MIL-W-2038C(SHIPS)
AMENDMENT - 2
1 December 1965
SUPERSEDING 1/
Amendment - 1
21 August 1964

MILITARY SPECIFICATION

WOOD LAMINATES, DOUGLAS FIR
(FOR SHIP AND BOAT USE)

This amendment forms a part of Military Specification MIL-W-2038C(SHIPS), dated 26 October 1960.

Page 1, paragraph 1.2: Delete and substitute:

"1.2 Classification. - Laminations used shall consist of the following grades, types, densities, and classes:

Grade: (strength quality):
- Grade AA
- Grade A
- Grade B
- Grade C
- Grade D

Type: (orientation of annual rings).
- Type 1 - Mixed grain.
- Type 2 - Flat grain.
- Type 3 - Edge grain.

Density:
- Close grain, or better.
- Dense material.

Durability class:
- Class 1 - High decay resistance.
- Class 2 - Good decay resistance.
- Class 3 - Moderate decay resistance."

1/ CHANGES FROM PREVIOUS ISSUE. THE EXTENT OF CHANGES (DELETIONS, ADDITIONS, ETC.) PRECLUDE THE ANNOTATION OF THE INDIVIDUAL CHANGES FROM THE PREVIOUS ISSUE OF THIS DOCUMENT.

FSC 5510

Page 1, paragraph 2.1, under Federal Specifications: Add:

"TT-W-535 - Wood Preservative; Fluor Chrome Arsenate Phenol Mixture."

Page 1, paragraph 2.1, under Military Specification: Delete reference to MIL-W-6110 and substitute the following:

"MIL-W-19463 - Wood Moisture Content Determination."

Page 2, paragraph 2.2: Add the following:

"U.S. DEPARTMENT OF COMMERCE
Commercial Standard CS 253 - Structural Glued Laminated Timber.

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.)

"AMERICAN SOCIETY FOR TESTING AND MATERIALS
ASTM D 245-64T - Methods for Establishing Structural Grades of Lumber."

(Copies may be obtained from the American Society for Testing and Materials 1916 Race Street, Philadelphia, Pennsylvania 19103.)

"(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)"

Page 1, paragraph 3.1: Delete and substitute:

"3.1 Prior to award of contract or order, when a manufacturer has not produced laminates within the past 24 months conforming to this specification, for the class specified, evidence shall be submitted certifying the following (see 6.5):

(a) Tests on laminates produced show conformance with the test requirements of this specification for the class ordered, as evidenced by an identified report (see 3.6).

(b) The manufacturer is equipped to continue to produce material of quality equal to that tested, in the amount of the order and within the delivery date as evidenced by plant facilities, manpower and quality control capability (see 4.1.1). Appendix A shall be used as a guide to determine the adequacy of the facilities and personnel producing laminates under this specification. Evidence of conformance under Commercial Standard CS 253 may be offered for review in fulfillment of these requirements subject to the detail requirements of this specification."

Page 2, paragraph 3.2.2: Delete and substitute:

"3.2.2 Grade of lumber. - Grades and maximum allowable defects shall be in accordance with the table I, 3.2.2.1 and 3.2.2.2(see 6.2). Allowable knot and equivalent defect sizes for the strength ratios specified in table I shall be the permissible size for the given strength ratio. As specified in table II and table IV of ASTM D245-64T ,(strength ratios for joists and planks for knots on faces and edges within middle third of length). Knot sizes shall apply to full length of faces and edges. Slope of grain and knot sizes shall be measured in accordance with 4.5.3 and 4.5.4 respectively. For laminates intended for remanufacture into smaller cross-sections, defect limitations shall apply to end use dimensions."

Page 2, table I: Delete and substitute:

"Table I - Permissible slope of grain, knots, and equivalent knot defect limitations, for lamination grades.

Lamination grade	Maximum slope of cross grain expressed as one inch rise in inches of length	Maximum sum of diameters of knots and equivalent knot defects, expressed as percentage strength ratio (see 3.2.2).
Grade AA	1 in 18	85
Grade A	1 in 15	72
Grade B	1 in 12	65
Grade C	1 in 10	55
Grade D	1 in 8	50

Note (1) Defect limitations apply to finished laminate width. Defect size for 7 inch width (actual) shall be maximum permitted regardless of width over 7 inches."

Page 3, table II, column 1, line 10: Delete "3 inches in length" and substitute "6 inches in length."

Page 3, table II, column 1, last six lines: Delete and substitute " 4 inches in length, or 3/8 inch in width and 2 inches in length."

Pages 3 and 4, paragraphs 3.2.3 through 3.2.3.3: Delete and substitute:

"3.2.3 Type (orientation of annual rings) (see 6.2 and 6.7). -

"3.2.3.1 Type 1 (mixed grain). - Laminates may contain either flat grain or edge grain, or both and individual lamination components may contain both flat and edge-grain.

"3.2.3.2 Type 2 (flat grain). - The annual growth rings in laminations and lamination components shall be so oriented that tangent lines to the annual growth rings form an angle of less than 45 degrees with the wide surface of the piece.

"3.2.3.3 Type 3 (edge-grain). - The annual growth rings in laminations and lamination components shall be so oriented that tangent lines to the annual rings form an angle of more than 45 degrees with the wide surface of the piece."

Page 4, paragraph 3.2.4.2, line 3: Delete "fifty" and substitute "thirty".

Page 3, paragraph 3.2.5.1: Delete and substitute:

"3.2.5.1 Class 1 (high decay resistance). - Lamination shall contain the following:

"(a) Bright sapwood on not less than 75 percent of the area of any face or edge, in any two feet of length, treated in accordance with 3.2.5.1.1 through 3.2.5.1.4: or

"(b) Any combination of heartwood and sapwood, treated as specified in 3.2.5.1 (a), provided that 100 percent penetration of both is achieved."

Page 4, paragraph 3.2.5.1.2: Delete and substitute:

"3.2.5.1.2 Preservative material (Fluor-chrome-arsenate-phenol mixture). - The preservative shall conform to TT-W-535. The treating solution shall be of a concentration to provide a retention of 0.50 pounds per cubic foot of dry salt in the sapwood or heartwood and sapwood portion (see 3.2.5.1)."

Page 4, paragraph 3.2.5.1.3: Delete and substitute:

"3.2.5.1.3 Treatment. - The treatment shall be any method which does not use a pressure higher than 150 pounds per square inch (p.s.i.) or a temperature higher than 140° Fahrenheit (F.), and provides 100 percent penetration of preservative in the sapwood or heartwood and sapwood with a dry salt retention of not less than 0.50 lbs/ft. 3/. Incising of the lumber is not permitted."

Page 4, paragraph 3.2.5.2 and 3.2.5.3: Delete and substitute:

"3.2.5.2 Class 2 (good decay resistance). - Laminations shall be free of sapwood or may contain unlimited sapwood if treated as specified in 3.2.5.1, with 100 percent penetration of sapwood portion.

"3.2.5.3 Class 3 (moderate decay resistance). - Laminations may contain bright sapwood on not more than 25 percent of the area of any face or edge, in any two feet of length, or may contain unlimited sapwood if treated as specified in 3.2.5.1 with 100 percent penetration of the sapwood portion."

Page 4, paragraph 3.3, first sentence: Delete and substitute: "Adhesives used for all gluing operations shall conform to Specification MIL-A-22397."

Page 4, paragraph 3.4.1: Delete and substitute:

"3.4.1 Lamination thickness. - All laminations in a given laminate shall be approximately the same thickness. The maximum lamination thickness for straight laminates shall be 1-5/8 inches. For curved laminates the maximum permissible lamination thickness shall be computed from the following relationships:

"For lamination thickness over 1 inch but not over 1-5/8 inches:

$$\frac{\text{Thickness}}{\text{Radius of curvature}} = \frac{1}{295} = 0.0034$$

For lamination thickness 1 inch and under:

$$\frac{\text{Thickness}}{\text{Radius of curvature}} = \frac{1}{200} = 0.005$$

Pages 4 and 5, table III: Delete.

Page 5, paragraph 3.4.2: Delete and substitute:

"3.4.2 Arrangement of end joints. - Laminated assemblies may contain end joints in individual laminations of the design specified in 3.5.1.2. End joint spacing within the laminate shall meet one of the following arrangements as specified (see 6.9 and 6.2).

"Arrangement 1 - Spacing of adjacent end joint tips at a glueline shall be not less than 6 inches. Any plane at right angles to the longitudinal axis of the laminate that intersects an end joint shall not intersect any part of an end joint in the adjacent lamination to either side. Any 6 inch long section of the finished laminate shall not contain more than 1/4 of the total number of laminations in the 6 inch section.

"Arrangement 2 - Within the outer 1/4 of the total depth of the laminate spacing of adjacent end joint tips at a glueline shall be not less than 6 inches. Within the center 1/2 of the depth of the laminate, the end joint spacing shall be not less than 2 inches. Any plane at right angles to the longitudinal axis of the laminate that intersects an end joint shall not intersect any part of an end joint in the adjacent lamination to either side."

Page 6, paragraph 3.5.5, first and second sentences: Delete and substitute:

"In the curing process, the glueline temperature shall be maintained for the time period specified by the adhesive manufacturer for the particular approved adhesive, except that the glueline temperature shall not be less than 120°F. for straight laminates and 150°F. for curved laminates. The chamber temperature shall not exceed 215°F. for untreated lumber and 170°F. for 60 minutes for preservative treated lumber."

Page 7, paragraph 3.8.1, line 1: After "After machining," add "class 2 and class 3".

Page 8, table III; columns 1 through 4: Delete "Grain close (see 3.2.4.2)", "Orientation of annual rings (flat or edge-grain) (see 3.2.3)", "Casehardening (see 3.2)", and "Class (see 3.2.5)" requirements and substitute the following:

"Grain, close (see 3.2.4.1)	I-components prior to end-joining	6.5-Five rings per inch, with less than 1/3 summerwood, and between 31 and 50 rings per inch with less than 1/3 summerwood.	a. Individual boards have less than 5 or greater then 50 rings per inch. b. The number of boards with 5 rings per inch which have less than 1/3 summerwood, or between 31 and 50 rings per inch which have less than 1/3 summerwood, exceeds the acceptance number.
"Orientation of annual rings (flat or edge-grain)(see 3.2.3)	I Laminations or I Lamination components prior to bonding	1.5	a. Number of laminations with predominately the wrong grain exceeds acceptance number.
		4.0	a. Number of pieces with predominately the wrong grain exceeds acceptance number.
"Casehardening (see 3.2)	S-3-lamination components prior to end-joining (test 4.5.2)	4.0-casehardened or over steamed	a. The number of laminations which are casehardened or oversteamed exceeds the quality acceptance number. (Individual laminations which have components which are casehardened or oversteamed shall be subject to rejection.

"Class (see 3.2.5) Class 1	I	2.5 Preservative treatment 6.5 heartwood untreated	a. The number of laminations which do not meet the required class requirement, exceeds the acceptance number. (Individual laminations which do not meet the class requirement shall be subject to rejection). b. If heartwood untreated, any lamination exceeds 50 percent heartwood on any face or edge in any two feet of length.
"Class 2	I	2.5 Preservative treated or untreated.	a. The number of laminations which do not meet the required class requirement, exceeds the acceptance number (Individual laminations which do not meet the class requirement shall be subject to rejection). b. If untreated, any lamination exceeds 25 percent sapwood, on any face or edge, in any two feet.

"Class 3	I	2.5	preservative treated or untreated	a. The number of laminations which do not meet the required class requirements, exceeds the acceptance number. (Individual laminations which do not meet the class requirement shall be subject to rejection). b. If untreated, any lamination exceeds 50 percent sapwood, on any face or edge, in any two feet."

Page 7, paragraph 4.1: Delete and substitute:

"4.1 Responsibility for inspection. - Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services confrom to prescribed requirements."

Page 7, paragraph 4.3: Delete and substitute:

"4.3 Sampling for examination and tests. - For the sampling specified in 4.3.1 through 4.3.4 the "single sampling plan" of MIL-STD-105 is applicable."

Page 10, paragraph 4.3.2, last line: Delete "4.4.3" and substitute "4.4.2".

Page 10, paragraphs 4.3.4.1 through 4.3.4.2.3: Delete and substitute the following:

"4.3.4.1 No previous production experience. - When a laminator who has not previously produced marine laminates conforming to this specification is beginning production, specimens for test shall be selected from each member, until five consecutively produced members have passed all requirements of this specification. Thereafter, samples shall be selected for test in accordance with inspection level III of MIL-STD-105 until fifteen consecutively tested, major members, such as frames and stems, have met the requirements. Thereafter, members shall be sampled in accordance with 4.3.4.2.

"4.3.4.2 Continued production. - When a laminator has met the prerequisites in 4.3.4.1, specimens shall be selected for moisture content, block shear and cyclic delamination tests on an unbiased random basis in accordance with tables IV and V (column headed "Normal sampling") and MIL-STD-105. The acceptable quality level for moisture content shall be AQL = 4.0 percent defective. For laminates with shear strength not more than 50 p.s.i. below the required minimum, or wood failures percent of 70 to 75 percent, the acceptable quality level shall be as follows:

AQL = 1.5 percent defective when sample is less than lot size.
AQL = 4.0 percent defective when sample is the entire lot.

Sampling shall shift from "normal" to "reduced" or "tightened" sampling when the criteria specified under these column headings in tables IV and V are met.

"4.3.4.3 Lapse in production. - When a laminator has not produced laminates conforming to this specification for a period of 12 months, specimens for test shall be selected from each member, until five consecutively produced members have passed all requirements of this specification. Thereafter samples shall be selected for test in accordance with 4.3.4.2."

Page 10, paragraph 4.4, first line: Delete "lot acceptance" and substitute "Quality conformance".

Pages 11 and 12, table V and VI, columns 2 and 3: Delete reference to "L-1", "L-3", and "L-8" and substitute "S-1", "S-2", "S-3" and "S-4", respectively.

Page 12, paragraph 4.4.1.2: Delete and substitute:

"4.4.1.2 Examination and test for preservative (treated laminations only). - A 0.2 inch diameter boring shall be taken from each sample board selected in accordance with table IV, so that the boring extended through the deepest section of the sapwood into the heartwood or through the heartwood and sapwood, as required by the class specified. The borings shall be examined and tested in accordance with 4.5.7.1, for preservative penetration. One-half of the sample borings shall be analyzed for retention (4.5.7.2). If desired by the laminator, full cross-sections may be substituted for borings for the examinations and tests specified in 4.5.7.1 and 4.5.7.2."

Page 13, paragraphs 4.4.4 through 4.4.4.2.2: Delete and substitute:

"4.4.4 Test of finished laminates. -

"4.4.4.1 Moisture content. - Moisture content of finished laminates shall be determined in accordance with 4.5.1. If the number of laminates not meeting the moisture content requirements of 3.6.1 exceed the acceptance level listed in 4.3.4, the lot represented by the sample shall be rejected.

"4.4.4.2 Block shear test of interlamination glue line. - Each of the samples selected for block shear tests in accordance with 4.3.4 shall be tested in accordance with 4.5.5. Failure of any sample member to conform to the requirements of 4.3.4 shall result in rejection of the lot, and every member of the lot shall be tested individually. The rejection of two lots in succession for failure to conform to 3.6.2 shall require that the manufacturer dvelop test information which shows that the difficulty has been diagnosed and corrected, the requirements can be met ,and the quality control system has been corrected to effectively screen out defective laminates. The rejection of 3 lots in succession is considered sufficient reason for stopping production until corrective action is taken.

"4.4.4.3 Cyclic delamination test. - Samples selected for cyclic delamination tests in accordance with 4.3.4 shall be tested in accordance with 4.5.6. Failure of any of the sample members to conform to all of the requirements of 3.6.3.1 and 3.6.3.2 shall be basis for rejection of the lot involved, and every laminate in the lot shall be tested individually. All individual laminates not meeting the requirements of 3.6.3.1 and 3.6.3.2 shall be rejected. The rejection of any members in 2 lots in succession for failure to conform with 3.6.3.1 shall require that the manufacturer present test information which indicates that the difficulty has been diagnosed and corrected, and the requirements can be met. Failure of 2 consecutive edge-joint samples to meet the requirements of 3.6.3.2 shall be basis for rejection of material containing edge-joints until the manufacturer presents test information which indicates that requirements can be met. Consecutive failures of interlamination glue line in excess of those listed above shall be considered sufficient reason for stopping production until corrective action is taken."

Page 13, paragraph 4.5.1, line 2: Delete "MIL-W-6110" and substitute "MIL-W-19463".

Pages 13 and 14, paragraphs 4.5.4 through 4.5.4.2: Delete and substitute:

"4.5.4 Measurements of knots and holes. - Knot or hole sizes shall be determined by averaging the distance between lines drawn parallel and perpendicular to the edges of the piece and tangent to the knot or hole being measured."

Page 14, figure 1-D-, caption: Delete "(SECTION TO BE ROOM DRIED BEFORE CONCLUSION AS TO CASE-HARDENING IS MADE.)"

Page 15, paragraphs 4.5.5.2 through 4.5.5.3: Delete and substitute:

"4.5.5.2 Apparatus. - The testing machine shall be fitted with a compression shearing tool containing a self-aligning seat to insure uniform lateral distribution of the load. The shearing tool shown on figure 3 has been found satisfactory. For range of loads encountered in test, indicated loads shall be accurate within ± 2.5 percent of true values as determined by standard procedures for verification of testing machine. Increments of load on the indicating device shall be in easily readable divisions between one and 2.5 percent of the value of loads encountered when test specimens break. The load indicating device shall include damping apparatus which permit reading of ultimate loads under conditions of sudden failure. Provisions should be included for a fairly uniform rate of loading to failure. The load shall be applied with a continuous motion of the movable head to a maximum load at a rate of 0.025 inch per minute with a permissible variation of ± 25 percent.

"4.5.5.3 Procedure. - The test specimen shall be placed in the shearing tool so that the load may be applied as specified in 4.5.5.2. The loading shall continue until failure. The shear stress at failure shall be calculated in pounds per square inch, by dividing load at failure by the area of the adhesive line area between the two laminations measured to the nearest 0.01 square inch. Also the percent wood failure for each adhesive line shall be estimated to the nearest five percent. The average percent wood failure and shear strength shall be calculated for each specimen. If either the average percent wood or shear strength fail to meet the requirements of 3.6.2, the remainder of the adhesive lines in the test specimen shall be prepared and tested, and a new average for shear strength and percent wood failure shall be computed which includes all adhesive lines in the test specimen."

Page 17, paragraph 4.5.7: Delete "(class 1)" and substitute "(treated laminations only)".

Page 17, paragraph 4.5.7.1, line 3: Delete "sapwood" and substitute "heartwood and sapwood or heartwood as required by the class specified".

Page 18, paragraph 4.5.7.2: Delete and substitute:

"4.5.7.2 Preservative retention. - According to durability class, the entire heartwood or heartwood and sapwood portion of each boring or cross-section shall be composited and the composite analyzed by an accurate and recognized assay method."

Page 18, paragraph 4.6, heading: Delete "and tests".

Page 18, paragraph 4.7: In heading, delete "Inspection: and substitute "Examination" and in line 2, delete "inspected" and substitute "examined".

Page 18, paragrpah 6.2, item (b): Delete and substitute:

"(b) Pre-award certification (see 3.1 and 6.5)."

Page 19, paragraph 6.2, item (g): Delete "6.8" and substitute "6.6".

Page 19, paragraph 6.4, last sentence: Delete.

Page 19, table VII: Delete

Page 19, paragraph 6.5: Delete and substitute:

"6.5 Pre-award examination. - Pre-award evidence submitted by prospective suppliers shall be forwarded for technical review and recommendations to:

Commander
Quality Assurance Division
Puget Sound Naval Shipyard
Bremerton, Washington 98314"

Page 20: Add the following new paragraphs:

"6.7 Laminate type. -

"(a) Mixed grain. - A general purpose, economical type, for use where repeated wetting and drying will not occur. Cyclic wetting tends to cause excessive distortion due to mixed grain.

"(b) Flat grain. - A general purpose, readily available grade, suitable for most applications.

"(c) Vertical grain. - A more expensive, special type for use where wearing surface is important or moisture movement across width (perpendicular to annual rings) should be a minimum. This type may be more efficiently produced by vertically laminating flat grain stock.

"6.8 Laminate class[1/]. -

"(a) Class 1 (high decay resistance). - For service where high decay or wood destroying insect hazard exists, such as damp, humid, warm areas, having poor ventilation and an exposure to freshwater leakage and condensation, for parts where replacement would be difficult and costly, and long time service is required.

"(b) Class 2 (good decay resistance). - For service where decay insect hazard is moderately high, or may be high at times, but ventilation and drying is generally possible and long time service is required. May be used under adverse decay conditions where a shorter service life can be tolerated.

"(c) Class 3 (moderate decay resistance. - For service where decay or insect hazard is not high or where occasional wetting occure but good ventilation prevails and long time service is required; may be used in higher decay hazard locations where replacement or moderate service life can be tolerated; may be used under continuously submerged, water-logged conditions.

"6.9 End-joint arrangements. - Arrangement 1 is intended for laminates which will be loaded primarily in tension. Arrangement 2 is intented for laminates which will be loaded primarily in bending."

Page 20: Add the following footnote:

"1/ Laminate classes do not refer to marine borer resistance. For direct exposure to marine borers (Toredo, Bankia, Limnoria), class 3 laminates, with unlimited, untreated sapwood, should be specified to be treated after all shaping and drilling, in accordance with applicable requirements of TT-W-571."

Page 22, paragraph 30.5.3: Delete and substitute:

"30.5.3 Equipment for curing scarfs. - The method used for curing scarf joints must be capable of consistently producing acceptable quality scarfs which meet the requirements of the laminating specifications. The curing temperature specified by the adhesive manufacturer shall be maintained at all points of the glueline for the period of time specified by the adhesive manufacturer for the particular approved adhesive conforming to Specification MIL-A-22397 when used with the wood species of interest. Also the glueline temperature shall not be less than, or more than specified in the laminating specifications. The temperature shall not exceed 215°F. at any point in the piece being scarfed. When treated lumber is being scarfed, the temperature shall not exceed 170°F. for more than 60 minutes. Relative humidity shall be maintained to the extent that no appreciable change in moisture content of the wood occurs. The scarf jointing process must also result in no degrade of the wood. Curing has been done most satisfactorily in a chamber. Hot platens and dielectric heating methods, in general, have not consistently produced acceptable quality, but may be used if satisfactory results can be consistently obtained in production."

Page 23, paragraph 30.11: Delete and substitute:

"30.11 Adhesive. - The adhesive used for all marine laminating operations shall be an approved adhesive conforming to Specification MIL-A-22397."

Page 23, paragraph 3.13, last line: After "laminations" add "above 60°F.".

Page 28, paragraph 60.4.1.4, second sentence: Delete and substitute:

"During the cure period, no glueline temperature in any sample shall be less than the temperature specified by the adhesive manufacturer for the particular approved adhesive conforming to Specification MIL-A-22397. Also no glueline temperature shall be less than the minimum temperature specified in the applicable laminating specification for the wood species of interest."

Preparing activity:
Navy - SH
(Project 5510-N017Sh)