



INSTRUCTION MANUAL OF THE PROPELLER
DUC FC WINDSPOON



Chemin de la Madone - 69210 LENTILLY - FRANCE
Phone: + 33 (0) 4 74 72 12 69 - Fax: +33 (0) 4 74 72 10 01
E-mail: contact@duc-helices.com - www.duc-helices.com



ISO 9001:2008
Certified Company



DUC FC WINDSPOON

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1. Purpose

The purpose of this document is to provide all necessary information relating to the use of the DUC FC WINDPSOON propeller.

2. Propeller description

2.1. Characteristics



This DUC FC propeller is available in:

- Two-blade
- Three-blade

Depending on its application, its structure can be reinforced (-R).

Diameter:

- Ø1727 mm

Weight:

- Standard Two-blade: 2.380 kg
- Standard Three-blade: 3.115 kg

2.2. Advantages

The DUC FC propeller, with its revolutionary shape called WINDSPOON, offers unrivalled performance.

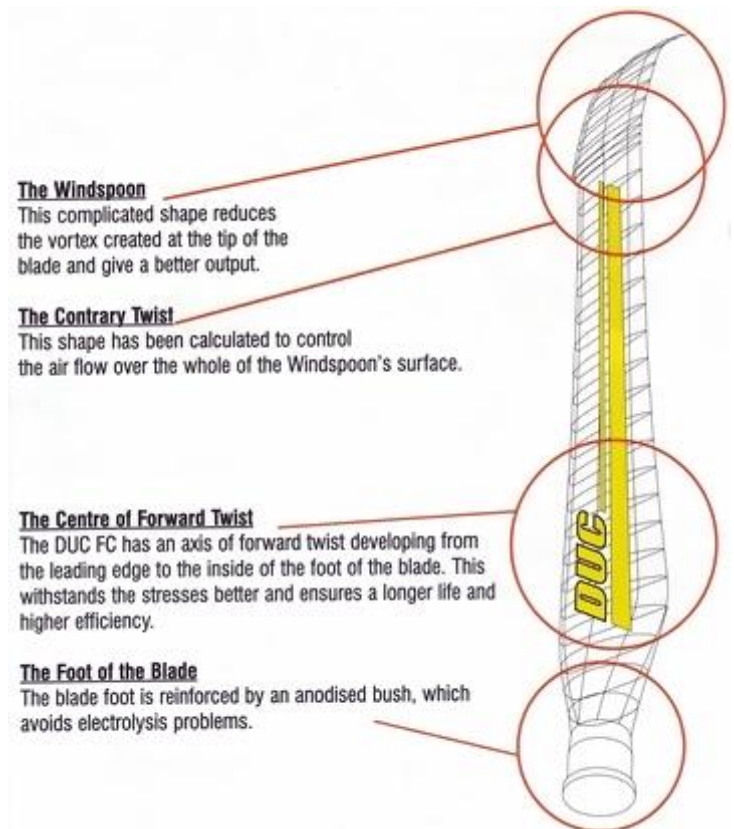
Its technical innovations are several consequences:

- **Better performance**
- **Lower fuel consumption**
- **Less noise**

The very special profile of the DUC FC blade has been calculated to optimize the airflow over the whole surface of the WINDSPOON.

The offset of the twisting results in better reduction of friction and a longer life.

The DUC FC propellers are produced in accordance with the strictest standards of the industry, with unique equipment specially made to ensure the highest quality.



2.3. Carbon hub



The used hub is in carbon fibers, produced by the patented process **CARBONE FORGÉ®**. In addition to weight gain, it provides exceptional mechanical strength.



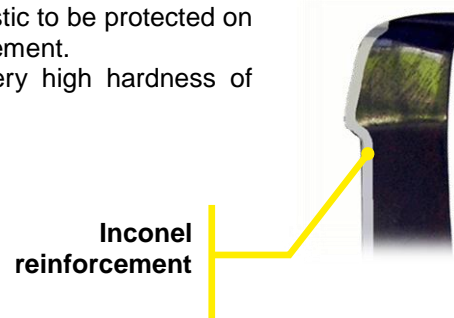
2.1. Option leading edge reinforced in Inconel



The DUC FC blade is available in two leading edge versions:

- **Standard DUC FC**
- **Inconel DUC FC**

The Inconel DUC FC blade has the characteristic to be protected on the leading edge with Inconel metallic reinforcement. The Inconel is refractory stainless with a very high hardness of surface.



3. Installation precautions

WARNING

Make sure the ignition is turned off before starting any type of work on the propeller.
Do not run the engine without propeller, engine damage will result.

IMPORTANT

The spinner is an important element for cooling the engine. Fitting a different spinner will be an addendum to this manual of instruction approved by DUC Hélices Company to confirm its compatibility with the mounting of the propeller.

On the Rotax 2-stroke engines and on the other reduced engines with the power below 65 hp, screws are able to work in shearing into the end of threads. For all the other direct gearing engines and the reduced engines with the power exceeds 65 hp, it should add three indexing pawns of 10-mm-diameter on the side of the propeller hub and of the propeller shaft. For the 4-stroke engines (Ex: Rotax 912, 912S, 914) equipped by the propeller shaft with the smooth holes, the screws should work on the smooth part of the screw (the value of shear screws on the smooth part is 2 times higher than on the threaded part). The propeller is delivered to you with the appropriate screws. The change of screws is contrary to our recommendations unless validated by the manufacturers.

WARANTY CONDITIONS

The user is still flying under its full responsibility (see **0. General terms of sale**).

4. Applications

Engine	Type	Gear box	Recommended propeller	Propeller diameter (mm)	Blade angle (°)	Flight potential (hour)
3 AXIS - TRACTOR						
ROTAX 912	4-stroke	2.273	Two-blade DUC FC Std/Inconel Tractor Right	Ø1727	14°	800
ROTAX 912S	4-stroke	2.43	Three-blade DUC FC Std/Inconel Tractor Right	Ø1727	12°	800
ROTAX 914	4-stroke	2.43	Three-blade DUC FC-R Std/Inconel Tractor Right	Ø1727	14°	800
ROTAX 503	2-stroke	2.58	Two-blade DUC FC Standard or Inconel Tractor Left	Ø1727	6°	800
		2.62			8°	
		3			14°	
		3.47	Three-blade DUC FC Standard or Inconel Tractor Left		15°	800
		4			17°	
ROTAX 582	2-stroke	2.58	Two-blade DUC FC Standard or Inconel Tractor Left	Ø1727	8°	800
		2.62			11°	
		3			17°	
		3.47	Three-blade DUC FC Standard or Inconel Tractor Left		17°	800
		4			21°	
3 AXIS - PUSHER						
ROTAX 912	4-stroke	2.273	Two-blade DUC FC Std/Inc. Propulsive Left	Ø1727	14°	800
ROTAX 912S	4-stroke	2.43	Three-blade DUC FC Std/Inc. Propulsive Left	Ø1727	12°	800
ROTAX 914	4-stroke	2.43	Three-blade DUC FC-R Std/Inc. Tractor Left	Ø1727	14°	800
ROTAX 503	2-stroke	2.58	Two-blade DUC FC Std/Inc. Propulsive Right	Ø1727	6°	800
		2.62			8°	
		3			14°	
		3.47	Three-blade DUC FC Std/Inc. Propulsive Right		15°	800
		4			17°	
ROTAX 582	2-stroke	2.58	Two-blade DUC FC Std/Inc. Propulsive Right	Ø1727	8°	800
		2.62			11°	
		3			17°	
		3.47	Three-blade DUC FC Std/Inc. Propulsive Right		17°	800
		4			21°	
PENDULARS - PUSHER						
ROTAX 912	4-stroke	2.273	Three-blade DUC FC Std/Inc. Propulsive Left	Ø1727	11°	800
ROTAX 912S	4-stroke	2.43	Three-blade DUC FC Std/Inc. Propulsive Left	Ø1727	12°	800
ROTAX 503	2-stroke	2.58	Two-blade DUC FC Std/Inc. Propulsive Right	Ø1727	6°	800
		2.62			8°	
		3			14°	
		3.47	Three-blade DUC FC Std/Inc. Propulsive Right		15°	800
		4			17°	
ROTAX 582	2-stroke	2.58	Two-blade DUC FC Std/Inc. Propulsive Right	Ø1727	8°	800
		2.62			11°	
		3			17°	
		3.47	Three-blade DUC FC Std/Inc. Propulsive Right		17°	800
		4			21°	

The values of blade angle are theoretical values and the engine speed in static must be verified.

For proper use of the propeller, refer to item **6. Maintenance**.

Other application

For all other applications, thank you to contact the DUC Hélices Company to assess the possibility of adjusting the propeller DUC FC WINDSPOON.

5. Assembly

The assembly of the propeller DUC FC WINDSPOON is explained below. The procedure is the same for two-blade and three-blade propellers.

If necessary, contact the DUC Hélices Company for mounting or controlling your propeller.

5.1. Content package



Nomenclature

1. DUC FC blades (x2 or x3)
2. Carbon half-hubs (x2)
3. Hub spacer (x1)
4. Large washer for clamping (x1)
5. Large screws + washers pour fixing (x6)
6. Small screws + nuts for hub (x6)



CAUTION WHEN HANDLING THE BLADES: CUTTING TRAILING EDGE

5.2. Assembly of the propeller

STEP 1



Place a half hub on a worktable.
Place the spacer in the center of the half hub.

STEP 2



Place 2 or 3 blades in their recesses.
Direct the **DUC** sticker facing you.

STEP 3



Place the 2nd half hub on the whole.

STEP 4



From the front of the hub, set up the 6 short screws for the assembly of the hub.

Behind, place the nuts and tighten moderately.

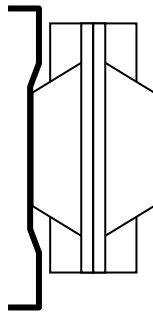
STEP 5



Position the large washers on the front of the propeller hub (sticker side), then place the 6 large screws with their washers.

The washer grooves must be in contact with the screw head.

STEP 6



To the back, position the fixing plate of the spinner by screws.

Be careful to respect the direction of the plate.

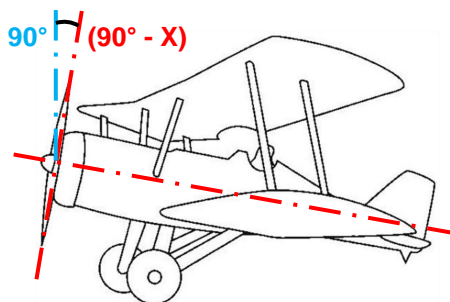
STEP 7



Place your aircraft so that the propeller shaft plate is perfectly vertical.

Check with the level of the adjustment tool (**90°**).

If unable to change the longitudinal axis of the aircraft, raising the value of the X angle propeller shaft plate to subtract the value of the blade angle to be resolved.



STEP 7



Put all stacked on the propeller shaft (Or on the adaptor spacer corresponding). **Tighten moderately.**

STEP 8



Slightly loosen the screws so that each blade can rotate in its recess without too much effort.

STEP 10



The adjusting of the blade angle is made with a specific tool set. (See 5.3. **Adjusting the blade angle of the propeller**)

STEP 11

SCREWS TIGHTENING TORQUE = 25 Nm (2.5 kg/m)



When the blades are set at the appropriate angle of installing, tighten all the screws to a **torque of 25 Nm (2.5 kg / m)**.

The tightening of the propeller consists of two steps:
1st approach to close the screws tightening moderately
2nd tightening with a torque wrench



STEP 12

Finally, once all the settings of the propeller were made, mount the spinner of the propeller.
At this point, the DUC FC WINDSPOON propeller is ready for flight tests.



CAUTION

After a 1 hour operation following the installation or modification of the assembly, tighten again your propeller according the manual instructions.

PRECAUTIONS

If you notice any abnormal installation or operation, do not undertake the flight and immediately contact the DUC Hélices Company.



**Being aware of potential risks during assembly and initial testing of the propeller.
Stay focused, attentive and vigilant to your surroundings. Recheck several points to be observed.
Maintaining high safety clearance during the set operation.**

The accessories of assembly and the propeller must be mounted according to technical documents from the DUC Hélices Company.

The non-compliance of these data would release the liability of the company (see **0. General terms of sale**).

The potential flight hours of the DUC FC propeller depends on the engine on which it is mounted.
See section **4. Applications** to know the value thereof.

When achieving the potential flight time of the DUC FC propeller, thank you for returning the propeller to full control then credited back to a new potential if no major fault is detected (see 6. Maintenance).

INDICATIONS FOR TESTING



The tests are important. It is normal to make several adjustments successive alternating ground flight tests.

GROUND TEST: Stabilize your aircraft, brakes locked. Follow the manufacturer's recommendations for safety on.

Put the engine on, leave heat.

Full throttle, the engine must be at least 85% of the recommended maximum engine speed in flight by the manufacturer. **If this is not the case, adjust the blade angle of blades.**

FLIGHT TEST: Check all tightening.

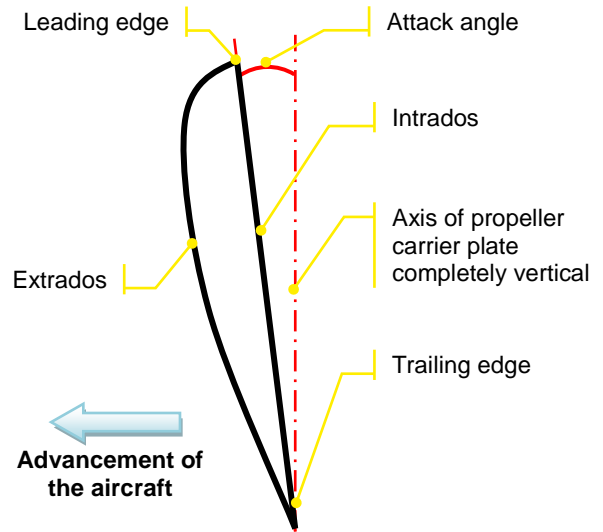
Take off and put you in steady horizontal flight, vario zero.

Full throttle, the maximum engine speed recommended by the manufacturer must be reached **but not exceeded**.

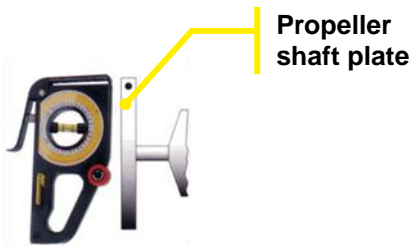
5.3. Adjusting the blade angle of the propeller

Above all, the blade to adjust must be set to horizontal.

The calibration is done with the adjustment tool flattened against the intrados (leading edge up) to 14 cm from the blade tip. The attack angle is formed by the vertical and the intrados of the blade.

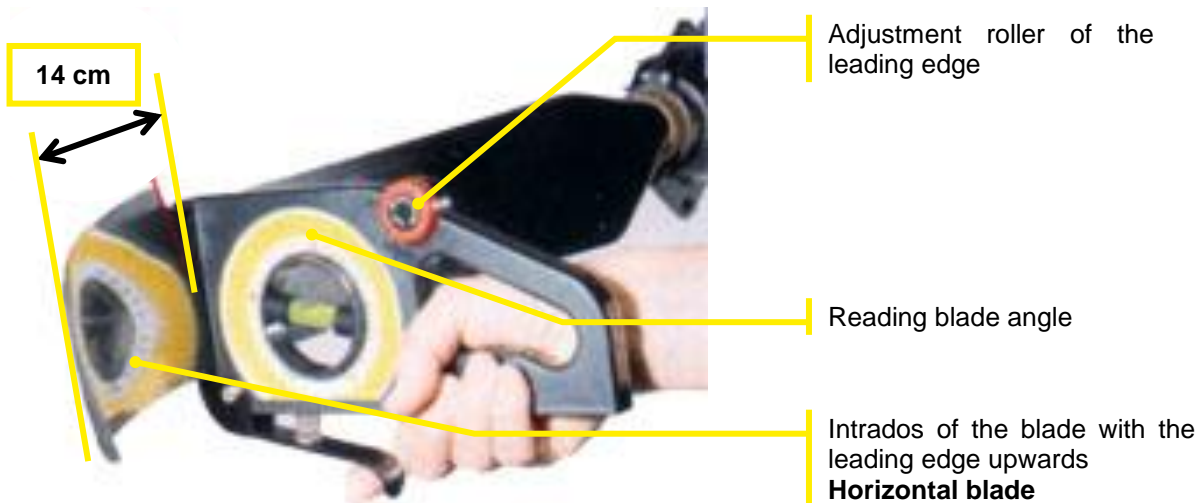
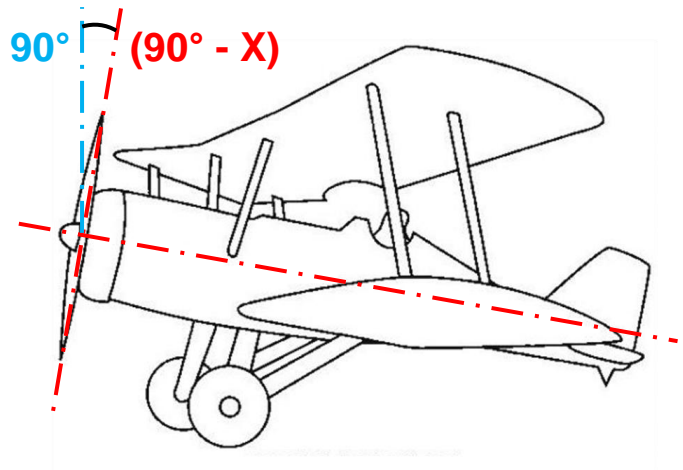


To do this, place your aircraft so that the propeller shaft is perfectly vertical.



Check with the level of the adjustment tool (90°).

If unable to change the longitudinal axis of the aircraft, raising the value of the **X** angle propeller shaft plate to subtract the value of the blade angle to be resolved.





DUC FC WINDSPOON

6. Maintenance

6.1. Regular maintenance (Customer)

For a safety use of the DUC FC propeller, it is necessary that the user performs regular maintenance to detect any abnormalities. This maintenance is usually just a simple check.

Frequency of checking: Each pre-flight

Control methods: Visual inspection & Manual handling

Checkpoints:

- Fixation of the propeller:

Manually maintaining the tip of a blade of the propeller, shake it firmly to feel if a too much clearance appears in the setting of the propeller.

- Degradation of material:

Check visually the entire propeller without dismantling (blade root, Inconel leading edge, surface of the blade, spinner, hub, etc.)

- Fixation of the spinner:

Check visually the fixation screws of the spinner. A marking paint can be made between each screw and spinner to have a means of visual inspection of proper tightening the screws.

Possible problems:

- Too much clearance in the propeller fixation

- Degradation of surface
Crack apparent

- Screw unscrewed or damaged

Corrective actions:

Depending on the importance:

1. Perform a repair with the DUC repair kit (ref. 01-80-004)
2. Tighten the screws to proper torque
3. Replace(s) damage component(s)
4. Contact DUC Hélices to define a solution

6.1. General maintenance (Client)

A general maintenance by the customer must be made at lower frequency.

Frequency of checking: Every 100 hours or annually

Control methods: Visual inspection & Torque wrench

Checkpoints:

- Fixation of the propeller: By removing the spinner of the propeller, check the proper tightening of the screws to the wrench. These screws of the hub should be tightened to proper torque, defined in the installation instructions attached. A marking paint of all the screw/washer/hub after tightening can be done to help make a visual check outside of the general maintenance.

- Degradation of material: Check visually the entire propeller (blade root, Inconel leading edge, surface of the blade, spinner, hub, etc.)

Possible problems:

- Too much clearance in the propeller fixation

- Degradation of surface
Crack apparent

- Screw unscrewed or damaged

Corrective actions:

Depending on the importance:

1. Perform a repair with the DUC repair kit (ref. 01-80-004)
2. Tighten the screws to proper torque
3. Replace(s) damage component(s)
4. Contact DUC Hélices to define a solution

6.2. Complete maintenance (DUC Hélices)

After many hours of use (potential) defined by DUC Hélices, the propeller must be returned to the company for a full expertise of all components of the propeller.

See section 4. **Applications** for the potential value of an hour's flight engine.

The possible degradation of the propeller components may vary depending on the location of use.

7. General terms of sale

7.1. Ordering procedure

Orders placed by fax, by phone or mail server engage the customer upon receipt by our Customer Service Order and the Regulations.

7.2. Delivery

DUC Hélices Company agrees to make every effort to deliver the order within the shortest time, and the receipt of the order together with the Regulation. The delivery times indicated on the order are only indicative and the possible delays do not entitle the buyer to cancel the sale, to refuse the goods or claim damages. Any claim for non-compliance or failure will be sent within one week following the date of receipt of order.

The DUC Hélices Company is released from its obligation to deliver for all fortuitous events or force majeure. As an indication, the total or partial strikes, floods, fires are cases of force majeure. The transfer of ownership of goods supplied or delivered is suspended until full payment of price by the customer and without affecting the transfer of risk.

7.3. Price

The DUC Hélices Company may change its prices at any time.

The customer agrees to pay the purchase price in effect at the time of order entry. Regulation Order is payable in advance in one payment when sending the DUC Hélices Company purchase order.

7.4. Right of withdrawal

Under Article L121-16 of the Consumer Code, the customer shall have seven clear days after the delivery of his order to return the products to the DUC Hélices Company for exchange or refund, without penalties except for the return costs. Returned products must not have suffered damage consequence of shock or improper use and be packaged in original packaging. Goods shipped with postage due will not be accepted.

7.5. Warranties

The DUC Hélices Company's products must be installed and used in accordance with instruction manuals provided. The failure of these data releases any liability of the DUC Hélices Company.

The user is still flying under its sole responsibility.

The legal guarantee of industrial products is six months or for the potential duration of the helix (depends on which engine it is installed) against defects and hidden defects. See the section **4. Applications** to determine the potential value of an hour's flight engine.

DUC Hélices Company guarantees its product defect under normal use in the manner described below: If the customer finds a defect, he must report it immediately to the DUC Hélices and features of one month after its purchase to return to society DUC Hélices, all structural defects will snuff into account (except for damage result of incorrect operation, shock, injury, impairment or neglect, water or generally inappropriate use by the engine type, power, speed and gear). To qualify for this warranty, the customer must send at its expense within one month after its purchase to be returned to society with DUC Hélices delivery order attached to the product. In return, the DUC Hélices Company takes no responsibility for damage or loss during transit due to improper or inadequate packaging. The company DUC Propellers then returned at his expense to the customer at the address on the delivery note, an identical or equivalent.

In addition to these guarantees, the company DUC Hélices provides no other warranties.

7.6. Privacy Policy

All the data you entrust to us are able to process your orders. Under Law No. 78-17 of January 6, 1978 relating to data, files and freedoms you have with the customer service company DUC Hélices right to access, review, correct, correct and delete data you have provided.

7.7. Litigation

Any order placed convincing the customer, without any restriction, the General Conditions of sale of the DUC Hélices Company. Any dispute concerning the sale (price, GTS, product ...) will be subject to French law before the Tribunal de Commerce de Lyon.

8. Appendix

I. Technical folder of the CARBONE FORGÉ® propeller hub

1. COMPARISON OF CARBONE FORGÉ® HUB/ ALUMINIUM HUB

The objective of these tests is to evaluate the potential of half-hub carbon composite manufactured with CARBONE FORGÉ® process, comparing different half-hubs made with different types of aluminum.

PARTS AND MATERIALS

4x CARBONE FORGÉ® HALF HUBS



Produced in carbon fiber pre-impregnated class 180 type aircraft.

6x ALUMINIUM HALF HUBS



- AS 7 G06 with heat treatment 1: parts n° 1 / 2
- AS 7 G06 with heat treatment 2: parts n° 3 / 4
- AS 10 S8 G without heat treatment: parts n° 5 / 6

WEIGHT PARTS

Part n°	Aluminum (g)	Carbone Forgé® (g)
1	537	270
2	509	272
3	520	268
4	-	270
5	528	
6	525	

Carbon half-hub weights are typically half the weight of aluminum parts.

Very low weight variation of the CARBONE FORGÉ® parts.

TESTING PROCEDURE

1st TEST: Tension (up to about 15 kN), then compression (up to about 70 kN) of the half-hub along its symmetry axis



2nd TEST: Application of a tension along an axis inclined relative to the axis of symmetry of the part



For both cases, the results in terms of rigidity and apparent fracture loads are operated. The capacity load cells is limited, the test can reach the breaking part in most cases. In addition, disruptions of screw parts on the equipment during testing were repeatedly produced.

3rd TEST: Compression along the axis of symmetry of the half-hub to 100kN

The parts were equipped with strain gauges on their flat flange to directly obtain the local stress state.

RESULTS

1st TEST: No damage or cracks observed on both parts in aluminum or composite. Note that the tensile strength of carbon parts is comparable to those obtained with aluminum alloys. However, given the significantly lower weight parts carbon, the specific values are much higher.

2nd TEST: The carbon parts show the same or a higher stiffness than the aluminum parts. Except for the aluminum sample No. 1, the tensile strengths are virtually identical. The break seems to be less fragile parts CARBONE FORGÉ®. The spread occurs by delamination of the material around the holes.

Part n°	Weight (g)	Tension (N/mm)	Tension (N/mm/g)	Compression (N/mm)	Compression (N/mm/g)
ALUMINIUM HALF-HUB					
2	509	29400	58	55500	109
6	525	27800	53	58800	112
CARBONE FORGÉ® HALF-HUB					
3	268	28600	107	50000	186
4	270	23330	86	52600	195

Parts n°	Weight (g)	Tension (N/mm)	Tension (N/mm/g)	Rupture (kN)	Rupture (N/g)
ALUMINIUM HALF-HUB					
1	537	7410	13.8	>43.9	-
5	528	7410	14	37.4	71
CARBONE FORGÉ® HALF-HUB					
1	270	9610	35.6	40.5	150
2	272	8000	29.4	38.9	143

3rd TEST: Compression strain gauges.

Unit constraint: $1\mu\text{def} = 10^{-6}$

Parts n°	Strength / Stiffness (N/ μdef)
Aluminum – part n°2	111
Aluminum – part n°3	83
Carbon – part n°5	47

CONCLUSION

The process CARBONE FORGE[®] is very suitable for the manufacture of engineered components, such as half-hub, with excellent mechanical and following the directions of the reinforced structure. The mechanical properties examined CARBONE FORGE[®] hubs are comparable to those obtained from forged aluminum alloys, for similar size pieces, and therefore better performance specific, with the lower density material (1.5 against 2.9).

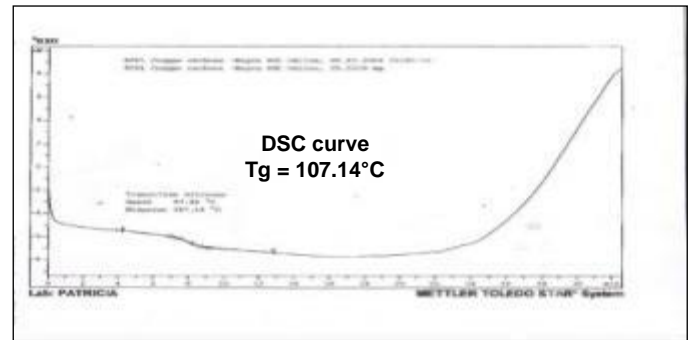
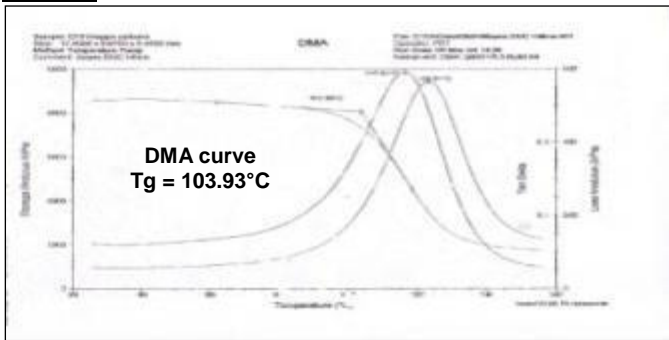
2. TEMPERATURE RESISTANCE – DUC CARBONE HALF-HUB

The tests of temperature resistance were carried out on a sample of DUC propeller half hub manufactured with the Forged Carbon process in HEXCEL COMPOSITES laboratory.

Material: Layer UD carbon fiber pre-impregnated class 180 type aircraft

Procedure: Measurements of glass transition temperature Tg were performed on DSC and DMA devices.

Results:



II. Technical folder of the Standard DUC FC blade

1. CENTRIFUGAL FORCE SOLICITATION OF THE DUC FC BLADE ACCORDING THE ENGINE/GEAR BOX

Calculation of the centrifugal force: $F = \frac{M \times V^2}{R_G}$

- RPM_{max} : Maximum engine speed (RPM)
- RPM_{red} : Propeller rotation speed (RPM)
- Red. : Gear box ratio
- Ø_{hélice} : Propeller diameter (mm)
- G_{pale} : Gravity center position on the blade (mm)
- R_G : Radius of the gravity center of the blade (mm)
- V : Linear speed in tip blade of the propeller (m/s)
- M : Weight of the blade (kg)
- F : Centrifugal force (N)
- F_{FoS(2)} : Centrifugal force with factor of safety 2 (RPM)

Standard DUC FC blade

Type	MOTEUR			HELICE					FORCE CENTRIFUGE	
	RPM _{max} (tr/min)	Red.	RPM _{red} (tr/min)	Ø _{hélice} (mm)	G _{pale} (mm)	R _G (mm)	V (m/s)	M (kg)	F (N)	F _{FoS(2)} (N)
MOTEUR 4 TEMPS										
ROTAX 912	6000	2.273	2640	Ø1730	279	316	87.31	1.005	24 242	48 485
ROTAX 912S	6000	2.43	2469	Ø1730	279	316	81.67	1.005	21 211	42 422
ROTAX 914	6000	2.43	2469	R-Ø1730	282	319	82.44	1.081	23 032	46 063
MOTEUR 2 TEMPS										
ROTAX 582	6800	2.58	2636	R-Ø1730	279	316	87.17	1.005	24 168	48 337
ROTAX 582	6800	2.62	2595	R-Ø1730	279	316	85.84	1.005	23 436	46 872
ROTAX 582	6800	3.00	2267	R-Ø1730	279	316	74.97	1.005	17 875	35 750
ROTAX 582	6800	3.47	1960	Ø1730	279	316	64.81	1.005	13 361	26 721
ROTAX 582	6800	4.00	1700	Ø1730	279	316	56.23	1.005	10 055	20 109

2. BREAK TEST OF THE SWIRL BLADE (Equivalent of the DUC FC WINDSPOON blade)

The complete failure of the SWIRL blade could not be obtained by a tensile test in the axis of the blade because of the limit of the facility. Thus, to estimate the value of the axis break in a tensile test static skewed by 32 ° is achieved. The rupture occurred at the foot of the shoulder blade. We can consider that the failure of the blade along the axis is about twice the break value to 32 ° because in that position, only half foot blade is in contact with the assembly.

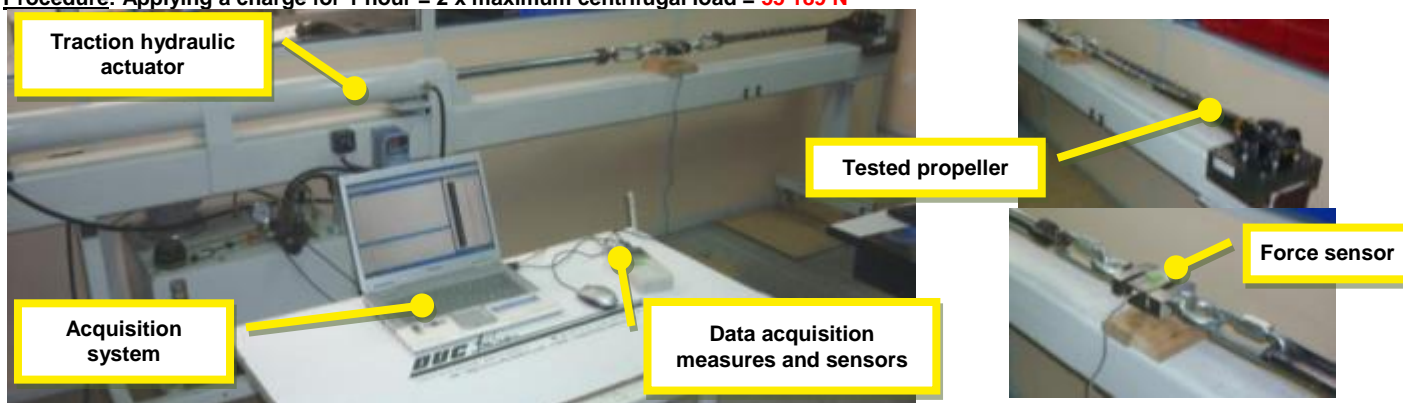
Static pulling of the blade along the axis	Delaminating at 58 000 N
Static pulling of the blade at 32° to the axis	Break point at 48000 N
Estimated break value to pulling of the blade	Calculated break point at 96 000 N



3. TESTING OF CENTRIFUGAL FORCE UNDER THE CS-P350 SPECIFICATION

The test of centrifugal force propeller is defined by the certification specification of propeller CS-P 350. Its objective is to demonstrate its compliance with the certification specification of propeller (CS-P) defined by the European Aviation Safety Agency (EASA). After the test, the propeller must show no evidence of fatigue, failure or permanent deformation that would result in a major or hazardous effect on the propeller. It is considered that this test is used to validate the mechanical strength of the propeller, i.e. to confirm the manufacturing process thereof. This test is conducted with the propeller SWIRL Inconel Ø1520mm a solicitation representative of its mounting on the engine JABIRU. Being the most detrimental to the test, this configuration was chosen. Thus, the test is used to validate all configurations below that selected. **In addition, all using the same propeller design and the same manufacturing technology will be considered consistent with values similar or lower than those of the test.**

Procedure: Applying a charge for 1 hour = 2 x maximum centrifugal load = 55 189 N



Results: Obtain by visual analysis of comparative sections of the internal structure of the products tested.

No external damage was observed during and after the centrifugal load test. Comparative analysis of the blade:

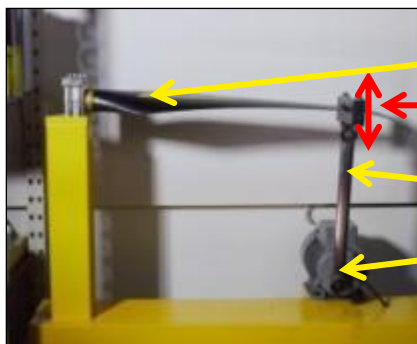
- Good compaction and homogeneity of carbon/epoxy layers in intrados and extrados, and the blade foot inside the ring (a few tiny air bubbles but acceptable)
- No visible pores or clusters of resin
- Good adhesion between the skin and the inner core
- Good densification of inner core
- Liaison homogeneous of extrados and intrados skin located on the leading edge and trailing edge
- Exterior profiles identical blades
- Good cohesion of the Inconel reinforcement of the leading edge on the structure

As for the visual analysis of sections of the hub:

- Good compaction and homogeneity of carbon/epoxy layers
- No deformation, wear, surface delamination observed in and around the holes
- Good position and tension of the fiber in the room
- No visible porosity

The centrifugal load test according to specification CS-P 350 leads to the conclusion that the propeller is properly sized and is designed to operate on an installation or less JABIRU engine, seeking the blade in a centrifugal force of 27 594 N.

4. BENDING FATIGUE TEST OF DUC BLADE



Foot blade held in a bearing aluminum

Oscillation of 70 mm from the blade tip

Eccentric rod

Electric engine:
V = 1 300 tr/min
Number of beat of 70 mm:
78 000 beats/hour

DUC blades suffered a bending test for 30 hours or 2 340 000 cycles of oscillation of 70 mm.

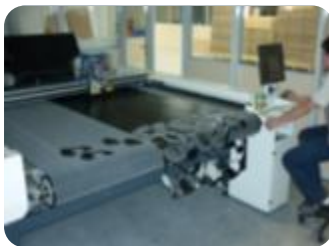
Following these requests, these blades have been tensile test and the results showed no change in resistance of structure.

DUC Hélices



Chemin de la Madone - 69210 LENTILLY - FRANCE
Phone: + 33 (0) 4 74 72 12 69 - Fax: +33 (0) 4 74 72 10 01
E-mail: contact@duc-helices.com - www.duc-helices.com
Customers service: service.technique@duc-helices.com

ISO 9001:2008
Certified Company



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