

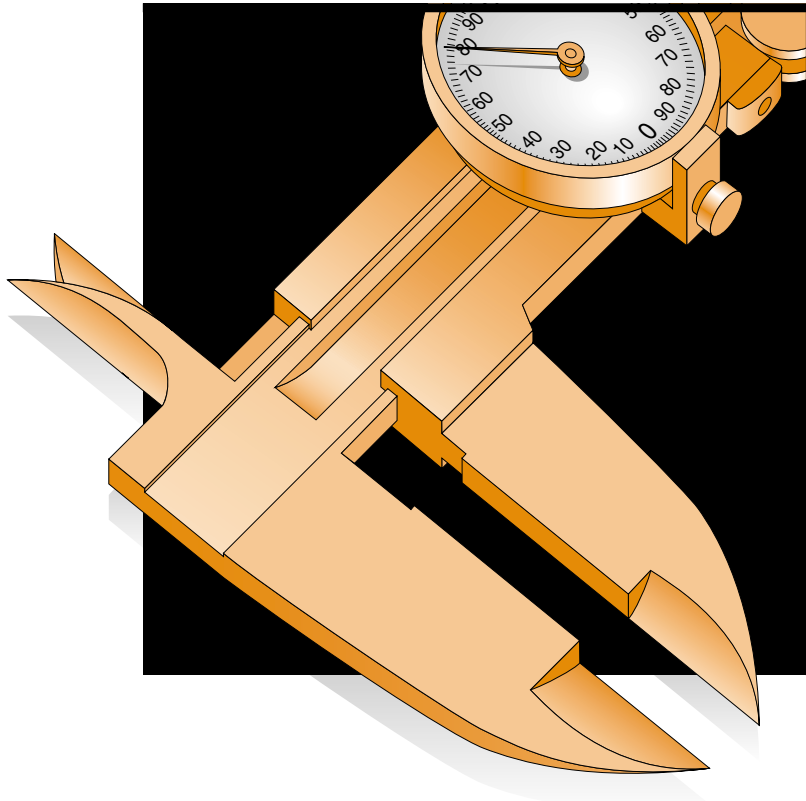
VOLUNTARY PRODUCT STANDARD

PS1-95

CONSTRUCTION AND INDUSTRIAL PLYWOOD*
(WITH TYPICAL APA TRADEMARKS)

Effective Date September 7, 1995

**Reproduced from copy furnished by the Office of Standards Services,
National Institute of Standards and Technology*



APA
THE ENGINEERED
WOOD ASSOCIATION

Be Constructive WOOD



Wood is the right choice for a host of construction applications. It is the earth's natural, energy efficient and renewable building material.

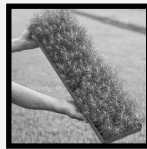
Engineered wood is a better use of wood. It uses less wood to make more wood products. That's why using APA trademarked I-joists, glued laminated timbers, laminated veneer lumber, plywood and oriented strand board is constructive ... for the environment, for innovative design, and for strong, durable buildings.

A few facts about wood.

- **We're not running out of trees.** One-third of the United States land base – 731 million acres – is covered by forests. About two-thirds of that 731 million acres is suitable for repeated planting and harvesting of timber. But only about half of the land suitable for growing timber is open to logging.



Most of that harvestable acreage also is open to other uses, such as camping, hiking, and hunting. Forests fully cover one-half of Canada's land mass. Of this forestland, nearly half is considered productive, or capable of producing timber on a sustained yield basis. Canada has the highest per capita accumulation of protected natural areas in the world – areas including national and provincial parks.



- **We're growing more wood every day.** American landowners plant more than two billion trees every year. In addition, millions of trees seed naturally. The forest products industry, which comprises about 15 percent of forestland ownership, is responsible for 41 percent of replanted forest acreage. That works out to more than one billion trees a year, or about three million trees planted every day. This high rate of replanting accounts for the fact that each year, 27 percent more timber is grown than is harvested. Canada's replanting record shows a fourfold increase in the number of trees planted between 1975 and 1990.

- **Manufacturing wood is energy efficient.** Wood products made up 47 percent of all industrial raw materials manufactured in the United States, yet consumed only 4 percent of the energy needed to manufacture all industrial raw materials, according to a 1987 study.

Material	Percent of Production	Percent of Energy Use
Wood	47	4
Steel	23	48
Aluminum	2	8



- **Constructive news for a healthy planet.** For every ton of wood grown, a young forest produces 1.07 tons of oxygen and absorbs 1.47 tons of carbon dioxide.

Wood. It's the constructive choice for the environment.



NOTICE:

The recommendations in this report apply only to panels that bear the APA trademark. Only panels bearing the APA trademark are subject to the Association's quality auditing program.

FOREWORD

Voluntary Product Standard PS 1-95, reproduced in the following pages, provides expanded and updated requirements for producing, marketing, and specifying plywood for construction and industrial uses.

It covers manufacture of such plywood from some 70 wood species and supersedes the product standard published in 1983.

The Office of Standards Services of the National Institute of Standards and Technology (formerly National Bureau of Standards) assists in development of voluntary product standards on a nationwide basis through the cooperative efforts of producers, distributors, consumers, and users.

The role of the National Institute of Standards and Technology in the establishment of a Voluntary Product Standard is to (1) act as an unbiased coordinator in the development of the standard, (2) provide editorial assistance in the preparation of the standard, (3) supply such assistance and review as is required to assure the

technical soundness of the standard, (4) seek satisfactory adjustment of valid points of disagreement, (5) determine compliance with the criteria of the Department's procedures, and (6) publish the standard as a public document.

It must be emphasized that the Department of Commerce has no regulatory authority or enforcement power to police the provisions of this or other product standards; but, inasmuch as the standard represents the consensus of the industry, its provisions are established by trade custom and are made effective through incorporation by reference in sales contracts, federal specifications, building codes, purchase invoices, advertising, and similar means.

The text of PS 1-95, prepared from material supplied by the National Institute of Standards and Technology, is set forth in this publication. In addition, the trademarks of *APA – The Engineered Wood Association*, which do not appear in the Government Printing Office version, are explained and illustrated on pages 39 and 40.

TABLE OF CONTENTS

SECTION	PAGE
1. Scope.....	1
2. Terminology.....	1
3. Reference Publications.....	4
4. Classification.....	4
4.1 General.....	4
4.2 Exposure durability.....	4
4.2.1 Interior plywood.....	4
4.2.2 Exterior plywood.....	4
4.3 Grade.....	4
5. Requirements.....	4
5.1 General.....	4
5.2 Wood species.....	4
5.2.1 Species groups.....	4
5.2.2 Species for faces and backs.....	4
5.2.3 Species for inner plies.....	5
5.2.4 Species classified by testing.....	5
5.3 Synthetic repairs.....	5
5.3.1 Synthetic fillers.....	5
5.3.2 Synthetic shims, patches, and plugs.....	5
5.4 Grade description of veneers.....	5
5.4.1 Grade N veneer (intended for natural finish).....	5
5.4.2 Grade A veneer (suitable for painting).....	6
5.4.3 Grade B veneer.....	6
5.4.4 Grade C veneer.....	7
5.4.5 Grade C Plugged veneer.....	7
5.4.6 Grade D veneer.....	7
5.5 Veneers and layers.....	8
5.5.1 Veneer thickness.....	8
5.5.2 Parallel laminated layers.....	8
5.5.3 Scarfed veneers.....	8

5.6	Panel grades	8
5.6.1	Marine	10
5.6.2	Decorative panels	10
5.6.3	Underlayment, C-C Plugged	10
5.6.4	B-B concrete form panels	10
5.6.5	Structural panels.....	10
5.6.6	Interior bonded with exterior glue (Exposure 1)	11
5.6.7	Special Exterior.....	11
5.6.8	Overlays	11
5.7	Adhesive bond requirements for a panel or a lot.....	12
5.7.1	Interior bonded with interior glue	12
5.7.2	Interior bonded with intermediate glue	12
5.7.3	Interior bonded with exterior glue (Exposure 1)	12
5.7.4	Exterior	13
5.8	Panel constructions and workmanship	13
5.8.1	Crossband gaps and center gaps	15
5.8.2	Veneer requirements	15
5.8.3	Sanded panels	16
5.8.4	Unsanded and touch-sanded panels	16
5.8.5	Span ratings for unsanded and touch-sanded panels	18
5.8.6	Performance testing qualification requirements for span-rated panels	18
5.8.7	Performance testing qualification requirements for other than span-rated panels	21
5.9	Scarf and finger jointed panels	23
5.9.1	Strength requirements (Interior and Exterior) for scarf and finger jointed panels.....	23
5.9.2	Scarf and finger joint durability for Interior bonded with interior glue	23
5.9.3	Scarf joint durability for Exterior plywood and Interior bonded with exterior glue (Exposure 1) or intermediate glue	24
5.9.4	Finger joint durability for Exterior plywood and Interior bonded with exterior glue (Exposure 1) or intermediate glue	24
5.10	Dimensional tolerances and squareness of panels	24
5.10.1	Size tolerances	24
5.10.2	Thickness tolerances.....	24
5.10.3	Squareness and straightness.....	24
5.11	Moisture content	24
5.12	Loading or packing.....	24
6.	Specimen Preparation and Testing.....	24
6.1	Bond durability.....	24
6.1.1	General	24
6.1.2	Specimen preparation (see Appendix A for sampling for reinspection)	24

6.1.3	Test for Interior plywood bonded with interior glue	25
6.1.4	Tests for Interior plywood bonded with intermediate glue.....	25
6.1.5	Tests for Exterior plywood and Interior bonded with exterior glue (Exposure 1)	26
6.1.6	Test for determination of moisture content (oven-drying method).....	27
6.1.7	Scarf and finger joint tests	28
6.1.8	Mold test.....	30
6.1.9	Bacteria test.....	31
6.2	Structural performance	31
6.2.1	Tests for performance under concentrated static and impact loads	31
6.2.2	Test for performance under uniform loads	32
6.2.3	Test for panel bending.....	33
6.2.4	Test for planar shear strength	34
6.2.5	Test for shear-through-the-thickness strength.....	34
7.	Grademarking and Certification	34
7.1	Certification of shipments.....	34
7.2	Qualified inspection and testing agency	34
7.3	Panel marking	34
7.4	Voiding marks	35
8.	Effective date.....	35
Appendix A.	Reinspection Practices.....	36
A1.	General	36
A2.	Request for reinspection	36
A3.	Responsibility of the buyer.....	36
A4.	Responsibility of the seller	36
A5.	Cost and assistance	36
A6.	Reinspection procedures and settlement	36
A6.1	Condition of plywood.....	36
A6.2	Sampling for panel grade, size, and thickness reinspections	36
A6.3	Plywood panel grade, size, and thickness reinspections	36
A6.4	Sampling for glue bond quality reinspections	37
A6.5	Plywood glue bond quality reinspections	37
Appendix B.	Maintenance, History, and Current Edition of Standard	38
B1.	Standing Committee.....	38
B2.	History of project	38
B3.	Current edition.....	38
APA Trademarks	39

VOLUNTARY PRODUCT STANDARD PS 1-95
CONSTRUCTION AND INDUSTRIAL PLYWOOD
EFFECTIVE SEPTEMBER 7, 1995. (SEE SECTION 8.)

(This Standard, which was initiated by APA – *The Engineered Wood Association* [formerly the American Plywood Association], has been developed under the *Procedures for the Development of Voluntary Product Standards* of the U.S. Department of Commerce as a revision of PS 1-83, *Construction and Industrial Plywood*.)

1. SCOPE

1.1 This Voluntary Product Standard establishes requirements for the principal types and grades of construction and industrial plywood and provides a basis for common understanding among producers, distributors, and users of the product.

1.2 This Standard covers the wood species, veneer grading, glue bonds, panel construction and workmanship, dimensions and tolerances, marking, moisture content, and packing of plywood intended for construction and industrial uses.

1.3 Included in this Standard are 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 identified as complying with this Standard. Information on reinspecting practices is provided in Appendix A; and information on the maintenance, history, and current edition of the Standard is provided in Appendix B.

1.4 This Voluntary Product Standard incorporates the International System of Units (SI) as well as U.S. customary units of measurement. In conversion of U.S. 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, more precise conversions to SI units are made. For nominal U.S. customary units, actual dimensions in SI units are given. The values given in SI units are the standard. The values in parentheses are for information only.

1.5 Advisory notes in this Standard and Appendix B shall not be considered mandatory.

2. TERMINOLOGY

2.1 Back –

Back of a plywood panel – The side of a panel that is of lower veneer quality on any panel whose outer plies (front and back) are of different veneer grades.

Back ply of a plywood panel – The outer veneer on the back side of a panel.

2.2 Borer holes – Voids made by wood-boring insects, such as grubs or worms.

2.3 Broken grain – A (leafing, shelling, grain separation) separation on veneer surface between annual rings.

2.4 Butt joint – A straight joint in which the interface is perpendicular to the panel face. An end butt joint is perpendicular to the grain.

2.5 Centers – Inner layers whose grain direction runs parallel to that of the outer plies. Some centers consist of parallel laminated plies.

2.6 Center gap – See 2.12.

2.7 Check – A lengthwise separation of wood fibers, usually extending across the rings of annual growth, caused chiefly by strains produced in seasoning.

2.8 Class I, II – Term used to identify different species group combinations of B-B concrete form panels. (See 5.6.4.)

2.9 Construction (panel construction) – Term referring to detailed manner in which veneers are assembled and/or thickness of veneer used, e.g., “4-ply/3-layer construction,” “2.5 mm (1/10-inch) face and back,” etc.

2.10 Core – See 2.11.

2.11 Crossband – Inner layers whose grain direction runs perpendicular to that of the outer plies. Some crossbands consist of parallel laminated plies.

2.12 Crossband gap and center gap – An open joint extending through or partially through a panel, which results when crossband or center veneers are not tightly butted.

2.13 Defects, open – Irregularities such as splits, open joints, knotholes, or loose knots, that interrupt the smooth continuity of the veneer.

2.14 Delamination – A visible separation between plies that normally receive glue 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.

2.14.1 For purpose of reinspection, areas coinciding with open knotholes, pitch pockets, splits, and gaps and other voids or characteristics permitted in the panel grade are not considered in evaluating ply separation of Interior type panels bonded with interior or intermediate glue.

2.14.2 In evaluating Exposure 1 panels, delamination in any glueline is not to exceed 19.4 cm² (3 in²) except where directly attributable to defects permitted in the grade as follows:

Delamination associated with:

- (a) Knots and knotholes – not to exceed the size of the defect plus a surrounding band not wider than 19 mm (3/4 inch).
- (b) All other forms of permissible defects – not to exceed the size of the defect.

2.14.3 For purposes of evaluation of Exterior panels for ply separation, the area coinciding with the grade characteristics noted in 2.14.1 is considered, and a panel is considered delaminated if visible ply separation at a single glueline in such area exceeds 19.4 cm² (3 in²).

2.15 Edge splits – Wedge-shaped openings in the inner plies caused by splitting of the veneer before pressing.

2.16 Face –

Face of the plywood panel – The side of a panel that is of higher veneer quality on any panel whose outer plies (front and back) are of different veneer grades; either side of a panel where the grading rules draw no distinction between outer plies.

Face ply of a panel – The outer veneer on the face of a panel.

2.17 Finger joint – A term indicating the method by which panels or sections of panels have been joined to create longer lengths or widths by means of a well-bonded series of sloped scarf cuts resembling fingers.

2.18 Grade name – Term used to identify panels having special characteristics and/or requirements as described under 5.6, such as Marine, Decorative, and Underlayment.

2.19 Group – Term used to classify species covered by this Standard. Species covered by this Standard are classified as Groups 1, 2, 3, 4, and 5. See table 1 for listing of species in individual groups and the reference in section 4 for product use information.

2.20 Heartwood – Nonactive core of a log generally distinguishable from the outer portion (sapwood) by its darker color.

2.21 Inner plies – Plies other than face or back plies in a panel construction. Sub-face, sub-back, crossband and center are classed as inner plies.

2.22 Jointed inner plies – Crossband and center veneer that has had edges machine-squared to permit tightest possible layup.

2.23 Knot – Natural characteristic of wood that occurs where a branch base is embedded in the trunk of a tree. Generally the size of a knot is distinguishable by (1) a difference in color of limbwood and surrounding trunkwood; (2) an abrupt change in growth ring width between knot and bordering trunkwood; and (3) a diameter of circular or oval shape described by points where checks on the face of a knot that extend radially from its center to its side experience an abrupt change in direction.

2.24 Knotholes – Voids produced by the dropping of knots from the wood in which they were originally embedded.

2.25 Lap – A condition where the veneers are so placed that one piece overlaps the other.

2.26 Layer – A single veneer ply or two or more plies laminated with grain direction parallel. Two or more plies laminated with grain direction parallel is a “parallel laminated layer.”

2.27 Lot – Any number of panels considered as a single group for evaluating conformance to this Standard.

2.28 Moisture content – The weight of the water in wood expressed as a percent of the weight of the oven-dry wood. (See 6.1.6.)

2.29 Nominal thickness – Full “designated” thickness, subject to acceptable tolerances. For example, nominal 2.5 mm (1/10-inch) veneer is 2.5 mm (0.10 inch) thick; nominal 12.7 mm (1/2-inch) thick panel is 12.7 mm (0.50 inch) thick. Also, commercial size designation, subject to acceptable tolerances.

2.30 Patches – Inserts of sound wood or synthetic material in veneers or panels for replacing defects. “Boat” patches are oval-shaped with sides tapering in each direction to a point or to a small rounded end; “Router” patches have parallel sides and rounded ends. “Sled” patches are rectangular with feathered ends.

2.31 Pitch pocket – A well-defined opening between rings of annual growth, usually containing, or which has contained, pitch, either solid or liquid.

2.32 Pitch streak – A localized accumulation of resin in coniferous woods which permeates the cells forming resin soaks, patches, or streaks.

2.33 Plugs – Sound wood of various shapes, including among others, circular and dog-bone, for replacing defective portions of veneers. Also synthetic plugs used to fill openings and provide a smooth, level, durable surface. Plugs usually are held in veneer by friction until veneers are bonded into plywood.

2.34 Plugged inner plies – (Also referred to as solid inner plies.) – Refers to C Plugged crossband and centers and additional limitations, as given in 5.8.1.

2.35 Ply – A single veneer lamina in a glued plywood panel. (See also 2.26.)

2.36 Plywood – Plywood is a flat panel built up of sheets of veneer called plies, united under pressure by a bonding agent to create a panel with an adhesive bond between plies as strong as or stronger than, the wood. Plywood is constructed of an odd number of layers with grain of adjacent layers perpendicular. Layers consist of a single ply or two or more plies laminated with parallel grain direction. Outer layers and all odd numbered layers generally have the grain direction oriented parallel to the long dimension of the panel. The layers with alternating grain direction equalize strains, reduce splitting, and minimize dimensional change and warping of the panel.

2.37 Repair – Any patch, plug, or shim.

2.38 Rough grain – Grain characteristics which prevent sanding to a smooth surface.

2.39 Sapwood – The living wood of lighter color occurring in the outer portion of a log. Sometimes referred to as “sap.”

2.40 Scarfed joint – A term indicating the method by which panels or veneer, or sections of panels or veneer, have been joined to create longer lengths or widths by means of a well-bonded, sloped cut.

2.41 Shim – A long, narrow repair of wood or suitable synthetic not more than 4.8 mm (3/16 inch) wide.

2.42 Shop-cutting panel – A panel which has been rejected as not conforming to a standard grade because of deficiencies, other than adhesive bond quality, which prevent it from meeting the requirements of this Standard. Blistered panels are not considered as coming within the category of “shop-cutting panel.” Localized delamination occurs as a result of a deficiency.

However, shop-cutting panels are suitable for cut-up use where cutting eliminates the deficiency in the portion of the panel salvaged. Such a panel must be identified with a separate mark as specified in 7.4.

2.43 Span rating – A set of numbers used in marking sheathing and combination subfloor-underlayment (single floor) grades of plywood as described in 5.8.5. Formerly called Identification Index.

2.44 Split – Lengthwise separation of wood fibers completely through the veneer, caused chiefly by the manufacturing process or handling.

2.45 Streaks – See 2.32.

2.46 Sub-face (Sub-back) – The ply adjacent to the exposed face (or back) of a parallel laminated outer layer.

2.47 Touch-sanding – A sizing operation consisting of a light surface sanding to thickness dimension in a sander. Sander skips to any degree are admissible.

2.48 Veneer – Thin sheets of wood of which plywood is made. Also referred to as “plies” in the glued panel.

2.49 Wane – Thin to open areas in veneer sheets that result from outer log surface irregularities. Generally, only veneer peeled from the outer log surface will contain wane. Some wane areas contain bark inclusions. For grading, wane is classed as an open defect.

2.50 Waterproof adhesive – Glue capable of bonding plywood in a manner to satisfy the exterior performance requirements of this Standard.

2.51 White pocket – A form of decay (*Fomes pini*) that attacks most conifers but has never been known to develop in wood in service. In plywood manufacture, routine drying of veneer effectively removes any possibility of decay surviving.

2.51.1 Light white pocket – Advanced beyond incipient or stain stage to a point where pockets are present and plainly visible, mostly small and filled with white cellulose; generally distributed with no heavy concentrations; pockets for the most part separate and distinct; few to no holes through the veneer.

2.51.2 Heavy white pocket – Contains a great number of pockets, in dense concentrations, running together and at times appearing continuous; holes extend through the veneer but wood between pockets appears firm. At any cross section extending across the width of the affected area, sufficient wood fiber shall be present to develop not less than 40 % of the strength of clear veneer. Brown cubicle and similar forms of decay which have caused the wood to crumble are prohibited.

2.52 Wood failure (percent) – The area of wood fiber remaining at the glue line following completion of the specified shear test. Determination is by means of visual examination and expressed as a percent of the test area.

3. REFERENCE PUBLICATIONS¹

ASTM E 661-88 *Test Method for Performance of Wood and Wood-Based Floor and Roof Sheathing Under Concentrated Static and Impact Loads.*

ASTM D 2718-90 *Test Method for Structural Panels in Planar Shear (Rolling Shear).*

ASTM D 2719-89 *Test Methods for Structural Panels in Shear Through-the-Thickness.*

ASTM D 3043-87 *Methods of Testing Structural Panels in Flexure.*

4. CLASSIFICATION

4.1 General – The plywood covered by this Standard is classified by exposure durability and by grade.

4.2 Exposure durability – The plywood covered by this Standard is classified as either Exterior or Interior. Each classification is a function of veneer grade and adhesive durability.

4.2.1 Interior plywood – Adhesive durability levels for Interior plywood are as follows and are listed in increasing order of durability:

- (a) **Interior with interior glue** – This is plywood bonded with interior glue. Plywood with this glue bond is intended for interior application. Adhesive performance requirements are provided in 5.7.1.
- (b) **Interior with intermediate glue** – This is plywood bonded with intermediate glue. Plywood with this glue bond is intended for protected construction and industrial uses where potential for conditions of high humidity and water leakage exist. Adhesive performance requirements are provided in 5.7.2.
- (c) **Interior with exterior glue** – This is plywood bonded with exterior (waterproof) glue identified as “Exposure 1” (see 5.8.6.4). Plywood with this glue bond is intended for protected construction and industrial uses where the added bond durability of a waterproof adhesive is required. Adhesive performance requirements are provided in 5.7.3.

4.2.2 Exterior plywood – This is plywood which will retain its glue bond when repeatedly wetted and dried or otherwise subjected to the weather or to exposure of similar severity. It is, therefore, designed for permanent exterior exposure. Adhesive performance requirements are provided in 5.7.4.

4.3 Grade – Within each exposure durability classification, there are a number of panel grades based on the grade of the veneers and the panel construction.

5. REQUIREMENTS

5.1 General – All plywood panels represented as conforming to this Standard shall meet or exceed all applicable requirements set forth herein. Test methods are given in section 6. All terms shall be as defined in section 2. Requirements for grademarking and certification shall be as provided in section 7.

5.2 Wood species

5.2.1 Species groups – For the purpose of this Standard, species shall be any softwood or hardwood species or trade groups listed in table 1 and other species meeting the requirements of 5.2.3 or 5.2.4.

5.2.1.1 Species segregation – Species which cannot be distinguished in veneer form from similar species shall be classed as the largest numbered species group applicable (Group 4 is larger numbered than Group 1) unless the manufacturer provides valid evidence to the qualified inspection and testing agency that the species are properly segregated. Such segregation shall be in the form of separation prior to peeling, mechanical testing for performance capability, or other means approved by the qualified inspection and testing agency.

5.2.2 Species for faces and backs – The species of face and back plies shall be from any group listed in table 1. When a face or back is made of more than one piece, the entire ply shall be of the same species. When outer layers consist of two or more plies, the outer or exposed plies are classified as faces (face plies) or backs (back plies) and the unexposed plies (sub-faces and sub-backs) are classified as inner plies, in terms of species requirements as provided in 5.2.3. Requirements for identification of all panels are given in 7.3.

¹Copies of these publications are available from the ASTM, 1916 Race Street, Philadelphia, PA 19103.

Table 1. Classification of Species

Group 1	Group 2		Group 3	Group 4	Group 5
Apitong ^{(a)(b)}	Cedar, Port Orford	Maple, Black	Alder, Red	Aspen	Basswood
Beech, American	Cypress	Mengkulang ^(a)	Birch, Paper	Bigtooth	Poplar, Balsam
Birch	Douglas-fir 2 ^(c)	Meranti, Red ^{(a)(d)}	Cedar, Alaska	Quaking	
Sweet	Fir	Mersawa ^(a)	Fir, Subalpine	Cativo	
Yellow	Balsam	Pine	Hemlock, Eastern	Cedar	
Douglas-fir 1 ^(c)	California Red	Pond	Maple, Bigleaf	Incense	
Kapur ^(a)	Grand	Red	Pine	Western Red	
Keruing ^{(a)(b)}	Noble	Virginia	Jack	Cottonwood	
Larch, Western	Pacific Silver	Western White	Lodgepole	Eastern	
Maple, Sugar	White	Spruce	Ponderosa	Black (Western Poplar)	
Pine	Hemlock, Western	Black	Spruce	Pine	
Caribbean	Lauan	Red	Redwood	Eastern White	
Ocote	Almon	Sitka	Spruce	Sugar	
Pine, Southern	Bagtikan	Sweetgum	Engelmann		
Loblolly	Mayapis	Tamarack	White		
Longleaf	Red Lauan	Yellow Poplar			
Shortleaf	Tangile				
Slash	White Lauan				
Tanoak					

(a) Each of these names represents a trade group of woods consisting of a number of closely related species.

(b) Species from the genus *Dipterocarpus* marketed collectively: Apitong if originating in the Philippines, Keruing if originating in Malaysia or Indonesia.

(c) Douglas-fir from trees grown in the states of Washington, Oregon, California, Idaho, Montana, Wyoming, and the Canadian Provinces of

Alberta and British Columbia shall be classed as Douglas-fir No. 1. Douglas-fir from trees grown in the states of Nevada, Utah, Colorado, Arizona and New Mexico shall be classed as Douglas-fir No. 2.

(d) Red Meranti shall be limited to species having a specific gravity of 0.41 or more based on green volume and oven dry weight.

5.2.3 Species for inner plies – Unless otherwise specified herein, inner plies of Groups 1, 2, 3 or 4 panels shall be of any species listed in Groups 1, 2, 3 or 4 in table 1. Inner plies of Group 5 panels shall be of any species listed in table 1. Unless otherwise specified herein, inner plies of all panels shall also be permitted to be of any softwood species or any hardwood species having a published average specific gravity value of 0.41 or more based on green volume and oven dry weight. The U.S. Forest Products Laboratory shall be considered as final evaluator of published specific gravity data.

5.2.4 Species classified by testing – Species not listed in table 1 or otherwise not covered by the provisions of 5.2 shall be qualified for use by panel performance testing in accordance with 5.8.6 for span-rated panels or with 5.8.7 for other panels except B-B concrete form, Marine and Structural grades. For panel marking purposes, re-classification of Group designation for species listed in table 1 by panel performance testing in accordance with 5.8.7 is permitted.

5.3 Synthetic repairs

5.3.1 Synthetic fillers – Use of synthetic fillers shall be limited to the repair of minor defects as specified. Synthetic fillers shall be approved by the qualified testing and inspection agency.

5.3.2 Synthetic shims, patches, and plugs –

These repairs shall completely fill kerfs or voids; shall present a smooth, level surface; and shall not crack, shrink, or lose their bond. Performance of synthetic shims, patches, and plugs under normal conditions of service shall be comparable to that of wood repairs. The equivalency shall be established by the qualified testing and inspection agency.

5.4 Grade description of veneers – All veneers in the finished plywood panel shall conform to one of the grade requirements listed in 5.4.1 through 5.4.6. Unless otherwise stated, these requirements apply to 1220 mm by 2440 mm (48- by 96-inch) panels and are proportionate for other sizes. Grade N is the highest classification.

5.4.1 Grade N veneer (intended for natural finish)

5.4.1.1 General – Grade N veneer shall be smoothly cut 100 % heartwood or 100 % sapwood, free from knots, knotholes, pitch pockets, open splits, other open defects, and stain. The veneer shall consist of not more than two pieces in 1220 mm (48-inch) widths and not more than three pieces in wider panels, and shall be well matched for color and grain.

Synthetic fillers shall be permitted to fill:

- (a) small cracks or checks not more than 0.8 mm (1/32 inch) wide.
- (b) small splits or openings up to 1.6 mm (1/16 inch) wide if not exceeding 50 mm (2 inches) in length.
- (c) small chipped areas or openings not more than 3.2 mm (1/8 inch) wide by 6.4 mm (1/4 inch) long.

5.4.1.2 Growth characteristics – Where pitch streaks occur, each shall average not more than 9.5 mm (3/8 inch) in width and shall blend with the color of the wood.

5.4.1.3 Repairs – Repairs shall be of wood, neatly made, and parallel to grain. They shall be limited to a total of six in number and be well matched for color and grain.

Patches shall be limited to three “router” patches not exceeding 25 mm (1 inch) in width and 90 mm (3-1/2 inches) in length. There shall be no overlapping.

Shims shall not exceed 4.8 mm (3/16 inch) in width or 305 mm (12 inches) in length and shall occur only at the ends of the panel.

5.4.2 Grade A veneer (suitable for painting)

5.4.2.1 General – Grade A veneer shall be firm; smoothly cut; and free of knots, pitch pockets, open splits, and other open defects and well joined when of more than one piece.

Synthetic fillers shall only be used to fill:

- (a) In Exterior panels: small cracks or checks not more than 0.8 mm (1/32 inch) wide; small splits or openings up to 1.6 mm (1/16 inch) wide, if not exceeding 50 mm (2 inches) in length; small chipped areas or openings not more than 3.2 mm (1/8 inch) wide by 6.4 mm (1/4 inch) long.
- (b) In Interior panels: small cracks or checks not more than 4.8 mm (3/16 inch) wide; openings or depressions up to 12.7 mm (1/2 inch) wide by 50 mm (2 inches) long or equivalent area.

5.4.2.2 Growth characteristics – Where pitch streaks occur, each shall average not more than 9.5 mm (3/8 inch) in width and shall blend with the color of the wood. Sapwood and discolorations to any degree shall be permitted.

5.4.2.3 Repairs – Repairs shall be of wood or synthetic patching material, neatly made, parallel to grain and limited to a total of 18 in number, excluding shims.

5.4.2.4 Patches – Patches, when of wood, shall be “boat,” “router,” or “sled” type. The radius of ends of boat patches shall not exceed 3.2 mm (1/8 inch) and shall not be more than 57 mm (2-1/4 inches) in width singly.

Multiple wood repairs shall consist of not more than two patches, neither of which shall exceed 180 mm (7 inches) in length if either is wider than 25 mm (1 inch), except that one multiple repair consisting of three die-cut veneer patches shall be permitted.

Synthetic repairs shall not exceed 57 mm (2-1/4 inches) in width.

Shims shall not be used over or around patches or as multiple repairs.

5.4.3 Grade B veneer

5.4.3.1 General – Grade B veneer shall be solid and free from open defects and broken grain, except as permitted in 5.4.3.1 through 5.4.3.4. Slightly rough grain shall be permitted.

Minor sanding and patching defects, including sander skips, shall not exceed 5 % of panel area.

Synthetic fillers shall only be used to fill:

- (a) In Exterior panels: small splits or openings up to 1.6 mm (1/16 inch) wide if not exceeding 50 mm (2 inches) in length; small chipped areas or openings not more than 3.2 mm (1/8 inch) wide by 6.4 mm (1/4 inch) long.
- (b) In Interior panels: small cracks or checks not more than 4.8 mm (3/16 inch) wide; openings or depressions up to 12.7 mm (1/2 inch) wide by 50 mm (2 inches) long or equivalent area.

5.4.3.2 Growth characteristics – Knots shall not exceed 25 mm (1 inch) measured across the grain and shall be both sound and tight.

Where pitch streaks occur, they shall average not more than 25 mm (1 inch) in width.

Discolorations to any degree shall be permitted.

5.4.3.3 Open defects – Splits shall not be wider than 0.8 mm (1/32 inch).

Vertical borer holes shall not exceed 1.6 mm (1/16 inch) in diameter and shall not exceed an average of one per 930 cm² (1 ft²) in number.

Horizontal or surface worm and borer holes shall be limited to 1.6 mm (1/16 inch) across, 25 mm (1 inch) in length, and to 12 in number.

5.4.3.4 Repairs – Repairs shall be of wood or synthetic patching material and neatly made.

Wood veneer repairs shall be die cut. Wood panel repairs shall be “router” or “sled” type.

Wood repairs shall not exceed 75 mm (3 inches) in width where occurring in multiple repairs, or 100 mm (4 inches) in width where occurring singly.

Synthetic veneer repairs shall not exceed 100 mm (4 inches) in width.

Synthetic panel repairs shall not exceed 57 mm (2-1/4 inches) in width.

Shims shall be permitted without limit.

5.4.4 Grade C veneer

5.4.4.1 General – Sanding defects shall not impair the strength or serviceability of the panel.

5.4.4.2 Growth characteristics – Knots shall be tight and not more than 38 mm (1-1/2 inches) across the grain.

Discolorations to any degree shall be permitted.

5.4.4.3 Open defects – Knotholes shall not exceed 25 mm (1 inch) measured across the grain; except that, an occasional knothole more than 25 mm (1 inch) but not more than 38 mm (1-1/2 inches) measured across the grain, occurring in any section 305 mm (12 inches) along the grain shall be permitted, provided the aggregate width of all knots and knotholes occurring wholly within the section does not exceed 150 mm (6 inches) in a 1220 mm (48-inch) width, and proportionately for other widths.

Splits measured at a point 205 mm (8 inches) from the end of the panel shall not exceed 12.7 mm (1/2 inch) in width by 1/2 panel length or 9.5 mm (3/8 inch) in width by any panel length, provided separation at one end does not exceed 1.6 mm (1/16 inch) where split runs full panel length; however, the maximum width within 205 mm (8 inches) of the end of the panel (open end of split) shall not exceed the maximum width of knotholes permitted within the grade.

Splits on panel faces and backs shall not exceed 6.4 mm (1/4 inch) where located within 25 mm (1 inch) of parallel panel edge.

Voids due to missing wood on panel faces and backs not otherwise specified above shall not exceed the maximum width of knotholes permitted in the grade and the length of such voids shall not exceed 150 mm (6 inches).

Wane not exceeding the size of permitted open defects shall be allowed, providing that where wane occurs at edges of veneer sheets, panel ply separation due to wane shall not exceed limit equivalent to that permitted for short and narrow inner plies in 5.8.3 for sanded panels, or 5.8.4 for unsanded or touch-sanded panels.

5.4.4.4 Repairs – Repairs shall be wood or synthetic patching material, neatly made.

Wood veneer repairs shall be die cut. Wood panel repairs shall be “router” or “sled” type.

Wood repairs shall not exceed 75 mm (3 inches) in width where occurring in multiple repairs, or 100 mm (4 inches) in width where occurring singly.

Synthetic veneer repairs shall not exceed 100 mm (4 inches) in width.

Synthetic panel repairs shall not exceed 57 mm (2-1/4 inches) in width.

Shims shall be permitted without limit.

5.4.5 Grade C Plugged veneer – Knotholes, worm and borer holes, and other open defects not larger than 6.4 mm (1/4 inch) by 12.7 mm (1/2 inch); sound and tight knots up to 38 mm (1-1/2 inches) measured across the grain; splits up to 3.2 mm (1/8 inch) wide; broken grain; pitch pockets, if solid and tight; plugs; patches and shims shall be permitted. Synthetic repairs in veneer shall not exceed 100 mm (4 inches) in width. Synthetic panel repairs shall not exceed 57 mm (2-1/4 inches) in width. Where grades having C Plugged face veneer are identified as fully sanded, sanding defects shall be the same as admitted under B grade. Sander skips to any degree shall be admissible in touch-sanded C Plugged veneer.

5.4.6 Grade D veneer

5.4.6.1 General – Except as otherwise required in 5.4.6.2 through 5.4.6.4, any number of plugs, patches, shims, worm or borer holes, sanding defects, and other characteristics shall be permitted, provided they do not seriously impair the strength or serviceability of the panels.

5.4.6.2 Growth characteristics – Tight knots in inner plies shall be permitted.

In D grade backs, knots shall be tight and not larger than 65 mm (2-1/2 inches) across the grain except that an occasional tight knot larger than 65 mm (2-1/2 inches) but not larger than 75 mm (3 inches) measured across the grain, occurring in any section 305 mm (12 inches) along the grain shall be permitted, provided the aggregate width of all knots and knotholes occurring wholly within the section does not exceed 255 mm (10 inches) in a 1220 mm (48 inch) width and proportionately for other widths.

5.4.6.3 Open defects – Knotholes shall not exceed 65 mm (2-1/2 inches) across the grain, except that an occasional knothole larger than 65 mm (2-1/2 inches) but not larger than 75 mm (3 inches) across the grain occurring in any section 305 mm (12 inches) along the grain shall be permitted, provided the aggregate width of all knots and knotholes occurring wholly within the section does not exceed 255 mm (10 inches) in a 1220 mm (48-inch) width, and proportionately for other widths.

Knotholes in sanded panels shall not exceed 65 mm (2-1/2 inches) across the grain in veneer thicker than 3.2 mm (1/8 inch).

Knotholes shall not exceed 90 mm (3-1/2 inches) across the grain in veneers at least two plies removed from the face or back plies of C-D and C-D Plugged grades having five or more plies.

Splits measured at a point 205 mm (8 inches) from the end of the panel shall not exceed 25 mm (1 inch) in width, tapering to not more than 1.6 mm (1/16 inch) where split runs full panel length; however, the maximum width within 205 mm (8 inches) of the end of the panel (open end of split) shall not exceed the maximum width of knotholes permitted within the grade.

Splits on panel faces and backs shall not exceed 6.4 mm (1/4 inch) in width where located within 25 mm (1 inch) of parallel panel edge.

Voids due to missing wood on panel backs not otherwise specified in 5.4.6.3 shall not exceed the maximum width of knotholes permitted in the grade and the length of such voids shall not exceed 150 mm (6 inches).

Wane not exceeding the size of permitted open defects is allowed, providing that where occurring at edges of veneer sheets, panel ply separation due to wane shall not exceed limit equivalent to that permitted for short and narrow inner plies in 5.8.3 for sanded panels, or 5.8.4 for unsanded or touch-sanded panels.

5.4.6.4 White pocket – Any area 610 mm (24 inches) wide across the grain and 305 mm (12 inches) long, in which light or heavy white pocket occurs, shall contain not more than three of the following characteristics, in any combination:

- (a) A 150 mm (6-inch) width of heavy white pocket.
- (b) A 305 mm (12-inch) width of light white pocket.
- (c) One knot or knothole, 38 mm (1-1/2 inches) to 65 mm (2-1/2 inches), or two knots or knotholes, 25 mm (1 inch) to 38 mm (1-1/2 inches). Knots or knotholes less than 25 mm (1 inch) shall not be considered. Sizes of any knot or knothole shall be measured across the grain. Any repair in a white pocket area shall be considered for grading purposes as a knothole.

5.5 Veneers and layers

5.5.1 Veneer thickness – Except as provided for in 5.5.1, veneer shall be 2.5 mm (1/10 inch) or thicker in panels of 9.5 mm (3/8 inch) rough (unsanded) thickness or over; 2.1 mm (1/12 inch) or thicker in panels of less than 9.5 mm (3/8-inch) rough (unsanded) thickness. In no case shall veneers used in face or back layers be thicker than 6.4 mm (1/4 inch), or veneers used in inner layers be thicker than 7.9 mm (5/16 inch).

Veneer of 2.1 mm (1/12 inch) shall be permitted as crossbands in 5-ply, 5-layer, 11.9 mm (15/32-inch) and 12.7 mm (1/2-inch) panels and in parallel-laminated layers as provided for in 5.5.2.

Veneer of 1.1 mm (1/16 inch) shall be permitted for any ply in 5-ply, Exterior type panels less than 11.9 mm (15/32 inch) in thickness; as the center only in other 5-ply panels; and in a parallel laminated layer as provided for in 5.5.2.

Face and back veneers shall be a minimum thickness of 3.2 mm (1/8 inch) for 15.1 mm (19/32 inch) and 15.9 mm (5/8-inch), 3-, 4-, and 5-ply, 3-layer panels of C-D, C-D Plugged, C-C, C-C Plugged and Underlayment grades.

Further limitations on panel layup are provided in 5.8, Panel Constructions and Workmanship.

The average veneer thickness shall conform to the limitations given in this Standard within a tolerance of $\pm 5\%$ of the specified nominal thickness measured dry before layup.

5.5.2 Parallel laminated layers – Parallel-laminated outer layers shall only be used in C-C, C-D, and Structural I C-C and C-D grades. Such layers shall consist of veneers 2.5 mm (1/10 inch) or thicker in any combination not exceeding 6.4 mm (1/4-inch) total layer thickness. The face and back plies or exposed plies of outer layers shall conform to the species group and grade requirements for faces and backs, respectively, of the panel grade. The unexposed plies of outer layers, or sub-face and sub-back plies, shall conform to the species group and grade requirements for inner plies of the panel grade as specified in tables 2 and 3 and 5.6.5. The maximum split or gap in sub-faces and sub-backs shall be 6.4 mm (1/4 inch) under the faces of Structural I C-C and C-D panels; 12.7 mm (1/2 inch) under the faces of C-C and C-D grades, and 12.7 mm (1/2 inch) under D backs.

Parallel-laminated inner layers in any grade shall consist of veneers 1.6 mm (1/16 inch) or thicker in any thickness combination not exceeding 11 mm (7/16-inch) total layer thickness. Individual plies in such layers shall conform to the species group and grade requirements for inner plies of the panel grade.

5.5.3 Scarfed veneers – Scarfed veneers shall be permitted for any face, back, or inner ply except as provided in 5.9. Scarfed joints shall not have a slope steeper than 1 to 8. Veneer in the scarf area shall not contain defects which reduce its effective cross section by more than 20 %. Veneer scarfed joints shall be glued with a waterproof adhesive.

5.6 Panel grades – The standard combination of the veneers in 5.4 into the various panel grades shall be as provided in tables 2 and 3, with the additional requirements provided in 5.6.1 through 5.6.8. The grain direction of the outer layers shall be either parallel or perpendicular to the long dimension of the panel.

Table 2. Interior plywood grades

Panel Grade Designations	Minimum Veneer Quality			Surface
	Face	Back	Inner Plies	
N-N	N	N	C	Sanded 2 sides
N-A	N	A	C	Sanded 2 sides
N-B	N	B	C	Sanded 2 sides
N-D	N	D	D	Sanded 2 sides
A-A	A	A	D	Sanded 2 sides
A-B	A	B	D	Sanded 2 sides
A-D	A	D	D	Sanded 2 sides
B-B	B	B	D	Sanded 2 sides
B-D	B	D	D	Sanded 2 sides
Underlayment ^(a)	C Plugged	D	C & D	Touch-sanded
C-D Plugged	C Plugged	D	D	Touch-sanded
Structural I C-D		See 5.6.5		Unsanded ^(b)
Structural I C-D Plugged, Underlayment		See 5.6.5		Touch-sanded
C-D	C	D	D	Unsanded ^(b)
C-D with exterior glue (See 5.6.6)	C	D	D	Unsanded ^(b)

^(a) See 5.6.3 and table 5 for special limitations.

^(b) See 5.8.4 for requirements.

Table 3. Exterior plywood grades^(a)

Panel Grade Designations	Minimum Veneer Quality			Surface
	Face	Back	Inner Plies	
Marine, A-A, A-B, B-B, HDO, MDO		See 5.6.1		See regular grades
Special Exterior, A-A, A-B, B-B, HDO, MDO		See 5.6.7		See regular grades
A-A	A	A	C	Sanded 2 sides
A-B	A	B	C	Sanded 2 sides
A-C	A	C	C	Sanded 2 sides
B-B (concrete form)		See 5.6.4		–
B-B	B	B	C	Sanded 2 sides
B-C	B	C	C	Sanded 2 sides
C-C Plugged ^(b)	C Plugged	C	C	Touch-sanded
C-C	C	C	C	Unsanded ^(c)
A-A High Density Overlay	A	A	C Plugged	–
B-B High Density Overlay	B	B	C Plugged ^(d)	–
B-B High Density Concrete Form Overlay (See 5.6.4)	B	B	C Plugged	–
B-B Medium Density Overlay	B	B	C	–
Special Overlays	C	C	C	–

^(a) Available also in Structural I classification as provided in 5.6.5.

^(b) See 5.6.3 and table 5 for special limitations.

^(c) See 5.8.4 for requirements.

^(d) C centers where used in panels of five or more plies.

5.6.1 Marine – Marine grades shall meet the requirements of Exterior plywood and shall be of one of the following grades: A-A, A-B, B-B, High Density Overlay, or Medium Density Overlay, all as modified in 5.6.1.1 through 5.6.1.3.

5.6.1.1 Species – Only Douglas-fir 1 and Western Larch veneers shall be used.

5.6.1.2 Veneers – Grade A faces shall be limited to a total of nine single repairs in a 1220 mm by 2440 mm (48- by 96-inch) sheet, or to a proportionate number in any other size as manufactured.

All inner plies shall be B grade or better and shall be full length and width.

All wood repairs shall be glued with an adhesive meeting the Exterior performance requirements of 5.7.4 and, in addition, shall be set in the panel using a technique involving both heat and pressure.

When the inner plies consist of two or more pieces of veneer, the edges shall be straight and square, and shall not overlap.

5.6.1.3 Crossband gaps and edge splits –

Neither edge of a panel shall have any crossband gap or edge split in excess of 3.2 mm (1/8 inch) wide. Crossband gaps and edge splits per 2440 mm (96 inches) of crossband ply shall not exceed four in number. End splits and gaps on either end of a panel shall not exceed 3.2 mm (1/8 inch) in aggregate width.

There shall be no filling of crossband gaps and edge splits.

5.6.2 Decorative panels – Specialty panels with decorative face and veneer treatments which, except for the special face treatment, meet all of the requirements of this Standard, including veneer qualities, glue bond performance and workmanship, shall be considered as conforming to this Standard. All grades in tables 2 and 3 shall be permitted to be manufactured as decorative grades.

An occasional butt joint used for decorative effect in veneer shall have a maximum width of 150 mm (6 inches) and shall be limited to one panel face. Where butt joints occur, the aggregate width of all knots and knotholes and two-thirds the aggregate width of all repairs, including butt joints, shall not exceed 150 mm (6 inches) in any area 305 mm (12 inches) along the grain by 1220 mm (48 inches) wide or proportionately for other widths.

5.6.3 Underlayment, C-C Plugged – Face veneer shall be 2.5 mm (1/10 inch) or thicker before sanding. The veneer immediately adjacent to the face ply of C-C Plugged and Underlayment shall be C grade or better with no knotholes over 25 mm (1 inch) across the grain; except that, (1) veneer immediately adjacent to the face ply of Underlayment shall be permitted to be D grade with open defects up to 65 mm (2-1/2 inches) across the grain or (2) veneer immediately adjacent to the face ply of C-C Plugged shall be permitted to be C grade with open defects up to 38 mm (1-1/2 inches) across the grain, provided the face veneer is of Group 1 or 2 species of 4.2 mm (1/6 inch) minimum thickness before sanding. Also see table 5 requirements.

5.6.4 B-B concrete form panels – Face veneers shall not be less than B grade and shall always be from the same species group. Inner plies shall be not less than “C” grade. This grade of plywood is produced in two classes and panels of each class shall be identified accordingly. Panels shall be sanded two sides and mill-oiled unless otherwise agreed upon between buyer and seller. Species shall be limited as follows and are applicable also to High Density Overlaid Exterior concrete form panels:

- (a) Class I – Faces of any Group 1 species, crossband of any Group 1 or Group 2 species, and centers of any Group 1, 2, 3, or 4 species.
- (b) Class II – Faces of any Group 1 or Group 2 species, and crossband and centers of any Group 1, 2, 3, or 4 species, or faces of Group 3 species of 3.2 mm (1/8 inch) minimum thickness before sanding, crossband of any Group 1, 2, or 3 species, and centers of any Group 1, 2, 3, or 4 species.

5.6.5 Structural panels – These panels are especially designed for engineered applications such as structural components where design properties, including tension, compression, shear, cross-panel flexural properties and nail bearing are of significant importance. In addition to the special species, grade and glue bond requirements set forth in the following table, structural panels shall meet all other requirements in this Standard for the applicable types and grades.

Grade	Glue Bond	Species
Structural I C-D ^(a) C-D Plugged ^(a) Underlayment ^(a)	Shall meet the requirements of 5.7.3	Face, back and all inner plies limited to Group 1 species
Structural I All Exterior grades (see table 3)	Exterior	Face, back and all inner plies limited to Group 1 species

^(a) Special limitations applying to Structural (C-D, C-D Plugged, Underlayment) grade panels are:

- In D grade veneers, white pocket in any area larger than the size of the largest knothole, pitch pocket or split specifically permitted in D grade shall not be permitted in any ply.
- Sound tight knots in D grade shall not exceed 65 mm (2-1/2 inches) measured across the grain, except as provided in table 5.
- Plugs, including multiple repairs, shall not exceed 100 mm (4 inches) in width.
- Panel construction shall be as specified in 5.8.

5.6.6 Interior bonded with exterior glue

(Exposure 1) – This is Interior plywood bonded to meet the requirements of 5.7.3.

5.6.7 Special Exterior – An Exterior panel that is produced from any species covered by this Standard. Except in regard to species, it shall meet all of the requirements for Marine panels (see 5.6.1) and be produced in one of the following grades: A-A, A-B, B-B, High Density Overlay, or Medium Density Overlay.

5.6.8 Overlays – For overlaid plywood, the grade designation for face and back, as given in table 3, refers to the veneer directly underlying the surface. All overlaid plywood shall be overlaid on two sides unless otherwise agreed to between buyer and seller. When only one side is overlaid, the exposed back shall be C or better.

5.6.8.1 High Density Overlay (HDO) – The standard grades of High Density Overlay shall be as listed in table 3. The surface of the finished product shall be hard, smooth, or uniformly textured, although some evidence of underlying grain shall be permitted. The surface shall be of such character that further finishing by paint or protective coating is not necessary. Although the common resin type employed in HDO is phenol, other resin systems that meet the requirements of this section shall be permitted. A phenolic resin-based overlay system shall consist of a cellulose-fiber sheet or sheets, containing not less than 45 % resin solids, based on the volatile-free weight of fiber and resin exclusive of glueline. The total resin-impregnated materials for each face,

exclusive of gluelines, shall be not less than 0.30 mm (0.012 inch) thick before pressing and shall weigh not less than 29 kg per 100 m² (60 pounds per 1000 ft²) in the ready-to-use condition. The bond of the overlay system to the plywood shall be continuous and without voids or blisters. Other resin-cellulose fiber overlay systems having a weight of not less than 29 kg per 100 m² (60 pounds per 1000 ft²) of single surface, exclusive of glueline, and which possess performance capabilities of the above phenol system, shall be permitted to be identified as High Density Overlay. Determination of equivalent performance shall be made by the qualified testing and inspection agency.

5.6.8.2 Medium Density Overlay (MDO) – The standard grade of Medium Density Overlay shall be as listed in table 3. The resin-treated facing on the finished product shall present a smooth, uniform or uniformly textured surface intended for high-quality paint finishes. Some evidence of underlying grain shall be permitted. Although the characteristic resin type employed is phenol, other resin systems that meet the requirements stated below shall be permitted. The typical thermosetting phenolic resin system shall consist of a cellulose-fiber sheet or sheets containing not less than 17 % resin solids for a beater-loaded sheet, or 22 % for an impregnated sheet, both based on the volatile-free weight of resin and fiber, exclusive of glueline. The resin-treated material shall weigh not less than 28 kg per 100 m² (58 pounds per 1000 ft²) of single face, including both resin and fiber, but exclusive of glueline. After application, the material shall measure not less than 0.30 mm (0.012 inch) thick. Other resin-cellulose fiber overlay systems having a weight of 28 or more kg per 100 m² (58 or more pounds per 1000 ft²) of single surface exclusive of glueline, and which possess performance capabilities of the above phenol system, shall be permitted to be identified as Medium Density Overlay. Determination of equivalent performance shall be made by the qualified testing and inspection agency.

5.6.8.3 Special overlays – These are surfacing materials having special characteristics which do not fit the particular description of High Density or Medium Density overlays as given in 5.6.8.1 and 5.6.8.2 and consist in significant part of resin-treated fiber. Special overlays shall meet the glue bond requirements for overlaid plywood (see 5.7.4.2). Although designed for a wide variety of uses, this overlaid plywood shall be Exterior, including the base panel, bond of overlay to the panel, and the overlay itself. Panels shall be identified as “Special Overlay.”

5.7 Adhesive bond requirements for a panel or a lot

– Any adhesive or bonding system that causes degradation of the wood or latent failure of bond shall not be used.

5.7.1 Interior bonded with interior glue

A panel shall be considered as meeting the adhesive bond requirements of this Standard if three or more of the five test specimens pass when tested in accordance with 6.1.3. Panels from lots shall be evaluated for conformance in the following manner:

- (a) **Underlayment, C-D Plugged, and C-D** – A panel shall be classed as failing if more than two of the five test specimens fail. The material represented by the sampling shall be considered as meeting the requirements if 90 % or more of the panels pass the test described in 6.1.3.
- (b) **All other grades** – A panel shall be classed as failing if more than two of the five test specimens fail. The material represented by the sampling shall be considered as meeting the requirements if 85 % or more of the panels pass, when tested in accordance with 6.1.3.

5.7.1.1 Mold resistance: Underlayment, C-D Plugged and C-D

– These grades shall be made with an adhesive possessing a mold resistance equivalent to that created by adding, to plain protein glue, 2.3 kg (5 pounds) of pentachlorophenol or its sodium salt per 45 kg (100 pounds) of dry glue base. The equivalency shall be established by testing and evaluation in accordance with 6.1.8. This procedure is specifically designed for adhesive qualification approval and is not applicable to inspection and testing, as covered in section 6.

Four panels shall be tested according to the procedures of 6.1.8. The panels shall be considered to have satisfactory mold resistance if each test group over the 20-week period shows an average glue-line shear load of at least 90 % of the control. In addition, no more than two groups shall rate less than 80 % and no single group shall rate less than 75 %.

5.7.1.2 Resistance to elevated temperature: Underlayment, C-D Plugged and C-D

– These grades shall be made with an adhesive possessing resistance to temperatures up to 71 °C (160 °F) at least equal to that of plain protein glue. Urea resin glue shall not be used in these grades unless evidence is submitted indicating performance equivalent to that of plain protein glue.

5.7.2 Interior bonded with intermediate glue

– A panel of Interior plywood bonded with intermediate glue shall be considered as meeting the adhesive bond requirements of this Standard if the test specimens taken from a panel

average 45 % wood failure or more when tested in accordance with 6.1.4.

Lots represented by test panels shall be considered as meeting the requirements of this Standard if both of the following minimum requirements are met:

- (a) The average wood failure of all test specimens, regardless of the number of panels tested, shall be not less than 45 %.
- (b) When more than one panel is tested, at least 90 % of the panels represented by the test pieces shall have 30 % wood failure or better.

Specimens cut through localized defects permitted in the grade shall be discarded. Test specimens showing delamination in excess of 3.2 mm (1/8 inch) deep and 25 mm (1 inch) long shall be rated as zero (0) % wood failure.

5.7.2.1 Intermediate glue heat durability

– Requirements shall be the same as for exterior glue (see 5.7.4.1).

5.7.2.2 Bacteria-mold resistance – Adhesives, in order to qualify as intermediate glue, shall meet the requirements of 6.1.9. This procedure is specifically designed for adhesive qualification and is not applicable to inspection and testing, as covered in section 6.

A minimum of four panels shall be tested according to the procedures of 6.1.9. The panels shall be considered to have bacteria resistance if each test group over the 12-week test shows an average load of at least 80 % of the control. No single group shall rate below 70 % of the control.

5.7.3 Interior bonded with exterior glue

(Exposure 1) – A panel of Interior plywood bonded with exterior glue (Exposure 1) shall be considered as meeting the adhesive bond requirements of this Standard if the test specimens taken from a panel average 80 % wood failure or greater when tested in accordance with 6.1.5.

Lots represented by test panels shall be considered as meeting the requirements of this Standard if the minimum requirements of (a) and (b) are met:

- (a) The average wood failure of all test specimens, regardless of the number of panels tested, shall be not less than 80 %; and
- (b) When more than one panel is tested:
 - (1) at least 90 % of the panels represented by the test pieces shall have 60 % wood failure or better; and
 - (2) at least 95 % of the panels represented by the test pieces shall have 30 % wood failure or better.

The requirements of 5.7.3 are applicable separately and independently to the results obtained from the vacuum-pressure test (6.1.5.2) and the boiling test (6.1.5.3). Specimens cut through localized defects permitted in the grade shall be discarded. Test specimens showing delamination in excess of 3.2 mm (1/8 inch) deep and 25 mm (1 inch) long shall be rated as zero (0) % wood failure.

5.7.3.1 Interior bonded with exterior glue (Exposure 1): Heat durability – Panels shall meet the heat durability requirements for exterior glue (see 5.7.4.1).

5.7.4 Exterior – When tested in accordance with 6.1.5, Exterior plywood shall be considered as meeting the adhesive bond requirements of this Standard if the test specimens taken from a panel average 85 % wood failure or greater.

Lots represented by test panels shall be considered as meeting the requirements of this Standard if the minimum requirements of (a) and (b) are met:

- (a) The average wood failure of all test specimens, regardless of the number of panels tested, shall be not less than 85 %; and
- (b) When more than one panel is tested:
 - (1) at least 75 % of the panels represented by the test pieces shall have 80 % wood failure or better;
 - (2) at least 90 % of the panels represented by the test pieces shall have 60 % wood failure or better; and
 - (3) at least 95 % of the panels represented by the test pieces shall have 30 % wood failure or better.

The requirements of 5.7.4 are applicable separately and independently to the results obtained from the vacuum-pressure test (6.1.5.2) and the boiling test (6.1.5.3). Specimens cut through localized defects permitted in the grade shall be discarded. Test specimens showing delamination in excess of 3.2 mm (1/8 inch) deep and 25 mm (1 inch) long shall be rated as zero (0) % wood failure.

5.7.4.1 Exterior glue heat durability – Exterior plywood shall be considered as meeting the requirements of this section if there is no delamination in any specimen, except when occurring at a localized defect permitted in the grade when tested in accordance with 6.1.5.4. When testing overlaid plywood, blisters or bubbles in the surface caused by combustion shall not be considered as delamination.

5.7.4.2 Overlaid plywood – The bond between veneers of overlaid plywood as well as the bond between the overlay and the base panel shall meet the wood failure requirements described in 5.7.4 for Exterior plywood. In evaluating specimens for separation of the resin-treated face from the plywood, fiber failure shall be considered the same as wood failure.

5.8 Panel constructions and workmanship – Constructions for all panels shall conform to the minimum number of plies and layers as set forth in table 4. The proportion of wood with grain perpendicular to panel face grain shall be not less than 33 % nor more than 70 % of the total panel thickness. The combined thickness of inner layers in panels having 4 or more plies shall be not less than 45 % of the total panel thickness. For application of these requirements, the panel thickness shall be the actual finished panel thickness and the veneer thickness shall be the dry veneer thickness before layup.

The grain of all layers shall be perpendicular to the grain of adjacent layers and to the ends or edges of the panel. The entire area of each contacting surface of the adjacent plies, including repairs, shall be bonded with an adhesive in a manner to assure compliance with the performance requirements for its type as set forth in the test described in section 6.

For the purpose of veneer repairing or edge joining, strings, ribbons, or tapes up to 9.5 mm (3/8 inch) maximum width can occur in a glueline and shall be considered as allowable localized defects in the evaluation of glueline test specimens. Wider strings, ribbons, or tapes shall not be used for veneer repairing or joining unless they are pre-qualified to show bonding equal to the required bonding for the panel. Glueline test specimens cut to include the strings, ribbons, or tapes wider than 9.5 mm (3/8 inch) shall not be discarded because of the presence of these materials.

Veneer strips shall not be joined by string stitching unless the punch for making holes prior to stitching has a dimension across the grain of 2.4 mm (0.095 inch) or less and the holes are spaced 12.7 mm (1/2 inch) center-to-center or greater. All veneer used for inner plies shall be permitted to be stitched. Stitched veneer used for outer plies is limited to panels with C or D grade faces or backs, except stitched C veneer shall not be used for faces in Decorative panels. Stitched veneer shall not be used for both the face and back ply.

Table 4. Panel constructions

Panel Grades	Finished Panel Nominal Thickness Range	Minimum Number of Plies	Minimum Number of Layers
Exterior Marine Special Exterior (See 5.6.7) B-B concrete form High Density Overlay High Density concrete form overlay	Through 9.5 mm (3/8 inch) Over 9.5 mm (3/8 inch), through 19 mm (3/4 inch) Over 19 mm (3/4 inch)	3 5 7	3 5 7
Interior N-N, N-A, N-B, N-D, A-A, A-B, A-D, B-B, B-D Structural I (C-D, C-D Plugged and Underlayment) Exterior A-A, A-B, A-C, B-B, B-C Structural I (C-C and C-C Plugged) (See 5.6.5) Medium Density and special overlays	Through 9.5 mm (3/8 inch) Over 9.5 mm (3/8 inch), through 12.7 mm (1/2 inch) Over 12.7 mm (1/2 inch), through 22.2 mm (7/8 inch) Over 22.2 mm (7/8 inch)	3 4 5 6	3 3 5 5
Interior (Including grades with exterior glue) Underlayment Exterior C-C Plugged	Through 12.7 mm (1/2 inch) Over 12.7 mm (1/2 inch), through 19 mm (3/4 inch) Over 19 mm (3/4 inch)	3 4 5	3 3 5
Interior (Including grades with exterior glue) C-D C-D Plugged Exterior C-C	Through 15.9 mm (5/8 inch) Over 15.9 mm (5/8 inch), through 19 mm (3/4 inch) Over 19 mm (3/4 inch)	3 4 5	3 3 5

Rough or unsanded plywood shall be permitted to have paper tape on either face or back, or both; except that, in C-C Exterior, no tape used for veneer splicing shall be permitted.

Shims or strips of veneer shall not be used to repair panel edge voids. However, filling of permissible edge voids with synthetic fillers neatly applied shall be allowed, except as prohibited in Marine grades (see 5.6.1). Staples or pins of metal or synthetic material shall be prohibited.

Where face or back plies consist of more than one piece of edge joined veneer, gaps between adjacent pieces shall be graded as splits.

End butt joints shall only be used under the following conditions:

- (a) Decorative grades as provided in 5.6.2.
- (b) Butt joints having a total aggregate width not exceeding the width of the panel shall occur in the center ply of 5-ply, 5-layer panels. The butt joints shall be perpendicular to the grain of the panel face and back plies. The use of butt-jointed centers shall be allowed in Interior sanded grades in thicknesses up to and including 12.7 mm (1/2 inch), and in C-D and C-D Plugged thicknesses up to and including 19 mm (3/4 inch). End butt joints shall not be used in Structural I panels. Panels with butt joints in center plies shall be marked "butt-jointed center" as specified in 7.3.

Plywood shall be clean and free from blisters, laps and other defects, except as expressly permitted in 5.8 and its subsections. Panels shall have no continuous holes or through openings from face to back.

5.8.1 Crossband gaps and center gaps –

Crossband gaps or center gaps, except as noted for plugged crossband and jointed crossband, shall not exceed 25 mm (1 inch) in width for a depth of 205 mm (8 inches) measured from panel edge. The average of all gaps occurring in a panel shall not exceed 12.7 mm (1/2 inch). Where inner layers are thicker than 6.4 mm (1/4 inch), gaps in the laminated plies shall be offset 25 mm (1 inch) if over 6.4 mm (1/4 inch) wide.

Where plugged inner plies are specified, inner plies shall be of C Plugged veneer and gaps between adjacent pieces of inner plies shall not exceed 12.7 mm (1/2 inch).

Where jointed inner plies are specified, gaps between pieces of inner plies shall not exceed 9.5 mm (3/8 inch), and the average of all gaps occurring in a panel shall not exceed 4.8 mm (3/16 inch).

5.8.2 Veneer requirements – The veneers used in each ply of each panel and the completed panel shall conform with the applicable veneer grade and with the construction and workmanship requirements given herein. Additionally, in recognition of the requirements of selected end uses, the type and frequency of specific characteristics shall be further limited for grades in table 5.

Table 5. Characteristics prohibited or restricted in certain panel grades

Panel Grade Designation	Description and Number of Characteristics Per Panel
N-N, N-A	No crossband laps adjacent to faces and backs
N-B	No crossband laps adjacent to N faces No more than 2 crossband laps adjacent to B grade side (5.8.3) Laps are limited to 4.8 mm (3/16 inch)
N-D	No crossband laps adjacent to faces No more than a total of 2 of any combination of the following: – Knothole in D veneer over 65 mm (2-1/2 inches) but not over 75 mm (3 inches) – Split in D veneer over 12.7 mm (1/2 inch) but not over 25 mm (1 inch) – Crossband lap adjacent to backs
Underlayment and C-C Plugged	No knotholes in veneer adjacent to face over 25 mm (1 inch) across the grain where C grade is required per tables 2 and 3 No knotholes in veneer adjacent to face over 65 mm (2-1/2 inches) where D grade is permitted or over 38 mm (1-1/2 inches) where C grade is permitted per 5.6.3 No laps adjacent to face
Structural I C-D	No splits in faces over 6.4 mm (1/4 inch) No splits in backs over 12.7 mm (1/2 inch) No more than a total of 2 of any combination of the following: – Knothole in C veneer over 25 mm (1 inch) but not over 38 mm (1-1/2 inches) – Knot in D backs over 65 mm (2-1/2 inches) but not over 75 mm (3 inches) – Knothole in D veneer over 65 mm (2-1/2 inches) but not over 75 mm (3 inches) – Crossband lap adjacent to faces (See 5.8.4) – Crossband lap adjacent to backs (See 5.8.4)
Structural I C-D Plugged	No splits in backs over 12.7 mm (1/2 inch) No more than a total of 2 of any combination of the following: – Knot in D backs over 65 mm (2-1/2 inches) but not over 75 mm (3 inches) – Knothole in D veneer over 65 mm (2-1/2 inches) but not over 75 mm (3 inches) – Crossband lap adjacent to faces (See 5.8.4) – Crossband lap adjacent to backs (See 5.8.4)
Structural I Underlayment	No knotholes in core veneer next to face over 25 mm (1 inch) No crossband laps adjacent to faces No splits in backs over 12.7 mm (1/2 inch) No more than a total of 2 of any combination of the following: – Knot in D backs over 65 mm (2-1/2 inches) but not over 75 mm (3 inches) – Knothole in D veneer over 65 mm (2-1/2 inches) but not over 75 mm (3 inches) – Crossband lap adjacent to backs (See 5.8.3, 5.8.4)

5.8.3 Sanded panels – Unless otherwise specified, sanded plywood shall be sanded on two sides. Sanding defects for N, A, B, and C Plugged faces shall be as given in 5.4. Exposed N, A, and B veneer surfaces of panels shall have the bark or tight surface out. Plies directly under the surface of overlaid panels are not considered exposed veneers. Faces and backs of panels shall be full width and full length; except that, C grade and D grade backs shall be permitted to be narrow on one edge or short on one end only, but by not more than 3.2 mm (1/8 inch) for half the panel length or width. Inner plies shall be full width and length; except that, panels other than Marine, shall be permitted to have one edge or end void not exceeding 3.2 mm (1/8 inch) in depth and 205 mm (8 inches) in length per panel. Except as otherwise specified in table 5 for specific panel grade designations, crossband veneers not exceeding 3.2 mm (1/8 inch) in thickness shall be permitted to be lapped but by not more than 4.8 mm (3/16 inch) when adjacent to faces, or 12.7 mm (1/2 inch) when adjacent to backs, and provided such laps create no adjacent visible openings. Sanding defects resulting from crossband laps shall not be permitted in panel faces.

5.8.4 Unsanded and touch-sanded panels – Grade C or D veneers shall be permitted to be lapped by not more than 12.7 mm (1/2 inch) provided such laps shall create no adjacent visible opening. Additional limitations on laps adjacent to panel faces and backs are included in table 5. All plies of C-D panels shall be full length and full width; except that, no more than

half the length of one edge nor half the width of one end shall be permitted to contain short or narrow plies, provided:

- (a) Such plies shall not be short or narrow by more than 4.8 mm (3/16 inch); except that, crossbands shall be permitted to be short by 12.7 mm (1/2 inch) and centers shall be permitted to be narrow by 12.7 mm (1/2 inch) provided they taper to within 4.8 mm (3/16 inch) or less of the panel edge in 205 mm (8 inches).
- (b) When short or narrow by more than 4.8 mm (3/16 inch), the aggregate area in the plane of the plies of such edge characteristics shall not exceed 39 cm² (6 in²) in the entire panel.
- (c) Such edge characteristics shall not occur in more than one ply at any panel cross section.

In grades other than C-D, backs shall be permitted to be narrow on one edge or short on one end only, but by not more than 3.2 mm (1/8 inch) for half the panel length or width; inner plies shall be full width and length; except that, one edge or end void not exceeding 3.2 mm (1/8 inch) in depth and 205 mm (8 inches) in length per panel, shall be acceptable.

Panels manufactured as C-C, C-D, Structural C-C and Structural C-D shall not be sanded, touch-sanded, surface textured, or thickness sized by any mechanical means. However, sanded or touch-sanded panels which do not meet the grades for which they were intended shall not be reclassified and marked as C-C or C-D, unless the panels meet all applicable requirements for C-C or C-D and the finished face and back veneers after sanding each have a minimum net thickness equal to 90 % of the applicable thickness in table 6.

Table 6. Span ratings for sheathing and single-floor panels

(For special ply-layer and species requirements applicable to STRUCTURAL panels, see 5.6.5 and table 4. For crossband and total inner ply thickness proportion requirements, see 5.8.)

Span Rating ^(a)	Nominal Panel Thickness	Minimum Number of Plies-Layers	Minimum Face & Back Veneer Thickness Before Pressing, for Species Group ^(b)				Inner Ply Species Group
			1	2	3	4	
Sheathing Panels (C-D, C-C)							
12/0	7.9 mm (5/16 inch)	3-3	2.1 mm (1/12 inch)	2.1 mm (1/12 inch)	2.1 mm (1/12 inch)	2.1 mm (1/12 inch)	1, 2, 3 or 4
16/0	7.9 mm (5/16 inch)	3-3	2.1 mm (1/12 inch)	2.1 mm (1/12 inch)	2.1 mm (1/12 inch)	(c)	1, 2, 3 or 4
	8.7 mm (11/32 inch)	3-3	2.1 mm (1/12 inch)	2.1 mm (1/12 inch)	2.1 mm (1/12 inch)	2.1 mm (1/12 inch)	1, 2, 3 or 4
20/0	7.9 mm (5/16 inch)	3-3	2.1 mm (1/12 inch)	(c)	(c)	(c)	1, 2, 3 or 4
	8.7 mm (11/32 inch)	3-3	2.1 mm (1/12 inch)	2.1 mm (1/12 inch)	2.5 mm (1/10 inch)	(c)	1, 2, 3 or 4
	9.5 mm (3/8 inch)	3-3	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	1, 2, 3 or 4
24/0	9.5 mm (3/8 inch)	3-3	2.5 mm (1/10 inch)	(c)	(c)	(c)	1, 2, 3 or 4
	10.3 mm (13/32 inch)	3-3	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	(c)	(c)	1, 2, 3 or 4
	12.7 mm (1/2 inch)	3-3	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	1, 2, 3 or 4
32/16	12.7 mm (1/2 inch)	3-3	2.5 mm (1/10 inch)	4.2 mm (1/6 inch)	(c)	(c)	1, 2, 3 or 4
	13.5 mm (17/32 inch)	3-3	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	4.2 mm (1/6 inch)	(c)	1, 2, 3 or 4
	15.9 mm (5/8 inch)	3-3	(d)	(d)	(d)	(d)	1, 2, 3 or 4
40/20	15.9 mm (5/8 inch)	3-3	(d)	4.2 mm (1/6 inch)	(c)	(c)	1, 2, 3 or 4
	16.7 mm (21/32 inch)	3-3	2.5 mm (1/10 inch)	3.2 mm (1/8 inch)	4.2 mm (1/6 inch)	(c)	1, 2, 3 or 4
	19 mm (3/4 inch)	4-3	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	3.2 mm (1/8 inch)	1, 2, 3 or 4
	19.8 mm (25/32 inch)	4-3	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	1, 2, 3 or 4
48/24	19 mm (3/4 inch)	4-3	2.5 mm (1/10 inch)	4.2 mm (1/6 inch)	(c)	(c)	1, 2, 3 or 4
	19.8 mm (25/32 inch)	4-3	2.5 mm (1/10 inch)	3.2 mm (1/8 inch)	4.2 mm (1/6 inch)	(c)	1, 2, 3 or 4
	22.2 mm (7/8 inch)	5-5	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	(c)	1, 2, 3 or 4
	23 mm (29/32 inch)	5-5	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	3.2 mm (1/8 inch)	1, 2, 3 or 4
Single-Floor Panels (UNDERLAYMENT, C-C Plugged)							
16 oc	12.7 mm (1/2 inch)	3-3	2.5 mm (1/10 inch)	(c)	(c)	(c)	1, 2, 3 or 4
	15.1 mm (19/32 inch)	4-3	(d)	(d)	(d)	4.2 mm (1/6 inch)	1, 2, 3 or 4
	15.9 mm (5/8 inch)	4-3	(d)	(d)	(d)	(d)	1, 2, 3 or 4
20 oc	15.1 mm (19/32 inch)	4-3	(d)	4.2 mm (1/6 inch)	(c)	(c)	1, 2, 3 or 4
	15.9 mm (5/8 inch)	4-3	(d)	3.2 mm (1/8 inch)	4.2 mm (1/6 inch)	(c)	1, 2, 3 or 4
	18.3 mm (23/32 inch)	4-3	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	3.2 mm (1/8 inch)	1, 2, 3 or 4
	19 mm (3/4 inch)	4-3	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	1, 2, 3 or 4
24 oc	18.3 mm (23/32 inch)	4-3	2.5 mm (1/10 inch)	4.2 mm (1/6 inch)	4.8 mm (3/16 inch)	(c)	1, 2, 3 or 4
	19 mm (3/4 inch)	4-3	2.5 mm (1/10 inch)	3.2 mm (1/8 inch)	4.2 mm (1/6 inch)	(c)	1, 2, 3 or 4
	22.2 mm (7/8 inch)	5-5	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	2.5 mm (1/10 inch)	3.2 mm (1/8 inch)	1, 2, 3 or 4
48 oc	28.6 mm (1-1/8 inch)	7-5	3.2 mm (1/8 inch)	4.2 mm (1/6 inch)	(c)	(c)	1 or 2
	28.6 mm (1-1/8 inch)	7-5	3.6 mm (1/7 inch)	4.2 mm (1/6 inch)	(c)	(c)	1, 2 or 3
	28.6 mm (1-1/8 inch)	7-7	2.5 mm (1/10 inch)	4.2 mm (1/6 inch)	4.8 mm (3/16 inch)	(c)	1
	28.6 mm (1-1/8 inch)	7-7	3.2 mm (1/8 inch)	4.2 mm (1/6 inch)	4.8 mm (3/16 inch)	(c)	1, 2 or 3

^(a) See 5.8.5 for description.

^(b) Intermixing between species groups and/or thicknesses in the faces and backs of panels is permitted. Use the lowest applicable span rating to identify the panel. Also see 5.5.1.

^(c) Not permitted.

^(d) A minimum of 3.2 mm (1/8-inch) for 3-, 4- and 5-ply 3-layer panels per 5.5.1. A minimum of 2.5 mm (1/10-inch) for 5-ply 5-layer panels.

5.8.5 Span ratings for unsanded and touch-sanded panels

Grade-trademaking of C-C, C-D, Structural C-C, Structural C-D, and of C-C Plugged and Underlayment to be used as combination subfloor-underlayment (single floor) shall include a “span rating.” The numbers are presented as a fraction in the marking of sheathing grades of plywood, and as a single number for C-C Plugged and Underlayment. They describe the maximum spans in inches under normal use conditions and are in accordance with commonly accepted criteria. Panels for which there is no span rating shall be identified by largest species group number of the face and back, or by the span rating of the next thinner comparable panel. Sheathing panels manufactured 0.8 mm (1/32 inch) over standard thickness shall be permitted to be identified as the standard thickness.

For sheathing, the left-hand number shall refer to spacing of roof framing, and the right-hand number shall relate to spacing of the floor framing. The single number for Underlayment and C-C Plugged refers to spacing of the floor framing in single floor applications. Actual maximum spans are established by local building codes.

The span rating number is related to species and thickness of the panel face and back veneers, and panel thickness. It shall be established by either procedure (a) or (b):

- (a) By specification as detailed in table 6, or
- (b) By performance testing to satisfy the strength, stiffness and durability criteria as detailed in 5.8.6. Such performance testing shall be performed by a qualified testing agency, as described in 7.2.

5.8.6 Performance testing qualification requirements for span-rated panels

5.8.6.1 General – Acceptance of performance tested plywood under this Standard is based upon testing of panel strength, stiffness and durability. Panels selected for testing shall be of near-minimum grade and near-minimum thickness. Panel average thickness shall be established in accordance with 5.10.2, except that all four measurements shall be taken as described. Thickness sampling shall be such that the panel average thickness does not vary more than + 0.25 mm (0.010 inch) from the least panel average thickness in the lot. All provisions of veneer grade and panel workmanship are applicable.

5.8.6.2 Performance testing – Panels qualified by performance testing shall satisfy the criteria called for in 5.8.6 when tested in accordance with 5.8.6.3 and 5.8.6.4.

5.8.6.3 Structural performance

Concentrated loads

A minimum of ten tests (specimens taken from at least five panels) shall be conducted for both concentrated static and impact loads according to 6.2.1. The tests shall be conducted for each exposure condition specified in table 7 or table 9 (Wet, Dry, and/or Wet/Redry).

Deflection – At least 90 % of tests shall deflect no more than the specified maximum.

Retest. If no more than two tests in a lot of ten fail to meet the deflection requirements, another lot of ten shall be tested for that requirement. If no more than one test fails in this second round of testing, the requirements shall be considered as being satisfied.

Ultimate load

For each lot, 100 % of tests shall support the specified minimum ultimate load.

Retest. If no more than one test in a lot of ten fails to meet the minimum ultimate load requirement, another lot of ten shall be tested for that requirement. If all pass the retest, the requirements shall be considered as satisfied.

Uniform loads

A minimum of ten tests (specimens taken from at least five panels) shall be conducted for uniform load capacity according to 6.2.2. The tests shall be conducted for each exposure condition specified in table 8 or table 10.

Deflection – The average deflection shall not be greater than that specified.

Retest. If the average deflection is greater than specified, but does not exceed the requirement by 20 %, another lot of ten shall be tested for that requirement. If the average of the first and second lot taken together does not exceed that specified, the requirement shall be considered as being satisfied.

Ultimate load

For each lot, 100 % of tests shall support the specified minimum ultimate load.

Retest. If no more than one test in a lot of ten fails to meet the ultimate load requirement, another lot of ten shall be tested for that requirement. If all specimens pass this retest, the requirements shall be considered as being satisfied.

Table 7. Concentrated static and impact test performance criteria for panels tested according to 6.2.1 – Sheathing

End Use – Span Rating	Test Exposure Conditions ^(a)	Performance Requirements		
		Minimum Ultimate Load		Maximum Deflection Under 0.89 kN (200-lbf) Load ^(b)
		Static	Following Impact ^(d)	
Roof – 16	Dry Wet	1.78 kN (400 lbf) 1.78 kN (400 lbf)	1.33 kN (300 lbf) 1.33 kN (300 lbf)	11.1 mm (0.438 inch) (c)
Roof – 20	Dry Wet	1.78 kN (400 lbf) 1.78 kN (400 lbf)	1.33 kN (300 lbf) 1.33 kN (300 lbf)	11.9 mm (0.469 inch) (c)
Roof – 24	Dry Wet	1.78 kN (400 lbf) 1.78 kN (400 lbf)	1.33 kN (300 lbf) 1.33 kN (300 lbf)	12.7 mm (0.500 inch) (c)
Roof – 32	Dry Wet	1.78 kN (400 lbf) 1.78 kN (400 lbf)	1.33 kN (300 lbf) 1.33 kN (300 lbf)	12.7 mm (0.500 inch) (c)
Roof – 40	Dry Wet	1.78 kN (400 lbf) 1.78 kN (400 lbf)	1.33 kN (300 lbf) 1.33 kN (300 lbf)	12.7 mm (0.500 inch) (c)
Roof – 48	Dry Wet	1.78 kN (400 lbf) 1.78 kN (400 lbf)	1.33 kN (300 lbf) 1.33 kN (300 lbf)	12.7 mm (0.500 inch) (c)
Subfloor – 16	Dry Wet/Redry	1.78 kN (400 lbf) 1.78 kN (400 lbf)	1.78 kN (400 lbf) 1.78 kN (400 lbf)	4.8 mm (0.188 inch) 4.8 mm (0.188 inch)
Subfloor – 20	Dry Wet/Redry	1.78 kN (400 lbf) 1.78 kN (400 lbf)	1.78 kN (400 lbf) 1.78 kN (400 lbf)	5.6 mm (0.219 inch) 5.6 mm (0.219 inch)
Subfloor – 24	Dry Wet/Redry	1.78 kN (400 lbf) 1.78 kN (400 lbf)	1.78 kN (400 lbf) 1.78 kN (400 lbf)	6.4 mm (0.250 inch) 6.4 mm (0.250 inch)

(a) Wet/redry is exposure to three days continuous wetting followed by testing dry. Wet conditioning is exposure to three days continuous wetting and tested wet.

(b) Criteria apply under static concentrated load according to 6.2.1. They do not apply following impact.

(c) Not applicable.

(d) Impact shall be 102 N•m (75 lbf•ft) for span ratings up to 24, 122 N•m (90 lbf•ft) for 32, 163 N•m (120 lbf•ft) for 40, and 203 N•m (150 lbf•ft) for 48.

Table 8. Uniform load performance criteria for panels tested according to 6.2.2 – Sheathing

End Use – Span Rating	Test Exposure Conditions ^(a)	Performance Requirements	
		Average Deflection Under Load	Minimum Ultimate Uniform Load
Roof – 16	Dry	1.7 mm at 1.68 kPa (0.067 inch at 35 lbf/ft ²)	7.2 kPa (150 lbf/ft ²)
Roof – 20	Dry	2.0 mm at 1.68 kPa (0.080 inch at 35 lbf/ft ²)	7.2 kPa (150 lbf/ft ²)
Roof – 24	Dry	2.5 mm at 1.68 kPa (0.100 inch at 35 lbf/ft ²)	7.2 kPa (150 lbf/ft ²)
Roof – 32	Dry	3.4 mm at 1.68 kPa (0.133 inch at 35 lbf/ft ²)	7.2 kPa (150 lbf/ft ²)
Roof – 40	Dry	4.2 mm at 1.68 kPa (0.167 inch at 35 lbf/ft ²)	7.2 kPa (150 lbf/ft ²)
Roof – 48	Dry	5.1 mm at 1.68 kPa (0.200 inch at 35 lbf/ft ²)	7.2 kPa (150 lbf/ft ²)
Subfloor – 16	Dry	1.1 mm at 4.79 kPa (0.044 inch at 100 lbf/ft ²)	15.8 kPa (330 lbf/ft ²)
Subfloor – 20	Wet/Redry	1.1 mm at 4.79 kPa (0.044 inch at 100 lbf/ft ²)	15.8 kPa (330 lbf/ft ²)
	Dry	1.3 mm at 4.79 kPa (0.053 inch at 100 lbf/ft ²)	15.8 kPa (330 lbf/ft ²)
Subfloor – 24	Wet/Redry	1.3 mm at 4.79 kPa (0.053 inch at 100 lbf/ft ²)	15.8 kPa (330 lbf/ft ²)
	Dry	1.7 mm at 4.79 kPa (0.067 inch at 100 lbf/ft ²)	15.8 kPa (330 lbf/ft ²)
	Wet/Redry	1.7 mm at 4.79 kPa (0.067 inch at 100 lbf/ft ²)	15.8 kPa (330 lbf/ft ²)

(a) Wet/redry is exposure to three days continuous wetting followed by testing dry.

Table 9. Concentrated static and impact test performance criteria for panels tested according to 6.2.1 – Single Floor

Span Rating	Test Exposure Conditions ^(a)	Performance Requirements		
		Minimum Ultimate Load		Maximum Deflection Under 0.89 kN (200-lbf) Load ^(b)
		Static	Following 102 N•m (75 lbf•ft) Impact	
16	Dry	2.45 kN (550 lbf)	1.78 kN (400 lbf)	2.0 mm (0.078 inch)
	Wet/Redry	2.45 kN (550 lbf)	1.78 kN (400 lbf)	2.0 mm (0.078 inch)
20	Dry	2.45 kN (550 lbf)	1.78 kN (400 lbf)	2.4 mm (0.094 inch)
	Wet/Redry	2.45 kN (550 lbf)	1.78 kN (400 lbf)	2.4 mm (0.094 inch)
24	Dry	2.45 kN (550 lbf)	1.78 kN (400 lbf)	2.8 mm (0.109 inch)
	Wet/Redry	2.45 kN (550 lbf)	1.78 kN (400 lbf)	2.8 mm (0.109 inch)

^(a) Wet/redry is exposure to three days continuous wetting followed by testing dry.

^(b) Criteria apply under static concentrated load and following 102 N•m (75 lbf•ft) impact according to 6.2.1.

Table 10. Uniform load performance criteria for panels tested according to 6.2.2 – Single Floor

Span Rating	Test Exposure Conditions ^(a)	Performance Requirements	
		Average Deflection Under Load	Minimum Ultimate Uniform Load
16	Dry or Wet/Redry	1.1 mm at 4.79 kPa (0.044 inch at 100 lbf/ft ²)	15.8 kPa (330 lbf/ft ²)
20	Dry or Wet/Redry	1.3 mm at 4.79 kPa (0.053 inch at 100 lbf/ft ²)	15.8 kPa (330 lbf/ft ²)
24	Dry or Wet/Redry	1.7 mm at 4.79 kPa (0.067 inch at 100 lbf/ft ²)	15.8 kPa (330 lbf/ft ²)

^(a) Wet/redry is exposure to three days continuous wetting followed by testing dry.

5.8.6.4 Bond durability – Panels shall be classed as “Exposure 1” or “Exterior.”

Exposure 1 – Panels rated as “Exposure 1” shall be so identified and shall satisfy the bond requirements for Interior panels bonded with exterior glue, as specified in 5.7.3.

Exterior – Panels rated as “Exterior” shall be so identified and shall satisfy the bond requirements specified in 5.7.4.

5.8.6.5 Product evaluation

Mill specification – Upon conformance with the appropriate requirements of 5.8.6.3 and 5.8.6.4, a manufacturing specification shall be written based on product evaluation. This specification is to be used for quality assurance purposes by the manufacturer and the qualified testing agency, per 7.2. Product evaluation will be accomplished on the same lot supplied by the manufacturer for

qualification testing. Control values established during product evaluation will be the basis for quality evaluation of future production. The mill specification shall contain the following information:

- (a) **Panel construction** – Panels shall be defined as to veneer species and construction.
- (b) **Thickness** – The control value shall be the minimum average panel thickness as sampled under 5.8.6.1.
- (c) **Mechanical properties** –

Bending stiffness – Twenty tests (specimens taken from at least ten panels) shall be evaluated for bending stiffness both along and across the major panel axis according to the procedures of 6.2.3. The control value for each panel direction will be the sample mean and the minimum will be the lower value of a 90 % confidence interval established on the mean.

Bending strength – Ten tests (specimens taken from ten different panels) shall be tested for maximum bending moment both along and across the major panel axis according to the procedures of 6.2.3. The control value for each panel direction will be the minimum observed value, or the sample mean less 1.8 times the sample standard deviation, whichever is the higher value.

5.8.6.6 Reexamination

Quarterly reexamination – A product qualified by performance testing shall be subjected to quarterly reexamination by the manufacturer’s qualified testing agency (7.2). Panels shall be tested according to the procedures of 5.8.6.5, Mechanical Properties.

Resampling – Failure to meet established control values shall result in an immediate intensive resampling of current production which will be tested for the failing property. This resampling shall consist of 20 panels.

Requalification – When results of the resampling fail to meet the applicable test requirements, a requalification for structural properties under 5.8.6.3 shall be required.

5.8.7 Performance testing qualification requirements for other than span-rated panels

5.8.7.1 General – Panels using species as provided in 5.2.4 shall be qualified for use under this Standard based upon testing of panel strength and stiffness in accordance with 5.8.7.2. Results of testing shall establish a Group classification for use as required in 7.2. Group classification established by panel testing shall be determined by the largest Group number obtained from all performance tests. Panels qualified in accordance with this section shall also be subject to reexamination as provided in 5.8.6.6.

5.8.7.2 Performance testing

Bending stiffness – A minimum of 20 tests (specimens taken from at least ten panels) shall be evaluated for bending stiffness both along and across the major panel axis according to the procedures of 6.2.3. At least 90 % of tests shall meet the minimum stiffness value (EI) along the major axis given in table 11 for the nominal thickness tested.

Table 11. Species group classification test criteria for other than span-rated panels

Thickness mm (inch)	Group	F_{vt} ^(a) kN/m (lbf/inch)	Stress Along (Parallel to Face)		
			EI ^(b) kN•m ² /m (lbf•inch ² /ft)	F_bKS ^(c) kN•m/m (lbf•inch/ft)	$F_s(Ib/Q)$ ^(d) kN/m (lbf/ft)
6.4 (1/4)	1	21.0 (120)	0.15 (16 000)	0.087 (235)	3.7 (255)
	2	15.8 (90)	0.12 (13 000)	0.063 (170)	3.7 (255)
	3	15.8 (90)	0.10 (10 500)	0.063 (170)	3.7 (255)
	4	14.5 (83)	0.08 (8 800)	0.057 (155)	3.7 (255)
8.7 (11/32)	1	22.8 (130)	0.35 (37 500)	0.137 (370)	5.1 (350)
	2	16.6 (95)	0.30 (31 500)	0.100 (270)	5.1 (350)
	3	16.6 (95)	0.24 (25 000)	0.100 (270)	5.1 (350)
	4	15.6 (89)	0.20 (21 000)	0.093 (250)	5.1 (350)
9.5 (3/8)	1	22.8 (130)	0.50 (53 500)	0.183 (495)	5.8 (395)
	2	17.0 (97)	0.42 (44 500)	0.133 (360)	5.8 (395)
	3	17.0 (97)	0.33 (35 500)	0.133 (360)	5.8 (395)
	4	15.8 (90)	0.28 (29 500)	0.124 (335)	5.8 (395)
11.9 (15/32)	1	33.3 (190)	1.22 (130 000)	0.313 (845)	7.7 (525)
	2	24.5 (140)	1.04 (110 000)	0.228 (615)	7.7 (525)
	3	24.5 (140)	0.82 (87 000)	0.228 (615)	7.7 (525)
	4	22.8 (130)	0.68 (72 500)	0.211 (570)	7.7 (525)
12.7 (1/2)	1	34.1 (195)	1.41 (150 000)	0.347 (935)	8.3 (570)
	2	25.4 (145)	1.18 (125 000)	0.252 (680)	8.3 (570)
	3	25.4 (145)	0.94 (100 000)	0.252 (680)	8.3 (570)
	4	23.6 (135)	0.80 (84 500)	0.234 (630)	8.3 (570)
15.1 (19/32)	1	43.8 (250)	2.17 (230 000)	0.463 (1250)	10.1 (695)
	2	32.4 (185)	1.79 (190 000)	0.335 (905)	10.1 (695)
	3	32.4 (185)	1.41 (150 000)	0.335 (905)	10.1 (695)
	4	29.8 (170)	1.18 (125 000)	0.311 (840)	10.1 (695)
15.9 (5/8)	1	43.8 (250)	2.40 (255 000)	0.500 (1350)	10.8 (740)
	2	32.4 (185)	2.02 (215 000)	0.361 (975)	10.8 (740)
	3	32.4 (185)	1.60 (170 000)	0.361 (975)	10.8 (740)
	4	29.8 (170)	1.32 (140 000)	0.335 (905)	10.8 (740)
18.3 (23/32)	1	44.7 (255)	3.34 (355 000)	0.575 (1550)	12.2 (835)
	2	33.3 (190)	2.78 (295 000)	0.408 (1100)	12.2 (835)
	3	33.3 (190)	2.21 (235 000)	0.408 (1100)	12.2 (835)
	4	30.6 (175)	1.84 (195 000)	0.389 (1050)	12.2 (835)
19.1 (3/4)	1	45.5 (260)	3.67 (390 000)	0.612 (1650)	12.6 (860)
	2	33.3 (190)	3.06 (325 000)	0.445 (1200)	12.6 (860)
	3	33.3 (190)	2.45 (260 000)	0.445 (1200)	12.6 (860)
	4	30.6 (175)	2.02 (215 000)	0.408 (1100)	12.6 (860)
22.2 (7/8)	1	46.4 (265)	5.18 (550 000)	0.760 (2050)	14.6 (1000)
	2	34.1 (195)	4.33 (460 000)	0.556 (1500)	14.6 (1000)
	3	34.1 (195)	3.44 (365 000)	0.556 (1500)	14.6 (1000)
	4	32.4 (185)	2.87 (305 000)	0.500 (1350)	14.6 (1000)
25.4 (1)	1	65.7 (375)	7.91 (840 000)	0.982 (2650)	16.8 (1150)
	2	48.2 (275)	6.59 (700 000)	0.704 (1900)	16.8 (1150)
	3	48.2 (275)	5.27 (560 000)	0.704 (1900)	16.8 (1150)
	4	44.7 (255)	4.38 (465 000)	0.649 (1750)	16.8 (1150)
28.6 (1-1/8)	1	66.5 (380)	10.36 (1 100 000)	1.205 (3250)	18.3 (1250)
	2	49.0 (280)	8.52 (905 000)	0.871 (2350)	18.3 (1250)
	3	49.0 (280)	6.83 (725 000)	0.871 (2350)	18.3 (1250)
	4	45.5 (260)	5.70 (605 000)	0.816 (2200)	18.3 (1250)

(a) Shear-through-the-thickness strength value.

(b) Minimum stiffness value.

(c) Maximum moment value.

(d) Planar shear strength value.

Bending strength – A minimum of ten tests (specimens taken from ten different panels) shall be tested for maximum bending moment both along and across the major panel axis according to the procedures of 6.2.3. At least 95 % of tests shall meet the maximum moment value (F_bKS) along the major axis given in table 11 for the nominal thickness tested.

Planar shear strength – A minimum of ten tests (specimens taken from ten different panels) shall be tested for planar shear strength both along and across the major panel axis according to the procedures of 6.2.4. At least 95 % of tests shall meet the planar shear strength value ($F_s[lb/Q]$) along the major axis given in table 11 for the nominal thickness tested.

Shear-through-the-thickness strength – A minimum of ten tests (specimens taken from ten different panels) shall be tested for shear strength through the thickness according to the procedures of 6.2.5. At least 95 % of tests shall meet the shear-through-the-thickness strength value (F_{v,t_s}) given in table 11 for the nominal thickness tested.

5.8.7.3 Mill specification – Upon conformance with the requirements of 5.8.7.2, a manufacturing specification shall be written. This specification shall be used for quality assurance purposes by the manufacturer and the qualified testing agency according to 7.2. The manufacturing specification shall define veneer species and panel construction, and shall include the following control values:

Thickness – The minimum individual panel average thickness of panels tested under 5.8.7.2;

Bending stiffness – The sample mean and the minimum shall be the lower value of a 90 % confidence interval established on the mean for each panel direction;

Bending strength – The minimum observed value, or the sample mean less 1.8 times the sample standard deviation, whichever is the higher value for each panel direction;

Planar shear strength – The minimum observed value, or the sample mean less 1.8 times the sample standard deviation, whichever is the higher value for each panel direction;

Shear-through-the-thickness strength – The minimum observed value, or the sample mean less 1.8 times the sample standard deviation, whichever is the higher value.

5.9 Scarf and finger jointed panels – Neither panels with N faces, nor the faces of such panels, unless longer than 3 m (10 ft), shall be scarf or finger jointed unless otherwise agreed

to by buyer and seller. Panels of other grades shall be permitted to be scarf or finger jointed unless otherwise agreed to by buyer and seller, and panels longer than 3.7 m (12 ft) are necessarily scarf or finger-jointed. Plain scarfed joints and the scarfed portion of finger-joints shall not have a slope greater than 1 to 8. All plies with grain perpendicular to the finger joint shall be included in the scarfed portions of the joint, except that such plies shall be permitted to include up to 0.8 mm (1/32 inch) of vertical shoulder in the scarf (see figure 5). Joints shall be glued with a waterproof adhesive and shall meet the test requirements set forth in 5.9.1, 5.9.2, 5.9.3, and 5.9.4 as applicable. In addition, the adhesive shall not show creep or flow characteristics greater than unjointed wood when subject to load under any conditions of temperature and moisture.

5.9.1 Strength requirements (Interior and Exterior) for scarf and finger jointed panels

If the average ultimate stress of the three test specimens of any one panel is less than 27.6 MPa (4000 psi) for panels of Group 1 species, or less than 19.3 MPa (2800 psi) for panels of Group 2 or Group 3 species, or less than 16.5 MPa (2400 psi) for panels of Group 4 species, or less than 13.8 MPa (2000 psi) for panels of Group 5 species, when tested in accordance with 6.1.7.1, then that panel shall fail. The jointed panels represented by a sampling of ten panels shall be acceptable if not more than one of the panels fails and the average ultimate stress of the failing panel is at least 80 % of that specified for the applicable species group. If the average ultimate stress of the failing panel is at least 75 % of that specified for the applicable species group, another series of ten panels shall be tested. If none of the panels in this series fails, the jointed panels shall be accepted; otherwise they shall be rejected.

5.9.2 Scarf and finger joint durability for Interior bonded with interior glue

Scarfed panels shall be tested in accordance with 6.1.7.2. Finger jointed panels shall be tested in accordance with 6.1.7.4. Test specimens showing continuous delamination in excess of 1.6 mm (1/16 inch) deep and 12.7 mm (1/2 inch) long at the joint glue line shall be considered as failing. More than one failing specimen in a panel shall constitute failure of that panel. The jointed panels represented by a sampling of ten panels shall be acceptable if not more than one of the panels fails.

5.9.3 Scarf joint durability for Exterior plywood and Interior bonded with exterior glue (Exposure 1) or intermediate glue – Panels shall be tested in accordance with 6.1.7.3. The material represented by the sampling shall be evaluated in accordance with 5.7.2, 5.7.3, and 5.7.4, as applicable.

5.9.4 Finger joint durability for Exterior plywood and Interior bonded with exterior glue (Exposure 1) or intermediate glue – Panels shall be tested in accordance with 6.1.7.5. The joints shall meet all of the following minimum conditions:

- (a) The average wood failure rating of all specimens from each panel when tested in accordance with 6.1.7.5 shall be not less than 85 %.
- (b) No single specimen from a panel (average of face and back gluelines) shall rate less than 60 % wood failure.
- (c) No single face or back glueline in any specimen shall rate less than 30 % wood failure.

5.10 Dimensional tolerances and squareness of panels – Panel measurements shall be based on a moisture content of 9 %.

5.10.1 Size tolerances – A tolerance of plus zero (0) mm, minus 1.6 mm (1/16 inch) shall be allowed on the specified length and width.

5.10.2 Thickness tolerances – Sanded panels shall have a tolerance of ± 0.4 mm (1/64 inch) for specified thicknesses of 19 mm (3/4 inch) and less and ± 3.0 % of the specified thickness for panels thicker than 19 mm (3/4 inch). Unsanded, touch sanded, and overlaid panels shall have a tolerance of ± 0.8 mm (1/32 inch) for specified thicknesses of 20.5 mm (13/16 inch) and less and ± 5 % of the specified thickness for panels thicker than 20.6 mm (13/16 inch).

Panel thickness shall be measured with a micrometer having 19 mm (3/4 inch) (minus 0, plus 1.3 mm [0.050-inch]) diameter anvils. Measurement shall be taken at an applied anvil pressure of not less than 34 kPa (5 psi) or more than 69 kPa (10 psi). The location of measurement shall be representative of general panel thickness at approximate mid-width on one end of each panel. If that measurement is below minimum or above maximum requirements, three additional measurements shall be taken, one at

approximate mid-width on the opposite end and one at approximate mid-length on each side of the panel, and the average of four measurements shall be taken as the thickness of that panel.

5.10.3 Squareness and straightness – Panels 1220 mm (4 ft) or greater in length and width shall be square within 1.3 mm per meter (1/64 inch per lineal foot.) Panels less than 1220 mm (4 ft) in length or width shall be square within 1.6 mm (1/16 inch) measured along the short dimension. All panels shall be manufactured so that a straight line drawn from one corner to the adjacent corner shall fall within 1.6 mm (1/16 inch) of panel edge.

5.11 Moisture content – Moisture content of panels at time of shipment shall not exceed 18 % when tested in accordance with 6.1.6.

5.12 Loading or packing – The plywood shall be securely loaded or packaged to ensure delivery to destination in a clean and serviceable condition.

6. SPECIMEN PREPARATION AND TESTING

6.1 Bond durability

6.1.1 General – The tests set forth in this section shall be used to determine the glue bond quality of plywood produced under this Standard.

6.1.2 Specimen preparation (See Appendix A for sampling for reinspection) – One test piece shall be cut from each panel selected. For panels bonded with interior glue, the test piece shall be cut into five test specimens 50 mm wide by 125 mm along the grain (2 inches by 5 inches). For panels bonded with exterior glue, 10 test specimens shall be cut as described in 6.1.5.1. For panels bonded with intermediate glue, five test specimens shall be cut as described in 6.1.4.1. Of the 10 specimens cut from each test piece for panels bonded with exterior glue, five shall be for the vacuum-pressure test and five shall be for the boil test. From each overlaid panel selected, 10 additional test specimens shall be cut (as described in 6.1.5.1) to test the bond between the overlay and the base panel. In addition, from each panel selected, excluding Interior plywood panels bonded with interior glue, a specimen 140 mm by 205 mm (5-1/2 by 8 inches) shall be cut and tested as described in 6.1.5.4.

6.1.3 Test for Interior plywood bonded with interior glue

– The test specimens prepared as described in 6.1.2 shall be placed in a pressure vessel and completely submerged in 43 °C (110 °F) water. A vacuum of 51 kPa (15 inches) of mercury shall be drawn, maintained for 30 minutes and released. Specimens shall then be allowed to soak in the same water at atmospheric pressure for 4-1/2 hours with no additional heating. They shall be removed and dried for 15 hours at 66 °C (150 °F) in an oven with fan-forced air circulation of 45 to 50 air changes per minute. Specimens shall then be examined for delamination and evaluated in accordance with requirements given in 5.7.1.

Total continuous visible delamination of 6.4 mm (1/4 inch) or more in depth and 50 mm (2 inches) in length along the edges of a 50 mm by 125 mm (2-inch by 5-inch) test specimen shall be considered as failure. When required, this shall be determined by probing with a suitable feeler gage not greater than 0.33 mm (0.013 inch) in thickness. When delamination occurs as a result of a localized defect permitted in the grade, other than white pocket, that specimen shall be discarded.

6.1.4 Tests for Interior plywood bonded with intermediate glue

6.1.4.1 Preparation of test specimens – Test specimens shall be cut 85 mm long and 25 mm wide (3-1/4 inches by 1 inch), and kerfed one-third of the length of the specimen from each end as illustrated in figure 1 to provide a 25 mm (1 inch) square test area in the center. Specimens shall be oriented so that the grain direction of the ply under test runs at a 90° angle to the length of the specimen. Kerfing shall extend two-thirds of the way through the ply under test, and shall not penetrate the next glue line.

If the number of plies exceeds three, the cuts shall be made so as to test any two of the joints. The additional plies need not be stripped except as demanded by the limitations of the width of the retaining jaws on the testing device. When required to accommodate thicker plywood, special jaws shall be constructed. If the number of plies exceeds three, the choice of joints to be tested shall be left to the discretion of the qualified inspection and testing agency, but at least one-half of the tests shall include the innermost joints.

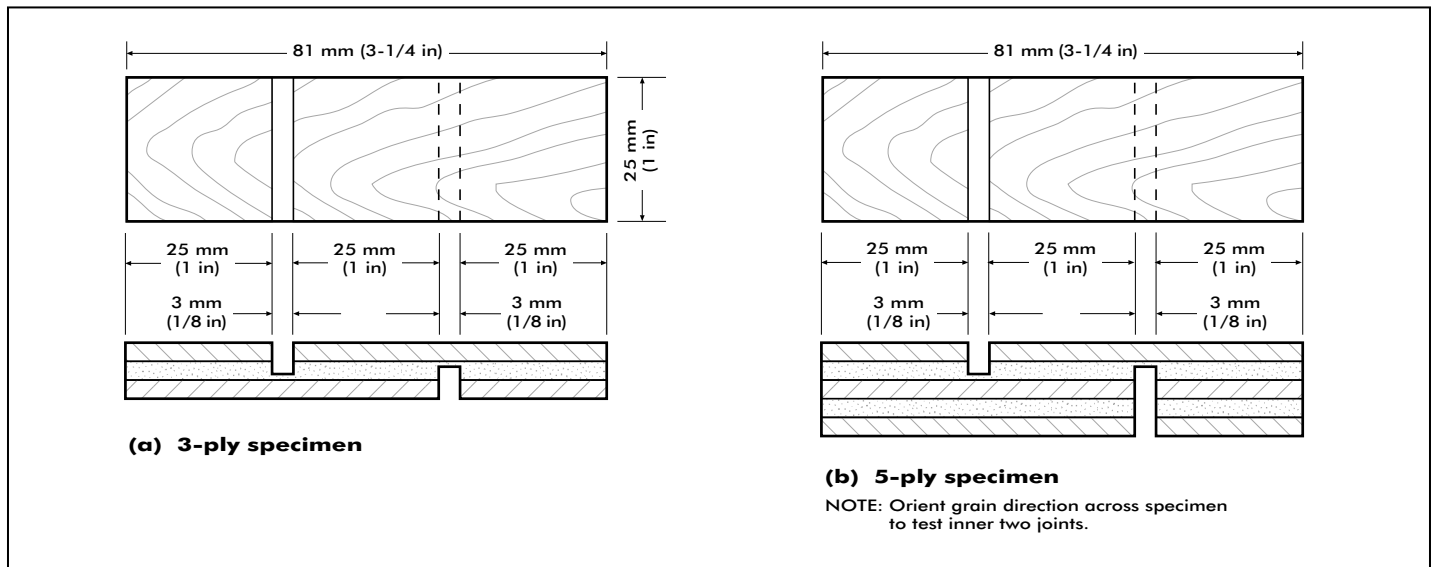


Figure 1. Shear test specimens.

6.1.4.2 Vacuum-soak test – The test specimens shall be placed in a pressure vessel and submerged in water at 48 °C (120 °F). A vacuum of 51 kPa (15 inches) of mercury shall be drawn and maintained for 30 minutes. Following the release of the vacuum, specimens shall continue soaking for 15 hours at atmospheric pressure. The temperature of the water shall not drop below 24 °C (75 °F) at any time during the 15 hour soaking period. Specimens shall then be removed from the vessel and tested while wet by tension loading to failure in a shear testing machine operated at a maximum head travel of 405 mm (16 inches) per minute. Jaws of the machine shall securely grip the specimen so there is no slippage. The percentage of wood failure of the specimens shall be determined with specimens in a dry condition and shall be evaluated as described in 5.7.2.

6.1.5 Tests for Exterior plywood and Interior bonded with exterior glue (Exposure 1).

6.1.5.1 Preparation of test specimens – Test specimens, taken as described in 6.1.2 shall be cut 85 mm (3-1/4 inches) long by 25 mm (1 inch) wide, and kerfed one-third of the length of the specimen from each end, as illustrated in figure 1 to provide a 25 mm (1-inch) square test area in the center. Specimens shall be oriented so that the grain direction of the ply under test runs at a 90° angle to the length of the specimen. Kerfing shall extend two-thirds of the way through the ply under test, and shall not penetrate the next glueline. For overlaid plywood, the additional 10 specimens for testing of bond between veneers shall be cut as described in this section for Exterior specimens, except that, they shall be cut 25 mm (1 inch) wide and 75 mm (3 inches) long, and kerfed just through the overlay 25 mm (1 inch) from the end, on each overlay face.

If the number of plies exceeds three, the cuts shall be made so as to test any two of the joints, but the additional plies need not be stripped except as demanded by the limitations of the width of the retaining jaws on the testing device. When required to accommodate thicker plywood, special jaws shall be constructed. If the number of plies exceeds three, the choice of joints to be tested shall be left to the discretion of the qualified inspection and testing agency, but at least one-half of the tests shall include the innermost joints.

6.1.5.2 Vacuum-pressure test – The test specimen shall be placed in a pressure vessel and submerged in cold tap water. A vacuum of 85 kPa (25 inches) of mercury shall be drawn and maintained for 30 minutes, followed immediately with application of 450 kPa to 480 kPa (65 psi to 70 psi) of pressure for 30 minutes duration. Specimens shall then be removed from the

vessel and tested while wet by tension loading to failure in a shear testing machine operated at a maximum head travel of 405 mm (16 inches) per minute. The jaws of the machine shall securely grip the specimens so there is no slippage. The percentage of wood failure of the specimens shall be determined in a dry condition and evaluated as described in 5.7.3 and 5.7.4.

The bond between veneers in overlaid plywood shall be tested in an identical manner and evaluated as described in 5.7.4. Specimens for testing the bond between the overlay and the base panel shall be subjected to the same test cycle just described. The bond between the overlay and the base panel shall be tested by inserting a sharp, thin blade of adequate stiffness into the corner of the 25 mm (1-inch) test area at the overlay-veneer interface, taking care not to cut into the overlay, and attempting to peel the overlay off. Reinsertion of the blade several times shall be permitted if necessary to remove the overlay from the 6.5 cm² (1-in²) area. The percentage of wood and/or fiber failure shall then be estimated with specimens in a dry condition and evaluated as described in 5.7.4. The value for each specimen shall be the average of the test areas on each face.

6.1.5.3 Boiling test – Test specimens shall be boiled in water for 4 hours and then dried for 20 hours at a temperature of 63 ± 3 °C (145 ± 5 °F) with sufficient air circulation to lower moisture content of the specimens to a maximum of 8 %. The specimens shall be boiled again for a period of 4 hours, cooled in water, and tested while wet by tension loading for failure in a shear testing machine operated at a maximum head travel of 405 mm (16 inches) per minute. Jaws of the machine shall securely grip the specimens so there is no slippage. The percentage of wood failure of the specimens shall be determined with specimens in a dry condition and evaluated as described in 5.7.3 and 5.7.4.

The bond between veneers in overlaid plywood shall be tested in an identical manner and evaluated as described in 5.7.4. Specimens to test the bond between the overlay and the base panels shall be subjected to the same test cycle described in the previous paragraph. The bond between the overlay and the base panel shall be tested by inserting a sharp, thin blade of adequate stiffness into the corner of the 25 mm (1-inch) test area at the overlay-veneer interface, taking care not to cut into the overlay, and attempting to peel the overlay off. Reinsertion of the blade several times shall be permitted if necessary to remove the overlay from the 6.5 cm² (1-in²) area. The percentage of wood and/or fiber failure shall then be estimated with specimens in a dry condition and evaluated as described in 5.7.4. The value for each specimen shall be the average of the test areas on each face.

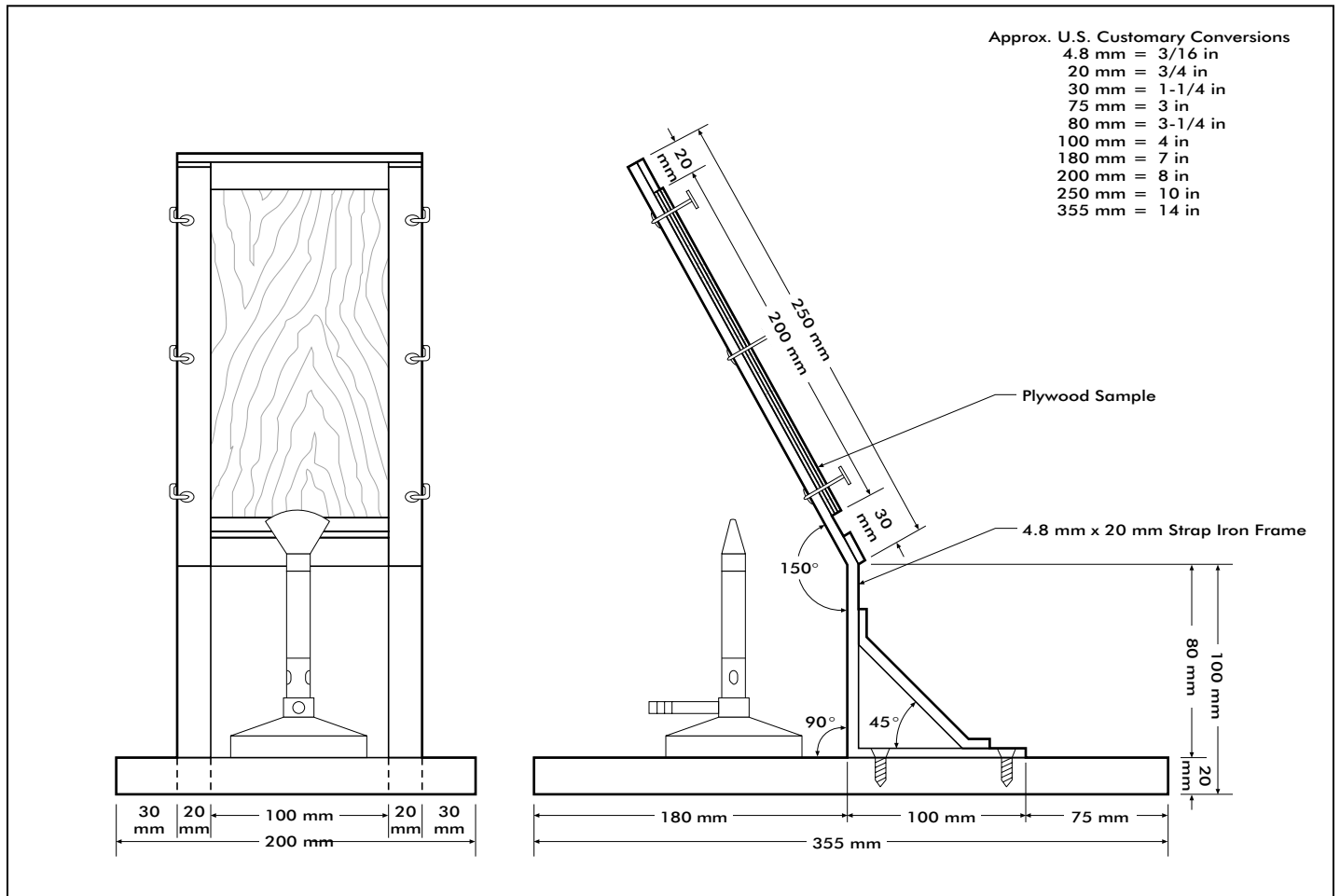


Figure 2. Apparatus for heat durability test.

6.1.5.4 Heat durability test – A specimen cut as described in 6.1.2 shall be placed on a stand as illustrated in figure 2. A specimen shall then be subjected to a 800 °C to 900 °C (1472 °F to 1652 °F) flame from a Bunsen-type burner for a period of 10 minutes, or until a brown charred area appears on the back side, whichever occurs first. The burner shall be equipped with a wing top to envelop the entire width of the specimen in flame. The top of the burner shall be 25 mm (1 inch) from the specimen face and the flame 38 mm (1-1/2 inches) high. The flame shall impinge on the face of the specimen 50 mm (2 inches) from the bottom end. After the test, the sample shall be removed from the stand and the gluelines examined for delamination by separating the charred plies with a sharp, chisel-like instrument. Specimens shall be evaluated in accordance with the requirements of 5.7.4.1.

6.1.6 Test for determination of moisture content (oven-drying method) – The moisture content of the plywood shall be determined as follows: A small test specimen shall be cut from each sample panel; the test specimen shall measure not less than 58 cm² (9 in²) in area and shall weigh not less than 20 grams (approximately 3/4 ounce). All loose splinters shall be removed from the specimen. The specimen shall be immediately weighed on a scale that is accurate to ±0.5 %, and the weight shall be recorded as the “original” weight. The specimen shall then be dried in an oven at 100 °C to 105 °C (212 °F to 221 °F) until constant weight is attained. After drying, the specimen shall be reweighed immediately, and this weight shall be recorded as the “oven-dry” weight. The moisture content shall be calculated as follows:

$$\frac{\text{Original weight} - \text{Oven-dry weight}}{\text{Oven-dry weight}} \times 100 = \text{Moisture content (\%)}$$

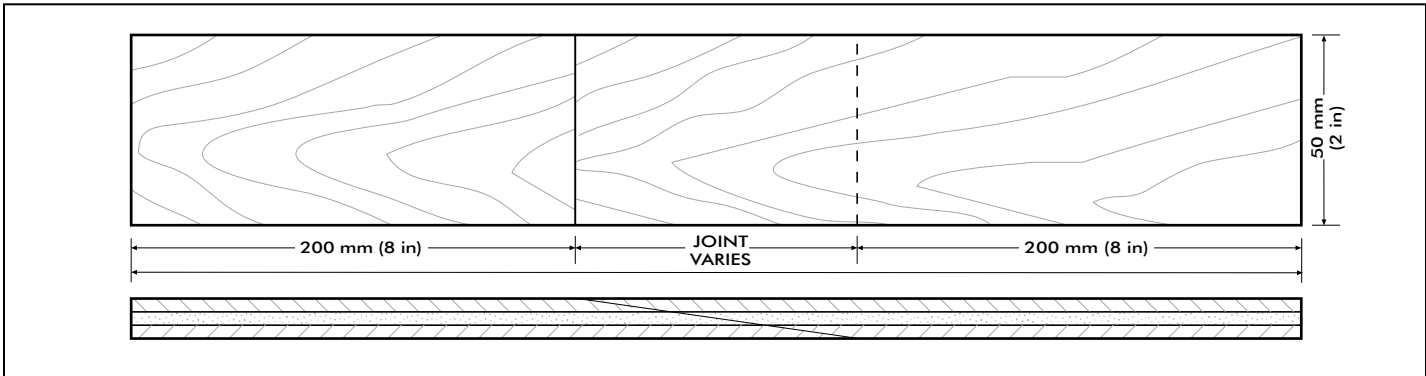


Figure 3. Tension specimen for scarfed jointed panels.

6.1.7 Scarf and finger-joint tests

6.1.7.1 Scarf and finger-joint strength – Three test specimens shall be cut at random along each joint from each panel selected. Type, grade and species of the panels shall be recorded. The specimens shall be cut so as to include the joint and shall be prepared as illustrated in figure 3.

Insofar as possible, the joint test area shall contain no localized natural defects permitted within the grade. At the joint, the maximum thickness and width of plies parallel with the load shall be recorded. Each specimen shall then be placed in the tension grips of a testing machine and loaded continuously at a rate of cross-head travel of from 0.7 mm to 1 mm (0.030 inch to 0.040 inch) per minute until failure, and the ultimate load shall be recorded. The ultimate stress in MPa (psi) shall be computed using the ultimate load and area of those plies whose grain is parallel with direction of load. Moisture content of the specimens at the time of testing shall not exceed 16 %.

6.1.7.2 Scarf joint durability of Interior plywood panels bonded with interior glue

– Ten test specimens shall be cut at random along each scarf joint from each panel selected and shall be prepared following the general procedure in 6.1.2, but shall be cut so that the scarf joint occurring on one surface of the panel runs across the middle of five specimens and the joint occurring on the opposite surface runs across the middle of the other five specimens. The specimens shall be subjected to the same test procedure as outlined in 6.1.3.

6.1.7.3 Scarf joint durability of Exterior plywood and Interior plywood bonded with exterior glue (Exposure 1) or intermediate glue

– Ten test specimens shall be cut at random along each joint from each panel selected according to 6.1.2. The specimens shall be prepared following the general procedure described in 6.1.4.1 and 6.1.5.1 but, in addition, shall be cut so that the joint runs through the test specimens as shown in figure 4.

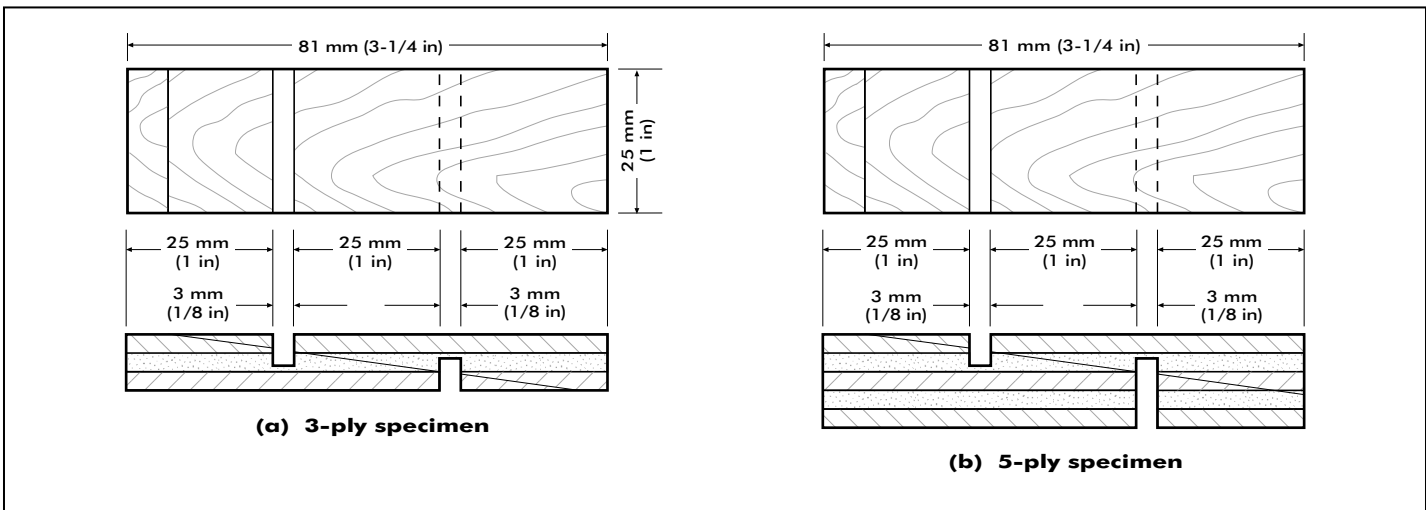


Figure 4. Specimen preparation.

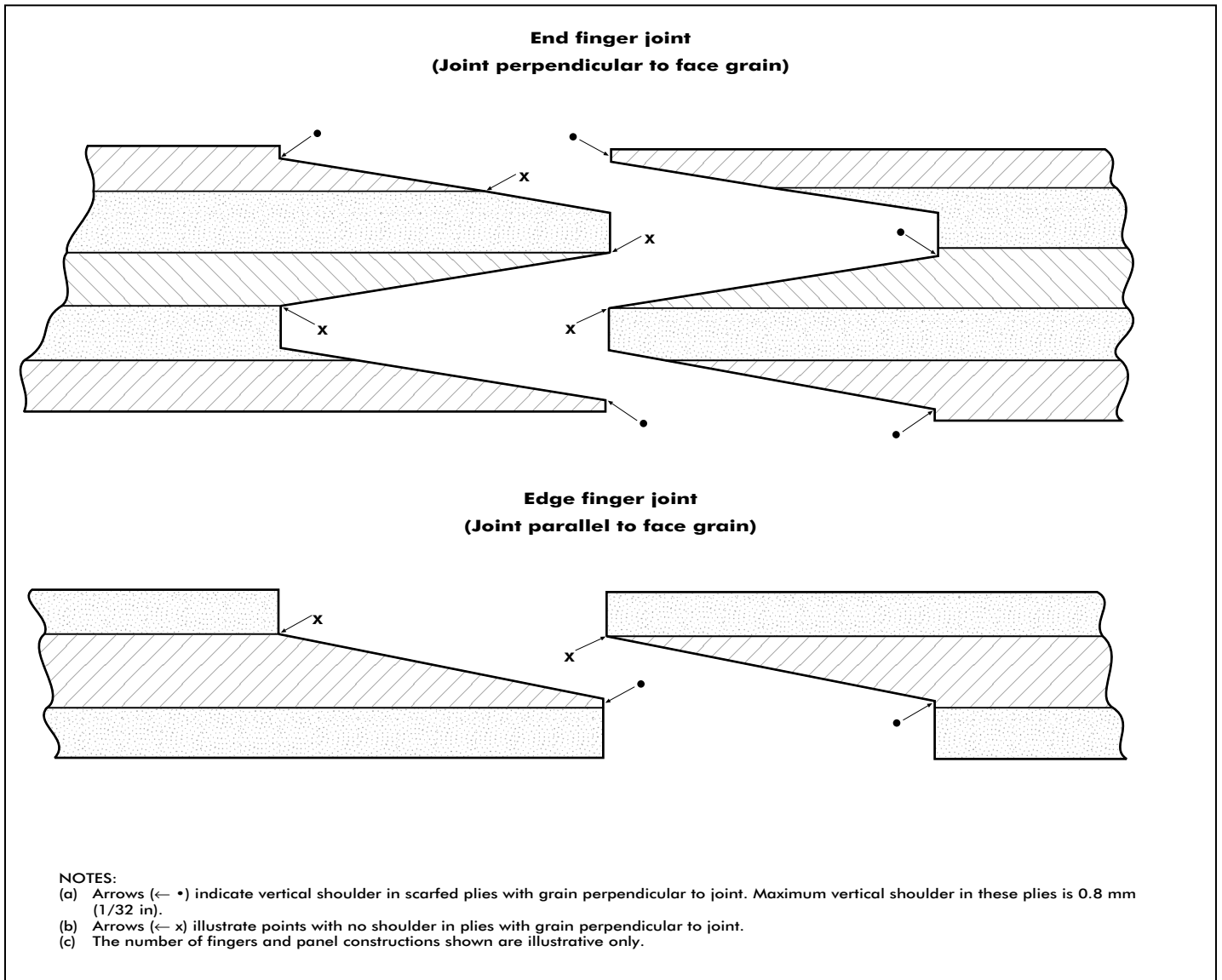


Figure 5. Finger joints – Location of scarfed portion of joints.

For Exterior panels and Interior panels bonded with exterior glue, five specimens shall be subjected to the vacuum pressure test described in 6.1.5.2, and five to the boiling test of 6.1.5.3. The panels shall be evaluated as described in 5.7.3 and 5.7.4.

For Interior panels bonded with intermediate glue, the ten specimens shall be subjected to the vacuum soak test outlined in 6.1.4.2. The panels shall be evaluated as described in 5.7.2.

6.1.7.4 Finger-joint durability of Interior panels bonded with interior glue – Five specimens shall be cut at random along the finger joint from each panel selected and shall be prepared following the general procedure in 6.1.2, so that the middle of the joint coincides with the middle of the five specimens. The specimens shall be subjected to the same test procedure as outlined in 6.1.3.

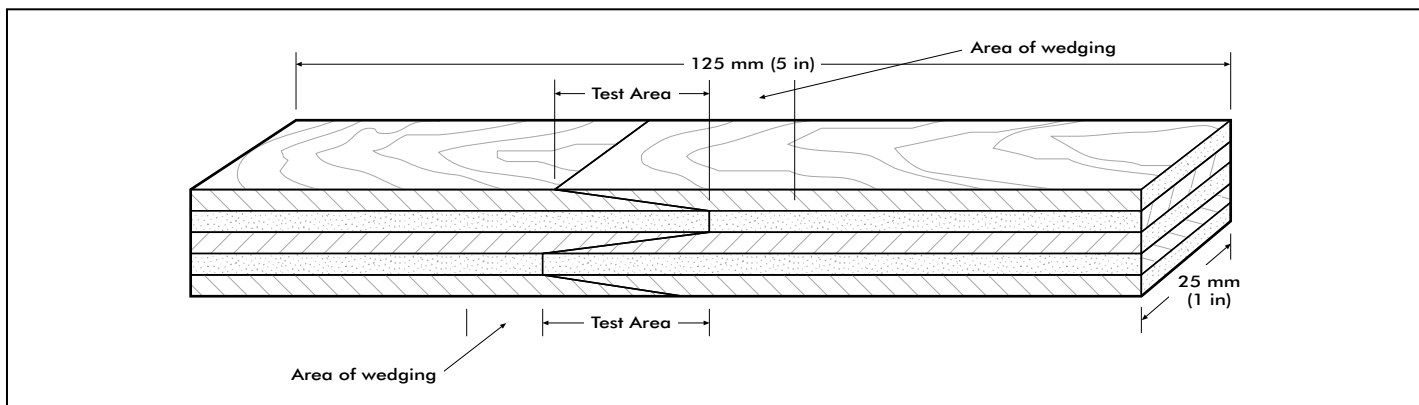


Figure 6. Cleavage test, typical test specimen.

6.1.7.5 Finger-joint durability of Exterior panels and Interior panels bonded with exterior glue (Exposure 1) or intermediate glue – Ten specimens shall be cut at random along the finger joint from each panel selected according to 6.1.2. These specimens shall be cut so as to include the joint and shall be prepared as illustrated in figure 6.

For Exterior panels and Interior panels bonded with exterior glue, five of the specimens shall be subjected to the vacuum-pressure test of 6.1.5.2 and five to the boiling test of 6.1.5.3.

For Interior panels bonded with intermediate glue, the ten specimens shall be subjected to the vacuum-soak test of 6.1.4.2.

Upon completion of the vacuum-pressure and boil tests, or vacuum-soak tests, as applicable, a wedge or chisel (see figure 7) shall be inserted in locations shown in figure 6 in such a manner as to pry apart the scarfed portions of the joint without directly contacting the glued area. Test specimens shall be dried and percent wood failure in the test area estimated and applied separately for both the boil and vacuum-pressure treatments. The panels shall be evaluated as described in 5.9.4.

6.1.8 Mold test

6.1.8.1 General – This method determines if an adhesive system possesses sufficient resistance to mold to retain bond integrity under conditions which promote mold growth.

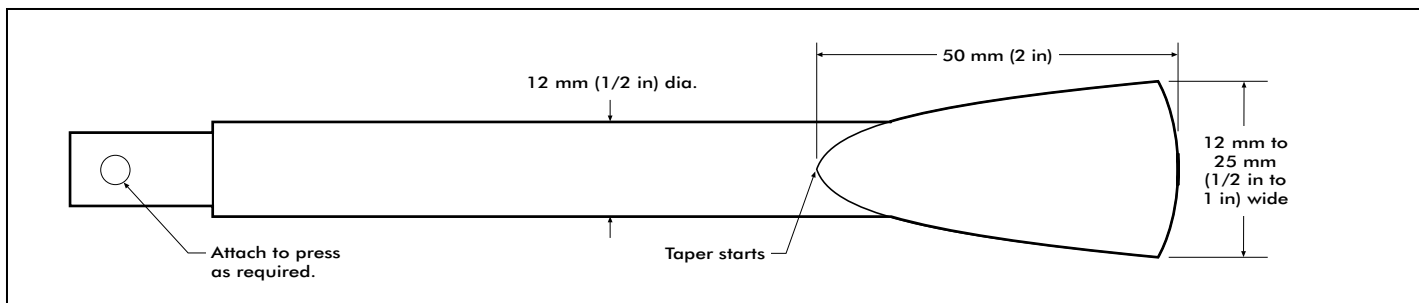


Figure 7. Wedge or chisel used for cleavage test.

6.1.8.2 Equipment – Cabinets shall be used to house test specimens under mold-producing conditions. Each cabinet shall be divided into three interconnecting compartments with adjustable specimen trays, each with a sealed door in the front. On each side of the trays, toweling shall be suspended vertically with the lower ends in a water pan acting as wicking in order to provide maximum wet surface area. These pans shall rest on the floor of the mold cabinet under each compartment. The water level in these pans shall be kept 65 mm to 75 mm (2-1/2 to 3 inches) in depth.

To maintain a uniform temperature within the mold cabinets, a walk-in housing shall surround the cabinets. The temperature within this housing shall be maintained at 27 ± 1 °C (80 ± 2 °F) with a 500-watt heater controlled by a thermostat. Fan-forced air circulation sufficient to avoid stratification shall be used to insure even temperature in all areas of the housing. No air circulation shall occur within the mold cabinets since mold growth is dependent upon still air.

A uniform temperature shall be maintained in the housing around the cabinets.

6.1.8.3 Specimen preparation – Panels shall be tested by preparing plywood shear specimens as described in 6.1.4.1, kerfed to pull lathe checks closed for maximum breaking load.

The four panels to be mold tested shall be cut into 100 pairs of specimens. These paired specimens (mold test specimen and adjacent control specimen) shall be completely randomized and assembled into 10 groups of 20 specimens each for each direction tested (10 test specimens and 10 controls). The controls and test specimens for each group shall then be separated.

6.1.8.4 Test procedure – Prior to placing specimens in the mold cabinet, the specimens and their controls shall be stickered, given a five-second dip in tap water at room temperature, and then conditioned for one week at 90 % to 97 % relative humidity and a temperature of 27 ± 1 °C (80 ± 2 °F) in a separate conditioning chamber. After one week, test and control specimens shall be removed. Test specimens shall be dusted with soybean flour and placed flat on green pine sapwood veneer strips that have been stored in the mold cabinet. A stack of these veneer strips and test specimens shall then be placed in the mold cabinet. The control specimens shall be allowed to dry at room conditions.

At two-week intervals, the designated mold groupings shall be removed from the cabinet and allowed to dry at room conditions for one week. Test specimens and corresponding control specimens shall then be tested as required. Ten of these groups shall be sufficient to test mold-resistant properties.

6.1.9 Bacteria test

6.1.9.1 General – This method determines if an adhesive system possesses sufficient resistance to bacterial attack to retain bond integrity under conditions which promote bacterial growth.

6.1.9.2 Specimen preparation – Panels shall use shear specimens described in 6.1.5.1, kerfed to pull lathe checks closed for maximum breaking load. Panels shall be cut with the 125 mm (5-inch) dimension parallel to the grain. The veneer shall be completely free of defects.

Sufficient material is needed to provide 80 specimens per set as required. Specimens within each set shall be numbered consecutively 1 through 80 as cut, with odd-numbered specimens destined for bacteria exposure and the adjacent even-numbered specimens destined for control. Ten odd-numbered specimens and their matching ten even-numbered specimens shall then comprise an exposure group and control for that group. Four such groups shall be made up from the 80 specimens for each direction tested.

6.1.9.3 Test procedure – Specimens, including the controls, shall be subjected to one-half hour vacuum and one-half hour pressure under tap water following the cycle used in 6.1.5.2. Control specimens shall then be tested as required in the wet condition. The breaking load shall be recorded and control averages shall be determined for each of the exposure groups.

All specimens designated for the bacteria exposure shall be floated flat in a slurry of soybean flour, water and alder sawdust consisting of 7 % soybean flour, 83 % water and 10 % alder sawdust (sawdust at 18 % moisture content). To this slurry shall be added 0.3 % by weight of a 50 % solution of sodium hydroxide. The slurry shall be poured into trays, filling them to a depth of 25 mm (1 inch). (Note: Do not use copper trays.) These trays containing slurry and specimens shall then be placed into a cabinet described and maintained according to 6.1.8.1.

One exposure group shall be removed from the cabinet every 3 weeks over the 12-week period of the test. Specimens shall be tested wet according to 6.1.4.

6.2 Structural performance

6.2.1 Tests for performance under concentrated static and impact loads

6.2.1.1 General – The general provisions of ASTM E-661 shall be followed.

6.2.1.2 Specimen preparation – Test specimens shall be prepared as specified in ASTM E-661. The number of specimens required is given in 5.8.6.3. Specimens shall also be moisture cycled as required.

6.2.1.3 Test procedure

Concentrated static – Procedures of ASTM E-661 shall be followed, except the test frame shall be constructed of lumber with nails or of steel using fasteners which simulate nails. The loading rate shall be 445 N (100 lbf) per 30 seconds to yield failure within 5 minutes if a hand-pumped hydraulic loading system is used.

Concentrated impact – Procedures of ASTM E-661 Method A shall be followed, except:

- (a) The test frame shall be constructed of lumber with nails or of steel using fasteners which simulate nails.
- (b) For span ratings greater than 24 oc, the shot bag shall weigh 27 kg (60 pounds).

The width of individual pieces in assembling a test shall be 610 mm (24 inches) or greater for span ratings up to 24 oc, and 1220 mm (48 inches) for greater span ratings.

6.2.2 Test for performance under uniform loads

6.2.2.1 General – This method shall determine the performance of structural-use panels under uniform loads such as

snow, wind and occupancy loads. The uniform load is applied by atmospheric pressure as a vacuum is drawn under the test specimen which is mounted on fully supported framing members in a vacuum chamber.

6.2.2.2 Equipment

Vacuum chamber – The vacuum chamber (see figure 8) shall consist of a sealed box with the panel to be tested forming the top. A 0.015 mm (6-mil or 0.006-inch) polyethylene sheet or equivalent, the perimeter of which is attached securely with tape, shall seal the top surface of the vacuum chamber. The chamber shall be strong and rigid to resist the applied load without failure or excessive deformation. A vacuum pump shall be used to reduce the air pressure under the specimen. The load shall be measured with absolute pressure gages for electronic data readout, but manometers or vacuum gages shall also be permitted.

Joist supports – The framing members shall be supported so as to resist deflection or rotation under applied load.

Deflection gages – The deflection gages shall be mounted to rigid tripods whose legs rest above the joists. Deflection shall be measured to the nearest 0.025 mm (0.001 inch).

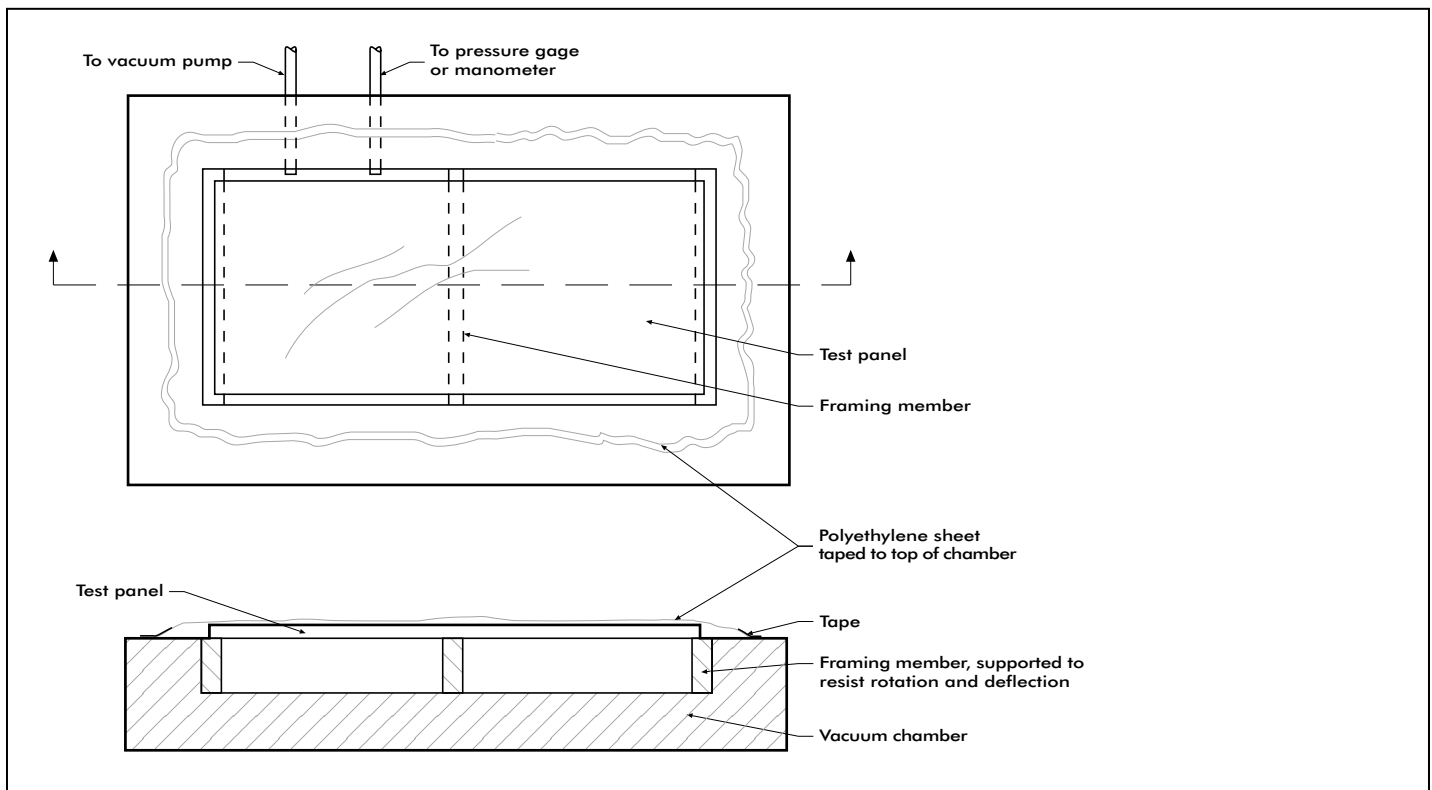


Figure 8. Vacuum chamber test equipment.

6.2.2.3 Specimen preparation – Samples shall be selected that are representative of the product being tested.

Length – The specimen length perpendicular to the framing member shall be equal to twice the center-to-center spacing.

Width – The specimen width shall be at least 595 mm (23-1/2 inches).

Thickness – The specimen thickness shall be measured after conditioning and recorded.

Conditioning – Prior to testing, the specimen shall be conditioned as specified in ASTM E-661, as required.

6.2.2.4 Test procedure – After conditioning, the specimen to be tested shall be mounted on the framing members in the vacuum chamber in accordance with the anticipated joist spacing and the recommended nail size and spacing. The top of the vacuum chamber shall then be sealed with the polyethylene sheet, and the tripod holding the deflection gages set in its proper position with the gages positioned to read deflection at the point of maximum deflection² of the two outer spans (figure 9).

²The point of maximum deflection for a uniformly loaded two-span system shall occur at $0.4215 (S)$ measured from the centerline of the outer joist, where S equals the center-to-center joist spacing.

The panel shall be loaded at a uniform rate of 2.4 kPa (50 lbf/ft²) per minute and deflections recorded at 1.2 kPa (25 lbf/ft²) increments until maximum load is achieved or until the desired proof load is achieved, as required. Deflection data shall be required only in sufficient numbers to develop the straight line portion of the load-deflection curve. In no case shall the number of data points be less than six. Deflection at a given load shall be determined by translating the slope to pass through the origin, thereby correcting for any settling of the system.

6.2.3 Test for panel bending

6.2.3.1 General – This test procedure shall provide the basic data regarding full panel bending strength and stiffness. The general provisions of ASTM D-3043 Method C shall be followed.

6.2.3.2 Specimen preparation – Specimens shall be prepared according to ASTM D-3043 Method C, except specimen size shall be 1220 mm by 1220 mm (48-inch by 48-inch) half panels.

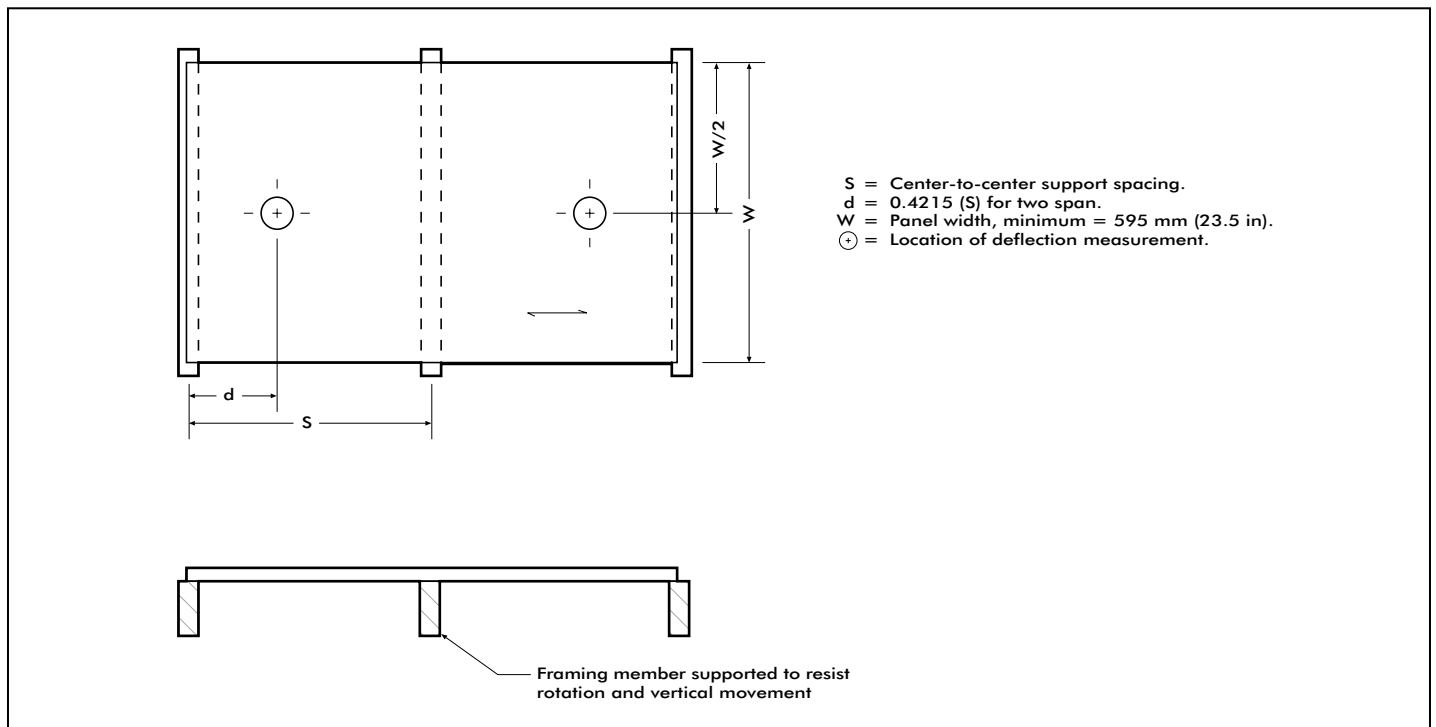


Figure 9. Uniform-load test specimens.

6.2.3.3 Test procedure – The procedures of ASTM D-3043 Method C shall be followed except specimens shall be tested for stiffness both along and across the major panel axis, and the maximum bending moment shall be taken as required.

6.2.4 Test for planar shear strength

6.2.4.1 General – This test procedure shall determine the shear strength when loads are developed along opposite planar surfaces of panels. The general provisions of ASTM D-2718 shall be followed.

6.2.4.2 Specimen preparation – Specimens shall be prepared in accordance with ASTM D-2718. The panel specimen shall be 455 mm (18 inches) long and 150 mm (6 inches) wide. Specimens shall be prepared to evaluate planar shear with the face grain direction parallel to the long dimension and with the face grain perpendicular to the long dimension.

6.2.4.3 Test procedure – The procedures of ASTM D-2718 shall be followed. The planar shear strength in both panel directions shall be measured and reported as planar shear strength capacity, F_s (lb/Q).

6.2.5 Test for shear-through-the-thickness strength

6.2.5.1 General – This test procedure shall determine the shear strength when loads are developed along opposite edges of panels. The general provisions of ASTM D-2719 Method C shall be followed.

6.2.5.2 Specimen preparation – Specimens shall be prepared in accordance with ASTM D-2719 Method C – Two Rail Test. The panel specimen shall be 610 mm (24 inches) long and shall have a width of 205 mm (8 inches) plus the width of the two rails. The face grain shall be perpendicular to the 610 mm (24-inch) length. The rails shall be heavy lumber or steel.

6.2.5.3 Test procedure – The procedures of ASTM D-2719 Method C shall be followed. The shear-through-the-thickness strength shall be measured and reported as a capacity, F_{vt} .

7. GRADEMARKING AND CERTIFICATION

7.1 Certification of shipments – To assure that the purchaser is receiving plywood of the grade and quality specified, the producer shall include with each shipment a “Certificate of Inspection” which states that the plywood conforms to this Standard. Each panel certified as being in conformance with this Standard shall bear the stamp of a qualified inspection and testing agency which (1) either inspects the manufacture (with adequate sampling, testing of glueline, and examination for quality of all veneers) or which (2) has tested a randomized sampling of the finished panels in the shipment being certified for conformance with this Standard. All plywood that is trademarked or otherwise designated as being in conformity with this Standard shall be accompanied by such Certificates of Inspection and applicable grade-trademarks of such inspection and testing agency as outlined in this section.

7.2 Qualified inspection and testing agency – A qualified inspection and testing agency is defined to be one that:

- (a) has the facilities and trained technical personnel to verify that the grading, measuring, species, construction, sanding, bonding, workmanship, and other characteristics of the products as determined by inspection, sampling and testing conform to all of the applicable requirements specified herein;
- (b) has developed procedures to be followed by agency personnel in performance of the inspection and testing;
- (c) has no financial interest in, or is not financially dependent upon, any single company manufacturing the product being inspected or tested; and
- (d) is not owned, operated or controlled by any such company.

7.3 Panel marking – All panels represented as conforming to this Standard shall be identified with marks giving the following information:

- (a) **Species group number, span rating and class** – Unless otherwise provided, panels which are produced with face and back veneers of the same species group shall be identified as being of that species group. Touch-sanded panels without span ratings that are manufactured with face and back plies of

different species groups shall be identified by the larger numbered species group (i.e., Group 4 is larger numbered than Group 1). Sanded panels 9.5 mm (3/8 inch) or less in thickness, and Decorative panels of any thickness, that are manufactured with face and back plies of different species groups shall be identified by the face species group number. Sanded panels greater than 9.5 mm (3/8 inch) that are manufactured with face and back plies of different species groups shall be identified by the larger numbered species group, except that sanded panels with C or D grade backs shall be permitted to be identified by the face species group number if backs are no more than one species group larger in number than the face and are 3.2 mm (1/8 inch) or thicker before sanding. A class number as provided in 5.6.4 shall be used in lieu of a species group number to identify concrete form panels and a span rating shall be used for unsanded and touch-sanded grades as provided for in 5.8.5.

- (b) **Either “Interior,” “Exposure 1” or “Exterior”** – Panels not fully satisfying exterior veneer requirements shall be identified as “Interior” or “Exposure 1.” When panels are identified as “Interior” the additional notation “exterior glue” or “intermediate (IMG)” shall be used where applicable to supplement the designation of Interior grades bonded with exterior glue or intermediate glue. Any further reference to adhesive bond, including those which imply premium performance or special warranty by the manufacturer, as well as manufacturer’s proprietary designations, shall be separated from the grademarks or trademarks of the testing agency by not less than 150 mm (6 inches).
- (c) The grade name or the grade of face and back veneers or 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.

- (d) The symbol “PS 1-95” signifying conformance with this Standard.
- (e) The manufactured thickness of panels if other than standard nominal thickness, except for panels meeting the requirements of table 6.
- (f) The designation “Butt-Jointed Center” for those panels manufactured with butt joints in center plies in accordance with 5.8.

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

- (a) Such panels shall be plainly marked by means of a 100 mm by 125 mm (4-inch by 5-inch) minimum size rectangular stamp carrying the legend “Shop-cutting panel – all other marks void.” (See 2.42.)
- (b) No reference shall be made to this Standard in the certification or grade trademarking of panels not conforming to all of the applicable provisions of this Standard.

8. EFFECTIVE DATE

The effective date of this Standard is September 7, 1995. The authority to refer to the superseded standard, PS 1-83, *Construction and Industrial Plywood*, as a voluntary standard developed under the Department of Commerce procedures is terminated as of June 30, 1996. As of the effective date, reference to PS 1-95 shall be permitted in contracts, codes, advertising, invoices, product labels, and the like, but no product shall be advertised or represented in any manner which would imply or tend to imply approval or endorsement of that product by the National Institute of Standards and Technology, the Department of Commerce, or by the Federal Government.

APPENDIX A. REINSPECTION PRACTICES

A1. General – Based on industry practice the following information is offered plywood purchasers:

A2. Request for reinspection – Any request by the buyer for the reinspection of any item or lot of plywood 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 plywood certified as conforming to this Standard shall be construed as involving agreement to submit such plywood to reinspection by the qualified inspection agency whose grademark was used.

A3. Responsibility of the buyer – A request for reinspection shall be made to the seller:

- (a) for panel grade – within 30 days³ 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 glue bond quality of Interior panels bonded with exterior glue (Exposure 1) – within 6 months after arrival at first point of receipt from the mill if delamination is visibly evident;
- (d) for glue bond quality of other Interior panels – within 30 days³ after arrival at the first point of receipt from the mill if delamination is visibly evident.

All plywood of disputed grade and Interior plywood of disputed glue bond quality shall be kept intact and properly protected from damage, deterioration and from direct exposure to moisture which could interfere with a fair reinspection. All plywood in question 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.

A4. Responsibility of the seller – A request for reinspection shall be promptly acknowledged by the seller following receipt of the request.

A5. 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 A6. If the plywood passes

the reinspection, said expenses shall be borne by the buyer. The buyer shall lend all reasonable assistance to facilitate the reinspection.

A6. Reinspection procedures and settlement

A6.1 Condition of plywood – All plywood designated as complying with this Standard shall be subject to reinspection in the white (unfinished) only, except that concrete-form material is permitted to have a priming coat of oil or other clear preparation before inspection. This requirement does not apply to Interior plywood bonded with exterior glue (Exposure 1) or Exterior plywood when tested for glue bond quality.

A6.2 Sampling for panel grade, size, and thickness reinspections – At buyer's or seller's option, grade, size, and thickness reinspections shall include all panels of an item whose conformance to this Standard is in dispute; however, agreement between the buyer and seller on a reduced basis for sampling is permitted provided at least 20 % or 300 panels, whichever is smaller and which represents only those items as invoiced which 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 found to be below grade or out of tolerance for size and thickness shall have improper grademarks obliterated and shall be remarked with appropriate designation with a special inspection mark registered by the qualified agency conducting the reinspection and applied by that agency's authorized representative.

A6.3 Plywood panel grade, size, and thickness reinspections – If reinspection establishes that a disputed item is more than 5 % below grade or out of dimensional tolerance for the product description as invoiced, that item fails to pass the reinspection. The nonconforming panels need not be accepted; however, all other panels shall be accepted as invoiced. If reinspection establishes that a disputed item is 5 % or less below grade or out of dimensional tolerance, it shall pass the reinspection and the buyer shall pay for the disputed item as invoiced. In addition to the above 5 % grade and dimensional tolerance, a 5 % tolerance shall apply separately to the inner ply gap limitations, including the limitations applicable to the plugged crossband and jointed crossband, as set forth in 5.8.1.

³For 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 6 months, provided the requirement for keeping the disputed plywood intact is observed and the plywood in question is held for at least 30 days following the request for reinspection.

A6.4 Sampling for glue bond quality

reinspections – For test purposes, twenty panels, or 5 % of the panels, whichever is less, shall be selected at random from the item, lot, or shipment which is in dispute. The number of panels required is calculated by applying the “percent panels” to the lot size and converting part panels to whole panels by using a rounding procedure where 0.01 to 0.49 parts are considered to be the smaller whole number, while 0.50 to 0.99 parts are considered to be the larger whole number. These panels shall be selected from locations distributed as widely as practicable throughout the material being sampled. When an item, lot, or shipment involves panels with different adhesive bond requirements as provided for in 5.7, testing and evaluation shall apply separately to each category. Sampling shall include no less than 20 panels of Interior Underlayment, C-D Plugged, and C-D. Sampling of Interior plywood (including the different adhesive qualities) or Exterior plywood, shall be prorated on the basis of ratio of their volume to total volume (i.e., for shipment containing 50 % Exterior, 10 Exterior panels shall be selected), but in no case shall less than 10 panels of each type or

adhesive quality be selected. Shipments of Interior plywood bonded with exterior glue shall be sampled in the same manner as Exterior plywood.

From each of five of the panels selected, excluding Interior panels bonded with interior glue, and from each of five of the overlaid panels selected, a specimen 140 mm by 205 mm (5-1/2 inches by 8 inches) shall be cut and tested as described in 6.1.5.4.

A6.5 Plywood glue bond quality

reinspections – Reinspection of the unused panels in the disputed item, lot, or shipment shall be carried out following the procedures set forth, in section 6, “Specimen Preparation and Testing,” and A6.4. If the reinspection tests establish that the glue bond quality of the panels does not meet the requirements of 5.7, as applicable, the item, lot, or shipment shall fail to pass the reinspection and is not required to be accepted by the buyer. If the glue bond quality requirements are met, the item, lot, or shipment shall pass the reinspection and the buyer shall accept the item, lot, or shipment as invoiced, except that the buyer is not required to accept any delaminated Exterior plywood or overlaid panels.

APPENDIX B. MAINTENANCE, HISTORY, AND CURRENT EDITION OF STANDARD

B1. Standing Committee – A Standing Committee for PS 1-95 has been appointed to be responsible for interpretation and for consideration of future proposals for amendments and revisions to the Standard. The names of the members are available from the Committee’s Secretariat: Standards Management Program, Office of Standards Services, National Institute of Standards and Technology, Gaithersburg, MD 20899. Comments regarding the Standard and suggestions for its amendment or revision may also be sent to this address.

B2. History of project – On October 1, 1965, the American Plywood Association (now APA – *The Engineered Wood Association*) submitted to the National Bureau of Standards (now the National Institute of Standards and Technology) a draft of a proposed Commercial Standard on softwood plywood with a request that it be processed as a revision and consolidation of Commercial Standards CS 45-60 *Douglas Fir Plywood*, CS 122-60 *Western Softwood Plywood*, and CS 259-63 *Southern Pine Plywood*. On November 1, 1966, Product Standard PS 1-66 *Softwood Plywood, Construction and Industrial* became effective. It was the first Voluntary Product Standard developed under new Department procedures, issued on November 16, 1965, for development of Voluntary Product Standards.

Since 1966, there have been two revisions to the Standard: PS 1-74 became effective August 1, 1974, and PS 1-83 *Construction and Industrial Plywood*, became effective December 30, 1983. The history of these revisions may be found in each respective edition.





B3. Current edition – Following the publication of Voluntary Product Standard PS 2-92 *Performance Standard for Wood-Based Structural-Use Panels*, which became effective on August 27, 1992, and which relates to a variety of forms of structural panels including plywood, the Standing Committee for PS 1 initiated a thorough review of PS 1-83.

The consensus review process, which allowed for discussions and resolution of points of difference, moved at a steady pace. This resulted in some major changes to the Standard: the incorporation of a performance-based method for evaluating new species not listed in table 1, made desirable because of the changing available timber resource for plywood production; and the elimination of Structural II panel grades from the Standard because this product had rarely been manufactured since it was first introduced in PS 1-66. Also evident are changes resulting from the reformatting of some text and the incorporation of units of measurement in both metric and conventional units.


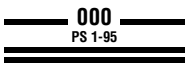

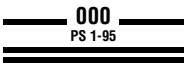


HOW TO READ THE BASIC TRADEMARKS OF APA - THE ENGINEERED WOOD ASSOCIATION


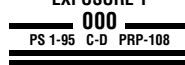

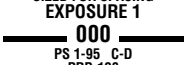





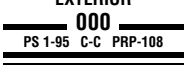


Product Standard PS 1-95 is intended to provide for clear understanding between buyer and seller. To identify plywood manufactured by association member mills under the requirements of Product Standard PS 1-95, four types of trademarks and one

typical edge mark are illustrated. They include the plywood's exposure durability classification, grade and group, and class or Span Rating. Here's how they look, together with notations on what each element means.

<p style="text-align: center;">SANDED GRADES</p> <div style="text-align: center;">  </div> <p>Grade of veneer on panel back _____</p> <p>Grade of veneer on panel face _____ A-C _____ GROUP 1</p> <p>Species Group number _____</p> <p>Exposure durability classification _____ EXTERIOR</p> <p>Mill number _____ 000 _____</p> <p>Product Standard governing manufacture _____ PS 1-95 _____</p>	<p style="text-align: center;">UNSANDED GRADES</p> <div style="text-align: center;">  </div> <p>Panel grade _____ RATED SHEATHING</p> <p>Span Rating _____ 32/16 _____ 15/32 INCH</p> <p>Thickness _____</p> <p>Exposure durability classification _____ SIZED FOR SPACING</p> <p>Product Standard governing manufacture _____ EXPOSURE 1</p> <p>_____ 000 _____</p> <p>Product Standard governing manufacture _____ PS 1-95 C-D PRP-108 _____</p> <p>APA's Performance-Rated Panel Standard _____</p>
<p style="text-align: center;">CONCRETE FORM</p> <div style="text-align: center;">  </div> <p>Registered trademark of APA - The Engineered Wood Association for B-B (concrete form) _____</p> <p>Grade of veneer on panel back _____ PLYFORM</p> <p>Grade of veneer on panel face _____ B-B _____ CLASS 1</p> <p>Class of production _____</p> <p>Exposure durability classification _____ EXTERIOR</p> <p>Mill number _____ 000 _____</p> <p>Product Standard governing manufacture _____ PS 1-95 _____</p>	<p style="text-align: center;">SPECIALTY PANELS</p> <div style="text-align: center;">  </div> <p>Panel grade _____ RATED SIDING</p> <p>Siding face grade _____ 303-6-S/W</p> <p>Span Rating _____ 16 oc _____ 19/32 INCH</p> <p>Species Group number _____ GROUP 1</p> <p>Exposure durability classification _____ SIZED FOR SPACING</p> <p>Mill number _____ EXTERIOR</p> <p>Product Standard governing manufacture _____ 000 _____</p> <p>_____ PS 1-95 HUD-UM-40 _____</p> <p>_____ PRP-108 _____</p> <p>FHA Use of Materials Bulletin number _____</p>
<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <p>Grade of veneer on panel face</p> <p>Grade of veneer on panel back</p> <p>Exposure durability classification</p> </div> <div style="text-align: center;"> <p>Product Standard governing manufacture</p> </div> </div> <div style="border: 1px solid black; padding: 5px; display: inline-block; margin: 10px auto;"> <p>A-B • G-1 • EXT-APA • 000 • PS1-95</p> </div> <div style="display: flex; justify-content: space-around; width: 100%;"> <div style="text-align: center;"> <p>Species Group number</p> </div> <div style="text-align: center;"> <p>Mill number</p> </div> </div>	

**INDEX TO THE TYPICAL REGISTERED TRADEMARKS AND EDGE MARKS OF
APA - THE ENGINEERED WOOD ASSOCIATION**

<p align="center">  A-D GROUP 1 EXPOSURE 1  </p>	<p align="center">  M. D. OVERLAY GROUP 1 EXTERIOR  </p>	<p align="center">  B-C 15/32 INCH GROUP 1 EXTERIOR  </p>
<p align="center">MDO • B-B • G-2 • EXT-APA • 000 • PS1-95</p> <p align="center">A-B • G-1 • EXT-APA • 000 • PS1-95</p>		

<p align="center">  RATED SHEATHING 32/16 15/32 INCH SIZED FOR SPACING EXPOSURE 1  </p>	<p align="center">  RATED SHEATHING STRUCTURAL I 24/0 3/8 INCH SIZED FOR SPACING EXPOSURE 1  </p>	<p align="center">  RATED STURD-I-FLOOR 20 oc 19/32 INCH SIZED FOR SPACING T&G NET WIDTH 47-1/2 EXPOSURE 1  </p>
<p align="center">  UNDERLAYMENT 11/32 INCH GROUP 1 EXPOSURE 1  </p>	<p align="center">  RATED SHEATHING 48/24 23/32 INCH SIZED FOR SPACING EXTERIOR  </p>	<p align="center">  C-C PLUGGED GROUP 1 EXTERIOR  </p>
<p align="center">HDO • B-B • PLYFORM I • 60/60 • EXT-APA • 000 • PS 1-95</p>		



APA RESEARCH AND TESTING

APA – The Engineered Wood Association’s 37,000-square-foot Research Center in Tacoma, Washington is the most sophisticated facility for basic panel research and testing in the world. The center is staffed with an experienced corps of engineers, wood scientists, and wood product technicians. Their research and development assignments directly or indirectly benefit all specifiers and users of engineered wood products.



We have field representatives in most major U.S. cities and in Canada who can help answer questions involving APA trademarked products. For additional assistance in specifying engineered wood products, contact us:

**APA – THE ENGINEERED
WOOD ASSOCIATION
HEADQUARTERS**

7011 So. 19th St. ■ P.O. Box 11700
Tacoma, Washington 98411-0700
(253) 565-6600 ■ Fax: (253) 565-7265

(International Offices:
Bournemouth, United Kingdom;
Mexico City, Mexico; Tokyo, Japan.)



www.apawood.org

PRODUCT SUPPORT HELP DESK

(253) 620-7400
E-mail Address: help@apawood.org

The product use recommendations in this publication are based on APA – The Engineered Wood Association's continuing programs of laboratory testing, product research, and comprehensive field experience. However, because the Association has no control over quality of workmanship or the conditions under which engineered wood products are used, it cannot accept responsibility for product performance or designs as actually constructed. Because engineered wood product performance requirements vary geographically, consult your local architect, engineer or design professional to assure compliance with code, construction, and performance requirements.

Form No. V995B
Revised May 2002/0400

