

STANDARDS ASSOCIATION OF AUSTRALIA.

Headquarters :

Science House, Gloucester and Essex Streets, Sydney.

AUSTRALIAN STANDARD SPECIFICATION FOR AIRCRAFT MATERIALS
(Emergency Series).

HOOP PINE PLYWOOD

This standard forms one of a series prepared by the Standards Association of Australia at the request of Departments of the Commonwealth Government for particular application in time of national emergency. In appropriate cases these specifications will be reviewed for inclusion in the normal series of Australian standards.

The terms and trade and botanical names used in this specification are to be interpreted in accordance with A.S. No. O.1, "Terms and Definitions used in Timber Grading Rules" and A.S. No. O.2, "Nomenclature of Australian Timbers."

SCOPE AND GENERAL PROVISIONS.

1. Scope. This specification applies to the manufacture and testing of hoop pine plywood intended for use in the construction of parts for aircraft.

The specification provides for the classification of the plywood into three grades, A, B and C, according to the quality of the timber from which it is made and the physical properties of the finished plywood.

2. Testing.

(a) *Selection of Test Samples.* Sheets of the same thickness made from plies of the same quality shall be stacked in lots of 25. The inspector shall select one sheet from each lot for testing. The sheet selected shall contain joins if any of the sheets represented thereby contain joins.

(b) *Preparation of Test Specimens.* Test specimens shall be cut from the sample sheets in the manner described in the appendices to this specification. The test specimens shall be as free as possible from wood defects.

(c) *Tests.* The tests shall be carried out to the satisfaction of the inspector, in the manner described in the appendices to this specification.

(d) *Re-tests.* If any sheet fails to comply with the test requirements applicable to the grade for which it is intended, the inspector shall select two further sheets from the same lot of 25 sheets for testing in the same manner. Test specimens prepared from these two further sheets shall comply with the test requirements, otherwise the lot shall be rejected.

Alternatively, if the results of the tests on the original sample comply with the requirements specified for an inferior grade, the lot represented thereby may be released as that grade without re-test.

3. Marking. The following particulars shall be clearly stamped on one side of each sheet of plywood accepted under this specification :

- (a) the supplier's name or distinguishing mark
- (b) the number of this specification (A.S. No. (E)D.812—1943)
- (c) the grade of plywood
- (d) the timber species
- (e) the manufacturer's batch number
- (f) the date of manufacture
- (g) the thickness of the plywood
- (h) the inspector's stamp.

SECTION I. MANUFACTURE.

4. **Timber.** The timber used in the construction of the plywood shall be hoop pine.

5. **Assembly of Plies.** The following precautions shall be observed in assembling the plies :

(a) Unless otherwise specified by the purchaser, the grain of the outer plies of 3-ply shall run parallel to the length of the sheet and that of the core shall be at right angles thereto.

(b) Unless otherwise specified by the purchaser, the grain of the adjacent plies of multi-ply shall cross at right angles throughout the thickness of the sheet, and that of the outer plies shall run parallel to the length of the sheet.

6. **Edge Joins in Plies.**

(a) Plies may contain edge joins, i.e., joins running parallel to the grain direction. The number of such joins shall be at the option of the manufacturer.

(b) The joins shall be completed in the individual plies before assembly of the plies into boards.

(c) All jointed plies shall be approved individually by the inspector before assembly.

(d) All joins shall be square cut.

(e) All joins in core plies shall be edge glued.

(f) All joins in face plies shall be either edge glued or taped with paper. The tape shall be on that face of the ply which will be an outer face of a board, and the tape shall be removed from that board before delivery.

7. **End Grain Joins in Plies.**

(a) End grain joins, i.e., joins running across the width of the plies at right angles to the grain direction shall not be permitted in sheets up to and including 72 in. long.

(b) Sheets longer than 72 in. may have one end grain join in each face. In any one cross section of the sheet there shall not be more than one join, and cross sections containing joins shall not be closer to each other than 12 in. No join shall be closer than 12 in. from either end of the sheet.

(c) The joins shall be scarfed, and the length of the scarf shall be not less than 15 times the thickness of the ply.

(d) The joins shall be completed in the individual plies before assembly of the plies into sheets.

(e) All jointed plies shall be approved individually by the inspector before assembly.

8. **Thicknesses, Tolerances and Arrangement of Plies.** The standard thicknesses and tolerance on thickness of sheets and the arrangement and thickness of plies shall be in accordance with Appendix E. Standard sheets should be used wherever possible.

Sheets not in accordance with Appendix E shall comply with the following requirements :

(a) The two outer plies in the finished sheet shall be of the same nominal thickness.

(b) The thickness of the core of 3-ply shall be at least equal to that of one of the outer plies, but shall not exceed the combined thickness of the two outer plies.

(c) The thickness of any ply in multi-ply shall not exceed twice the thickness of any other ply in the same sheet.

(d) No ply shall exceed $\frac{1}{16}$ in. in thickness.

(e) The actual thickness of any sheet shall not vary from the nominal thickness by more than the following :

<i>Nominal Thickness</i>	<i>Tolerance on Thickness</i>
Less than $\frac{1}{8}$ in.	$\pm 10\%$
$\frac{1}{8}$ in. and over.	$\pm 5\%$

9. **Scarf Joins in Sheets.** Joins through the thickness of the sheets shall not be permitted unless specified in the contract. If so specified, they shall be scarfed in an approved manner and in the position specified in the contract.

10. **Cauls.** Cauls used during the pressing operation shall not be greased.

11. **Cementing.** The adhesive shall be a resin glue of approved manufacture. It shall be uniformly applied and the plies shall be securely cemented together without overlap (except for the scarf joins specified in Clause 7).

12. **Moisture Content.** The moisture content of the conditioned plywood, when determined by the method described in Appendix A, shall be not greater than 14% and not less than 7%. Tests for the determination of moisture content shall be made when required by the inspector.

13. Density. The density of the finished plywood shall not exceed the value specified in Table I for the appropriate moisture content.

TABLE I.

Moisture Content	Density
%	lb. per cu. ft.
7	44
8	44
9	45
10	45
11	45
12	45
13	46
14	46

Tests for the determination of density shall be made when required by the inspector.

14. Finish.

- (a) The edges of the sheets shall be trimmed square, and the surfaces shall be free from defects.
- (b) Splits not exceeding 0.010 in. in width may be permitted in the plies in the finished plywood.
- (c) Open joints not exceeding 0.010 in. in width may be permitted in the face plies of the finished plywood.
- (d) Light sanding shall be permitted, provided that where this is carried out the sheets shall be sanded equally on both sides, unequal sanding being cause for rejection.
- (e) Glue stain shall normally be permitted at the discretion of the inspector.
- (f) The finished sheets shall be smooth and flat and free from blisters, wrinkles and overlaps. The surface shall be free from oil, wax, paraffin, tape and any other substance which will prevent adhesion of glue or paint finishes.

15. Storage. After drying or conditioning, the finished sheets shall be stacked in a dry room in such a manner as will avoid buckling.

SECTION II. GRADE C PLYWOOD.

16. Quality of Timber.

- (a) Each ply shall be of good quality, free from shakes, splits, checks, dote or dead streak, blue stain, compression wood and from filling or inlaying of any kind, and shall be of uniform thickness and of clean, smooth manufacture.
- (b) All plies shall be free from large loose or dead knots, but may contain occasional isolated open pin-knots and pin-holes not exceeding $\frac{1}{16}$ in. diameter.
- (c) The grain shall not be excessively oblique.
- (d) All plies shall be approved by the inspector before assembly.

17. Tests. Test specimens, cut from the sample sheets selected as specified in Clause 2 (a), shall be subjected to the following tests to the satisfaction of the inspector :

- (a) *Adhesion of Plies.* The adhesion of the plies shall be tested by forcibly separating them. The plies shall offer appreciable resistance to separation and the fractured surfaces shall show some adherent fibres distributed more or less uniformly.
- (b) *Resistance to Water.* The resistance to water shall be such that when tested by the method described in Appendix B, the material shall (i) show no appreciable signs of separation at the edges of the plies or formation of blisters, and (ii) still comply with the requirements specified in paragraph (a) of this clause.
- (c) *Bending Properties.* Sheets less than $\frac{1}{4}$ in. (6.35 mm.) thick shall withstand bending around a mandrel of diameter equal to 100 times the thickness of the sheet without showing signs of fracture or separation of the plies, when tested by the method described in Appendix C.

SECTION III. GRADE B PLYWOOD.

18. Plywood which complies with the provisions of Section I and II shall comply with the further provisions of this section before being released as Grade B plywood.

19. Tests. Tensile Strength. The tensile strength of the plywood as determined by the method described in Appendix D shall comply with the following :

Boards of Nominal Thickness not more than $\frac{3}{8}$ in.

- (i) not less than 8,000 lb. per sq. in. in the direction parallel to the grain direction of the face plies.
- (ii) not less than 5,000 lb. per sq. in. in the direction at right angles to the grain direction of the face plies.

(iii) the sum of the tensile strengths in both directions shall be not less than 15,000 lb. per sq. in.

Boards of Nominal Thickness more than $\frac{3}{8}$ in.

(iv) not less than 6,000 lb. per sq. in. in both directions, i.e., parallel and at right angles to the grain direction of the face plies.

(v) the sum of the tensile strengths in both directions shall be not less than 15,000 lb. per sq. in.

SECTION IV. GRADE A PLYWOOD.

20. Plywood which complies with the provisions of Sections I, II and III shall comply with the further provisions of this section before being released as Grade A plywood.

21. Quality of Timber.

(a) Each ply shall be of good quality, free from shakes, splits, checks, dote or dead streak, blue stain, compression wood, and from filling or inlaying of any kind and shall be of uniform thickness and of clean, smooth manufacture.

(b) All plies shall be free from large loose or dead knots, but may contain small live knots of diameter not greater than $\frac{1}{4}$ in. provided that the sum of the diameters of the knots in any square foot does not exceed $\frac{3}{4}$ in. They may also contain occasional isolated open pin-knots and pin-holes not exceeding $\frac{1}{16}$ in. diameter.

(c) The grain shall not be excessively oblique, and the plane of the plies shall nowhere diverge from the grain direction by more than 1 in 5.

(d) All plies shall be approved by the inspector before assembly.

22. **Tests. Tensile Strength.** The tensile strength, as determined by the method specified in Appendix D, shall comply with the following values :

Boards of Nominal Thickness not more than $\frac{3}{8}$ in.

(i) not less than 10,000 lb. per sq. in. in the direction parallel to the grain direction of the grain of the face plies.

(ii) not less than 6,500 lb. per sq. in. in the direction at right angles to the direction of the grain of the face plies.

(iii) the sum of the tensile strengths in both directions shall be not less than 20,000 lb. per sq. in.

Boards of Nominal Thickness more than $\frac{3}{8}$ in.

(iv) not less than 8,000 lb. per sq. in. in both directions i.e., parallel and at right angles to the grain direction of the face plies.

(v) the sum of the tensile strengths in both directions shall be not less than 20,000 lb. per sq. in.

APPENDIX A.

Method of Determining Moisture Content.

A small specimen, not less than 10 g. in weight, shall be weighed (W_1) and shall then be dried in an oven at a temperature of 212°F. to 221°F. (100°C. to 105°C.) until the weight is constant (W_0).

The percentage of moisture shall be calculated as follows :

$$\text{Percentage of Moisture} = \frac{W_1 - W_0}{W_0} \times 100$$

Care should be taken to prevent any change in moisture content between the cutting of the specimen and the first weighing, or between removal from the oven and the subsequent weighing.

APPENDIX B.

Method of Determination of Resistance to Water.

A test specimen approximately 4 in. \times 1 in. cut from each selected sheet, so that the length of the test piece is parallel to the grain of the face plies and containing a join if there are joins in the sheet, shall be submerged completely in water at room temperature for 48 hours.

The test specimens shall then be removed from the water and while still water-soaked, shall be tested for compliance with the requirements of Clause 17 (b).

APPENDIX C.

Method of Determination of Bending Properties.

A test specimen shall be cut from each selected sheet in such a manner that :

- (i) the length of the test specimen is parallel to the grain direction of the face plies, and
- (ii) a join shall run along each axis of the test specimen, if there are such joins in the sheet.

The test specimen shall be as free as possible from wood defects.

The test specimen shall be 1 in. wide and sufficiently long so that when bent over a mandrel of the specified diameter, a parallel-sided U is formed. The test specimen shall be bent once and bent again in the reverse direction.

The test specimen shall then be examined visually for fractures and separation of the plies.

APPENDIX D.

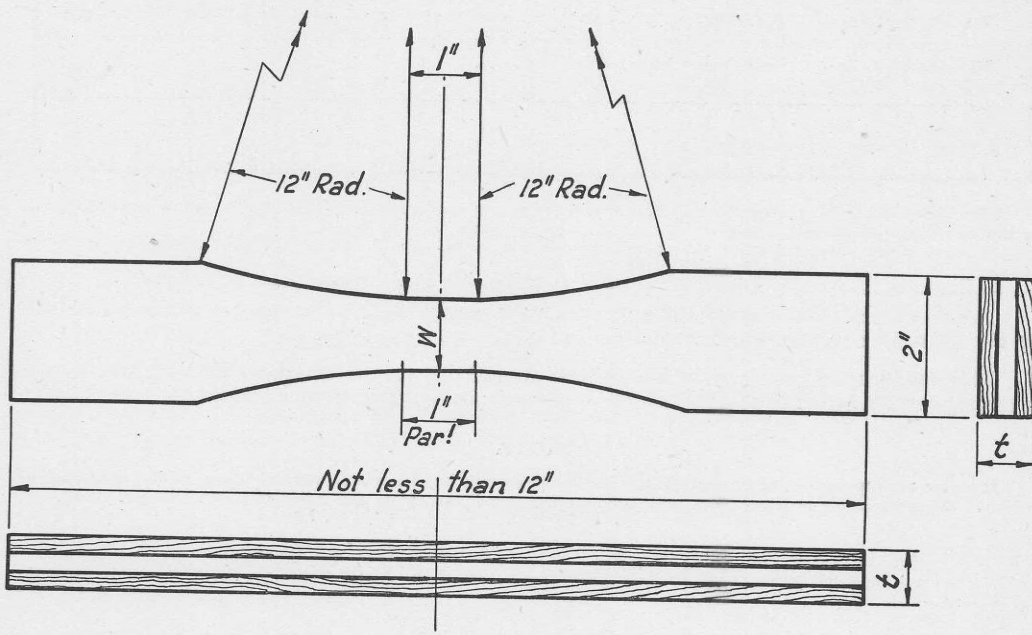
Method of Determination of Tensile Strength.

Two test specimens of the dimensions shown in Fig. D.1 shall be cut from each selected sheet in such a manner that :

- (i) the length of one of the test specimens is parallel to the grain direction of the face plies. If the sheet contains end grain joins, the test specimens shall be prepared so that one of the joins is centrally disposed in a direction at right angles to the length of the test specimen.
- (ii) the length of the other test specimen is at right angles to the grain direction of the face plies. If the sheet contains edge joins, the test specimen shall be prepared so that one of the joins is centrally disposed in a direction at right angles to the length of the test specimen.

The test specimens shall be as free as possible from wood defects.

Each test specimen shall be pulled in an approved testing machine the stress in the test piece being increased uniformly at a rate of from 4,000 to 8,000 lb. per sq. in. per min. The load shall be applied axially.



t = thickness of original material.

$$W = \frac{1}{8t} \text{ (Maximum = 1 in. Minimum = } \frac{1}{8} \text{ in.)}$$

FIG. D.1.—TENSILE TEST SPECIMEN.

APPENDIX E.
Standard Thicknesses, Arrangements and Tolerances for Aircraft Plywood.

PLYWOOD.				PLIES.			
Nominal Thickness in Inches	Equivalent Thickness in mm.	Maximum Thickness in Inches	Minimum Thickness in Inches	Arrangement and Thickness in Inches.			
$\frac{1}{32}$ ·031	·793	·034	·028	3-Ply Faces Core $2 \times \cdot 012$ $1 \times \cdot 012$			
$\frac{3}{64}$ ·047	1·190	·052	·042	$2 \times \cdot 016$ $1 \times \cdot 016$			
$\frac{1}{16}$ ·0625	1·587	·068	·056	$2 \times \cdot 021$ $1 \times \cdot 021$			
$\frac{5}{64}$ ·078	1·984	·086	·070	$2 \times \cdot 028$ $1 \times \cdot 028$			
$\frac{3}{32}$ ·094	2·381	·103	·085	$2 \times \cdot 031$ $1 \times \cdot 042$			
$\frac{1}{8}$ ·125	3·175	·131	·119	$2 \times \cdot 042$ $1 \times \cdot 050$			
$\frac{5}{32}$ ·156	3·968	·164	·148	$2 \times \cdot 050$ $1 \times \cdot 062$			
$\frac{3}{16}$ ·1875	4·762	·197	·178	$2 \times \cdot 062$ $1 \times \cdot 062$			
$\frac{1}{4}$ ·25	6·35	·262	·238	5-Ply Faces Crossbands Centres $2 \times \cdot 050$ $2 \times \cdot 050$ $1 \times \cdot 062$			
$\frac{5}{16}$ ·3125	7·937	·328	·297	$2 \times \cdot 062$ $2 \times \cdot 062$ $1 \times \cdot 062$			
$\frac{3}{8}$ ·375	9·525	·394	·356	7-Ply Faces Crossbands Longbands Centres $2 \times \cdot 062$ $2 \times \cdot 062$ $2 \times \cdot 050$ $1 \times \cdot 050$			
$\frac{1}{2}$ ·50	12·70	·525	·475	9-Ply Faces Crossbands Longbands Centres $2 \times \cdot 062$ $4 \times \cdot 062$ $2 \times \cdot 050$ $1 \times \cdot 062$			
$\frac{5}{8}$ ·625	15·875	·656	·594	11-Ply Faces Crossbands Longbands Centres $2 \times \cdot 050$ $4 \times \cdot 062$ $4 \times \cdot 062$ $1 \times \cdot 062$			
$\frac{3}{4}$ ·75	19·05	·788	·713	13-Ply $2 \times \cdot 062$ $6 \times \cdot 062$ $4 \times \cdot 062$ $1 \times \cdot 050$			
$\frac{7}{8}$ ·875	22·225	·919	·832	15-Ply $2 \times \cdot 062$ $6 \times \cdot 062$ $6 \times \cdot 062$ $1 \times \cdot 062$			
1 1·0	25·4	1·050	·950	17-Ply $2 \times \cdot 062$ $8 \times \cdot 062$ $6 \times \cdot 062$ $1 \times \cdot 062$			

This schedule has been compiled with the object of limiting the great variety of thicknesses at present in use, so that in future all aircraft designers will use the same thicknesses.

Plywood of any other thickness will constitute special material and should not be called for unless absolutely necessary.

For the purposes of this specification the term "Inspector" shall be interpreted in the manner directed by the Australian Airworthiness Authority concerned.

This specification, prepared by the Special Committee on Aircraft Materials and Components, was approved on behalf of the Council of the Association on 20th October, 1943.

NOTE.

In order to keep abreast of progress in the industries concerned, Australian standards are subject to periodical review. Suggestions for improvement, addressed to the Headquarters of the Association, will be welcomed.