conforming to the requirements of a DOC Voluntary Product Standard.

Abstract

This standard covers performance requirements, adhesive bond performance, panel construction and workmanship, dimensions and tolerances, marking, and moisture content of wood structural panels. Wood structural panels include structural plywood, oriented strand board (OSB), other mat-formed panels, and composite panels. The standard classifies panels by bond classification, span rating, performance category, and grade. It provides test methods, a glossary of trade terms and definitions, and a quality certification program whereby agencies inspect, sample, and test products for conformance to this standard. Information regarding industry practices for reinspection, a qualification flowchart, history of the standard, labeling, and environmental attributes are provided in nonmandatory appendices.

Keywords

Adhesive bond classification; certification; construction sheathing; wood structural panel; dimensions and tolerances; marking; moisture content; oriented strand board; OSB; panel construction; performance requirements; span rating; mat-formed panel; performance category; structural plywood; test methods; voluntary standard; wood-based panels.

CONTENTS

VOLUNTARY PRODUCT STANDARD PS 2-18

PERFORMANCE STANDARD FOR WOOD STRUCTURAL PANELS

Initially Approved as PS 2-92 August 27, 1992 (See Appendix C)
This Revision Approved March 30, 2019

(This standard, initiated by *APA – The Engineered Wood Association,* has been developed under the Procedures for the Development of Voluntary Product Standards for the U.S. Department of Commerce.)

1 SCOPE

1.1 This Voluntary Product Standard primarily establishes structural criteria for assessing the acceptability of wood structural panels for construction sheathing and single floor applications and provides a basis for common understanding among the producers, distributors, and the users of these products. The standard does not address non-structural issues such as resistance to biological agents. Applications other than construction sheathing and single floor may require additional engineering considerations that are not covered by this document.

1.2 This standard covers the performance requirements, adhesive bond performance, panel construction and workmanship, dimensions and tolerances, marking, and moisture content of wood structural panels.

1.3 This standard includes test methods to determine compliance and a glossary of trade terms and definitions. A quality certification program is provided whereby qualified testing agencies inspect, sample, and test products for qualification under this standard. Information regarding industry practices for reinspection is provided in Appendix A. A flowchart depicting the qualification process is provided in Appendix B. Information on the maintenance, history, and current edition of the standard is provided in Appendix C. Recommended thickness labeling is provided in Appendix D. Information on labeling regulations from NIST Handbook 130 and Handbook 133 are provided in Appendix E. Information on formaldehyde emissions is provided in Appendix F.

1.4 This standard incorporates the International System of Units (SI) as well as customary units of measurement. The values given in SI units are the standard. The values given in parentheses are for information only. In conversion of customary units where exact placement is not an issue, such as nail spacing, approximate conversions to SI units are made to yield more easily recognizable numbers. In critical matters, such as panel thickness, exact conversions to SI units are made. For nominal customary units, actual dimensions in SI units are given.

1.5 Advisory notes in this standard shall not be considered mandatory.

2 TERMINOLOGY

2.1 Composite panel

Any panel containing a combination of veneer and other wood-based material.

2.2 Delamination

For plywood or composite panels, delamination is a visible separation between plies or layers that normally receive adhesive at their interface and are firmly contacted in the pressing operation. Wood characteristics, such as checking, leafing, splitting, and broken grain, are not to be construed as delamination.

2.3 Exposure 1

A bond classification for structural panels suitable for uses not permanently exposed to the weather. Panels classified as Exposure 1 are intended to resist the effects of moisture on structural performance due to active construction.

2.4 Exterior

A bond classification for structural plywood suitable for repeated wetting and redrying or long-term exposure to weather or other conditions of similar severity.

2.5 Furnish

Wood-based material, such as flakes or strands, including applied resin, wax and other additives, as the primary constituent of mat-formed panels.

2.6 Mat-formed panel

Any wood-based panel that does not contain veneer, consistent with the definition of wood structural panels.

2.7 Mill specification

A document that defines product characteristics that affect (or may affect) the classification (Section 4) and/or the performance of the product relative to the requirements of this standard. The mill specification is unique to each qualified product of a given grade. The specification is used in the mill quality program as audited under third-party inspection.

2.8 Moisture resistant adhesive

Adhesive capable of bonding structural panels in a manner to satisfy the bond classification requirements of this standard.

2.9 OSB

An abbreviation for oriented strand board, a multi-layered board made from strands of wood, together with a binder, by the application of heat and pressure, with the strands in the external layers primarily oriented along the panel's strength axis.

2.10 Performance Category

A panel designation related to the panel thickness range that is linked to the nominal panel thickness designations used in the International Building Code (IBC) and International Residential Code (IRC). For purposes of labeling, as defined in Section 5.2.1.2, abbreviations PERF CAT, CAT, or Category are permitted.

Advisory Note: The IBC and IRC specify a minimum 3/8 Performance Category for wall sheathing.

2.11 Performance standard

A standard for trademarked products based on performance. Performance is measured by tests that approximate intended end-use conditions.

2.12 Plywood

A conventional all-veneer panel with alternate layers of veneer running perpendicular to one another. For all-veneer panels, a layer is a single veneer ply or two or more adjacent plies with grain direction parallel.

2.13 PS 1

Voluntary Product Standard PS 1-09 "Structural Plywood." Later issues of Voluntary Product Standard PS 1 shall be permitted providing the requirements are applicable and consistent with the issue designated.

2.14 Reference value

The numerical value established for the mill specification for a given mechanical or physical property.

2.15 Sample

A set of specimens analyzed together.

2.16 Sample average

The average test value, obtained by summing the observations and dividing by the number of tests.

2.17 Sample standard deviation

A measure of test variation. Calculated as:

$$S = \sqrt{\frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n-1}}$$

where:

S = sample standard deviation
x = test observation
n = number of observations.

2.18 Shop-cutting panel

A panel that has been rejected as not conforming to a panel grade because of deficiencies, other than adhesive bond quality, which prevent it from meeting the requirements of this standard. Such a panel shall be identified with a separate mark as specified in Section 8.3.1.

2.19 Sized for Spacing

An optional panel mark indicating that the panel manufacturer has sized the panel to allow for industry recommended panel installation spacing.

2.20 Specimen

The individual test piece.

2.21 Strength axis

The axis parallel to the face and back orientation of the flakes or the grain (veneer), which is generally the long panel direction, unless otherwise marked.

2.22 Wood Structural Panel

A panel product composed primarily of wood that, in its commodity end use, is essentially dependent upon certain mechanical and/or physical properties for successful end-use performance. Such a product carrying the trademark of a qualified inspection and testing agency shall conform to performance requirements of one or more of the end-uses contained herein and, where applicable, approved by one or more national regulatory agencies for single-layer floors or for sheathing with respect to roofs, subfloors, and walls. Such a panel shall be identified in a manner clearly conveying its intended end use. The International Building Code and International Residential Code (see Section 3.2) use the term “wood structural panel” to refer to panels that comply with PS 2 and PS 1.

2.23 Test exposure condition

The exposure condition to which a panel is subjected prior to test. The following terms apply to the panel moisture conditioning used during performance testing:

Dry test condition – Panel moisture content is within +/- 3% of the as-shipped moisture content.

Wet test condition – Panel moisture content upon three days of one-sided wetting.

Wet/redry test condition – After three days of one-sided wetting, the panel is dried until the panel moisture content is within +/- 3% of the as-shipped moisture content.

As-shipped moisture content – The expected panel moisture content when the panels are shipped from the panel manufacturer’s production facility.

3 REFERENCE PUBLICATIONS

3.1 ASTM standards[1]

- E 72-15 Standard Test Methods for Conducting Strength Tests of Panels for Building Construction
- E 661-03 Standard Test Method for Performance of Wood and Wood-Based Floor and Roof Sheathing Under Concentrated Static and Impact Loads
- D 1037-12 Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
- D 1761-12 Standard Test Methods for Mechanical Fasteners in Wood
- D 3043-17 Standard Test Methods for Structural Panels in Flexure
- D 4442-16 Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials
- D 2915-17 Standard Practice for Evaluating Allowable Properties for Grades of Structural Lumber

3.2 Other documents

- Voluntary Product Standard PS 1-09 – Structural Plywood[2]
- CSA-O325.0-2016 Construction Sheathing[3]
- International Building Code. International Code Council. Country Club Hills, IL.
- International Residential Code for One- and Two-Family Dwellings. International Code Council. Country Club Hills, IL.
- ISO/IEC 17020, Conformity Assessment – Requirements for the Operation of Various Types of Bodies Performing Inspection
- ISO/IEC 17025, General Requirements for the Competence of Testing and Calibration Laboratories
- ISO/IEC 17065, Conformity Assessment – Requirements for bodies certifying products, processes and services

4 CLASSIFICATION

4.1 General

The wood structural panels covered by this standard are specified by bond classification, span rating, performance category, and grade.

4.1.1 Bond classification

The bond classification is related to the moisture resistance of the glue bond under intended end-use conditions and does not relate to the physical (erosion, ultraviolet, etc.) or biological (mold, fungal decay, insect, etc.) resistance of the panel. This standard covers structural panels with Exterior (see section 2.4) and Exposure 1 (see section 2.3) bond classifications.

4.1.2 Grade

This standard covers grades of wood structural panels designed and manufactured for Sheathing, Structural I Sheathing, Single Floor and Structural I Single Floor.

4.1.2.1 Sheathing

A wood structural panel intended for use in construction applications as covering material for roofs, subfloors, and walls when fastened to supports spaced in accordance with the span rating.

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[1] Copies of these publications are available from ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, www.astm.org.

[2] Copies of the current standard are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 and the Standards Services Division, National Institute of Standards and Technology, 100 Bureau Drive, Stop 2100, Gaithersburg, MD 20899-2100, web site: standards.gov.

[3] Copies of this publication are available from the Canadian Standards Association, 5060 Spectrum Way, Mississauga, ON, Canada L4W 5N6, www.csa.ca.

4.1.2.2 Structural I Sheathing

A wood structural panel consistent with that described in Section 4.1.2.1, except that Structural I panels meet additional requirements in this standard for cross-panel strength and stiffness and for racking load performance.

4.1.2.3 Single Floor

A wood structural panel intended for use as combination subfloor and underlayment when fastened to supports spaced in accordance with the span rating.

4.1.2.4 Structural I Single Floor

A wood structural panel consistent with that described in Section 4.1.2.3 that also meets the additional requirements in this standard for cross-panel strength and stiffness and racking load performance.

4.1.3 Span rating

An index number, based on customary inch units, that identifies the recommended maximum center-to-center support spacing for the specified end use under normal use conditions. Spans are defined for end uses such as roof, wall, subfloor, and single floor. As a matter of convention, spans are typically specified singly for wall (Wall 24) and single floor (Floor 24 o.c.), while roof and subfloor are often combined in a fractional format. For example, a span rating of 32/16 designates a roof span of 32 inches and a subfloor span of 16 inches.

4.1.4 Performance Category

A panel designation related to the panel thickness range that is linked to the nominal panel thickness designations used in the International Building Code (IBC) and International Residential Code (IRC). For purposes of labeling, as defined in Section 5.2.1.2, abbreviations PERF CAT, CAT or Category are permitted.

ADVISORY NOTE: The IRC and IBC specify a minimum 3/8 Performance Category for wall sheathing.

5 REQUIREMENTS

5.1 General

Wood structural panels represented as conforming to this standard shall meet all applicable requirements set forth herein.

5.2 General Requirements

5.2.1 Dimensional tolerances and squareness of panels

5.2.1.1 Size

A length and a width measurement shall be made at a location 50 mm to 75 mm (2 in. to 3 in.) from the panel edge. A tolerance of plus or minus 1.6 mm (1/16 in.) shall be allowed on manufacturer's stated length and/or width.

5.2.1.2 Performance Category and Thickness Tolerance

A tolerance of plus or minus 0.8 mm (for metric basis) or 1/32 in. (for English basis) shall be allowed on the trademark-specified Performance Category of 20.5 mm (13/16 in.) and less, and +/- 5% of the trademark-specified Performance Category for panels thicker than 20.5 mm (13/16 in.), unless a closer tolerance is determined through qualification testing.

Panel thickness shall be measured with a micrometer having 19.1 mm (3/4 in.) (minus 0, plus 1.3 mm [0.050 in.]) diameter anvils. Measurements shall be taken at an applied anvil pressure of not less than 34 kPa (5 psi) or more than 69 kPa (10 psi) with the anvil center at 19 to 25 mm (3/4 to 1 in.) from the panel edge. The location of the measurements shall be representative of panel thickness mid-length, +/- 50 mm (2 in.) along each edge of the panel and the average of the four measurements shall be taken as the thickness of that panel. If a measurement point contains a permissible grade characteristic that affects panel thickness, then the measurement point shall be shifted from that point.

The panel thickness shall conform to Table 1.

Table 3. Uniform load performance criteria for panels tested according to Section 7.2. (See Section 6.2.2.2 for pass/fail criteria)

End Use - Span Rating	Test Exposure Conditions[b]	Performance Criteria: Average Deflection Under Load	Ultimate Uniform Load: kPa	Ultimate Uniform Load: lbf/ft²
Wall - 16[c]	Dry	6.8 mm at 1.20 kPa (0.267 in. at 25 lbf/ft²)	3.6	75
Wall - 24[c]	Dry	10.2 mm at 1.20 kPa (0.400 in. at 25 lbf/ft²)	3.6	75
Roof - 16[a]	Dry	1.7 mm at 1.68 kPa (0.067 in. at 35 lbf/ft²)	7.2	150
Roof - 20[a][d]	Dry	2.0 mm at 1.68 kPa (0.080 in. at 35 lbf/ft²)	7.2	150
Roof - 24[a]	Dry	2.5 mm at 1.68 kPa (0.100 in. at 35 lbf/ft²)	7.2	150
Roof - 32	Dry	3.4 mm at 1.68 kPa (0.133 in. at 35 lbf/ft²)	7.2	150
Roof - 40	Dry	4.2 mm at 1.68 kPa (0.167 in. at 35 lbf/ft²)	7.2	150
Roof - 48	Dry	5.1 mm at 1.68 kPa (0.200 in. at 35 lbf/ft²)	7.2	150
Roof - 54	Dry	5.7 mm at 1.68 kPa (0.225 in. at 35 lbf/ft²)	7.2	150
Roof - 60	Dry	6.4 mm at 1.68 kPa (0.250 in. at 35 lbf/ft²)	7.2	150
Subfloor - 16	Dry Wet/Redry	1.1 mm at 4.79 kPa (0.044 in. at 100 lbf/ft²)	15.8	330
Subfloor - 20[d]	Dry Wet/Redry	1.3 mm at 4.79 kPa (0.053 in. at 100 lbf/ft²)	15.8	330
Subfloor - 24	Dry Wet/Redry	1.7 mm at 4.79 kPa (0.067 in. at 100 lbf/ft²)	15.8	330
Subfloor - 32	Dry Wet/Redry	2.2 mm at 4.79 kPa (0.088 in. at 100 lbf/ft²)	15.8	330
Subfloor - 48	Dry Wet/Redry	3.4 mm at 3.83 kPa (0.133 in. at 80 lbf/ft²)	10.8	225
Single Floor - 16	Dry Wet/Redry	1.1 mm at 4.79 kPa (0.044 in. at 100 lbf/ft²)	15.8	330
Single Floor - 20[d]	Dry Wet/Redry	1.3 mm at 4.79 kPa (0.053 in. at 100 lbf/ft²)	15.8	330
Single Floor - 24	Dry Wet/Redry	1.7 mm at 4.79 kPa (0.067 in. at 100 lbf/ft²)	15.8	330
Single Floor - 32	Dry Wet/Redry	2.2 mm at 4.79 kPa (0.088 in. at 100 lbf/ft²)	15.8	330
Single Floor - 48	Dry Wet/Redry	3.4 mm at 3.83 kPa (0.133 in. at 80 lbf/ft²)	10.8	225

[a] Panels with Roof - 16 and Roof - 20 rating shall also meet performance requirements for Wall - 16 rating. Panels with Roof - 24 rating shall also meet requirements for Wall - 24 rating.

[b] Wet/Redry shall be exposure to three days of continuous wetting, followed by testing dry. Dry shall be within +/- 3% of the as-shipped moisture content.

[c] The panel strength axis shall be placed along the supports for testing, unless otherwise specified.

[d] The "20" span rating designation is intended for end-use spans of 19.2 inch.

Table 4. Uniform load performance criteria for Structural I Sheathing and Single Floor panels tested according to Section 7.2. (Also see Section 5.3.1.2 and Section 6.2.2.2 for pass/fail criteria)

Performance Category and Span Rating	Test Exposure Conditions[a]	Performance Criteria: Average Deflection Under Load	Ultimate Uniform Load: kPa	Ultimate Uniform Load: lbf/ft²
Structural I Sheathing				
7/16 Category 24/16	Dry	2.5 mm at 0.96 kPa (0.100 in. at 20 lbf/ft²)	4.3	90
15/32 Category 32/16	Dry	2.5 mm at 1.68 kPa (0.100 in. at 35 lbf/ft²)	6.5	135
1/2 Category 32/16	Dry	2.5 mm at 1.92 kPa (0.100 in. at 40 lbf/ft²)	7.2	150
19/32 & 5/8 Category 40/20	Dry	2.5 mm at 3.35 kPa (0.100 in. at 70 lbf/ft²)	11.5	240
23/32 & ¾ Category 48/24	Dry	2.5 mm at 4.31 kPa (0.100 in. at 90 lbf/ft²)	14.4	300
Structural I Single Floor				
19/32 & 5/8 Category 20 o.c.	Dry	2.5 mm at 2.40 kPa (0.100 in. at 50 lbf/ft²)	8.6	180
23/32 & ¾ Category 24 o.c.	Dry	2.5 mm at 3.84 kPa (0.100 in. at 80 lbf/ft²)	13.0	270

[a] Dry shall be within +/- 3% of the as-shipped moisture content.

Table 5. Racking load performance criteria for panels tested according to Section 7.3. (See Section 6.2.2.3 for pass/fail criteria)																	
Performance Category	Test Exposure Condition[b]	Nail Size (dia. x length)		Nail Spacing				Test Load				Performance Criteria[a]					
												Deflection @ Test Load		Ultimate Load			
				Panel Edge		Inter-mediate Studs[c]		Sheathing		Structural I Sheathing and Structural I Single Floor				Sheathing		Structural I Sheathing and Structural I Single Floor	
		mm	in.	mm	in.	mm	in.	kN/m	lbf/ft	kN/m	lbf/ft	mm	in.	kN/m	lbf/ft	kN/m	lbf/ft
Less than 5/16	Dry	2.9 x 51	0.113 x 2.0	150	6	300	12	2.2	150	---	---	5.1	0.2	9.5	650	---	---
								4.4	300	---	---	15.2	0.6				
5/16	Dry	2.9 x 51	0.113 x 2.0	75	3	300	12	5.1	350	---	---	5.1	0.2	14.3	980	---	---
3/8	Dry	3.3 x 64	0.131 x 2.5	75	3	300	12	6.0	410	6.7	460	5.1	0.2	16.8	1150	18.8	1290
7/16	Dry	3.3 x 64	0.131 x 2.5	75	3	300	12	6.6	450	7.4	505	5.1	0.2	18.4	1260	20.7	1415
15/32	Dry	3.8 x 76	0.148 x 3.0	75	3	300	12	8.8	600	9.7	665	5.1	0.2	24.5	1680	27.1	1860
19/32 and greater	Dry	3.8 x 76	0.148 x 3.0	75	3	300	12	9.7	665	9.7	665	5.1	0.2	27.1	1860	27.1	1860

[a] Stud spacing – 405 mm (16 in.) o.c. for Wall-16, Roof-16, and Roof-20; 610 mm (24 in.) o.c. for all other span ratings and all Structural I Sheathing and Structural I Single Floor panels.

[b] Dry shall be within +/- 3% of the as-shipped moisture content.

[c] For studs spaced 610 mm (24 in.) o.c., nail spacing on intermediate studs shall be 150 mm (6 in.) o.c. for panels with a Performance Category of 7/16 and less.

Table 6. Fastener performance criteria under lateral and withdrawal loads for panels tested according to Section 7.4. (See Section 6.2.2.4 for pass/fail criteria)									
						Performance Criteria for Ultimate Load[c]			
Grade	End Use	Performance Category	Nail Size[a] (dia. x length)		Test Exposure Condition[b]	Lateral Nail holding		With-drawal	
			mm	in.		N	lbf	N	lbf
Sheathing	Wall	Through 1/2	2.9 x 51	0.113 x 2.0	Dry	778	175	[d]	[d]
		Greater than 1/2	3.3 x 64	0.131 x 2.5	Wet/Redry	600	135	[d]	[d]
	Roof	Through 1/2	2.9 x 51	0.113 x 2.0	Dry	778	175	89	20
		Greater than 1/2	3.3 x 64	0.131 x 2.5	Wet/Redry	600	135	67	15
	Subfloor	Through 1/2	2.9 x 51	0.113 x 2.0	Dry	934	210	89	20
		Greater than 1/2	3.3 x 64	0.131 x 2.5	Wet/Redry	712	160	67	15
Single Floor	Floor	Through 1/2	2.9 x 51	0.113 x 2.0	Dry	934	210	89	20
		Greater than 1/2	3.3 x 64	0.131 x 2.5	Wet/Redry	712	160	67	15

[a] Common smooth-shank nail.

[b] Wet/redry shall be exposure to three days of continuous wetting, followed by testing dry. Dry shall be within +/- 3% of the as-shipped moisture content.

[c] Tabulated values represent the 10th percentile with 75% confidence from 20 specimens.

[d] Not applicable.

Table 7. Exposure 1 Criteria for OSB Tested Along the Strength Axis According to Section 7.6, Cycled According to Section 7.16[a] (See Section 6.2.4.1(d) for pass/fail criteria)			
		Bending Capacity (Required Moment)	
Performance Category	End Use - Span Rating	N-mm/mm	lbf-in./ft
3/8	Roof - 24	310	830
7/16	Roof - 24/Subfloor - 16	350	950
15/32 & 1/2	Roof - 32/Subfloor - 16	380	1,030
19/32 & 5/8	Roof - 40/Subfloor - 20	450	1,210
23/32 & 3/4	Roof - 48/Subfloor - 24	640	1,720
9/16	Single Floor - 16	390	1,060
19/32 & 5/8	Single Floor - 20	420	1,130
23/32 & 3/4	Single Floor - 24	610	1,650
7/8 & 1	Single Floor - 32	1,000	2,690
1-1/8	Single Floor - 48	1,140	3,060

[a] Bond performance may also be established using procedures defined in Section 6.2.4.1.e.

5.3.3 Bond performance

Panels shall meet the performance requirements of Sections 5.3.3.1 through 5.3.4.3 for properties that affect the adhesive bonding system when tested in accordance with the referenced test method. Section 6.2.4 details specimen requirements and additional test set procedures.

5.3.3.1 Bond classification

Wood structural panels shall meet the bond requirements listed below for their respective exposure bond classification.

a. Exterior Plywood – Plywood rated as Exterior shall meet PS 1 bond requirements for Exterior panels. Exterior delamination in plywood is a visible separation at a single glueline that exceeds 19.4 cm^2 (3 $in.^2$) in an area coinciding with open knotholes, pitch pockets, splits, gaps and other voids or characteristics permitted in the panel grade.

b. Exposure 1 Plywood – Plywood rated as Exposure 1 shall meet PS 1 bond requirements for Exposure 1. Exposure 1 delamination in plywood is a visible separation in any glueline that exceeds 19.4 cm^2 (3 $in.^2$) except where directly attributable to characteristics permitted in the grade as follows:

- Knots and knotholes – not to exceed the size permitted in the grade plus a surrounding band not wider than 19.1 mm (3/4 in.).
- Other permissible grade characteristics – not to exceed the size permitted in the grade.

c. Exposure 1 Composite panels - Composite panels rated as Exposure 1 shall satisfy the delamination requirements of Section 6.2.4.1.c when tested in accordance with Section 7.13, following moisture cycling according to Section 7.17. Exposure 1 delamination in composites is a visible separation along a test specimen edge and/or end, between veneer-to-veneer or veneer-to-wood-based material gluelines, not to exceed 6.4 mm (1/4 in.) depth for a continuous length of 25 mm (1 in.).

d. Exposure 1 OSB – OSB panels rated as Exposure 1 shall meet or exceed the criteria in Table 7 when tested in accordance with method Section 7.6 following moisture cycling according to Section 7.16 or the procedures of Section 5.3.3.1.e.

ADVISORY NOTE: Values in Table 7 are based on properties from representative industry panels that met requirements for structural performance when tested in accordance with Section 6.2.2.1 and bond performance when tested in accordance with Section 7.7 following moisture cycling according to Section 7.17.

e. Exposure 1 mat-formed panels - Mat-formed panels and wood-based material for composite panels rated as Exposure 1 shall exhibit a minimum average strength retention of 50% with no individual panel retained strength less than 40% when tested in accordance with Section 7.7 following moisture cycling according to Section 7.17.

5.3.3.2 Bond performance associated with knots and knotholes

Structural plywood rated as Exposure 1 shall satisfy the requirements of Section 6.3.4.4 when tested in accordance with Sections 7.18 and 7.19.

5.3.4 Adhesive performance

5.3.4.1 Adhesive mold resistance

Panel adhesive bonds shall satisfy the mold resistance test according to the procedures of Section 7.14 as defined in Section 6.2.5.1. Phenolic and isocyanate-based adhesives have demonstrated resistance to attack from mold and shall be considered as meeting this requirement.

5.3.4.2 Adhesive resistance to elevated temperature

Panel adhesive bonds shall be considered to satisfy sufficient elevated-temperature resistance (71°C [160°F]) when they meet the requirements of Section 5.3.3.1.

5.3.4.3 Adhesive bacteria resistance

Panel adhesive bonds shall satisfy the bacteria test according to the procedures of Section 7.15 as defined in Section 6.2.5.3. Phenolic and isocyanate-based adhesives have demonstrated resistance to attack from bacteria and shall be considered as meeting this requirement.

5.4 Moisture content

Moisture content of panels at time of shipment from the manufacturer and at the time of testing shall be less than 16% as determined by Section 7.11.

6 QUALIFICATION TESTING AND MILL SPECIFICATION

6.1 General

This section details test specimen requirements, conformance criteria, additional test set options, and mill specifications. See Appendix B for a flowchart.

6.2 Qualification testing

6.2.1 General

Qualification tests are a function of the panel grade. Required tests and performance criteria are detailed in Section 5. Conformance criteria and additional test set requirements are given by test in this section.

Panels for qualification testing shall be representative of minimum performance.

Tests shall be conducted according to the application specifications of the manufacturer and the use for which the panel is being qualified, at the support spacing to be shown on the trademark. Any special product modification that affects performance (e.g., moisturizing or water repellent treatment) shall be noted per Section 6.3. Upon failure of qualification tests, provisions shall be followed for one additional series of tests provided no change has been made in the manufacturing process. If a product satisfies the provisions of the additional testing, it shall pass the performance qualification test in question. If it does not, the product shall fail the performance qualification test. If a change in panel configuration or processing has been made, additional qualification tests shall be performed when required by the qualified testing agency.

6.2.2 Structural performance

6.2.2.1 Concentrated loads

Test a maximum of 20 specimens taken from at least 10 panels. Ten specimens (taken from at least five panels) for each test exposure condition shall be evaluated for both concentrated static and impact loads according to Section 7.1. Requirements are found in Table 2. If additional tests are needed, they shall also consist of 10 specimens, and the results of the two 10-specimen sets shall be combined. Only one additional test set is allowed. If the combined results meet or exceed the minimum passing rate, the sample passes.

a. Deflection – The initial test set consists of 10 specimens.

- The average deflection shall not be greater than the appropriate requirement in Table 2.
- If no more than one value is above the requirement, the sample passes.
- If two or three values are above the requirement, test an additional set.
- If four or more values are above the requirement, the sample fails.
- If 10 additional specimens are tested, the combined passing rate shall be at least 85%.

b. Ultimate load – The initial test set consists of 10 specimens.

- The average load shall not be less than the appropriate requirement in Table 2.
- If all of the values meet or exceed the requirement, the sample passes.
- If one of the values is below the requirement, test an additional set.
- If two or more values are below the requirement, the sample fails.
- If 10 additional specimens are tested, the combined passing rate shall be at least 95%.

6.2.2.2 Uniform loads

Test a maximum of 20 specimens taken from at least 10 panels. Ten specimens (taken from at least five panels) for each test exposure condition shall be evaluated for uniform-load capacity according to Section 7.2. Test requirements are found in Table 3 and Table 4 (Structural I Sheathing and Structural I Single Floor). If additional tests are needed, they shall also consist of 10 specimens, and the results of the two 10-specimen sets shall be combined. Only one additional test set is allowed. If the combined results meet or exceed the minimum passing rate, the sample passes.

For composite panels and for mat-formed panels containing non-oriented furnish, one specimen 75 mm x 300 mm (3 in. x 12 in.) shall be prepared perpendicular to the machine direction only from each panel to be tested.

For OSB and other mat-formed panels containing oriented furnish, one 75 mm x 300 mm (3 in. x 12 in.) specimen parallel and one perpendicular to the panel strength axis shall be prepared from each panel to be tested. Separate parallel and perpendicular reference values shall be determined when using Section 7.8.2.1 Procedure A.

6.3.4 Adhesive bond properties

6.3.4.1 Exposure 1 bond performance for OSB

The reference values for an OSB mill specification shall be established based on 20 samples evaluated parallel to the strength axis according to Section 7.6 after cycling according to Section 7.16, or based on procedures as described in Section 6.3.4.2 or based on the tabulated values in Table 7.

6.3.4.2 Exposure 1 bond performance for composites and mat-formed panels.

For composite and mat-formed panels classified Exposure 1, a minimum of 20 samples, one taken from each of 20 panels, shall be moisture cycled according to the procedures of Section 7.16 (single cycle soak-dry test) using specimens described in Section 7.7. For composite and mat-formed panels classified Exposure 1, a minimum of 20 samples, one taken from each of 20 panels, shall be moisture cycled according to the procedures of Section 7.17 (6-cycle test) using specimens described in Section 7.7. Immediately after cycling, composite samples will be evaluated for delamination based on procedures described in Section 7.13. Moisture-cycled samples shall then be tested according to the procedures of Section 7.13. The individual panel reference value for each qualification shall be the lowest observed breaking load (five-specimen average) or the sample average minus 1.8 times the sample standard deviation, whichever is the higher value. In addition, for Exposure 1 panels tested according to Sections 7.16 and 7.7, the lower 90% confidence interval shall be established on the qualification average.

6.3.4.3 Exposure 1 bond performance of plywood panels

Reference values for bond performance of Exposure 1 plywood panels shall be as specified in Section 6.2.4.1.(b).

6.3.4.4 Bond performance associated with knots and knotholes

Reference values for bond performance associated with knots and knotholes shall be as specified in Section 6.2.4.2 for knots and knotholes tested according to Section 7.19.

ADVISORY NOTE: Assessment of bond performance associated with knots and knotholes on a quality auditing basis should be conducted when a maximum-sized knot or knothole appears in the routine bond performance samples. When available, they should be tested according to Section 7.19 and meet the criteria of Section 6.2.4.2.

7 TEST METHODS

7.1 Concentrated static and impact load test

ASTM E-661 shall be followed except as modified in these sections.

The test span shall be 19.2 inch for the span rating of 20.

The dry test condition shall be within +/- 3% of the as-shipped moisture content. The wet test condition shall be exposure to three days of continuous one-sided wetting, then tested wet. The wet/redry condition shall be exposure to three days of continuous one-sided wetting, followed by drying. The panel moisture content at the time of testing for the wet/redry condition shall be within +/- 3% of the as-shipped moisture content.

7.1.1 Specimen preparation

ASTM E-661 shall be followed with regard to specimen preparation, and Section 6.2.2.1 of PS 2 shall be followed with regard to the number of specimens required. Specimens shall also be moisture cycled as required.

Processes and Services and meets the applicable requirements of ISO/IEC 17025 and has testing included in its certification scheme meets the definition of qualified testing agency.

8.3 Panel marking

All Sheathing, Structural I Sheathing, Single Floor and Structural I Single Floor panels represented as conforming to this standard shall be identified with a mark bearing the grade name appropriate under these specifications, and a mark of a qualified inspection and testing agency. If identified by such a mark, the product specification shall be available from the qualified inspection and testing agency whose mark appears on the panel. The panel grade, span rating, bond classification and the symbol PS 2-18 signifying conformance to this standard shall be included in the mark. Any supplemental application specifications of the manufacturer shall be clearly marked on each panel. The mark shall maintain legibility after weather exposure during construction. Mat-formed panels with oriented furnish shall be marked to show the direction of the strength axis. The optional notation "Size for Spacing" (see Section 2.19) is permitted.

ADVISORY NOTE: The following abbreviations in the panel mark are permitted:

- Sheathing – SHTG
- Structural I – Struc I
- Exposure 1 – EXP 1
- Exterior – EXT

The panel fractional Performance Category (see Section 5.2.1.2) and term "Performance Category" or abbreviation (i.e., PERF CAT, CAT or Category) shall be labeled on the panel. In addition, the thickness in 1,000ths of an inch within the permitted tolerance (see Section 5.2.1.2) for the Performance Category shall be labeled on the panel.

ADVISORY NOTE: See Appendix D for a table of recommended thickness labels.

8.3.1 Voiding marks

Panels originally marked as conforming to this standard but subsequently rejected as not conforming thereto shall have any reference to the standard obliterated or voided by the manufacturer as follows:

Shop panels shall be plainly identified by means of a 100 x 125 mm (4 x 5 in.) minimum size mark carrying the legend, "Shop-cutting panel – all other [agency] marks void" (See definition of shop-cutting panel), or

Other panels rejected as not conforming shall be plainly identified by a mark placed next to, and be no less prominent than the original mark, carrying the legend, "REJECT – All other agency marks void."

No reference shall be made to this standard in the certification or trademarking of panels not conforming to all of the applicable provisions of this standard.

9 EFFECTIVE DATE AND IDENTIFICATION

This standard became effective on March 30, 2019. As of that date, reference to this standard is permitted in contracts, codes, advertising, invoices, product labels, and the like; however, a product shall not be advertised nor represented in any manner that in any way might imply approval or endorsement of that product by the National Institute of Standards and Technology and/or the U.S. Department of Commerce.

The following suggested statements are permitted in representing products as conforming to the requirements of this standard:

- "This [*e.g, panel, shipment]* conforms to all requirements established in Voluntary Product Standard PS 2-18, 'Performance Standard for Wood Structural Panels,' in accordance with the U.S. Department of Commerce Procedures for the Development of Voluntary Product Standards. Full responsibility for the conformance of this product to the standard is assumed by (name and address of producer and/or distributor)."

- "Conforms to Voluntary Product Standard PS 2-18, (name and address of producer and/or distributor)."

10 STANDARD REVIEW COMMITTEE

A Standard Review Committee has been established to assist in keeping this standard current. Issues regarding interpretation or implementation of the standard and third-party quality assurance policies and procedures shall be considered by a Standard Implementation Review Subcommittee as appointed by the Standing Committee. A request to consider such issues shall be made in writing to the Secretariat of the Standing Committee (NIST), who will bring it to the attention of the Standard Review Committee. Formal operating procedures developed for the Subcommittee shall be subject to approval by NIST. Any recommended actions by the Subcommittee will be reported to the Standing Committee for their consideration and action.

APPENDIX A. (Nonmandatory)

A1 SHIPMENT REINSPECTION PRACTICES

A1.1 General

This information is based on industry practice and is offered to wood structural panel purchasers.

A1.2 Request for reinspection

Any request by the buyer for the reinspection of any item or lot of panels certified as conforming to this standard shall be directed to the seller. Lacking agreement of the buyer and seller as to the settlement of a complaint, the purchase, sale, or shipment of panels certified as conforming to this standard shall be construed as involving agreement to submit such panels to reinspection by the qualified inspection and testing agency whose trademark was used.

A1.3 Responsibility of the buyer

A request to the seller for reinspection is permitted:

a. for panel grade – within 30 days[6] after arrival at the first point of receipt from the mill, if the grade of any item, as invoiced, is in doubt;

b. for glue bond quality of Exterior panels – when delamination is visibly evident;

c. for bond quality and bond performance associated with knots and knotholes of Exposure 1 panels – within six months after arrival at first point of receipt from the mill, if delamination is visibly evident;

d. for structural performance, such as resistance to concentrated loads on panels – within six months after arrival at first point of receipt from the mill;

e. for physical properties, such as linear expansion of panels – within six months after arrival at first point of receipt from the mill.

All panels of disputed grade shall be kept intact and properly protected from damage, deterioration, and from direct exposure to moisture that could interfere with a fair reinspection.

All panels of disputed quality shall be held for a period not to exceed 30 days after the date of request for reinspection. Use by the buyer of any or all of the disputed stock within the 30-day period shall constitute an acceptance of the used portion.

A1.4 Responsibility of the seller

A request for reinspection shall be promptly acknowledged by the seller following its receipt.

A1.5 Cost and assistance

The expense of reinspection shall be borne by the seller if the item, lot, or shipment in dispute fails to pass the reinspection as provided for in A1.6. If the panels pass the reinspection, said expenses shall be borne by the buyer. The buyer shall lend all reasonable assistance to facilitate the reinspection.

A1.6 Reinspection procedures and settlement

A1.6.1 Condition of panels

All panels designated as complying with this standard shall be subject to reinspection in the as-manufactured condition only. This requirement does not apply to reinspections for bond quality.

A1.6.2 Sampling for panel grade, size and thickness reinspections

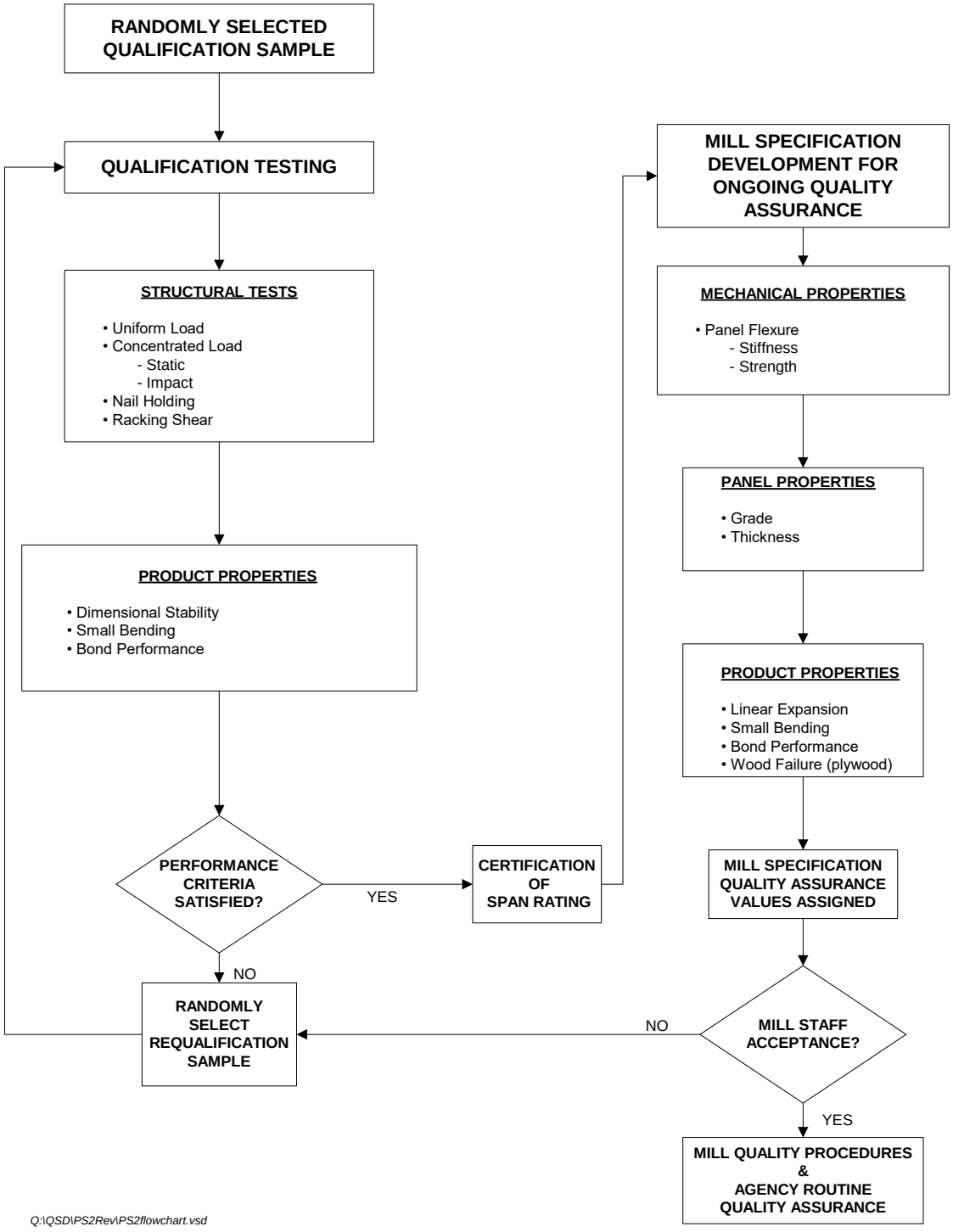
At buyer's or seller's option, grade, size, and thickness reinspections may include all panels of an item whose conformance to this standard is in dispute. However, buyer and seller may agree upon a reduced basis for sampling provided at least 20% or 300 panels, whichever is smaller and which represents only those items as invoiced that are in dispute, are reinspected for conformance. For reduced sampling, the quantity of panels selected from each disputed item shall be prorated according to the number of panels included in each item as invoiced. Panels

[6] For unitized shipments, the 30-day limit shall be extended to include the period dating from receipt of shipment to breaking of the first bundle, but not exceeding six months, provided the requirement for keeping the disputed panels intact is observed and the panels in question are held for at least 30 days following the request for reinspection.

APPENDIX B. (Nonmandatory)

PS 2 Qualification Flow Chart

PERFORMANCE-RATED PANEL QUALIFICATION
FOR
ROOF, SUBFLOOR, SINGLE FLOOR AND WALL APPLICATIONS



APPENDIX C. (Nonmandatory)

History of the Standard and Comments on the Current Edition

C1 History of PS 2

In September 1988, a special Bi-national Committee (BNC) was formed and charged with the task of fostering the mutual objective of the United States and Canada with respect to the development and implementation of harmonized standards with regard to performance requirements for plywood. This action was a consequence of the implementation of the Free Trade Agreement (FTA) of 1987. In accordance with the Agreement, U.S. tariffs on plywood and other structural panels could not be removed until the trade issues involving plywood standards were resolved. Of concern to the United States was the fact that certain grades of plywood permitted in PS 1 were not covered in Canadian plywood standards, and consequently not acceptable under Canadian building codes.

The BNC began its task by reviewing the existing industry standard *APA – The Engineered Wood Association* (APA), APA PRP-108, Performance Standards and Policies for Structural-Use Panels, and the Canadian Standards Association (CSA) standard CAN/CSA-O325, Construction Sheathing, to identify the technical differences and to consider the roles the standards might play in resolving the plywood trade issues. It concluded that the development of common criteria embodied in performance-based national standards offered means to resolve the trade issue.

Next, the BNC sponsored a joint U.S./Canadian study designed to produce additional comparative information on U.S. and Canadian plywood. Based on BNC's assessment of the technical differences in the APA and CSA standards and the data derived from the joint study, the BNC in November 1990 submitted new U.S. and Canadian draft standards, respectively, to the National Institute of Standards and Technology (NIST) in the United States and the CSA in Canada for processing as national consensus standards.

In March 1991, APA signed an agreement with NIST to support development of the proposed U.S. performance standard as a Voluntary Product Standard (VPS) under procedures of the U.S. Department of Commerce. In April 1991, NIST established a Standard Review Committee under the VPS Program to assume responsibility for development of the U.S. standard. On October 15, 1991, after two 30-day review periods and some editorial changes, the Committee recommended unanimously that the proposed standard be prepared for public review and acceptance as a Voluntary Product Standard.

In March 1992, the proposed VPS standard was distributed to a list of manufacturers, distributors, consumers, and others who might have interest in the subject standard, and on April 8, 1992, NIST announced in the Federal Register the public circulation of the proposed standard and invited public comments. A 75-day comment period was allowed. Following public review of the standard, which ended June 22, 1992, NIST determined that the responses indicated consensus among producers, distributors, and consumers in accordance with the published procedures. The standard was originally approved for publication by NIST as Voluntary Product Standard PS 2-92, Performance Standard for Wood-Based Structural-Use Panels, on August 27, 1992.

The new U.S. standard was not intended to replace existing standards such as Voluntary Product Standard PS 1-83, Construction and Industrial Plywood, but to serve as an alternative performance-based standard that would relate to a variety of forms of structural panels: plywood, oriented strand board, waferboard, structural particleboard, and composite panels.

C2 Edition PS 2-04

After considerable technical review, PS 2-04 was revised and accepted in December 2004. The PS 2-04 edition contained many revisions. The major technical revisions included the following.

APPENDIX E. (Nonmandatory)

Labeling Guidelines Based on the Uniform Packaging and Labeling Regulations of NIST Handbook 130 and Handbook 133

E1 Summary

E1.1 When intended for sale or distribution, the labeling of the panels should meet the requirements of the Uniform Packaging and Labeling Regulation. This section provides references to standards applicable to labeling and packaging.

E2 Background

E2.1 The National Institute of Standards and Technology of the U.S. Department of Commerce ("NIST") promotes the development of standards to be applied across industry and supports the publishing of NIST Handbook 130, "Uniform Laws and Regulations in the areas of legal metrology and engine fuel quality." NIST Handbook 130 is a compilation of the latest uniform laws and regulations regarding packaging and labeling requirements adopted by the National Conference on Weights and Measures, Inc. ("NCWM") and is intended to represent standards to be adopted into law by the weights and measures jurisdictions of the United States.

E2.2 Procedures used by Weights and Measures inspectors are included in NIST Handbook 133, "Checking the Net Contents of Packaged Goods"**E2.3** For information, a complete copy of the most recent version of NIST Handbook 130 and 133 are available at:

https://www.nist.gov/publications/

F3 Formaldehyde emission from PS 2 Structural Panels

F3.1 Information on formaldehyde emission from PS 2 panels is available from APA in Technical Note J330, “Formaldehyde and Engineered Wood Products” (see: www.apawood.org).