CIVIL AERONAUTICS BOARD

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CIVIL AIR REGULATIONS

18.—REPAIR AND ALTERATION OF AIRCRAFT

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PART 18 - REPAIR AND ALTERATION OF AIRCRAFT

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18.0 PROVISIONS FOR RE-RATING. Pursuant to the provisions of the Civil Aeronautics Act of 1938, as amended, empowering and requiring the Civil Aeronautics Board to prescribe reasonable rules and regulations and minimum standards governing, in the interest of safety, the inspection, servicing and overhaul of aircraft, aircraft engines, propellers and appliances, and such other practices, methods and procedure as the Board may find necessary to provide adequately for safety in air commerce, a certificated aircraft, aircraft engine, propeller or appliance which has been altered or repaired may be re-rated as to airworthiness in accordance with such of the following provisions as may be applicable.

18.1 TYPES OF REPAIR. An aircraft will be deemed to have been repaired when

18.10 (a) any non-structural member (such as a fairing, cowling or turtleback; 5 percent or less of the surface of a fabric covered wing or control surface; not more than two adjacent wing ribs; and the trailing edge of a wing or control surface) has been repaired, or when a structural component (such as a wheel; a landing gear, wing or control surface strut; and a control surface, but excluding a wing panel and a landing gear) has been replaced by one purchased from the original manufacturer, in which cases the repair will be designated as a minor repair, or when

18.11 (b) any structural member (such as a spar; a wing or control surface leading edge or tip strip; a control surface rib; three or more adjacent wing ribs; a wing or cabane strut wire; a wing compression member; a fitting; a landing gear or tail surface strut or wire; a fuselage longeron, cross tube, diagonal or bulkhead; any portion of the wooden or metal cover of a stressed-skin wing, control surface, fuselage or landing gear; and any bracket supporting a seat, baggage compartment, fixed equipment or control system part) has been repaired or replaced, in which case the repair will be designated as a major repair, or when

18.12 (c) the engine has been overhauled, or when

18.13 (d) the propeller has been repaired, or when

18.14 (e) an instrument has been repaired.

18.2 TYPES OF ALTERATION. An aircraft will be deemed to have been altered when

18.20 (a) the aircraft structure has been changed, except in a manner which incorporates the use of a member or a portion of a member of greater strength than the original member in accordance with Civil Aeronautics Manual (CAM 18), or when

18.21 (b) any change has been made in the engine, propeller, equipment or arrangement of equipment, which change may affect the balance, stability, local strength of supporting structures, or any other aspect of the airworthiness of the aircraft, or when

18.22 (c) the engine has been altered, or when

18.23 (d) the propeller has been altered.

18.3 TYPES OF REPAIR AGENCY. Agencies which alter or repair an aircraft in accordance with the classifications set forth in §§ 18.1 and 18.2 will be classified as follows:

18.30 MANUFACTURER means the manufacturer holding a type certificate for the construction of the aircraft, engine or propeller which is being altered, repaired or overhauled; or the manufacturer of the instrument being repaired.

18.31 CERTIFICATED REPAIR STATION means a repair station engaged in altering, repairing or overhauling an aircraft, engine, propeller or instrument in accordance with the classification for which it has been approved as provided for in Part 52.

18.310 An airplane manufacturer, upon application, shall be eligible for a certificate of competency to operate a repair station in the classification covering the same type of structure as employed in the aircraft for which he holds a type certificate.

18.311 A manufacturer holding a type certificate for an engine, upon application, shall be eligible for a certificate of competency to operate a repair station certificated for engine overhaul.

18.312 A propeller manufacturer, upon application, shall be eligible for a certificate of competency to operate a repair station in the classification covering the same type of propeller as that for which he holds a type certificate.

18.32 OTHER AGENCY means a certificated airplane or engine mechanic, i.e., one holding a certificate of competency as provided for in Part 24, not employed by a manufacturer as defined in § 18.30 or by a repair station as defined in § 18.31.

18.4 RULES GOVERNING REPAIR AGENCIES. Repair agencies as designated in § 18.30, 18.31, and 18.32 shall be governed by the following rules:

18.40 The alteration or repair of a structural component of a certificated aircraft shall be made by the manufacturer of the aircraft or made by, or continuously supervised by, a certificated airplane mechanic only.

18.41 The alteration or overhaul of a certificated engine shall be made by the manufacturer of the engine or made by, or continuously supervised by, a certificated engine mechanic only.

18.42 The alteration, overhaul or repair of a certificated propeller shall be made by the manufacturer of the propeller or made by, or continuously supervised by, a certificated airplane or engine mechanic only.

18.43 An agency as defined in § 18.32 shall not engage in the alteration of a certificated engine, or in the alteration, overhaul or repair of a certificated propeller, or in the repair or overhaul of an instrument with which a certificated air carrier aircraft is equipped.

18.44 Any agency engaged in the overhaul or repair of a certificated

engine shall use only structural engine parts which are deemed satisfactory by the Administrator.

18.45 When an engine part or a propeller part is rejected in accordance with these regulations, a copy of the notice of rejection shall be forwarded to the Administrator of Civil Aeronautics.

18.46 When an entry as to any alteration or repair is made in a logbook as required by these regulations, such entry shall include the signature, and title or mechanic certificate number, of the person making such entry.

18.5 PROCEDURE GOVERNING REPAIRS.

18.50 MAJOR REPAIRS. Any repair agency engaged in the major repair of a certificated aircraft shall execute Repair and Alteration Form ACA 18-1 in duplicate.

18.500 The repair agency shall accurately list the location and the nature of the repair on the blank pages of the form. It shall incorporate in the form such technical data as are necessary to substantiate the airworthiness of the repair, either by reference to the figures and tables in CAM 18, or by the incorporation of computations and well-dimensioned detail sketches, or by both. When such data are too extensive they shall be appended to the original copy of the form and reference thereto shall be made in both copies of the form.

18.501 The repair agency shall request a designated inspector of the Administrator to examine the form, the data and the repair.

18.502 The original parts removed from an aircraft in making a major repair or replacement shall be retained for comparison by such inspector.

18.503 The repair or replacement will be approved when comparison with the retained part indicates conformity with the original, but such inspector may, at his discretion, require that he be furnished a drawing from the original manufacturer of the part or parts in question, or that the agency make a drawing of the part or parts in question and have the drawing approved, in writing, by the manufacturer.

18.504 An invoice is not acceptable as sole proof of conformity of a purchased replacement with approved specifications therefor, except when such invoice is issued by the original manufacturer or his authorized agent.

18.505 Such inspector may require that he be furnished with a sample or samples of the material or materials used in making a major repair or replacement. When it is not possible to compare the materials by a visual inspection the results of material specification tests of the original and replacement samples shall be supplied.

18.506 Such inspector shall determine whether or not the workmanship and materials are in accordance with the regulations and accepted practice.

18.507 Provided such inspector deems the repair airworthy, he will issue a temporary airworthiness certificate.

18.508 The owner shall incorporate the duplicate copy of Form ACA 18-1 in the aircraft log-book.

18.51 MINOR REPAIR. A repair agency engaged in the minor repair of a certificated aircraft shall make a detailed entry descriptive thereof in the aircraft log-book. If replacement of a component purchased from the

original manufacturer is involved, the entry shall so state.

18.52 ENGINE OVERHAUL. A repair agency engaged in the overhaul of a certificated engine shall make a detailed entry descriptive thereof in the engine log-book.

18.53 PROPELLER REPAIR OR OVERHAUL. Only agencies as defined in §§ 18.30 and 18.31 may repair or overhaul a certificated propeller.

18.530 When a propeller has been repaired, the agency shall execute one copy of Repair and Alteration Form ACA 18-1 and deliver it to the owner who shall incorporate it in the aircraft log-book.

18.54 INSTRUMENT REPAIR. Any agency as defined in §§ 18.30, 18.31 or 18.32 may repair an instrument with which a certificated aircraft is equipped, except that an agency as defined in § 18.32 shall not repair an instrument with which a certificated air carrier aircraft is equipped.

18.540 When an instrument with which a certificated air carrier aircraft is equipped has been repaired, the agency or owner shall make an entry thereof in the aircraft log-book and the owner shall be responsible for the making of such entry.

18.6 PROCEDURE GOVERNING ALTERATIONS.

18.60 AIRCRAFT ALTERATION. A repair agency engaged in the alteration of a certificated aircraft shall execute Repair and Alteration Form ACA 18-1 in duplicate.

18.600 The repair agency shall accurately list the location and the nature of the alteration on the blank pages of the form. It shall incorporate in the form such drawings, well-dimensioned detail sketches, stress analyses and balance computations as are necessary to substantiate the airworthiness of the alteration. When such data are too extensive, they shall be appended to the original copy of the form and reference thereto shall be made in both copies of the form.

18.601 The repair agency shall request a designated inspector of the Administrator to examine the form, the data and the alteration.

18.602 Such inspector may, at his discretion, deem the alteration airworthy or request the agency to submit the original copy of the form together with the data to the Administrator.

18.603 If such inspector deems the alteration airworthy, he will issue a temporary airworthiness certificate and deliver the duplicate copy of the form to the agency or the owner for incorporation in the appropriate log-book.

18.604 If such inspector requests the agency to refer the decision to the Administrator, the alteration will be examined and either

18.6040 (a) deemed airworthy, in which case the form and the data will be transmitted to the supervising inspector of the district involved, together with an authorization to proceed with such inspection as may be considered necessary, or

18.6041 (b) deemed unairworthy, in which case the agency will be so notified.

18.605 If the inspection provided for in § 18.6040 is satisfactory, such inspector will proceed as provided in § 18.603.

18.61 ENGINE ALTERATION. Only agencies as defined in §§ 18.30 and 18.31

may engage in the alteration of a certificated engine.

18.610 A repair agency engaged in the alteration of a certificated engine shall execute Repair and Alteration Form ACA 18-1 in duplicate.

18.611 The repair agency shall accurately list the nature of the alteration on the blank pages of the form. It shall incorporate in the form such drawings, well-dimensioned detail sketches, stress analyses and test reports as are necessary to substantiate the airworthiness of the alteration. When such data are too extensive, they shall be appended to the original copy of the form and reference thereto shall be made in both copies of the form.

18.612 The repair agency shall submit the original copy of the form together with the data to the Administrator for examination.

18.613 Upon examination of the form and data, the Administrator may approve the alteration and so notify the agency, in which case the agency shall deliver the duplicate executed copy of the form to the owner who shall incorporate it in the engine log-book; or it may deem an inspection necessary, in which case it will transmit the form and the data to the supervising inspector of the district involved, together with authorization to proceed with such inspection as may be deemed necessary.

18.614 If the inspection provided for in § 18.613 is satisfactory, the agency will deliver the duplicate executed copy of the form to the owner who shall incorporate it in the engine log-book.

18.62 PROPELLER ALTERATION. The provisions in §§ 18.61 through 18.614 for the alteration of a certificated engine are applicable likewise in the case of alteration of a certificated propeller, except that the duplicate executed copy of the form shall be incorporated in the aircraft log-book by the owner.

18.7 TECHNIQUE AND PRACTICES.

18.700 MATERIALS. The use of materials of inferior quality or of those which experience has shown to lack uniformity of quality or strength shall be regarded as sufficient cause for withholding approval of alterations and repairs to certificated aircraft.

18.7000 The important physical properties of the materials used shall be definitely specified in the form or accompanying data, either by reference to an accepted standard such as Army, Navy, or S. A. E. specifications or by reference to reliable test results.

18.7001 Only the highest quality of casein or animal glue shall be used in making alterations or repairs to wood parts in certificated aircraft.

18.701 ALUMINUM ALLOY STRUCTURES.

18.7010 All aluminum alloy rivets used by repair agencies shall be properly heat-treated, driven within proper time limits, and of proper materials to insure suitable rivet strength, except in approved special cases in secondary parts where the rivets do not transmit stress, in which cases no heat treatment is necessary, and except in cases when the repair agency has drawings of the manufacturer which show that unheat-treated rivets are satisfactory. Special care shall be taken in the heat treatment of rivets to insure that individual rivets are actually rapidly quenched in the quenching medium.

18.7011 Bolts, screws and rivets employed in joints of dissimilar metals and of wood to aluminum alloy members, in addition to being properly heat-treated, shall be specially coated with paint just prior to assembly. (This is particularly important in the case where an aluminum bolt or screw passes through or into wood, or where bolts or rivets pass through tubing.) In structures made entirely from Alclad materials, bare bolts may be used.

18.7012 The following practices are hereby prohibited:

18.70120 (a) Quenching of 17S or 24S alloys in hot water or air after heat treatment.

18.70121 (b) Insufficiently rapid transfer of 17S or 24S alloys from the heat treatment medium to the quench tank. (An elapsed time of 10 or 15 seconds will, in many cases, result in noticeably impairing corrosion resistance.)

18.70122 (c) Painting after assembly, without prior protective treatment, of non-Alclad structures which are to be subjected to severe corrosive conditions. Whenever possible, parts which are not made from Alclad materials shall be anodized and shop primed prior to assembly.

18.70123 (d) Intimate contact of dissimilar metals or of wood with aluminum alloys.

18.70124 (e) Use of wood which is not thoroughly moisture-proof for assembly into aluminum alloy structures.

18.70125 (f) Re-heating at temperatures above that of boiling water of 17S or 24S alloys after heat treatment, and the baking of primers at temperatures above that of boiling water.

18.70126 (g) The use of annealed 17S or 24S alloys in parts subject to severe corrosive conditions.

18.70127 (h) The use of hygroscopic materials improperly moisture-proofed in attempting to effect water-tightness of joints and seams.

18.70128 (i) The use of paint removers which contain strong caustic compounds, and of thin paint removers which may have a tendency to run into joints, rather than of those which have a jelly-like consistency.

18.70129 (j) The leaving of any trace of welding flux immediately after welding. (This is most readily prevented by washing in a warm 5% solution of sulphuric acid, rinsing in clear warm water, scrubbing accessible welds with a stiff-bristled brush, and giving a final rinse in clear warm water.)

18.7013 Gasoline tanks with inaccessible interior welds shall be immersed in a tank containing warm 5% sulphuric acid, agitated while rinsing in clear warm water, and then dried.

18.702 HEAT TREATMENT. Before replacing damaged members with replacements not purchased from the original manufacturer of the aircraft, the repair agency shall in all cases determine that the material and heat treatment of the damaged members and of the replacements are identical.

18.703 WIRES AND CABLES.

18.7030 Wires or cables shall be replaced if injured or distorted.

18.7031 All control cables 3/32 inch and above shall be spliced and not soldered, using standard Army and Navy tuck splices of at least 5 full tucks, or a Roebling roll of at least 7 full turns.

18.7032 neither wires nor cables shall be subjected to heat.

18.7033 The substitution of cable for hard or streamlined wires is prohibited unless specifically approved by the Administrator.

18.704 FABRIC COVERING. All fabric used for recovering an aircraft structure shall be high grade airplane fabric of at least as good quality as that used originally in the aircraft. The dope and tape used shall be of as good quality as that used on the original aircraft, and the first two coats of dope shall be clear and shall be brushed on. The total number of coats of dope shall not be less than necessary to result in a taut finished job. Both surfaces of fabric covering on wings and control surfaces shall be securely fastened to the ribs by rib-stitching cord or any other method approved by the manufacturer. The spacing of these fasteners shall not exceed that recommended by the manufacturer. When rib-stitching cord is used, the cord shall be linen, or equivalent in strength to that used by the manufacturer. When stitching fabric to the ribs, reinforcing tape shall be used on the top of the fabric and over the ribs on both surfaces. This stitching shall be covered with pinked-edge tape, doped to the fabric.

18.705 METAL WING RIBS AND SPARS. Repairs to metal ribs and spars shall be made at the factory of origin or by a repair station which is certificated for this type of work, or the repair agency shall obtain a recommendation from the original manufacturer and comply with it as to the methods which shall be used in making the particular repair.

18.706 RIVETED OR BOLTED TRUSS TYPE METAL FUSELAGES. The provisions of § 18.705 apply to this type.

18.707 WOOD OR METAL COVERED (STRESSED-SKIN) WINGS.

18.7070 Repairs to damaged stressed-skin or monocoque types of wing structure shall be made at the factory of origin or by a certificated repair station recommended in writing by the manufacturer for this type of work. Such station shall make such repairs in accordance with specific recommendations from the manufacturer.

18.7071 Small holes which in the discretion of an inspector of the Administrator do not seriously impair the strength of the structure may be repaired by, or the repair may be supervised by, any certificated airplane mechanic, provided the specific recommendations of the manufacturer governing such types of repair are followed. Small holes may be patched by attaching a cover over the hole.

18.7072 In any case, repairs to damaged skin, if very extensive, shall be made by replacing an entire panel from one structural member to the next. Where holes are large, the seam shall be made to lie along a bulkhead or along a structural member.

18.708 WOOD OR METAL MONOCOQUE FUSELAGES. The provisions of § 18.707 apply to this type of structure.

18.709 FITTINGS.

18.7090 Damaged fittings shall be replaced by factory parts or by parts made by a repair station certificated for fitting repair work.

18.7091 Worn fittings which were designed without bushings shall not be reamed to oversize but shall be replaced, unless a stress analysis or a

test is made to show that the reamed fitting complies with strength requirements. Holes shall not be filled with welding rod and reamed.

18.7092 Torn, kinked or cracked fittings shall be replaced.

18.710 WOOD WING RIBS.

18.7100 Acceptable methods of repairing a damaged rib are shown in Figures 16 and 17 of CAM 18. Cap strips shall be replaced entirely or repaired at the spars or at a joint in the rib.

18.7101 Damaged web members shall be replaced.

18.7102 Complete ribs shall be made from a manufacturer's approved drawing or from a drawing made by the repair agency and certified by the manufacturer as correct, except that the original rib may be used as a pattern for making the new rib if it is not too seriously damaged to permit comparison. The drawing, if used, shall be retained by the repair agency for use by the inspector of the Administrator in making the inspection.

18.711 WOOD WING SPARS.

18.7110 Wood spars may be spliced at any point except at a wing fitting, which shall not overlap any part of the splice.

18.7111 Acceptable methods of splicing the various types of spars are shown in Figures 9 through 13 of CAM 18.

18.7112 No scarf shall be made with a slope steeper than 10 to 1, and all joints shall be made with the highest quality of casein or animal glue.

18.7113 When casein glue is used on soft woods, a pressure of 100 to 150 pounds per square inch shall be applied to the joint during the gluing process. In gluing hard woods a pressure of 200 to 250 pounds per square inch shall be applied.

18.7114 In cases of elongated bolt holes in a spar, a new section of spar shall be spliced in or the spar replaced entirely.

18.7115 Except at a fitting, cracked spars (except box spars) in which the cracks are longitudinal and the wood is not splintered may be repaired by gluing, to both sides of the spar, strips of spruce or plywood of sufficient thickness to develop the longitudinal shear strength of the spar, such strips to extend well beyond the termination of the cracks. When this is done a total thickness of spruce equal to the thickness of the spar web or a total thickness of plywood equal to one-half the spar web thickness shall be used as shown in Figure 15 of CAM 18.

18.712 WELDED STEEL TUBE FUSELAGES. Damaged members in steel tube fuselages may be repaired by the methods shown in Figures 1 through 8 of CAM 18, if it is possible to have a stub of the length indicated in the figures.

18.7120 If the member is damaged at the joint so that it is not possible to have such a stub, the member shall be replaced entirely in the case of web members, and in the case of longerons the splice shall be made in an adjacent bay.

18.7121 When it is necessary to remove a member at a joint or cluster, it shall be carefully and completely removed from the cluster without disturbing the surrounding members to which it is attached.

18.7122 A replacement tube shall be at least equal in strength to the original.

18.7123 Where a rosette weld is necessary the hole shall be made in the outside tube only and be of sufficient size to insure fusion with the inner tube.

18.713 ENGINE MOUNTS. The provisions of § 18.712 shall apply to tubular mount members.

18.714 LANDING GEARS.

18.7140 If damaged landing gear struts are made of streamlined tubing they shall not be repaired unless the method of repair is specifically approved by the Administrator. (See CAM 18.)

18.7141 If damaged landing gear struts are made of round tubing they may be repaired by using splices similar to those shown in Figures 1 through 8 of CAM 18.

18.7142 Damaged axles shall be replaced entirely.

18.7143 The straightening of landing gear struts and the filling of kinks with weld material are prohibited.

18.715 WING BRACE STRUTS. Damaged wing brace struts shall not be repaired but shall be replaced entirely.

18.716 WING TRAILING AND LEADING EDGES AND TIP STRIPS. Repairs to wing trailing and leading edges and tip strips shall be made by properly attached and reinforced splices.

18.717 WOOD COMPRESSION RIBS. Wood compression ribs shall not be repaired but shall be replaced entirely.

18.718 CONTROL SURFACES. Repair methods on control surfaces will depend upon the type of construction and the extent of damage. Procedure shall be in accordance with such portions of these regulations as are applicable.

18.719 HOLLOW STEEL PROPELLERS. Damaged hollow steel propeller blades shall not be repaired except by the manufacturer. Welding is not permissible on such blades even for very minor repairs except by the manufacturer, due to the special process employed and the heat treatment required. A blade developing a crack of any nature in service shall be returned to the manufacturer for inspection.

18.7190 Minor injuries to the leading and trailing edges only of hollow steel blades may be smoothed by hand stoning provided the injury is not deep.

18.720 ALUMINUM ALLOY PROPELLERS. Damaged aluminum alloy propeller blades and steel propeller hubs shall be repaired only by the manufacturer or by repair agencies certificated for this type of work. Such repair agencies shall be governed by the following considerations.

18.7200 A damaged metal propeller is one which has been bent, dented or cracked in such a manner as to render it unsafe for flight.

18.7201 Damaged blades with model numbers which are on the manufacturer's list of blades that cannot be repaired shall be rejected.

18.7202 The extent of a bend in the face alignment of blades shall be carefully checked by means of a protractor similar to the one illustrated in Figure 18 of CAM 18. Only bends not exceeding 20 degrees at .15 inch blade thickness to 0 degrees at 1.1 inches blade thickness may be cold straightened. Blades with bends in excess of this amount require heat treatment and shall be returned to the manufacturer or his authorized agent for repair.

18.7203 Blades which are bent in edge alignment shall not be repaired by anyone except the manufacturer or his authorized agent.

18.7204 Damaged blades shall be etched in a 20% caustic soda solution and cleaned in a 20% nitric acid solution, or in a cleaning

solution which will prcduce equivalent results, care being taken not to etch the shank portion. Scratches and suspected cracks shall be given a local etch and examined with a magnifying glass. The shank fillets and the front half of the under surface of the blades from 6 to 10 inches from the tip are the most critical portions. Adjustable pitch blades shall also be etched locally on the clamping portion of the shank at points 1/4 inch in from the hub edge in line with the leading and trailing edges, and examined with a magnifying glass for circumferential cracks. Any crack is cause for rejection.

18.7205 Nicks and dents on the leading edge and face of blades shall be blended into the blade contour with smooth curves by the use of a riffle file and crocus cloth. After removal of a nick or dent, the surface shall be etched and examined with a magnifying glass, to insure that the nick or dent is entirely removed and that a crack has not started. The surface shall then be polished locally. Blades requiring removal of more material than the following permissible reduction in width and thickness from the drawing dimensions, shall be rejected:

Inner 2/3	percent	2½
Outer 1/3	percent	5
Outer 12 inches	percent	10
Cuter 6 inches	May be modified as required	

18.7206 Hubs shall be minutely inspected for cracks by the wet or dry magnetic dust method. Particular attention shall be paid to the inside in the region of the shear shoulders. (Cracks usually start in line with the leading and trailing edges of the blade.) Any crack is cause for rejection.

18.7207 Hubs and clamp rings shall be cleaned by stripping off the plating in accordance with the manufacturer's recommended practice. They shall be dimensionally inspected for conformity to the drawing. Particular care shall be taken to check the 90 degree relation between shaft bore and blade socket centerline and track of the blade sockets, as these are the dimensions which are most likely to be affected by accidents. Any hub which is sprung shall be rejected.

18.7208 Splines and cone seats shall be carefully inspected for signs of wear. Splines shall be checked with a single key no-go gauge made to plus .002 of the base drawing dimensions for spline land width. If the gauge enters more than 20% of the spline area, the hub shall be rejected.

18.7209 Hubs and clamp rings shall be cadmium plated after they pass inspection. This plating shall be done in accordance with the manufacturer's recommended practice.

18.72010 Clevis pins, bolts and nuts shall be replaced if they show any indication of wear or distortion.

18.72011 The propeller shall be assembled as recommended by the manufacturer and checked for track and balance. All blades must track within plus or minus 1/16 inch.

18.72012 Horizontal unbalance may be corrected by adding lead not to exceed 1/4 ounce to the concentric hold in the light blade or by removing lead not to exceed 1/4 ounce from the heavy blade. An eccentric hole not over three-eighths inch (3/8") in diameter for any size blade end shall be drilled and filled with lead to procure vertical balance. The outer edge of such hole shall not be closer than 1/4 inch to the nearest external surface of the blade.

Only one such hole per blade will be permitted. The holes may equal the following dimensions, but in no instance shall they be made larger:

Size no. of shank	Maximum concentric hole diameter	Maximum concentric hole depth	Maximum eccentric 3/8-inch hole depth
00	7/16	2 1/2	2 1/4
0-V2	19/32	3 3/8	3
1/2	5/8	3 5/8	3 1/2
1	3/4	4 1/4	4
1 1/2	13/16	4 7/8	4 1/2
2	7/8	5 1/2	5
3	31/32	6 1/8	6

After securing final horizontal and vertical balance, the holes shall be corked to prevent the lead from falling out. If balance cannot be secured within the allowable limits given above, a reinspection is required because this is more than the maximum amount of unbalance that could occur if all parts were within specified tolerances.

18.72013 Vertical unbalance may be corrected when clamping rings are on the centerline by moving the two rings equally off center in the same direction by an amount which shall not exceed 1/4 inch. When the clamp rings are in the 45 degree position due to engine or cowling interference, vertical unbalance may be corrected by moving one ring only towards the front centerline for a distance which shall not exceed 1/2 inch. If this will not secure perfect balance, a reinspection is required. An arrow shall be stamped on the hub shell and on the clamp ring showing the final location of the ring.

18.721 WOODEN PROPELLERS.

18.7210 Wooden propellers shall be inspected for such defects as cracks, bruises, scars, warp, oversize holes in the hub, evidence of glue failure and separated laminations, sections broken off and defects in the finish. The tipping shall be inspected for such defects as looseness or slipping, separation of soldered joints, loose screws, loose rivets, breaks, cracks, eroded sections and corrosion.

18.7211 A wooden propeller damaged to the following extent shall be scrapped:

18.72110 (a) A crack or deep cut across the grain of the wood.

18.72111 (b) A comparatively long, wide or deep cut parallel to the grain of the wood.

18.72112 (c) A separated lamination.

18.72113 (d) An excessive number of screw or rivet holes.

18.72114 (e) An oversize hub or bolt hole.

18.72115 (f) An appreciable warp.

18.72116 (g) An appreciable portion of wood missing.

18.7212 Small cracks parallel to the grain of the wood shall be filled with hot glue thoroughly worked into all portions of the cracks, dried and then sanded smooth and flush with the surface of the propeller. This also applies to small cuts.

18.7213 Appreciable dents or scars which have rough surfaces or shapes that will hold a filler and will not induce failure, shall be filled with a mixture of casein glue and clean, fine sawdust thoroughly worked and packed into the defect, dried and then sanded smooth and flush with the surface of the propeller. In any case, all loose splinters shall be removed.

18.7214 The finish, where necessary, shall be renewed in accordance with the recommendations of the manufacturer.

18.7215 Tipping shall be replaced when it cannot be properly repaired. Cracks in the narrow necks of metal between pairs of lobes of the tipping are to be expected and are not defects. All other cracks are defects that shall be repaired, or eliminated by new tipping.

18.7216 For balancing, wood propellers shall be mounted on a hardened mandrel on a knife edge balancing stand in a room free from air currents. Each blade shall in turn be placed in a vertical position with the blade extending downward. The propeller shall then remain in either a vertical or horizontal position without showing any tendency to rotate in either direction. If the propeller does not balance, balance may be obtained in the following manner:

18.72160 Horizontal unbalance may be corrected by the application of clear varnish or solder to the light blade. The light blade may be coated with a high grade of clear primer allowing for a finishing coat of clear varnish. After allowing each coat to dry 48 hours, the balance shall be checked. Then, as may be necessary, either the required amount of varnish shall be removed by carefully sandpapering or an additional coat applied, allowing for the finishing coat of varnish which shall be a thin coat of high grade clear spar varnish. The balance shall be rechecked and sandpaper or additional varnish applied as may be required to effect final balancing. Only clear finish is permitted.

18.72161 When it is necessary to remove the finish at the cambered side of the tipping for inspection or repairs, balance may be effected by applying putty to the tip of the light blade after all grease, oil and other such substances have been removed and the surface has dried. The solder to be removed or applied shall be of the approximate weight of the putty. If balancing solder is already present on the wide section of tipping on the back of the heavy blade, the required amount shall be removed by careful filing or scraping. If there is no balancing solder, all of the wide section of tipping on the back of the light blade shall be thoroughly cleaned. All of the cleaned tipping shall be thoroughly tinned with ordinary solder and a soldering iron. A perfect bond must be made at all points between the tipping and the solder. To prevent burning of the wood under the tipping, more heat than is necessary to flow the solder shall not be applied. The required amount of solder shall be distributed over the entire tinned area. The balance shall be checked and, as may be necessary, solder may be removed or added until final balance is accomplished. The necessary coats of primer and spar varnish shall be allowed for.

18.72162 Vertical unbalance may be corrected by applying putty to the light side of the wood hub at a point on the circumference approximately 90 degrees from the longitudinal centerline of the blades. The putty shall be weighed and a brass plate weighing slightly more than the putty shall be cut out. The thickness of the plate will be from 1/16 to 1/8 inch depending on the final area, which must be sufficient for the required number of flat head attaching screws. The plate shall be formed to fit the shape of the light side of the wood hub, and drilled and countersunk for the required number of screws.

The plate shall then be attached and all of the screws tightened. After the plate is finally attached to the propeller, the screws shall be secured to the plate by soldering the screw heads. The balance shall be checked and all edges of the plate beveled to reduce its weight until balance is accomplished.

18.722 ENGINES.

18.7220 Repairs to, or overhaul of, certificated engines shall not be attempted by any but certificated engine mechanics or by employees of a manufacturer.

18.7221 In making repairs to (or overhauling) a certificated engine the mechanic shall be governed by the recommendations set forth in the respective instruction books published by the manufacturer, except when such recommendations conflict with Civil Air Regulations.

18.7222 Only structural parts approved by the Administrator shall be used in making replacements in certificated engines, and the repair agency shall furnish the owner a certified statement showing that the parts used are approved. This statement shall be pasted in and shall become a part of the engine log-book.

18.7223 Welding shall not be done on any structural part of a certificated engine except in special cases when it is proved conclusively to the Administrator that the repaired part is as airworthy as originally.

18.7224 Crankshafts shall be carefully inspected for alignment. If bent beyond the manufacturer's permissible limits, a crankshaft shall not be repaired, but shall be rejected.

18.723 INSTRUMENTS. Instruments with which certificated air carrier aircraft are equipped, and which are damaged to such an extent that repairs are necessary, shall be repaired or replaced by the manufacturer or a certificated repair station.

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