

Advanced Composite Tail Rotor

For the Bell-47 Helicopters and Its derivatives Equipped with
Bell 47-641-170 hub, and Bell 47-640-075 gear box.

Installation and Maintenance Manual

(Formerly “Owner’s Manual”)

Part Number HAC-47-3

Installation Eligibility:

**Bell 47, Bell 47B, Bell 47B3, Bell 47D, Bell 47D1, Bell 47E,
Bell 47G, Bell 47G2, Bell 47H-1, Bell 47J, Bell 47-J2, Bell 47J-2A,
Bell 47G-2A, Bell 47G-2A-1, Bell 47G-3, Bell 47G-3B, Bell 47G-3B-1,
Bell 47G-4, Bell 47 G-4A, Bell 475-5, Bell 47G-3B2, Bell 47G-5A, Bell 47G-3B-2A**



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HAC
1124 Ainsworth St. Pasco, WA
99301

Phone: (509) 545-3137, Fax: (509) 545-3862
www.hac-composites.com

RECORD OF REVISIONS

| <i>Revision</i> | <i>Date</i> | <i>Page(s)</i> | <i>Reason for Revision</i> |
|-----------------|-------------|-----------------|---|
| 1 | 05/05/2000 | All | <ol style="list-style-type: none"> 1. Update to reflect 70,000 hours of fleet experience. 2. Change format. |
| 2 | 12-20-2005 | All 21 pages | <ol style="list-style-type: none"> 1. Title change. 2. Update to reflect the re-issuance of the STC 3. Update to incorporate the requirements of the newly issued "H.A.C. Fabrication inspection System Manual" Rev.-0 4. Update to reflect the use of the Nickel abrasion strip 5. Incorporate new maintenance and inspection procedures. |
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Section 1

General Information

Introduction

The HAC-47-3 advanced composite tail rotor blades are approved for use on all Bell-47 model aircraft and its derivatives equipped with the Bell 47-641-170 hub and the associated Bell 47-640-075 gear box under STC SR 09066 RC and PMA PQ213M.

The use of a different airfoil and increased chord length reduces the tail rotor diameter, increases the ground clearance, and reduces the tail rotor noise while maintaining full control authority and eliminates the neutral pedal “dead zone” near the center or neutral pedal position that is normal to the OM blades.

Specifications and Limitations

The HAC-47-3 tail rotor blade has a mandatory retirement time of 4000 flight hours.

The aerodynamic design offers a noise reduction of 3.75 db. to 4.00 db.

The abrasion strip and bushings are replaceable by any qualified and HAC trained person using HAC tooling and procedures. These items may wear out before the 4000 flight hours depending on the environment in which the blade is being used.

The blades may be equipped with nickel or on older blades stainless steel abrasion strips over a urethane ‘impact cushion’.

! WARNING !
DELIBERATE EXPOSURE OF THE HAC-47-3 BLADES TO FUELS,
OILS, SOLVENTS, STEAM OR HOT WATER CLEANERS
SHOULD BE AVOIDED!

NOTE:

Blade Log must be kept with the Aircraft Maintenance log and /or Maintenance Records. **With Out either the Blade Log or the metal FAA-PMA tag, the blade is not airworthy and must be removed from service.**

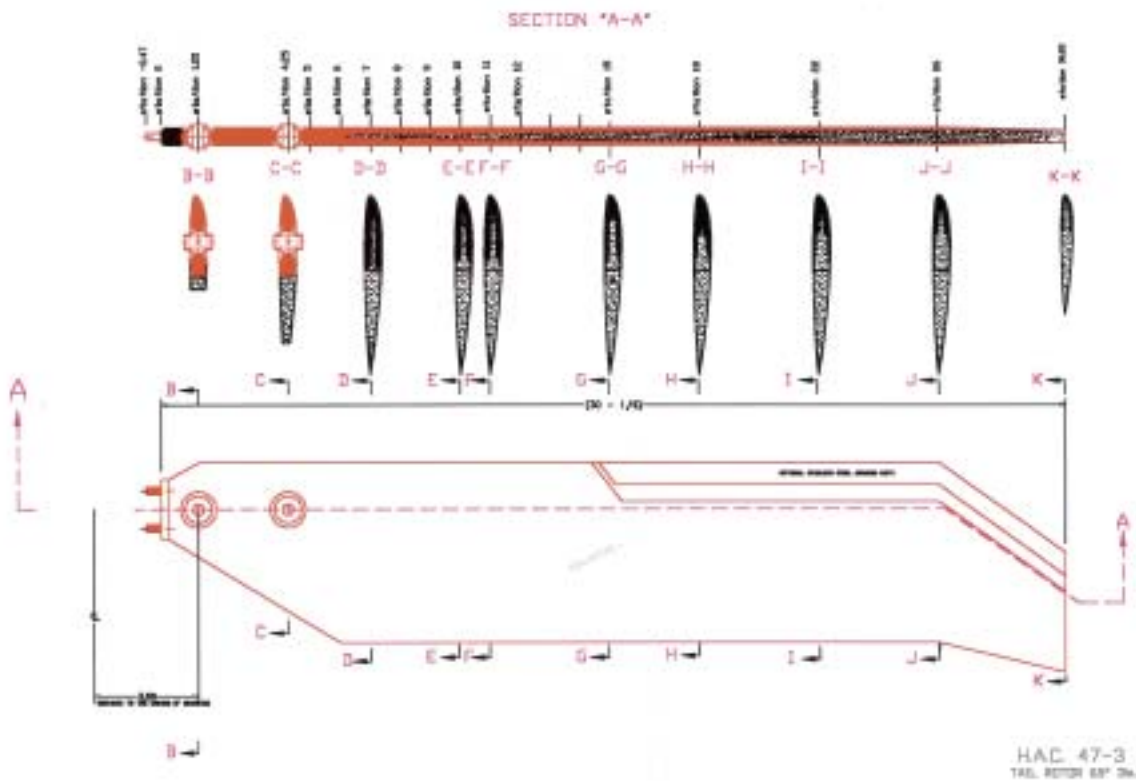
Design Description

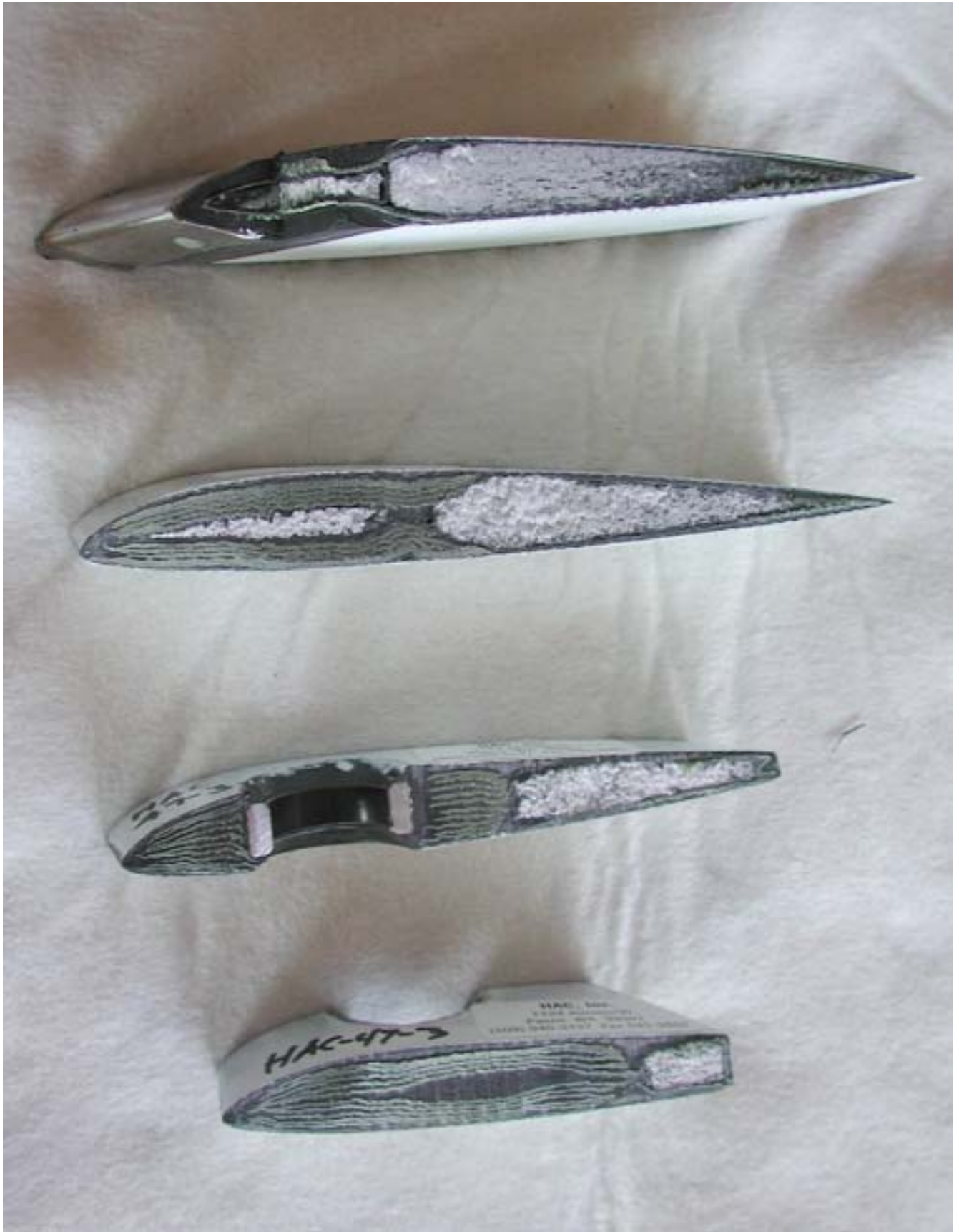
The HAC-47-3 tail rotor blade is designed around a mix of aramid, carbon, and glass fibers that are bound by an epoxy matrix.

The design incorporates both a stainless steel mesh embedded in the surface coat to provide lightning protection, and a foam core sacrificial tooling.

As shown in the drawing below, the internal structure tapers toward the tip of the blade.

The primary structure is located in the first 35% chord of the airfoil and is under the lightning protection screen and is not repairable.





In these cross-sections the variation of the primary structure is clearly visible as are the carbon And aramid, (Kevlar), layers.

Section 2

Installation instructions

General

The installation of the HAC-47-3 tail rotor blades is identical to those of the Bell 047-642-117-105 tail rotor blades which it replaces and because of the STC and PMA requires only a log book entry.

During pitch-horn ring installation care must be taken not to over-torque the pitch-horn ring Retention nuts. Torque-wrench of no greater capacity than 250 lb-in – 28.5 N*M should be used and the nuts should be torqued to only 36 Lb-in, (3.00 lb-ft = 4N*M). Larger torque-wrenches are not accurate enough at this low setting and may cause ‘over-torqueing’ the nuts shearing the ‘anti rotation pins’ and pulling out the studs. After torqueing safety wire nuts.

Pitch-horn assembly and Hub

Pitch-horn ring assembly, Bell part number 047-641-187-007 shown below (left).

Hub assembly, Bell part number 047-641-170, shown below (right).

Pitch-horn retention stud assembly showing the “anti rotation pins” shown in center.



Rotor Blade

Tail rotor blade, HAC part number HAC-47-3, shown below.

The leading edge abrasion strip may be replaced by any qualified and HAC Inc trained person using HAC supplied materials, tooling, and procedures.

The two bushings may be replaced by any qualified and HAC Inc trained person using HAC supplied materials, tooling, and procedures.

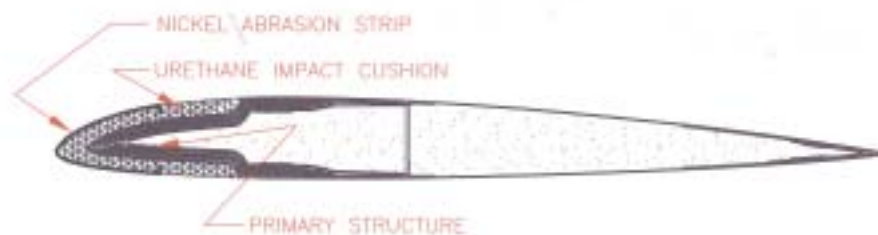


The blade is equipped with two replaceable HAC-SSWF ball bushings. Drawing Number: HAC-075-0003.

These bushings provide +/- 23° of maximum pitch movement.



The HAC-47-3 Blade with the Nickel abrasion strip.

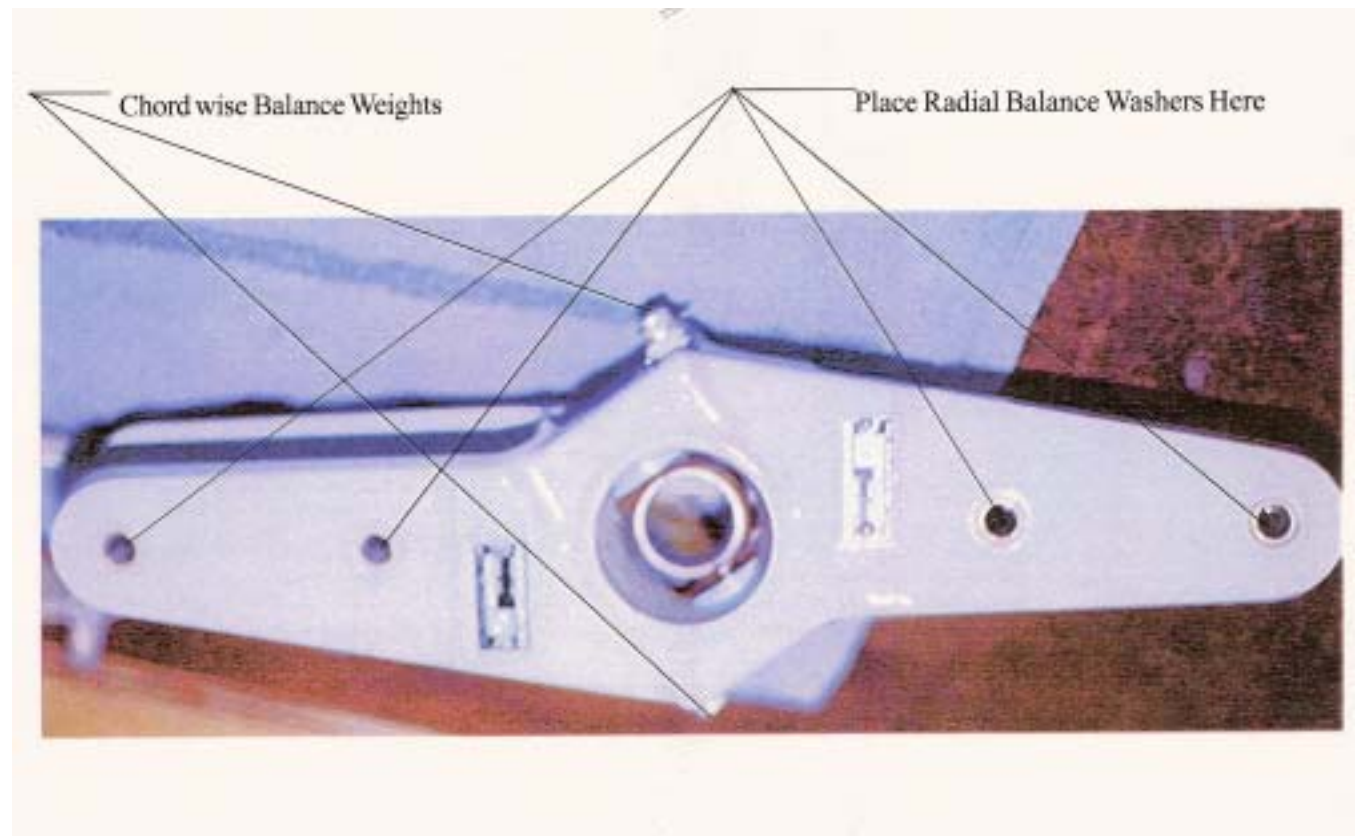


BALANCING

General

The pitch-horn ring, blade, and hub assembly should be statically pre-balanced. Either of the two standard Bell static balancing fixtures may be used. Attach balance weights, (washers), on the blade mounting bolts for radial balance and attach weights to the hub for chord wise balance as shown in picture below.

After installation final balancing should be accomplished using a 'Chadwick' or similar dynamic balancing system.



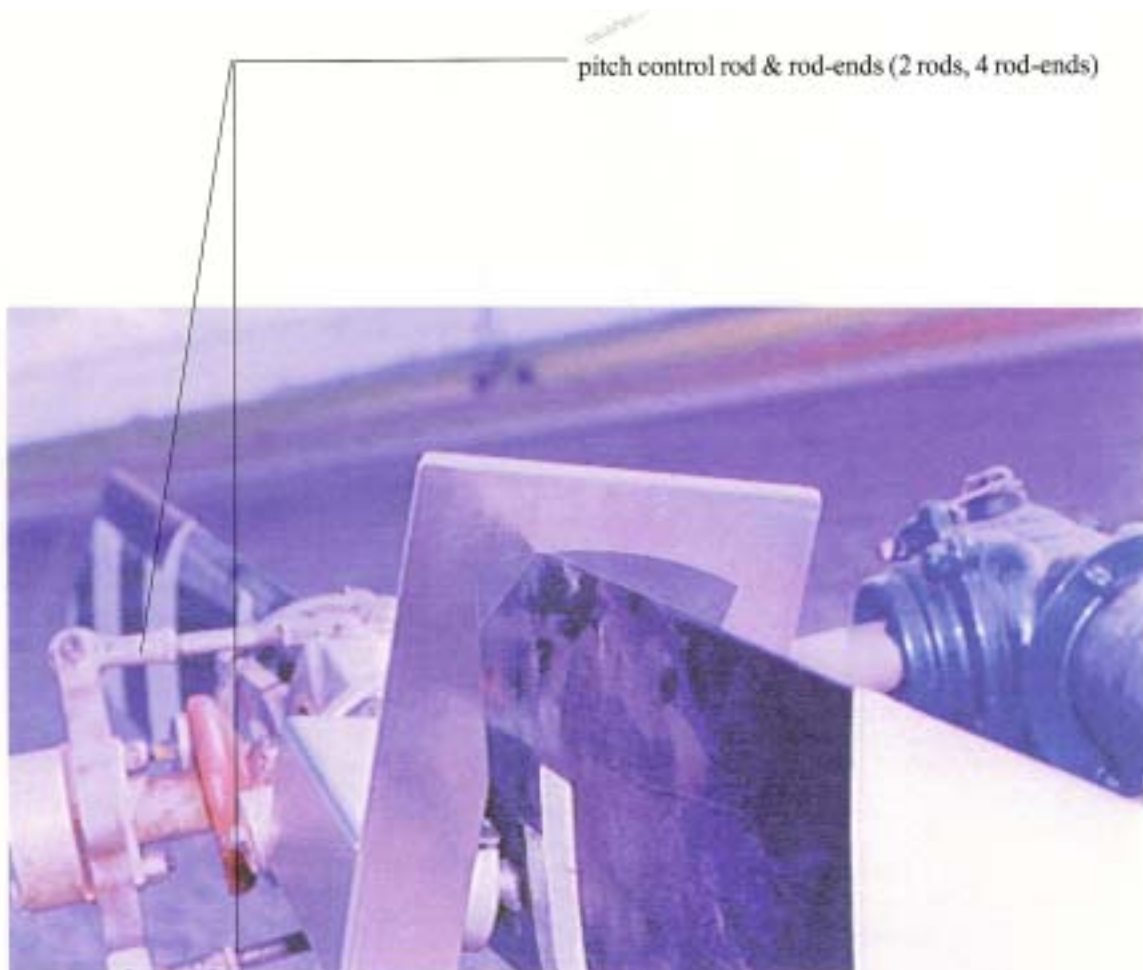
!WARNING!

**OUT OF BALANCE CONDITION, HOWEVER SMALL,
WILL DESTROY THE BLADE!**

Rigging

Tail rotor rigging for the HAC-3-47 blade is as follows: Turn the pitch control rod and rod-ends (see picture below) out until you see through the safety hole, then turn in one to two turns. This should give you 12 ½ to 15 degrees of travel in both directions. If you cannot achieve this travel see SECTION 4, Trouble Shooting.

! WARNING !
**DO NOT OVER TORQUE! DO NOT USE TORQUE WRENCH
LARGER THAN 250 lb-in CAPACITY**



Final Installation Check

Before Returning the Aircraft to Service

Recheck pitch horn attach nuts safety wires

Recheck pedal movement to ensure that pedals move freely

Section 3

Maintenance and Inspections

Paper Work

The HAC-47-3 composite tail rotor is a time limited, flight critical component and as such it is necessary to track its service history. This is accomplished by the use of a 'Log Sheet' supplied with the blade by the factory at the time of initial purchase.

Without its log sheet the blade is NOT AIRWORTHY. After surrendering a filled up, damaged but legible log sheet the factory may issue a replacement log sheet keeping the replaced log sheet on file at the factory in the blade's Fabrication Log.

Blades with the metal FAA-PMA tags removed are NOT AIRWORTHY.

The properly documented HAC-47-3 blades are direct replacement of the Bell 047-642-117-105 late model tail rotor blades and require only a simple logbook entry at installation. No field approval is required.

Upon removal, installation on another aircraft, or shipping, the log sheet has to be properly filled out and must accompany the blade in the shipment.

Log sheets must be signed off by a qualified mechanic or a Repair Station Inspector. A sample log sheet is shown in front of this manual.

Routine Maintenance

Wash blades with soap and water (warm or cold). Blades may be further cleaned using denatured alcohol soaked rag. Do not use other solvents or fuels. Clean tail rotor blades after each day's service.

Clean denatured alcohol soaked cloth may be used to remove grease and other sticky substances. However do not soak the urethane impact cushion with alcohol!

Bushings are self-lubricating, using a TEFLON type material. Lubrication 'swells' the liner and causes premature bushing wear out.

Preflight Inspection

Preflight inspection of the blades should be performed before the first flight of the day and is an FAA requirement. It should include the following:

1. (Blades with stainless steel abrasion strip) Visually inspect the stainless steel abrasion strip and mounting rivets for damage.
2. (Blades with nickel abrasion strip) Visually inspect nickel abrasion strip for damage. **Note the ‘Maintenance Inspection’ section of this document.**
3. Check for pitch bushing wear by immobilizing the hub with one hand and trying to move the blade tip perpendicular to the blade surface. (side to side). If there is movement but no pilot reported “Pedal Buzz” the blades are serviceable but are approaching replacement time. No pedal buzz is permissible.
4. Check blade for cracks between the outboard bushing, (ST-4.25), and the leading edge. None is permitted.
5. Check pitch horn ring mounting by trying to move it relative to the blade. No movement is permitted.

! WARNING !

DO NOT FLY WITH DAMAGED BLADES!

**IF EXPERIENCING INFLIGHT HIGH SPEED VIBRATION, ‘PEDAL BUZZ’
LAND IMMEDIATELY!**

Periodic Scheduled Maintenance Inspection

General

Periodic scheduled maintenance inspection may be part of a progressive maintenance plan such as a 100 hour inspection program or an annual inspection and should be performed by an properly certified mechanic under the. The inspection and the results of the inspection should be entered in the aircraft’s log book.

For these inspections, the blades should be removed from the hub but pitch horn rings do not have to be removed.

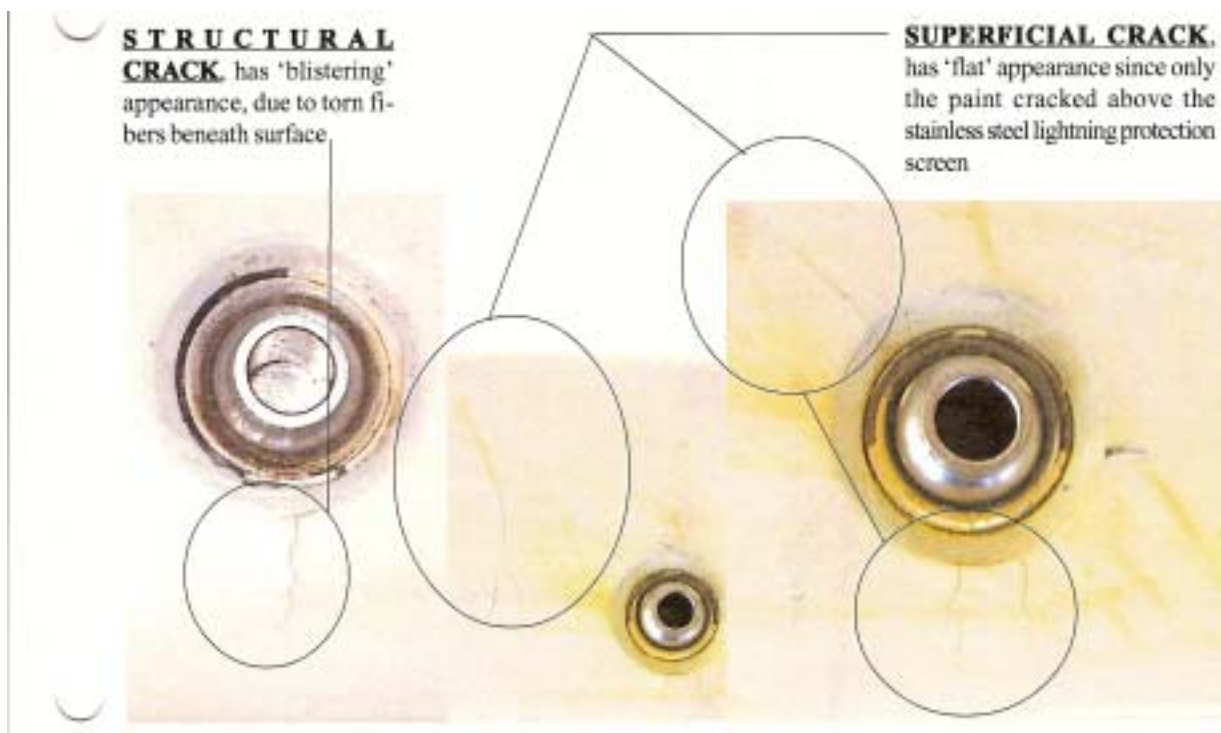
Clean blades thoroughly, with soap and water. Remove grease and oil residue from the bushings and the root end of the blade with denatured alcohol soaked rag.

Note: All repairs may be conducted by any qualified and properly certificated mechanic who: Was trained by HAC, using HAC supplied parts, tooling and procedures.

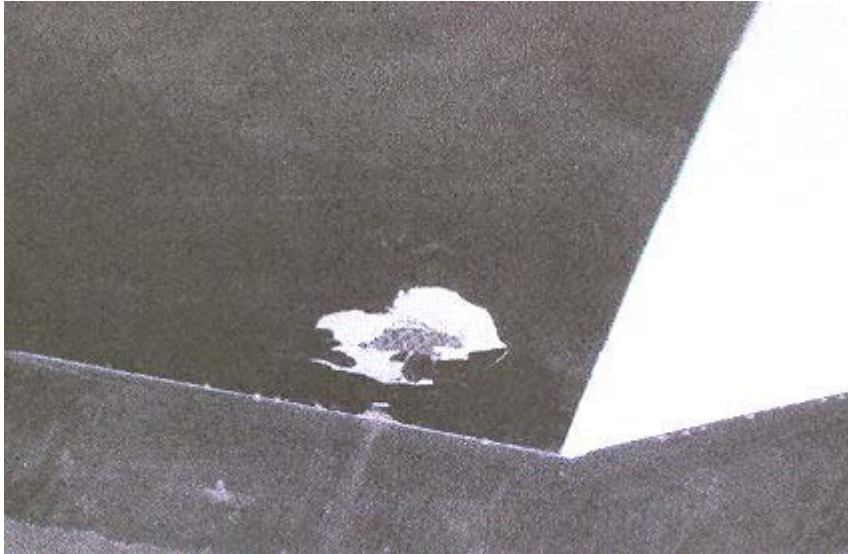
Painting is optional. The blades may be painted by any qualified and properly certificated mechanic.

Maintenance Inspection

1. Thoroughly inspect the blade visually for damage.
 - a. Visually inspect around each bushing cavity for cracks on both surfaces. (see photo)
No structural cracks permitted. If there is a structural crack, the blade is NOT AIRWORTHY.
 - b. Inspect the rest of the blade for cracks. Superficial cracks, cracks that are in the brittle paint only, may be touched up. (see photo)
2. Inspect pitch horn ring attachment. It should be solid. No play is permitted!
 - a. If there is play, remove the safety wire from the attach nuts and try to re-torque the nuts to 36 lb-in – 4 N*M, (3 lb-ft). If either of the nuts can not be re-torqued, the blade is NOT AIRWORTHY but may be repairable .
3. Inspect bushing for wear and retention:
 - a. Visually inspect torque-lock paint to ensure that the bushing has not moved. No movement is permitted. If there is indication of bushing side to side movement, the blade is NOT AIRWORTHY.
 - b. Place bushings into a 'soft jaw' vice and secure bushing end flanges, (ball). Check for bushing wear by trying to move blade side to side. No movement over 0.005" is permitted, if there is indication of greater movement , the blade is NOT AIRWORTHY.
4. Inspect abrasion strip and abrasion strip for damage and security of mounting:
 - a. (For blades with stainless steel abrasion strip) Visually inspect the stainless steel abrasion strip and mounting rivets for damage.
 - b. (For blades with nickel abrasion strip) Visually inspect nickel abrasion strip for damage.



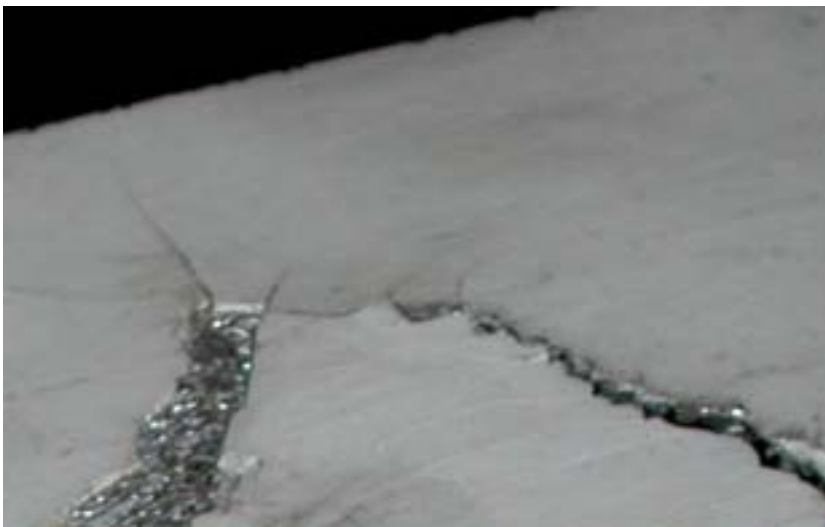
Note the structural crack is 'raised' and has a swelling appearance due to the torn fibers that are pulled out of place causing the swelled appearance while the superficial surface crack is flat and peel able.



This superficial damage is down to the 'lightning protection' screen and is easily repairable.



Another view of a superficial crack.



This is a picture of a major structural damage.



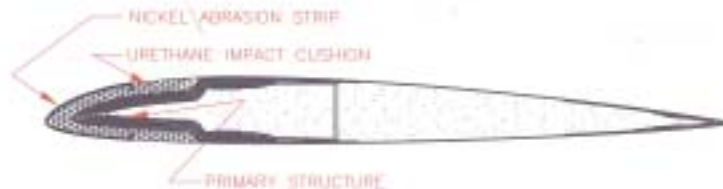
Swelling is clearly apparent in this picture of 'structural' damage

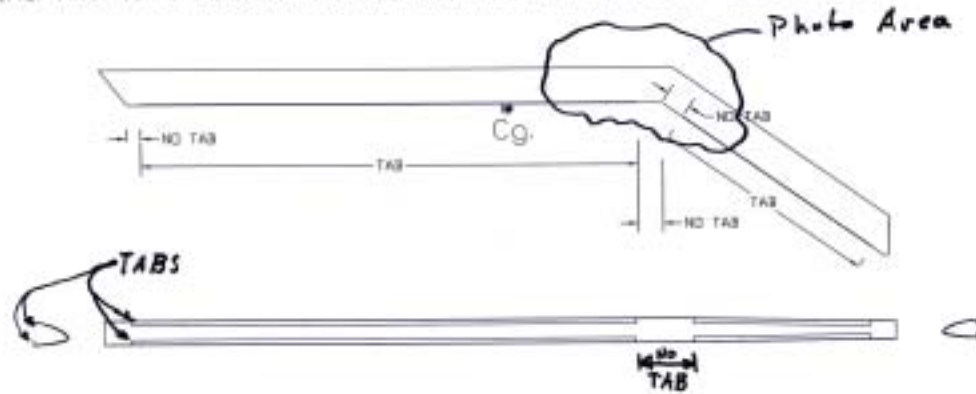
The Nickel Abrasion Strip

Since August of 1998 the HAC-47-3 blades came equipped with an electroformed nickel abrasion strip rather than the stainless steel that was previously used. The electro formed nickel abrasion strip offers several advantages:

1. It has a 'tailored' cross-section that is 0.010" thickness at the leading edge that tapers to 0.005" at the trailing edge.
2. It eliminates the weld at the sweepback a very difficult procedure with high failure potential.
3. It offers a perfect airfoil in a complex shape. (The sweepback)

HAC solved this by a unique design in which there is a mechanical tab along most of the abrasion strip which mechanically fastens the abrasion strip. This tab also limits the relative movement between the urethane cushion and the nickel strip during impact and thus prevents shear of the glue during impact. Subsequently the nickel strip is held both by adhesion as well as mechanically.





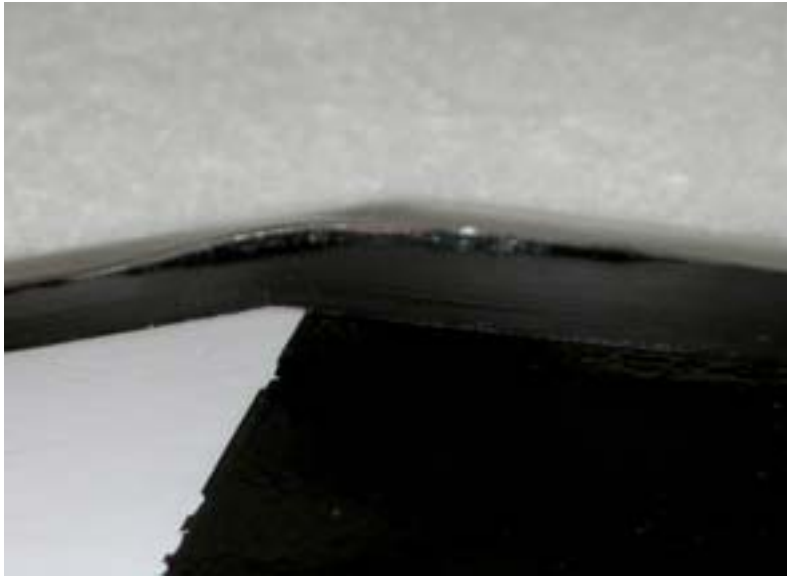
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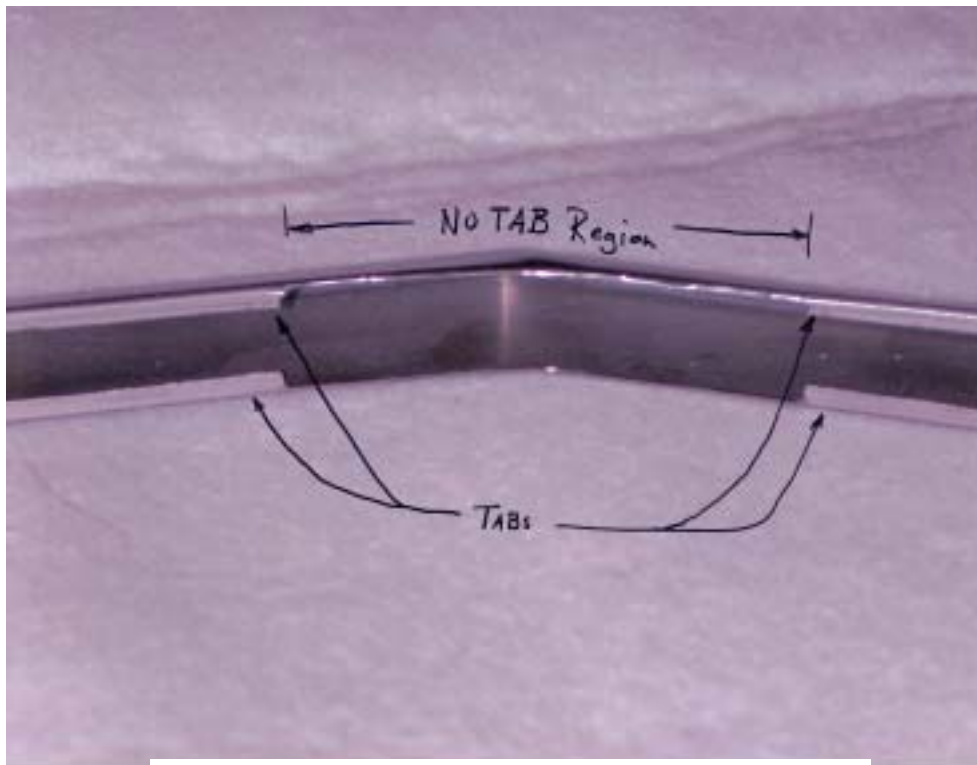
To install the abrasion strip both the blade and the abrasion strip are primed and inserted into a mold. Unfortunately the nickel strip cannot be held accurately as the stainless steel, which was held on pins, which fit into the rivet holes, the nickel can “float” 0.005” to 0.010” when the mold is closed. The urethane impact cushion is then injected and “green” cured before the cuffed blade is removed from the mold. Unfortunately the urethane does not form a glue line until it is fully cured, (14 days), but then clean up and the ‘flash’ removal of the blade would be extremely difficult if not impossible.

If the abrasion strip moved during the mold closure then due to the built up stress at the sweepback area is relieved breaking the glue line in the area 4 to 5 days after the beginning of the curing cycle. Where there is a vertical tab holding the nickel strip in place during curing the glue line is fully intact and functional.

This separation does not diminish the integrity of the abrasion strip attachment nor does it appreciably affect the blade's aerodynamic performance but it is an ecstastic anomaly as can be seen in these picture below.



'Worst case' separation can be seen enlarged in this photo.



The affected area is clearly the 'tab' less area.

Section 4

TROUBLE SHOOTING

Control Authority Problem

After flight pilot complains of 'running out of pedal':

1. Check and make sure you get a minimum of $\pm 11^\circ$ total pitch change.
2. Check and make sure you get a minimum of $11 \frac{1}{2}^\circ$ travel in each direction; 12° is preferred against the engine torque.
3. Be aware that the Bell pitch change mechanism design will give you the 23° pitch change regardless of how it is reassembled but the center, or neutral point will move if the shaft assembly is moved one cog in either direction. Most of these assemblies have been rebuilt many times and may be off one side or the other. The original blade is not as sensitive to a 'one cog' offset due to a $\pm 2^\circ$ 'dead zone' where the thrust remains '0'. You may have to reset this assembly.

Balancing Difficulty

The HAC-47-3 are to be balanced by the same procedures as the original Bell blade. If you have difficulty achieving balance on the 'static' test fixture you should contact the factory, (509) 545-3137.

If you have difficulty achieving 'dynamic' balance, check the 'pitch linkages' for identical length. During installation adjustment they may have been misadjusted causing a pitch difference between the blades.

In Flight Vibrations

In flight vibrations are very dangerous and destructive. They are normally caused By one of six conditions:

1. Out of balance.
 2. Icing.
 3. Worn-out bushing.
 4. Loose Bushing. (Bushings shift side to side)
 5. Loose pitch horn ring.
 6. Misadjusted pitch linkage. (i.e. different angle of attack between blades)
- You should immediately land, check for and eliminate the above conditions.

! WARNING !

**FLYING WITH TAIL ROTOR INDUCED VIBRATIONS IS EXTREMELY DANGEROUS
AND
SHOULD BE AVOIDED AT ALL COST!**

Section 5

SHIPPING

Required Paper Work

The HAC-47-3 tail rotor blades must be accompanied by properly filled out and signed off log sheets.

Suggested Packaging

Ship the HAC-47-3 tail rotor blades in its original shipping box.

Do not over pack the box; the box should have sufficient packing to prevent movement of blade(s) but the box shouldn't be bulging. Protect bushing area by placing a small piece of cardboard between the two blades bushings and protect the tip's trailing edge by folding a small piece of cardboard around the trailing edge of each blade.

FOR QUESTIONS OR SERVICE CONTACT HAC

Telephone: (509) 545-3137, Fax: (509) 545-3862

1124 Ainsworth St.

Pasco, WA 99301

www.hac-composites.com

Info@hac-composites.com