Propeller
Owner's Manual & Log Book

Series HC-A6( )-3( )( )

Six-Blade Lightweight Turbine Propeller

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HARTZELL PROPELLER INC.  
Manual No. 154

CAUTION: KEEP THIS SERVICE RECORD WITH THE PROPELLER AT ALL TIMES. WHEN THE PROPELLER IS INSTALLED AS PART OF AN AIRCRAFT OR ENGINE, THIS RECORD MUST BE MAINTAINED CONCURRENTLY WITH, AND BECOME A PART OF, THE AIRCRAFT AND ENGINE SERVICE RECORDS.

For updated information and additional copies of the Log Book, contact:

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REVISION NO. 3 HIGHLIGHTS:
Composite blade section updated and replaced in its entirety.
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Typical Single-Acting, Six Blade Lightweight Turbine Propeller

HC - A6( ) - 3( )( )/Blade Model

- Refer to Figure 1a

  Direction of Rotation
e.g. L = Left Hand; Blank = Right Hand

  Minor Modification

  Operational Features
e.g. External Beta System

  Propeller Hub Assembly
  Mounting Flange Type

  Number of Blades

  Blade Retention System

  Controllable (single-acting)

  Hartzell

**NOTE:** Parentheses in the model designation system can indicate either that an option or modification is included in the hub assembly or that it is not included in the hub assembly.
Typical Composite Blade Model Number

LM - 10585AK+4

- Change from basic propeller diameter (inches plus or minus)
- Type of de-icer boot
  - K external, foil element
  - B external, wire element
  - E internal element
  - EK internal and external
    (only external is working)
- Minor modifications
  - e.g. Cuff Shape
- Engineering designation for design characteristics
- Initial design diameter (inches)
  (Not necessarily the actual propeller dia.)

Blade retention system

- A shank: used with aluminum hub 6 blade propeller, has bolt-on pitch change knob, and counterweight attached to a clamp at the blade shank.
- B shank: used with aluminum hub "compact" propellers, has retention and pitch change knob similar to Y shank aluminum blades.
- E shank: three different types (refer to Manual 135)
- M shank: used with steel hub propellers, shank is similar to M shank aluminum blades, counterweights are attached to steel hub clamps.

Direction of rotation (L = Lefthand Blade)

Blade Model Designation
Figure 1a
1. Required Publications

It is important to note that this manual is not the sole document required in order to maintain the propellers described in this manual. Other Hartzell manuals referenced in the text, such as the applicable Propeller Overhaul Manual or Blade Repair Manual, provide essential information. One or more of the following publications, as applicable, are to be used in addition to this manual to maintain the propeller models covered herein. Consult the applicable Hartzell publications for additional information regarding specific recommendations and procedures.

Manual No.:

148(-): Composite Spinner Inspection, Maintenance and Repair
135(-): Composite Blade Inspection, Repair and Overhaul Instructions
126(-): Active Service Letters, Bulletins, Instruction, and Advisories
144(-): HC-A6A-3(-) Propeller Overhaul and Parts List

Consult the applicable manufacturer's manual for de-icer system inspection, repair and overhaul instructions.

2. Definitions of Propeller Life and Service

CAUTION: ALL OVERHAUL AND REWORK PROCEDURES MUST BE PERFORMED IN THE HARTZELL FACTORY OR IN A FACTORY-APPROVED FACILITY.

A. Overhaul is the periodic disassembly, inspection, reconditioning and reassembly of the propeller assembly which is constructed of a number of moveable, detachable parts.

1) The period between overhauls generally is based on hours of service (operating time) or on calendar time.

2) At such specified periods, the propeller hub assembly and the blade assemblies should be completely disassembled and inspected for cracks, wear, corrosion and other unusual or abnormal conditions. As specified, certain parts should be refinished, and certain other parts should be replaced. The propeller can then be reassembled and balanced.

3) Overhaul procedures must be performed in the Hartzell factory or in a factory-approved facility.
B. **Rework** is correction of major damage caused by physical mishap or failure.

1) Rework is done on an irregular basis as necessary and required. The propeller must be rebalanced after rework.

2) Amount, degree and extent of major damage determine whether or not a hub assembly or blade assembly can be reworked without overhaul. If in doubt, overhaul the assembly.

3) All rework must be performed in the Hartzell factory or in a factory-approved facility.

4) When a metal propeller blade is bent or twisted, repair is major, and the blade must be overhauled.

C. **Repair** is correction of minor damage caused during normal operations.

1) Most repair procedures may be performed in the field by a qualified mechanic.

2) Repair can be made without overhaul.

D. **Propeller Life** is expressed in terms of total hours of service (TT, or Total Time) and in terms of hours of service since overhaul (TSO, or Time Since Overhaul). Both references are necessary in defining the life of the propeller.

1) Overhaul returns the propeller assembly to zero hours TSO (Time Since Overhaul), but not to zero hours TT (Total Time).

2) Rework without overhaul does not affect TSO or TT.
Basic Components of the HC-A6( )-3( ) Six-Blade Lightweight Turbine Propeller

Figure 2

Page 6
4. **General Description and Components (refer to Figure 2)**

The Hartzell Series HC-A6(-3)( ) Six-Blade, Single-Acting Lightweight Turbine Propeller is a constant-speed, hydraulically actuated type of propeller with feathering and reversing capabilities. It is designed primarily for use with Pratt & Whitney Series PT-6 turbo-prop engines.

A 105-degree (105°) pitch range is available with externally adjustable feather angle, reverse angle and low pitch stop. These adjustments do not interact with each other.

In the single-acting control system, propeller rpm is controlled by the governor which is installed on the engine and supplies pressurized engine oil. The governor has been modified to act as a hydraulic low pitch valve and as a beta valve when the propeller is in the reverse mode of operation.

**NOTE:** The beta valve itself usually is built into the base of the governor.

An increase in pressure into the propeller from zero (0) psi to approximately 385 psi (27.07 kg/cm²) causes propeller pitch to decrease in the positive range and to increase in the negative (reversing) range. A reduction of governor oil pressure causes an increase in blade angle.

A loss of oil supply from the governor results in feathering the propeller since the combined action of feathering spring and blade counterweights forces oil from the propeller back into the engine.

Engine oil pressurized from the governor forced into a cavity between the piston and the cylinder moves the piston forward from high to low pitch position range. This linear motion is transmitted from the piston to each blade assembly through a pitch change rod, a slotted fork unit and a blade pitch change assembly. Blade pitch is controlled by a knob bolted and pinned to the shank of the blade. A slider block on the end of the knob minimizes friction and provides blade-to-blade pitch angle adjustment.

Each blade is supported by a blade retention split-bearing which permits pitch change. Counterweights mounted on the blades, and the large feathering spring inside the cylinder, oppose governor oil pressure and increase pitch to the feathered position.

The governor is linked to the propeller piston through external mechanisms which shut off the governor oil supply when the piston reaches its predetermined low pitch setting and prevent the governor from moving the piston beyond the prescribed low pitch position.

The piston engages beta rods. Movement of the blades to a lower pitch causes the rods to move the beta ring away from the engine.
A carbon block assembly rides in the groove of the beta ring. Linear motion from the low pitch position into the beta and reverse pitch range is transmitted from the rotating propeller assembly to the fixed engine through the beta ring and carbon block assembly.

The carbon block assembly is attached to an engine-supplied lever. This lever is connected to a beta valve mounted on a governor and to the power lever which is controlled in the cockpit. Blade movement below the preadjusted low pitch angle will move the beta lever and cause the beta valve to interrupt the hydraulic connection between propeller and governor. This prevents further travel of the blade pitch to a lower angle.
5. Basic Operating Principles

CAUTION: USE A TOW-BAR TO MOVE THE AIRCRAFT. DO NOT USE THE PROPELLER BLADES TO MOVE THE AIRCRAFT. BLADES CAN EASILY BE PUSHED OR PULLED OUT-OF-TRACK, RESULTING IN A CONDITION OF DYNAMIC IMBALANCE.

Avoid operating the aircraft in areas where loose stone or gravel can be pulled into the blades causing damage to the blade face and leading edge.

A. Feathering the Propeller

The propeller is feathered by releasing the governor oil pressure. This allows the counterweights and feathering spring to feather the blades.

Pulling the governor pitch control back to the limit of its travel opens a port in the governor. This allows the feathering spring to force oil out of the propeller back into the engine and increase blade angle to the feathered position.

Because of such variables as blade design and counterweight mass, elapsed time up to fifteen (15) seconds is typical for feathering with this system.

B. Unfeathering the Propeller

The propeller is installed (or removed) with the blades in a feathered position. The propeller has no centrifugal high pitch stops, so it feathers itself when stationary.

The propeller is unfeathered by pushing the governor control back into normal flight range position, restarting the engine, and using the governor to pump oil into the propeller. When the propeller has rotated a few turns, the governor will start to unfeather the blades.

When the propeller is unfeathered in flight, “windmilling” occurs and reduces the time required to accomplish unfeathering.
C. Reversing the Propeller

In the reverse mode of operation, the governor is reset to act as a source of pressurized oil. Control of the propeller then is transferred to the beta valve which controls blade angle rather than rpm.

**NOTE:** The beta valve usually is built into the base of the governor.

The propeller is reversed by manually repositioning the cockpit-controlled cable to cause the beta valve to supply oil from the governor pump to the propeller.

When the propeller reaches desired reverse position, movement of the beta ring and carbon block assembly cause the beta valve to shut off flow of oil to the propeller, holding the blade in a fixed position.
6. **Lightning Strike on Hub**

**CAUTION:** ANY PROPELLER ASSEMBLY WHICH IS EXPOSED TO LIGHTNING STRIKE MUST BE OVERHAULED BEFORE IT IS RETURNED TO SERVICE.

A. In a lightning strike, the blade retention split-bearing and the blade alignment bearing are subject to damage.
   1) Arcing may occur, and this will be evident on the bearing races, balls and/or rollers.

B. In every lightning strike case, the flow of current has magnetized all of the steel parts.
   1) Demagnetize all steel parts of the assembly.

**NOTE:** For lightning strike on composite blades, refer to the composite blade section in the back of this manual.
Grease leakage at any lubrication fitting

Oil leakage at seal between pitch change rod and piston

Oil leakage at pitch change rod nut

Oil leakage at seal between cylinder and piston

Grease leakage at beta rod exit from beta spring can

Grease leakage at seal between cylinder shoulder and cylinder-side hub-half

Grease leakage at blade socket in hub

Grease leakage at any lubrication fitting bleeder

Grease leakage at interface between hub halves

Oil leakage at seal between engine flange and propeller mounting flange

Grease leakage at beta rod exit from engine-side hub-half

**NOTE:** The only potential source for grease leakage is in the blade retention area of the hub.

Areas to Inspect Daily for Evidence of Leaking Oil or Grease

Figure 5
7. Propeller Hub Assembly Inspection and Maintenance

CAUTION: FOLLOW ALL SPECIFIED PROCEDURES FOR PROPELLER HUB ASSEMBLY INSPECTION, MAINTENANCE AND LUBRICATION.

Inspect visible hub parts daily for surface damage.
Look for evidence of grease and/or oil leaks (see Figure 5).
Lubricate the assembly periodically in accordance with inspection and maintenance procedures detailed in this manual.

CAUTION: DO NOT ALLOW STEEL PARTS TO RUST.

If the cadmium plating wears off of a steel part, clean the surface, treat it, and apply Hartzell Polane paint as a temporary measure until the part can be re-plated.

8. Propeller Blade Assembly Inspection

Inspect propeller blades in accordance with the composite blade section in the back of this manual.
9. **Required Inspections**

A. **100-Hour Inspection**

1) Remove the spinner dome.

2) Check for oil and grease leaks (see Figure 5).

3) Inspect all visible parts for wear and safety.

4) Inspect visible hub parts for cracks or wear.

5) Check blade edges and surfaces for corrosion, cracks, scratches, depressions, erosion and gouges.
   
   a) Check composite blade edges and surfaces for debond and delamination (see Figure 4).

6) Have any crack or gouge in a metal blade repaired before next flight (See Figure 6).

   **NOTE:** Minor damage to a composite blade does not necessarily have to be repaired before next flight.

7) If the propeller is equipped with external de-icer boots, make sure all de-icer boots are secure.

8) Inspect all attaching hardware for proper fit, torque requirements and safety.

9) Make an entry in the Log Book verifying that this inspection has been completed.
(Pages 17 through 19, including Figures 7, 8, and 9, have been removed being replaced with the new composite blade section in the back of this manual.)
B. 300 Hour Inspection

NOTE: Follow all steps of the 100-hour inspection procedure.
Proper and regular lubrication is essential to efficient, long-life operation of the Hartzell propeller.

CAUTION: THESE LUBRICATION PROCEDURES MUST BE FOLLOWED CORRECTLY TO MAINTAIN ACCURATE DYNAMIC BALANCE OF THE PROPELLER BLADE AND HUB ASSEMBLIES.

CAUTION: TO AVOID DISLODGING THE HUB O-RINGS, OPEN EACH BLEEDER FITTING ON THE ENGINE-HALF OF THE HUB UNIT A HALF-TURN BEFORE ADDING LUBRICANT THROUGH THE SIX LUBRICATION FITTINGS ON THE CYLINDER-HALF OF THE HUB UNIT.

CAUTION: USE A HARTZELL PROPELLER APPROVED LUBRICANT ONLY. DO NOT MIX DIFFERENT SPECIFICATIONS AND/OR BRANDS OF GREASE.

1) To lubricate the propeller assembly:
   a) As shown in Figure 10, open each of the six bleeder fittings on the engine-half of the hub unit far enough to ensure that none of the fittings is sealed.
   b) Add an equal number of pumps of lubricant through each of the six lubrication fittings on the cylinder-half of the hub unit.
   c) Lubrication of one blade retention split-bearing is completed when grease emerges from the bleeder fitting in a steady flow with no air pockets.
   d) At overhaul, install all new lubrication fittings, bleeder fittings and caps.

NOTE: Make sure the ball of each lubrication fitting is properly seated.
CAUTION: BEFORE ADDING LUBRICANT, OPEN EACH BLEEDER FITTING FAR ENOUGH TO ENSURE THAT IT IS NOT SEALED.

MAKE SURE THERE ARE NO AIR POCKETS IN LUBRICANT WHICH HAS BEEN ADDED.

USE HARTZELL PROPELLER APPROVED LUBRICANTS ONLY.

DO NOT MIX DIFFERENT SPECIFICATIONS AND/OR BRANDS OF GREASE.

Open each of the six bleeder fittings on engine-half of hub unit far enough to ensure that no fitting is sealed.

Add an equal number of pumps of lubricant through each of the six lubrication fittings on cylinder-half of hub.
11. **Approved Lubricants**

The following greases are approved by Hartzell Propeller Inc.:

- **Aeroshell 5** with certain limitations, see Bulletin 159( )
- **Aeroshell 6**
- **Aeroshell 7**
- **Aeroshell 22**
- **Exxon 5114EP**
- **Royco 22C**

**NOTE:** Other, previously issued, Hartzell documents indicate additional greases by brand name and/or MIL-specification. Not all of these greases meet our current performance standards. Hartzell has chosen to specify only those greases which have sufficient testing or field experience to establish that they are acceptable.

**NOTE:** For further information, see Service Advisory 17( ).
12. Recommended Overhaul Periods

CAUTION: A PROPELLER WHICH HAS BEEN EXPOSED TO IMPACT DAMAGE, WHICH RENDERS ONE (OR MORE) BLADES NOT AIRWORTHY, OR TO LIGHTNING OR OVERSPEED GREATER THAN TEN PER CENT (10%) OF MAXIMUM RATING OF THE PROPELLER MUST BE OVERHAULED BEFORE RETURN TO SERVICE.

A. The recommended Time Between Overhauls (TBO) for the Hartzell propellers covered by this manual is found in Hartzell Service Bulletin No. 152( ).

CAUTION: OVERHAUL PROCEDURES MUST BE PERFORMED IN THE HARTZELL FACTORY OR IN A FACTORY-APPROVED FACILITY.

B. Overhaul Inspection

1) The overhaul inspection should include the following:
   a) Removal of propeller assembly from the aircraft engine.
   b) Complete disassembly of hub and blades.
   c) Visual inspection of all parts.
   d) Magnetic inspection of all steel parts.
   e) Dye penetrant inspection of aluminum or titanium parts.
   f) Cadmium re-plating and baking of certain steel parts.
   g) Repair, replacement or rework as required.

2) Make an entry in the Log Book verifying that the overhaul inspection procedures have been completed.

NOTE: Hartzell Service Letter 61( ) describes storage times and the affect on overhaul times.

12a. Continued Airworthiness Limitations

Certain component parts as well as the entire propeller may have specific life limits established by the F.A.A. Such limits call for replacement of items after a specific number of hours of use.

NOTE: Life limits may be subject to frequent revision until sufficient service experience has been established. Details concerning life limited parts are found in the latest revision to Hartzell Service Bulletin 152( ).
HARTZELL PROPELLER INC.
Manual No. 154

13. Troubleshooting Guide

NOTE: The Troubleshooting Guide which follows helps isolate probable causes and suggests possible remedies for some of the more common propeller service problems. In any case, the remedy for a problem should follow the procedures detailed in the applicable section of this manual.

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<th>Probable Cause</th>
<th>Remedy</th>
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<td>A.</td>
<td>Excessive Friction in Hub Mechanism</td>
<td>CAUTION: DO NOT INCREASE ANY CLEARANCE BY REMOVING MATERIAL ON PARTS WHICH HAVE SPECIAL COATINGS.</td>
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<td>Insufficient clearance between various moving parts in the pitch change mechanism</td>
<td>Check the moving parts individually Increase clearances between individual parts as necessary to decrease friction in the mechanism</td>
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<td>or Balls in the blade retention split-bearing are unusually rough or chipped</td>
<td>Replace the blade retention split-bearing assembly</td>
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<td>B.</td>
<td>Excessive Friction in Piston</td>
<td>Blade preload is excessive</td>
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<td>or Lack of lubrication</td>
<td>Disassemble the propeller, and readjust blade preload</td>
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<tr>
<td></td>
<td>or Balls in the blade retention split-bearing are usually rough or chipped</td>
<td>Add approved lubricant Replace the blade retention split-bearing assembly</td>
</tr>
<tr>
<td></td>
<td>or Insufficient clearances between various moving parts in the pitch change mechanism</td>
<td>Increase clearances between the individual parts as necessary to decrease friction in the mechanism</td>
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<td>or Piston felt seal too tight</td>
<td>Replace the felt seal</td>
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### C. Failure to Change Pitch

- **Excessive friction in moving parts**
  - Refer to Problem A, "Excessive Friction in Hub Mechanism"

(Sluggish rpm in both directions)

- **Oil passages are not clear and open**
  - Inspect the hydraulic system

- **New governor has been installed with wrong direction of rotation or with bypass plug**
  - Refer to governor manufacturer's manual for instructions on correct installation if necessary in wrong hole

### D. Surging rpm or Torque

- **Excessive friction in pitch change mechanism**
  - Refer to Problem A, "Excessive Friction in Hub Mechanism"

- **Air is trapped in the propeller actuating piston or in the engine shaft**
  - The engine should have provision for allowing trapped air to escape from the system during one-half of the pitch cycle

  - Before each flight, exercise the propeller by changing pitch or feathering

- **Governor pressure is too low**
  - Refer to governor manufacturer's manual for instructions on adjusting relief pressure

- **Governor does not have sufficient dampening**
  - Refer to governor manufacturer's manual for instructions on providing sufficient dampening

- **Incorrect beta system rigging**
  - Refer to engine or aircraft rigging instructions
E. Oil Leakage

Faulty O-ring seals between piston and cylinder

Refer to Figure 5

or Faulty O-ring seal between pitch change rod and piston

or Faulty seal on pitch change rod nut

or Faulty O-ring seal between engine flange and propeller mounting flange

Disassemble the propeller, and inspect the O-rings and the surfaces they seal

Replace defective O-rings

F. Grease Leakage

NOTE: The only potential source of grease leakage is in the blade retention area of the hub.

Defective lubrication or bleeder fitting

Replace defective lubrication or bleeder fittings

or Missing lubrication fitting cap

Replace missing lubrication fitting caps

NOTE: Wire the lubrication fitting caps with .020-inch (.51 mm) minimum diameter stainless steel wire.

Make two wraps around the small diameter of each lubrication fitting cap, and tighten the wire enough to just bury it below the rubber surface of the cap

or Faulty seal at blade socket in hub

Disassemble the propeller, and replace defective seal

or Faulty seal at interface between hub halves

Disassemble the propeller, and add approved adhesive sealant to mating surface of the hub halves

or Faulty seal at beta rod exit from hub or spring can

Replace defective seal
G. End-Play in Blade

CAUTION: NO END-PLAY IN BLADE IS ALLOWED.

Refer to Figure 11

Buildup of manufacturing tolerances

or Blade retention bearing is worn
Follow Blade Retention Split-Bearing Inspection and Replacement

or Blade alignment bearing is worn
Blade alignment bearing must be replaced

H. Fore-and-Aft Movement in Blade

CAUTION: NO FORE-AND-AFT BLADE MOVEMENT IS ALLOWED.

Refer to Figure 11

Buildup of manufacturing tolerances

or Blade retention bearing is worn
Follow Blade Retention Split-Bearing Inspection and Replacement Procedures

or Blade alignment bearing is worn
Blade alignment bearing must be replaced

I. In-and-Out Movement in Blade

CAUTION: NO IN-AND-OUT BLADE MOVEMENT IS ALLOWED.

Refer to Figure 11

Buildup of manufacturing tolerances

or Blade retention bearing is worn
Follow Blade Retention Split-Bearing Inspection and Replacement Procedures
J. Excessive Radial Play in Blade (backlash) Refer to Figure 11 or Blade Retention bearing Follow Blade Retention Split-Bearing Inspection and Replacement Procedures NOTE: Radial play of ≤0.5-degree is allowed or Blade alignment bearing Blade alignment bearing must be replaced or Pitch adjustment unit Replace pitch adjustment unit is worn or out of tolerance or Buildup of Try another combination of parts manufacturing tolerances

K. Blades Not Tracking
or Ground strike damage Refer to applicable Blade Manual for Repair Procedure
or Blade face(s) are out of alignment Refer to applicable Blade Manual for Face Alignment Procedure NOTE: If blade tip angle is not correct according to specifications, reject the blade.
CAUTION: BLADE IS PRELOADED. NO END-PLAY, IN-AND-OUT, OR FORE-AND-AFT BLADE MOVEMENT IS ALLOWED.

NOTE: Use gentle hand pressure to check for fore-and-aft blade movement or end-play in blade. Excessive force will deflect the preload plate and cause an incorrect result of either check.

NOTE: Counterweight clamps removed for clarity.

Checking the Blade Preload
Figure 11
14. Removing the Propeller Assembly from the Aircraft Engine

A. With a suitable sling and mobile hoist, proceed as follows to disengage the propeller assembly from the aircraft engine:

1) Spinner Disassembly
   a) Remove the screws and washers that attach the spinner dome to the engine-side bulkhead unit.
   b) Remove the spinner dome and store with care.

2) Beta Control Unit Removal
   a) Disconnect the engine beta linkage and carbon block assembly from the beta ring.
   b) Use the special tool, Figure 12, to compress the beta system and pull the beta ring forward to expose the double hex head propeller mounting bolts and washers.

3) Remove safety wire, and remove the propeller mounting bolts and washers.

4) Carefully remove the propeller assembly from the aircraft engine.

5) Decompress and remove the special beta system tool (Figure 12).

6) Remove and discard the propeller mounting O-ring.

15. Preparing a Propeller Assembly for Lengthy Storage

CAUTION: A PROPELLER ASSEMBLY WHICH IS NOT GOING TO BE INSTALLED ON A AIRCRAFT WITHIN A REASONABLE LENGTH OF TIME MUST BE STORED IN A MANNER WHICH PROVIDES SUFFICIENT PROTECT AGAINST PHYSICAL DAMAGE AND AGAINST DAMAGE FROM EXTREMES IN TEMPERATURE OR HUMIDITY.

A. If the propeller assembly is not installed on an aircraft immediately, store the assembly in a sturdy, dry container.

NOTE: As necessary, add a dehydrating agent.
CAUTION: A PROPELLER ASSEMBLY BEING PLACED IN SERVICE AFTER LENGTHY STORAGE MUST COMPLY WITH ALL APPLICABLE FAA AIRWORTHINESS DIRECTIVES AS WELL AS APPLICABLE HARTZELL SERVICE LETTERS, BULLETINS, INSTRUCTIONS AND ADVISORY NOTICES.

A. Refer to Service Letter 61( ) to determine whether or not a propeller assembly has been stored for a longer period of time than is allowed without its being disassembled and inspected prior to being placed in service.
When an adapter is used with a torque wrench, use the following equation to determine torque value:

\[
\frac{(\text{actual torque required}) \times (\text{torque wrench length})}{(\text{torque wrench length}) + (\text{length of adapter})}\quad = \quad \text{torque wrench reading to achieve required actual torque}
\]

**EXAMPLE:**

\[
\begin{align*}
100 \text{ lb-ft} & \times \frac{1 \text{ ft}}{30.48 \text{ cm}} \quad = \quad 66.7 \text{ lb-ft} \\
\frac{1 \text{ ft}}{30.48 \text{ cm}} & + \frac{6 \text{ in.}}{15.24 \text{ cm}}
\end{align*}
\]

reading on torque wrench with 9 inch (22.86 cm) adapter for actual torque of 100 lb-ft (136 newton-meters)

Using Special Torquing Adapter (AST-2877) with Standard Torque Wrench to Torque Propeller Mounting Bolts

Figure 13
17. Installing the Propeller Assembly on the Aircraft Engine

A. Use the special tool, Figure 12, to compress the beta system.

B. With a suitable mobile hoist and sling, carefully move the propeller assembly up to the mounting flange on the aircraft engine.

**NOTE:** If the propeller is equipped with a de-icer system, follow the applicable manufacturer's instructions for installation.

1) Make sure the propeller hub flange and the engine flange are clean.

2) Line up the mounting holes in the propeller hub flange with the mounting holes in the engine flange.

3) Install the specified oil seal on the engine flange.

**WARNING:** USE ONLY PROPELLER MOUNTING BOLT PART NUMBER B-3347 FOR THE SIX-BLADE LIGHT-WEIGHT TURBINE PROPELLER.

**CAUTION:** MAKE SURE THAT COMPLETE AND TRUE SURFACE CONTACT IS ESTABLISHED BETWEEN THE PROPELLER HUB FLANGE AND THE ENGINE FLANGE.

**CAUTION:** REPLACE ALL PROPELLER MOUNTING BOLTS AND WASHERS AT OVERHAUL. MOUNTING BOLTS AND WASHERS MAY BE RE-USED ONLY WHEN THE PROPELLER ASSEMBLY IS BEING REINSTALLED AFTER HAVING BEEN REMOVED BETWEEN OVERHAULS.

4) Apply approved anti-seize compound to the threaded surfaces of the twelve propeller mounting bolts.

**NOTE:** A petROLated graphite lubricant conforming to MIL-T-5544 or MIL-T-83483 is approved. The following kits are available from the factory for this installation:

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5) Install the twelve mounting bolts with washers through the engine flange and into the propeller hub flange.

6) Use wrench with special adapter, Figure 13, to torque all mounting bolts in the sequences and steps shown in Figure 14.
a) Use a calibrated torque wrench and adapter that will assure correct torquing of the propeller mounting bolts.

NOTE: Refer to the formula in Figure 13 to determine correct calibration reading. The B-3347 mounting bolt has a 0.625 inch (15.875 mm) wrenching size.

7) Safety all mounting bolts in an airworthy manner with 0.032 inch (.81 mm) minimum diameter stainless steel wire.

8) Decompress the special tool on the beta system, and install the beta linkage. Then, remove the special beta system tool.

9) Proceed as follows to install the carbon block assembly (Figure 15) into the beta ring:
   a) Install the carbon block(s) on the lever supplied by the airframe or engine manufacturer.
   b) Fit the block(s) into the beta ring.
      NOTE: As shown in Figure 15, side clearance at installation must be 0.001 inch (0.03 mm) to 0.002 inch (0.05 mm).
   c) Dress the sides of the block(s) as necessary to establish the required clearance.
   d) Safety wire the beta linkage in an airworthy manner.

**SEQUENCE A**

Step 1 - Torque all bolts to 40 lb-ft (54 N·m)

Step 2 - Torque all bolts to 80 lb-ft (108 N·m)

**SEQUENCE B**

Step 3 - Torque all bolts between 100 lb-ft (136 N·m) and 105 lb-ft (142 N·m)

Diagram of Torquing Procedures for Propeller Mounting Bolts

Figure 14
C. Spinner Reassembly

1) Use new washers and screws to re-attach the spinner dome to the outer circumference of the engine-side bulkhead unit. Installation of the propeller assembly is now complete.
(Pages 36 - 40 and 61 were removed in Revision 2. Pages 41 through 60 have also been removed, being replaced with the new composite blade section in the back of this manual.)
Record of Model A10460 Composite Blade Damage Repair

Blade Design

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Revision 2 May/92
21. Record of Inspections, Repairs and Adjustments

A. Record every inspection, repair and adjustment made on the propeller hub assembly and blade assemblies in accordance with airworthiness directives, service bulletins, service letters.

B. This service record must be kept current and must remain with the equipment at all times.

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Hartzell Propeller Products
Manual No. 154

Record of Inspections, Repairs and Adjustments

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22. Propeller Assembly Vital Statistics

Record every inspection, maintenance and repair operation in the Log Book section of this manual.

Hub Model

Blade Design

Diameter

Blade Serial Numbers:

Blade No. 1
Blade No. 2
Blade No. 3
Blade No. 4
Blade No. 5
Blade No. 6

Pitch Range:

High
Low
Feather
Reverse

Custody Record

Owner

Date Received

Page 69
This Section Refers to Composite Blades Only

Models:
- B7421K
- M10083K
- A10460(E)(K)
- LM10585ANK+4
- LM10585(A)B+4
- M10877K
- E10950K
- E11990K
- E12902K

Insert this section in Hartzell Propeller Inc. Manuals: 115, 139, 149, 154
# Table of Contents

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1. **Introduction**

   A. **General Description**

   1) The Hartzell composite blade is composed of a metal blade shank retention section into which is molded a low-density foam core that supports built-up layers of composite laminate (Figure 1).

   2) An erosion shield of electroformed nickel or stainless steel is incorporated into the fabrication to protect the blade leading edge from impact damage. Erosion shields are adhesively bonded to blades. The LM10585 blade was introduced with a stainless steel erosion shield. All other blades, as well as recent production LM10585, use a nickel erosion shield.

   3) Some designs incorporate a stainless steel wire mesh into the fabrication to inhibit erosion in blade tip areas.

   4) Some designs incorporate a metal foil mesh on the surface of the blade to limit lightning strike damage.

![Section of Typical Composite Blade](CPS-051)
5) Some designs incorporate a non-structural blade cuff of low-density foam which is molded to the blade and covered with composite material (Figure 2).

6) Filament windings of composite material provide blade retention of the blade material to the internal metal plug. The composite laminates which are an integral component of the blade also provide a retention load path directly under the clamp in steel hubs (or bearing in aluminum hubs) for blade retention.

7) Some designs use a filament winding on the inboard end of the erosion shield to aid the retention of the erosion shield. This winding is sometimes referred to as an erosion shield winding and should not be confused with the blade retention winding used to secure the blade material to the internal metal plug.
8) The composite blade is balanced in the horizontal plane during production by the addition of lead wool to a centrally located balance tube in the metal blade shank (which may protrude into the blade’s foam core).

9) A finish covering of polyurethane paint protects the entire blade from erosion as well as ultraviolet damage. Aircraft that require de-icing protection use an external de-icer boot except for the A10460E blade which was introduced with an internal heating element in lieu of boots. Standard de-icer boots for this model are an option.
B. Component Life and Service

1) Overhaul or Major Periodic Inspection (MPI)
   a) Overhaul, or MPI, is the periodic disassembly, inspection, repair, refinish and reassembly of the composite blade assembly.

      NOTE: The term "overhaul" is used throughout the text of this manual.

   b) At such specified periods, the propeller hub assembly and the blade assemblies are completely disassembled and inspected for cracks, wear, corrosion and other unusual or abnormal conditions. As specified, some blades are refinished, and other blades are replaced. The blades can then be reassembled and balanced.

   c) Overhaul is to be accomplished in accordance with the latest revision of Hartzell Manual No. 61-13-35 Composite Blade Manual and other applicable publications.

   d) Overhaul is to be accomplished only by a Hartzell Propeller Inc. approved repair station.
2) Damage

a) Airworthy Damage

Airworthy damage is damage that does not affect the safety or flight characteristics of the propeller blade. The maximum limits of airworthy damage are specified in this section. Although a blade may continue in service with airworthy damage, this type of damage should be repaired at the earliest practical time to prevent further damage to the blade.

b) Unairworthy Damage

Unairworthy damage is damage that exceeds the maximum limits of airworthy damage. Unairworthy damage can affect the safety or flight characteristics of the propeller blade. This type of damage must be repaired prior to the next flight. Exceptions to this policy may be possible but require written authorization from Hartzell.
3) **Repair**
   
a) **Minor Repair**
   
   Minor repair is correction of damage that may be safely performed in the field by a certified aircraft mechanic (preferably a mechanic who has completed Hartzell composite blade training).
   
b) **Major Repair**
   
   1. Major repair is correction of damage that cannot be performed by elementary operations.
   
   2. Major repair must be performed by a Hartzell Propeller Inc. approved repair station. Propeller shop must meet facility, tooling and personnel requirements and may require approval of samples. (Refer to Hartzell Manual No. 61-13-35 Composite Blade Manual). Exceptions to this policy may be possible but require written authorization from Hartzell.
   
4) **Blade Life**
   
   Blade life is expressed in terms of total hours of service (TT, or Total Time), time between overhauls (TBO) and in terms of service since overhaul (TSO, or Time Since Overhaul). All references are necessary in defining the life of the propeller.
C. Personnel Requirements

1) Hartzell Propeller Inc. regularly schedules factory training classes specifically related to composite blade and spinner. Participation is strongly recommended, and in some cases, required.

2) Factory training is mandatory for all personnel performing major repairs and/or overhaul. All persons who receive factory training will be provided with a certificate after completion of training, which must be made available for review at the facility. A copy of all certificates is kept on file at the factory.

3) Personnel approved for major repair/overhaul (certificate holders) must be listed as such in the agencies' repair station manual.

4) It is recommended for personnel performing minor repair to attend factory training.
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D. Definitions

A basic understanding of the following terms will assist maintenance personnel in maintaining and operating composite blades:

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Corrosion</td>
<td>gradual wearing away or deterioration due to chemical action.</td>
</tr>
<tr>
<td>Crack</td>
<td>irregularly shaped separation within a material, usually visible as a narrow opening at the surface.</td>
</tr>
<tr>
<td>Debond</td>
<td>separation of two materials that were originally bonded in a separate operation.</td>
</tr>
<tr>
<td>Delamination</td>
<td>internal separation of the layers of composite material.</td>
</tr>
<tr>
<td>Depression</td>
<td>surface area where the material has been compressed but not removed.</td>
</tr>
<tr>
<td>Distortion</td>
<td>alteration of the original shape or size of a component.</td>
</tr>
<tr>
<td>Erosion</td>
<td>gradual wearing away or deterioration due to action of the elements.</td>
</tr>
<tr>
<td>Exposure</td>
<td>leaving material open to action of the elements.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Gouge</td>
<td>surface area where material has been removed.</td>
</tr>
<tr>
<td>Horizontal Balance</td>
<td>balance between the tip and the butt of the blade.</td>
</tr>
<tr>
<td>Impact Damage</td>
<td>occurs when the blade strikes or is struck by an object, either in-flight or on the ground.</td>
</tr>
<tr>
<td>Nick</td>
<td>removal of paint and possibly a small amount of composite material not exceeding one layer.</td>
</tr>
<tr>
<td>Porosity</td>
<td>an aggregation of microvoids. See &quot;Voids.&quot;</td>
</tr>
<tr>
<td>Scratch</td>
<td>same as &quot;Nick.&quot;</td>
</tr>
<tr>
<td>Split</td>
<td>delamination of blade extending to blade surface, normally found near trailing edge or tip.</td>
</tr>
<tr>
<td>Vertical Balance</td>
<td>balance between the leading and trailing edges; cannot be changed on a composite blade.</td>
</tr>
<tr>
<td>Voids</td>
<td>air or gas that has been trapped and cured into a laminate.</td>
</tr>
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</table>
2. **Determination of Repair**

   A. This section is arranged such that damage and repair are treated separately. This gives the operators and repair facilities greater clarification and freedom in dealing with composite blade damage.

   1) This section defines airworthy and unairworthy damage and also, lists the allowables for each.

   2) The type of repair is not dictated by the type of damage received. For example, a blade with airworthy damage may require a major repair.

   B. Upon inspection of a composite propeller blade, an operator should first determine the type of damage: airworthy or unairworthy. (Limits are in this section.) Figure 3 illustrates the determination of repair.

   1) If the damage is determined to be airworthy, the aircraft may continue in service. However, the operator should make arrangements to have repairs performed as soon as practical.

   2) If the damage is determined to be unairworthy, the propeller blade cannot be used until a repair is performed. Exceptions to this policy may be possible but require written authorization from Hartzell.
C. Next, the operator should determine if the repair falls into the category of minor or major. Limits for each repair are called out in the repair procedure.

1) If the repair is minor, a qualified mechanic (see qualifications in this section) may repair the damage.

2) If the repair is major, the operator should make arrangements to have the damage repaired at an approved facility.

D. Due to the infinite types of damage possible, not all types of damage that can be considered airworthy are covered in this manual. If there is any doubt as to airworthiness of the blade, contact the Hartzell.

**Determination of Repair Flow Chart**

Figure 3
3. **Inspection Requirements**

A. **Required Record-Keeping**

   Composite blade damage and a description of its repair must be recorded in the propeller log book. **Maintaining a good log book record is particularly important for composite propeller blades. Damage and/or repairs may suffer further degradation after continued use. Such degradation may be easily overlooked. Therefore it is important for inspectors to have access to accurate historical data when performing subsequent inspections.**

B. **Preflight Inspection**

   1) Follow propeller preflight inspection procedures as specified in the aircraft maintenance manual, or an air carrier’s operational specifications, or this manual. In addition, perform the following inspections:

   a) Visually inspect entire blade for nicks, gouges, looseness of material, erosion, cracks and debonds.

   b) Visually inspect blades for lightning strike. Refer to “Lightning Strike Damage” in this section for description of damage.

   2) Defects or damage discovered during preflight inspection must be evaluated in accordance with allowables outlined in this section to determine whether repairs are required prior to further flight.
4. **Coin-Tap Test (Figure 4)**

A. Composite blades can be inspected for delaminations and debonds by tapping the blade, or cuff (if applicable), with a "metal washer."

B. Use a washer-shaped metal tapper, approximately 2.5 inches O.D. x 1.25 inches I.D. x 0.25 inch thick, and weighing no less than 3 oz. Tap the surface. If an audible change is apparent, sounding hollow or dead, a debond or delamination is likely.

**NOTE:** Blades which incorporate a "cuff" will have a different tone when coin-tapped in the cuff area. To avoid confusing sounds, the cuff area and the transition area between cuff and blade should be coin-tapped separately from the blade area.

Using "Coin-Tap" Test to Check for Debond and Delamination

**Figure 4**
C. “Mapping” of the area to be coin-tapped is desirable to assure that the entire surface is adequately inspected. Coin-tap within an imaginary grid or matrix consisting of 2 inch squares during scheduled aircraft inspections. During blade overhaul, a more thorough inspection is required by using a smaller grid, a coin-tap within 0.5 inch squares.

1) The metal erosion shield is more likely to have problems than the blade, therefore a more thorough coin-tapping of the erosion shield is desirable. Also, slight deformations in the erosion shield may be noticed by careful visual and manual (touch) inspection. Such deformations may be the result of a debond and should be given a careful coin-tap inspection.

2) If a suspected delamination or debond is discovered, a localized, thorough coin-tap inspection is required to define precise area of delamination or debond.

**NOTE:** To provide a rough guideline, routine composite blade coin-tap inspections “on-aircraft” typically require about 0.2 man-hour per blade. Coin-tap inspections during overhaul typically require about 0.5 man-hour per blade.

D. Outline the suspect area with a grease pencil to determine approximate size of damage. Record damage/repairs in the propeller log book.
5. **Airworthy Damage**

A. Airworthy damage does not exceed the following limits. This type of damage will not affect the safety or flight characteristics of the propeller.

B. Areas of airworthy damage should be monitored and repaired as soon as practical.

C. **Airworthy Damage Limits**

1) **Nickel Erosion Shield (All blade models)**

   NOTE: The following damages, a) through h), cannot be resolved without replacement of the erosion shield, but within these limits, do not render the blade unairworthy.

   a) Any gouge that does not penetrate through to the surface of composite material.

   b) Any full width chordwise crack as long as the erosion shield is not debonded within 3.5 inches (8.89 cm) of the crack (Figure 5).

![Missing Portions of Nickel Erosion Shield (Trail Side) and Typical Cracks](image)
c) No two full width chordwise cracks may occur within 6 inches (15.24 cm) of each other.

d) Chordwise cracks less than 0.5 inch (12.7 mm) that are not debonded within 1 inch (2.54 cm).

e) Portions of the trail side of the erosion shield may be missing due to erosion or removal due to sanding (Figure 5).

f) Lengthwise cracks less than 2 inches (5.08 cm) that are not debonded within 3.5 inches (8.89 cm) of the crack.

g) For blades with attached counterweight clamps, cracks within 1 inch (2.54 cm) of counterweight clamp that are not debonded.

h) Minor deformations due to impact damage that does not greatly affect the airfoil shape.
NOTE: The following damages, i) through k), do not render the blade unairworthy but should be repaired as soon as practical to prevent degradation of the condition.

i) Debonds located along the trailing side of the erosion shield that total less than 10.5 inches (26.67 cm) in length. No individual debond may exceed 3.5 inches (8.89 cm) in length and 0.25 inches (6.35 mm) in width (Figure 6).

j) Debond which is located at least 0.25 inches (6.35 mm) from the erosion shield trail side and has total area less than 2.5 square inches (6.35 sq cm) and is separated by at least 6 inches (15.24 cm) from any other debond area on the same blade surface.

k) The total debonded area of all debonds may not exceed 10 square inches (25.4 sq cm).

Debonds which exist on the trailing edge of the erosion shield have this additional criteria:

- Maximum Length: 3.50 inches
- Minimum Length: 0.25 inch

Limits of Airworthy Damage in Erosion Shield Debond

Figure 6
2) **Stainless Steel Erosion Shield (Model: LM10585AK+4)**

**NOTE:** Debond area requirements apply only to portions of the erosion shield not fastened with screws or rivets. If screw and rivet holes have lengthwise cracks extending from them, debond repair is no longer considered effective.

**NOTE:** The following damages, a) through c), cannot be resolved without replacement of the erosion shield, but within these limits, do not render the blade unairworthy.

a) No single screw or rivet hole with a chordwise crack extending from it may have any lengthwise cracks also extending from it.

b) No two chordwise cracks may occur within 6 inches (15.24 cm) of each other.

c) Minor deformations due to impact damage that do not greatly affect the airfoil shape.
NOTE: The following damages, d) through h), do not render the blade unairworthy but should be repaired as soon as practical to prevent degradation of the condition.

d) Crack or gouge in the erosion shield which is less than 0.125 inch (3.175 mm) deep and less than 0.25 inch (6.35 mm) square, not to exceed 0.5 inch (12.7 mm) length.

e) Debond located along the trailing side of the erosion shield which is no longer than 3.5 inches (8.89 cm) and no wider than 0.25 inch (6.35 mm) (Figure 6).

f) Debond which is located at least 0.25 inch (6.35 mm) from the erosion shield trail side and has total area less than 2.5 square inches (6.35 sq cm), and is separated by at least 6 inches (15.24 cm) from any other debond area on the same blade surface (Figure 6).

g) The total debonded area of all debonds may not exceed 10 square inches (25.4 sq cm).

h) Cadmium screw corrosion.
3) **Blade Cuff (Model: LM10585( )() +4)**
   
   a) Nicks, scratches.
   
   b) Depressions less than 1 square inch (2.54 sq cm) area and less than 0.25 inch (6.35 mm) deep.
   
   c) Delaminations less than 2 square inches (5.08 sq cm).
   
   d) Cracks at the root end are airworthy, but should be sealed to protect the foam from contamination until time of overhaul where these cracks can be permanently repaired.
   
   e) Cracks located in the area where the cuff and blade meet must be within the limits as shown in Figure 7.
f) No more than two other cracks may be located elsewhere on the cuff. These cracks must be less than 3 inches (7.62 cm) in length.

g) No more than two damaged areas per side are permitted within 6 linear inches (15.24 cm) of each other. Root end cracks and cracks where the blade and cuff meet are not included in this requirement.

h) Cuffs with no boot or erosion shield covering the leading edge may have no cracks within 2 inches (5.08 cm) of leading edge.

i) Cracks parallel to the leading edge totaling less than 6 inches (15.24 cm) in length and not extending beyond the inboard edge of the de-icer boot are airworthy but should be repaired during overhaul.

   a) Gouges or loss of material less than 0.500 inch (12.7 mm) diameter or equivalent area (0.2 in²) and no more than 2.5 inches (6.35 cm) long and less than 0.020 inch (0.508 mm) deep anywhere on the outboard half of the blade.

   b) Delamination on outboard half of the blade totaling less than 2 square inches (5.08 sq cm) with no dark brown or black stain (indicating presence of grease).

   c) Gouges, loss of material, or delaminations on the inboard half of the blade can be unairworthy and the factory should be consulted.

   d) **Paint Erosion**

      Exposure of less than 5 square inches (12.7 sq cm) of the composite material and/or the primer filler. This allowable does not refer to primer sealer.
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e) "Crushed" Blade Trailing Edge (Figure 8)

Crushed area no larger than 0.25 inch (6.35 mm) deep x 1 inch (2.54 cm) long, on the outer half of the blade with no broken strands of composite material (i.e. epoxy crushed only).

f) Split Trailing Edge

Area less than 0.25 inch (6.35 mm) deep x 1 inch (2.54 cm) long on the outer half of the blade.
5) **Erosion Screen (Models: M10083K and E10950K)**

a) The limits of erosion screen damage which would require replacement at overhaul are given in Hartzell Manual No. 61-13-35. Prior to overhaul, these limits may be exceeded, with the blades still considered airworthy.

b) Operator should use best judgement as to whether screen should be replaced before overhaul. If damage is too severe, risk of rendering the blade unairworthy is possible.

**NOTE:** Airworthy damage to erosion screens should be repaired using limits and procedures for blade gouge minor repair.

6) **Blade Retention Windings (Models: M10083K, LM10585, M10877K)**

Cracks appearing in the paint over the blade retention windings are airworthy. These cracks should be repaired as soon as practical.
6. **Unairworthy Damage**

**CAUTION:** UNAIRWORTHY DAMAGE TO A HARTZELL COMPOSITE BLADE MUST BE REPAIRED BEFORE THE NEXT FLIGHT.

A. Any damage which exceeds that of airworthy is considered unairworthy.

B. Areas of unairworthy damage must be repaired prior to further flight.

C. Exceptions to this policy may be possible but require written authorization from Hartzell.
7. **Lightning Strike Damage (Figure 9)**

   A. The following text addresses the composite blade only. Refer to S.L. 61( ) and the applicable Propeller Maintenance Manual for complete overhaul procedures of the propeller assembly.

   **CAUTION:** ANY KEVLAR® COMPOSITE BLADE SUSPECTED OF LIGHTNING STRIKE MUST BE INSPECTED AND MAY REQUIRE OVERHAUL.

   B. **Kevlar® Blade**

   1) Lightning strikes usually enter a Kevlar® composite blade through the metal erosion shield. If the blade has stainless steel erosion screen, the lightning strike may enter the screen instead of the erosion shield.

   ![Evidence of Lightning Strike Damage to Composite Blade](APS-334)

   Evidence of Lightning Strike Damage to Composite Blade  
   Figure 9
2) If lightning strike is present, a darkened area and possible pitting, usually in the proximity of the tip, will be noticeable.

3) If a lightning strike is suspected or detected, perform a "coin-tap" test prior to further flight. This will detect debond and/or delamination. Then determine extent of damage and whether damage is airworthy or unairworthy.

   **NOTE:** Pay particular attention to erosion shield debonds upon inspection.

4) If only a darkened area is present on the erosion shield, and all blade damage is within limits specified, the damage is considered airworthy.
8. **Minor Repair**


B. It is *extremely important* that only those repair techniques, tools and materials described in Hartzell Manual No. 61-13-35 be used. Substitution of materials described in Manual No. 61-13-35 is not permitted (i.e. use of one part spray can lacquers and enamels is not permitted for refinishing blades between overhauls. Also, the use of “Quick Setting” epoxies, unless described in Manual No. 61-13-35, is not permitted when performing blade repairs).