

FILE NO. 11-690/92-AI(2)

EFFECTIVE : FORTHWITH

Subject:- Inspection of Wooden Aircraft.

1. INTRODUCTION :

- 1.1 The following instructions lay down the procedure to be followed in respect of the inspection of wooden structures of aircraft and should be read in conjunction with the relevant aircraft manuals, drawings and maintenance schedules, and should not be taken as overriding any specific requirements contained in those documents.

2. GENERAL :

- 2.1 The attention of aircraft owners and aircraft maintenance engineers is drawn to the possible deterioration of the wood and glued joints in aircraft, with the passage of time. Much of the deterioration is caused by water soakage.
- 2.2 Several cases have occurred where glued joints have completely collapsed and serious deterioration has taken place in the wood, with consequent weakening of the structure.
- 2.3 In most cases, the deterioration has occurred in places where normal inspection is impossible and it has not come to light until the adjacent structure has been disturbed to embody repairs or modifications or during extensive overhaul.

3. APPLICABILITY AND PERIOD OF INSPECTION :

- 3.1 All aircraft of wooden or composite construction shall be inspected before issue/renewal or validation of Certificate of Airworthiness and thereafter at periods not exceeding twelve months.

4. INSPECTION :

- 4.1 The inspection shall be such as to ensure that all defective timber and glued joints are made good.
- 4.2 The aircraft shall be opened up (including removal of upholstery) and dismantled to such extent as may be necessary to enable all timber and glued joints, particularly structural members, to be inspected for deterioration and serviceability.
- 4.3 Additional inspection and access holes shall be made as

required to enable inspection of parts of 10 years or more age, particularly when the parts are boxed in or are otherwise inaccessible.

- 4.4 The officers of the Regional Airworthiness Office will, before issue, renewal or validation of Certificate of Airworthiness of wooden aircraft, require evidence to show that exceptional measures have been taken to ensure that such aircraft have been dismantled and opened up to such an extent as to ensure that all defective timber and glued joints have been made good.
5. Glued Structures - The inspection of glued joints of aircraft structures present considerable difficulties. Even where access to the joint exists or has been made possible, it is still difficult to positively assess the integrity of the joint by any known method of examination and this should be borne in mind when inspecting wooden structures.
- 5.1 Some of the more common factors which may cause deterioration are :
- (a) chemical reactions of the glue itself due to aging or moisture, to extremes of temperature or to a combination of these factors.
 - (b) mechanical forces due mainly to timber shrinkage, and
 - (c) development of mycological growths (i.e., fungus).
- Note :- In some cases, oil percolating from the engine installation may also cause deterioration.
- 5.2 Aircraft exposed to large cyclic changes of temperature and humidity are especially prone to timber shrinkage which in turn may lead to glue deterioration. The amount of movement of timber members due to these changes varies with the volume of each member, the rate of growth of the tree from which the timber was cut and the way in which the timber was converted. Thus, two major members in an aircraft structure, secured to each other by glue, are unlikely to have identical characteristics and differential loads will, therefore, be transmitted across the glue film with changes of humidity since the two members will not react in an identical manner relative to each other. This will impose stresses in the glued joint which, in temperate zones, can normally be amply accommodated when the aircraft is new and for some years afterwards. However, with age the glue tends to deteriorate, even when the aircraft is maintained under ideal conditions, and stresses at the glued joint, due to changes in atmospheric conditions, may cause failure of the joint.
- 5.3 In most wooden aircraft of monoplane construction the main spars are of box formation consisting of long top and bottom transverse members (i.e., spar booms) joined by plywood sides. The spar booms themselves may be built up

from laminations glued together, and at intervals vertical wooden blocks are positioned between the two booms to add support to the plywood sides, the whole being glued together to form a series of long hollow cavities.

- 5.4 The main spars carry most of the loads in flight and are, at times subjected to flexing. The glued joints should, therefore, be beyond reproach but, without dismantling the spar to some extent, internal inspection can be virtually impossible.
- 5.5 Generally long exposure to inclement weather conditions or strong sunlight, will tend to destroy the weather proofing qualities of the proofed fabric coverings and of surface finishes, by affecting the plasticity of the covering; if neglected under these conditions, and due to ingress of moisture, considerable deterioration will occur from water soakage.
6. Survey of Structure -Whenever possible the aircraft should be kept in a dry, well ventilated hangar and with all inspection covers, hatches, access panels, etc., removed for as long as possible prior to inspection. If the aircraft is thoroughly dried out, this will facilitate the examination especially when inspecting the condition of glued joints.
 - 6.1 Before commencing a detailed examination of the joints and the timber, a rough assessment of the general condition of the structure can sometimes be obtained from the external condition of the aircraft, and in some cases of serious deterioration this assessment may be sufficient to consider the aircraft beyond practicable repairs and thus avoid further work.
 - 6.2 The wings, fuselage and tail unit should be checked for undulation, warping and any other departures from the original shape. In instances where wings, fuselage or tail unit structures and skins form integral stressed structures, such as inner and outer ply skins screwed and glued to structural members, no departure from the original contour or shape is permissible.
 - 6.3 Where light structures using single ply covering are concerned, some slight sectional undulation or panting between panels may be permissible provided the timber and glue is sound. However, where such conditions exist, a careful check must be made of the attachment of the ply to its supporting structure, and moderate pressure with the hand, to push the ply form the structure, should be used.
 - 6.4 The contours and alignment of leading and trailing edges are of particular importance and a careful check should be made for departure from the original shape. Any distortion of these light ply and spruce structures is indicative of deterioration, and a careful internal inspection will have

to be made for security of these parts of the main wing structure, and for general deterioration of the light ply and spruce members. If deterioration is found in these components the main wing structure may also be affected.

- 6.5 Where there are access panels or inspection covers on the top surfaces of wings or tail planes, care is necessary to ensure that water has not entered at these points where it can remain trapped to attack the surrounding structure.
- 6.6 Splits in the proofed fabric covering on plywood surfaces should not be repaired by doping on another piece of fabric over the affected area. In all cases, the defective fabric should be removed in order to ascertain whether the ply skin beneath is serviceable, since it is common for a split in the ply skin to be responsible for initiating a similar defect in the protective fabric covering.
- 6.7 Whilst a preliminary survey of the external structure can be useful in roughly assessing the general condition of the aircraft, it should be noted that timber and glue deterioration may often take place inside a structure without any external indications.

Where moisture can enter a structure, it will tend to find the lowest point where it will stagnate and promote rapid deterioration. It should also be noted that glue deterioration can take place through other causes without the presence of water.

- 7. Glued Joints and Timber inspection - Glue failure and wood deterioration are often closely allied and the inspection of glued joints must include an examination of the adjacent wood structure.
 - 7.1 The inspection of a complete aircraft for glue or wood deterioration will necessitate check as on remote parts of the structure which may be known or suspected trouble spots and which are, in many instances boxed in or otherwise inaccessible. In such instances considerable dismantling is required and it may be necessary to cut access holes in ply structures to facilitate the inspection; such work must be done only in accordance with approved drawings or the repair manual for the aircraft concerned and, after the inspection has been completed the structure must be made good and protected as described in these documents.
 - 7.2 All known or suspected trouble spots must be closely inspected even if the log book records indicate that the aircraft has been well maintained and properly housed throughout its life.

Note :- Where access is required and no approved scheme exists, a scheme should be obtained from the Director General.

- 7.3 Access Holes : In general, access holes are circular in shape and the cut should be made so as to avoid jagged edges.
- 7.4 Where rectangular access holes are prescribed, care is necessary to ensure that they are correctly located and that corner radii are as prescribed in the drawings.
- 7.5 The edges of all access holes must be smoothed with fine glass paper, preferably before inspection is commenced, since contact with the rough edges may cause wood fibres to be pulled away.
- 7.6 It is important that the whole of the aircraft structure, including its components, e.g. tailplane, elevators, etc. is inspected in detail before any decision is reached regarding general condition.
- 7.7 Glue Line : When checking a glue line (i.e. the edge of the glued joint) for condition, all protective coatings of paint should be removed by careful scraping; it is important to ensure that the wood is not damaged during the scrapping operation, and scraping should cease immediately the wood is revealed in its natural state and the glue line is clearly discernible.
- 7.8 The inspection of the glue line is often facilitated by the use of a magnifying glass where the glue line tends to part or where the presence of glue cannot be detected or is suspect, then, providing the wood is dry, the glue line should be probed with a thin feeler gauge aid. If any penetration is possible, the joint should be regarded as defective.
- Note :- It is important that the surrounding wood is dry, otherwise a false impression of the glue line would be obtained due to closing of the joint by sealing. In instances where pressure is exerted on a joint, either by the surrounding structure or by metal attachment devices such as bolts or screws, a false impression of the glue condition could be obtained unless the joint is relieved of this pressure before the glue line inspection is carried out.
- 7.9 The choice of feeler gauge thickness will vary with the type of structure, but a rough guide is that the thinnest possible gauge should be used.
- 7.10 Timber Condition : Dry rot and wood decay is not usually difficult to detect. Dry rot is indicated by small patches of crumbling wood, whilst a dark discoloration of the wood surface or grey streaks of stain running along the grain are indicative of water penetration. Where such discoloration cannot be removed by light scrapping, the part should be

rejected, but local straining of the wood by the dye from a synthetic adhesive hardener, can of course, be disregarded.

7.11 Water Penetration of Structure : In some instances where water penetration is suspected, the removal of a few screws from the area in question will reveal, by their degree of corrosion, the condition of the surrounding joint.

- (i) Straight corrosion of the screw due to the adhesive will occur following the original construction. Therefore, the condition of the screw should be compared with that of a similar screw, removed from another part of the structure known to be free from water soakage.

Note :- Plain brass screws are normally used for reinforcing glued wooden members, although zinc coated brass is sometimes used. Where hard woods such as mahogany or ash are concerned, steel screws are sometimes used. Unless otherwise specified by the aircraft construction, it is usual to replace screws with new screws of identical length but one gauge larger.

- (ii) another means of ascertaining if water penetration has taken place is to remove bolts holding fittings at spar root end joints, aileron hinge brackets etc. corrosion on the surface of such bolts and timber discoloration will provide a useful indication of any water penetration which may have taken place.

Note :- When refitting bolts it is important to ensure that the same number of shrinkage washers are fitted as were fitted originally.

- (iii) Experience of a particular aircraft will indicate those portions of the structure most prone to water penetration and moisture entrapment (e.g. at window rails or the bottom lower structure of entry doors) but it must be borne in mind that this is not necessarily indicative of the conditions of the complete aircraft.

Note :- Where drain holes have become blocked, water soakage will invariably be found.

7.12 Water penetration of Top Surface : As indicated in paragraph 5.5 the condition of the proofed fabric covering on ply surfaces is of great importance. If any doubt exists regarding its proofing qualities or if there are signs of poor adhesion, cracks, or other damage it should be peeled back to reveal the ply skin.

- (i) The condition of the exposed ply surface should be examined and if water penetration has occurred, this

will be shown by dark grey streaks along the grain and a dark discoloration, at ply joints on screw countersunk holes, together with patches of discoloration. If these marks cannot be removed by light scraping or, in the case of advanced deterioration, where there are small surface cracks or a separation of the ply laminations, then the ply should be rejected. Where evidence of water penetration is found, sufficient of the surfaces should be stripped to determine its extent.

- (ii) Provided good care is taken of the protective covering from the beginning, much deterioration can be avoided, also during maintenance of the covering care should be taken to ensure that drain holes are kept clear.

7.13 Miscellaneous Defects : During the inspection of the aircraft, the structure should be examined for other defects of a more mechanical nature. Guidance on such defects is given in the following paragraphs.

- (i) Elongated Bolts Holes, where bolts secure fittings which take load-carrying members, or where the bolts are subject to landing or shears loads, the bolts holes should be examined for elongation or surface crushing of the wood fibers. The bolts should be removed to facilitate the examination and, in extreme cases, the bolts itself may be found to be strained. It is important to ensure that the bolts are a good fit in the bolts.
- (ii) Bruising and Crushing : A check should be made for evidence of damage such as bruises or crushing of structural members which can be caused, for example, by overtightening bolts. Repair schemes for such damage are governed by the extent and depth of the defect.
- (iii) Compression Failures : Compression failures, often wrongly referred to as compression 'shakes' are due to rupture across the wood fibres. This is a serious defect which at times is difficult to detect, and special care is necessary when inspecting any wooden member which has been subjected to abnormal bending or compression loads which may occur during a heavy landing. In the case of a member having been subjected to an excessive landing load, the failure will appear on the surface which has been compressed, usually at a position of concentrated stress such as at the end of a hardwood packing block; the surface subjected to tension will normally show no defects. In the case of a member taking an excessive direct compression load, the failure will usually be apparent on all surfaces.

Note :- Where a compression failure is suspected a hand torch shone along the member with the beam of light

running parallel to the grain, will assist in revealing this type of failure.

8. Joint Failure : A glued joint may fail in service as a result of an accident or due to excessive mechanical loads having been imposed upon it, either in tension or in shear. It is often difficult to decide the nature of the load which caused the failure, but it should be borne in mind that glued joints are generally designed to take shear loads.
- 8.1 If a joint is expected to take tension loads, it will be secured by a number of bolts or screws (or both) fairly closely pitched in the area of tension loading. If a failure occurs in this area, it is usually very difficult to form an opinion of the actual reasons for it, due to the considerable break up of the timber occurring in close proximity with the bolts.
- 8.2 In all cases of glued joints failure, whatever the direction of loading, there should be a fine layer of wood fibres adhering to the glue, whether or not the glue has come away completely from one section of the wood member. If there is no evidence of fibre adhesion, this may be indicative of glue deterioration, but if the imprint of wood grain is visible in the glue this is generally due to case hardening of the glue during construction of the joint, and the joint has always been below strength. If the glue exhibits a certain amount of crazing or star shaped patterns, this is indicative of too rapid setting or the pot life of the glue having been exceeded. In all cases, the other glued joints in the aircraft should be considered suspect.

Note :- The use of a magnifying glass will facilitate the above inspections.

- 8.3 When carrying out an examination of a wooden structure for glue deterioration or wood damaged after, for example, a heavy landing a thorough inspection of the existing paint at the glued joints for signs of breaking or flaking is recommended.

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