SUPER CASA

Aircraft: CASA 212-200

Engine: TPE331-10R

Model: HC-E5N-5KL/JNC10905B

Propeller Diameter: 112 inches

Hub Material: Aluminum

Blade Material: Carbon Composite

Propeller Weight: 190.4 lbs.

CASA 212 operators around the world have been asking for a solution to the legacy aluminum Dowty and early technology composite Hartzell propeller for years. Texas Turbine Conversions, Inc and Hartzell Propellers have teamed up to produce the lightest, best performing propeller available for the *CASA 212* platform. This innovative new propeller couples Hartzell's latest blade design technology with the proven aluminum hub design for the most performance you can get out of the aircraft. The blades have been specifically designed around takeoff and climb performance, with the added bonus of a slight (2-3 knot) increase in cruise performance. The result……***pure performance***!

STC issued December 10, 2019.

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The New CASA 212 Propeller

The new propeller is a 112” (284.5 cm) five-blade propeller with an aluminum hub. The blades are manufactured using advanced carbon-composite technology. CASA 212 operators should know that this composite technology is different than the 40-year old technology used in the design of the old Hartzell Kevlar-composite propellers installed on many CASA 212 airplanes. It allows for a thinner and aerodynamically efficient blade design, with a wider blade chord. This technology has been used on propellers operating on many turboprop applications including the Pilatus PC-12, Beech King Air 250, Socata TBM900, Piper M500, and Cessna 208/208B Caravan.

Hartzell’s resin-transfer co-molding technology creates blades that are very closely match-balanced at production, resulting in very low vibration, making it easy to match spare blades. This process also results in propellers that are highly resistant to delamination when compared to other composite propellers.

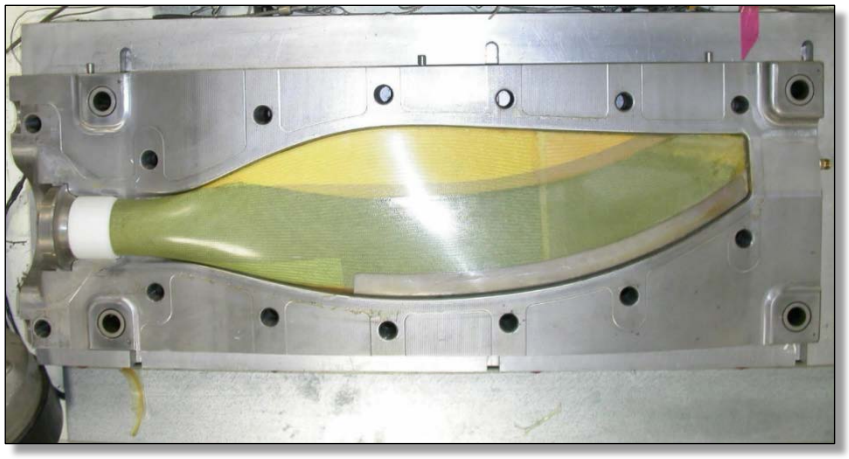


Figure 1: Hartzell Resin Transfer Blade Mold

The carbon-composite blades have outstanding repairability. *Minor* repairs can be performed by a certified A&P mechanics using manuals and procedures available to the general public. No special certificate or training is required to perform damage evaluations and perform minor repairs. Many propeller shops are currently certified by Hartzell to perform any *major* repairs that are necessary.

The advanced carbon-composite technology allows for the development of highly efficient aerodynamic shapes that simply cannot be achieved by traditional aluminum blades or wood composite blades offered by some other propeller manufacturers. Hartzell utilized this technology in developing a blade for Texas Turbine Conversions that is specifically aimed at improving takeoff and climb performance for the CASA 212. While the blade was designed to improve takeoff and climb performance, of the blade aerodynamics also resulted in a small increase in cruise speeds for the same torque and fuel burn as the existing propellers.

Figure 2, below, provides a comparison of the cross-sections of a typical wood-composite blade with the Hartzell carbon-composite blade.

Figure 2: Blade Shape Comparison – Wood-Composite v. Hartzell Carbon-Composite

Advantages of the Hartzell Five-Blade Carbon-Composite Propeller

- Improved Performance – See test results below.
- Lighter Blade Weight – Allowed for creation of a five-blade propeller, that is 2" larger in diameter, but the same weight as the existing CASA 212 propellers.
- High-Strength Co-Molded Nickel Leading Edge and Epoxy Paint – Results in blades that are far more resistant to FOD with improved erosion resistance, when compared to traditional aluminum blades.
- Outstanding Repairability
- Matched Blades – Advanced molding process results in blades that are uniform in weight and balance, resulting in very low vibration and effectively putting an end to difficult blade matching or purchasing multiple replacement blades.
- Hartzell predicts a 40,000+ hour life expectancy for the blades, compared to the 8,000 to 10,000-hour life expectancy for typical aluminum blades.
- TBO of 4000 hours/72 months, whichever comes first.
- Factory Warranty – Fully supported by Hartzell with a factory warranty covering the propeller through the first overhaul – *the longest warranty in the propeller industry*.
- Fast Propeller Overhaul – Most overhauls can be accomplished within a few weeks at the Hartzell facility or at one of dozens of Hartzell Recommended Service Facilities around the world.

Certification Program

The new propellers have received their STC certification through the FAA. The engineering analysis and reports, ground testing, flight testing, and other testing and analysis performed for the STC, include the following:

- Structural Analysis and Reports
- De-Ice System Analysis and Report
- Electrical System Analysis and Report
- Powerplant Substantiation Report
- Propeller Vibration Survey and Report on the C-212
- Ground Vibration Testing and Report
- Whirl Flutter Analysis and Report
- Flight Vibration Testing and Report
- Company and FAA Flight Testing
- Performance Analysis, Updated Charts, and Substantiation Report
- Acoustical Testing and Report under FAR Part 36

The STC includes new performance charts, as applicable, for the increased performance of the airplane with the new propellers. Below is a discussion of some the extensive testing and analysis performed in certifying these new propellers.

Figure 3: Test Flight Aircraft with New Propellers Installed

Ground and Flight Vibration Testing

To begin the certification effort, a propeller vibration survey was performed by Hartzell engineers with the propellers installed on the airplane. Extensive ground and flight vibration testing was then performed to evaluate the effect of the five-bladed propeller with a larger diameter on the airplane. Flight vibration testing involved attaching twenty-eight accelerometers on the flaps, control surfaces, control tabs, and fuselage. Flaps loads were also measured throughout testing. The airplane was flown through 80 different flight conditions with both the original Hartzell (Kevlar) propellers and the new Hartzell Carbon-Composite Propellers. These conditions included ground, takeoff, climb, cruise, and descent in various flaps configurations and to airspeeds exceeding V_D (257 KIAS).

This testing confirmed that the new propellers produce less vibration than the original propellers throughout the flight envelope. During this testing, flaps loads were also shown to be less with the new propellers.

Analysis

Extensive structural analysis was also performed to verify the safety of the new propeller installation, including structural loads analysis, propeller slipstream analysis, and whirl mode flutter analysis. De-Icing analysis was performed to verify that the de-ice system for the new propeller performs as good as or better than the de-icing with the original propellers. Electrical loads analysis was performed to demonstrate that the new propellers do not require any greater electrical power than the original propellers. The complete installation has been reviewed and has been approved by FAA Powerplant, Electrical, Structural, and Mechanical Systems DERs.

Flight Testing

The FAA flight testing involved testing both the original Hartzell Kevlar propellers and the new carbon-composite propellers, to collected data for comparative analysis and performance chart updates. New performance charts were created from the flight test data and were approved by the FAA in issuing of the STC. Summaries of the flight test results are provided below.

Company and FAA Flight Test Results

Both company flight testing and FAA flight testing have shown a marked improvement in airplane performance with the new propellers. The results of this testing are shown below.

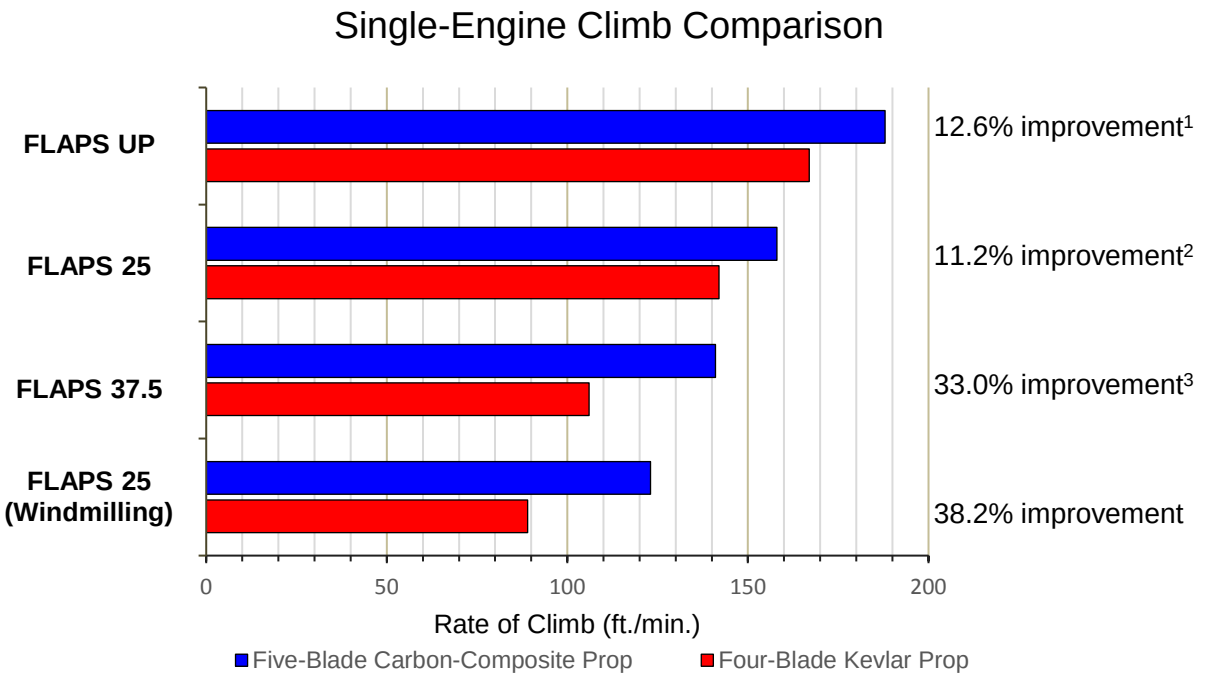
Takeoff Performance

The testing of the new propellers, which are two inches larger in diameter and have a 5th blade, have resulted in a 3-4 knot increase in the minimum control speed of the airplane. This means that the rotation and climbout speeds have each increased by about the same amount. Despite this increase in the takeoff speeds, the propeller, with its increased thrust, demonstrated a slightly shorter distance to clear a 35' obstacle (3-6% improvement).

It is worth noting that the takeoff performance testing demonstrated that, for the same V_1, the new propellers demonstrated a wind-corrected takeoff distance approximately 18% shorter than the Hartzell Kevlar propeller. This reveals the amount of additional thrust provided by the new propellers. This additional thrust is further demonstrated by the fact that the takeoff distance was slightly improved, even with V_1 being 4 knots higher. With the increase in V_{MCA} (and V_1), and given the modest increase in takeoff performance that resulted, no new takeoff performance charts were created in the STC project.

Single-Engine Climb Performance

The new propeller demonstrated improvement over the original Hartzell Kevlar propeller in all configurations tested The rate of climb improved between 11.2% and 38.2%, depending on the flap setting. The greatest improvement was seen with takeoff flaps where the inoperative engine was windmilling. The testing below was performed with the airplane loaded forward and heavy (90-100% MGW) – the most critical for climb performance – on hot (30°C - 35°C) days.



Note: The above test results were performed in slightly higher, hotter, and heavier conditions with the New propeller than the conditions tested with the Kevlar propeller. The results were corrected for equivalency by the flight analysts and developed into performance gradient charts that are discussed in the notes below.

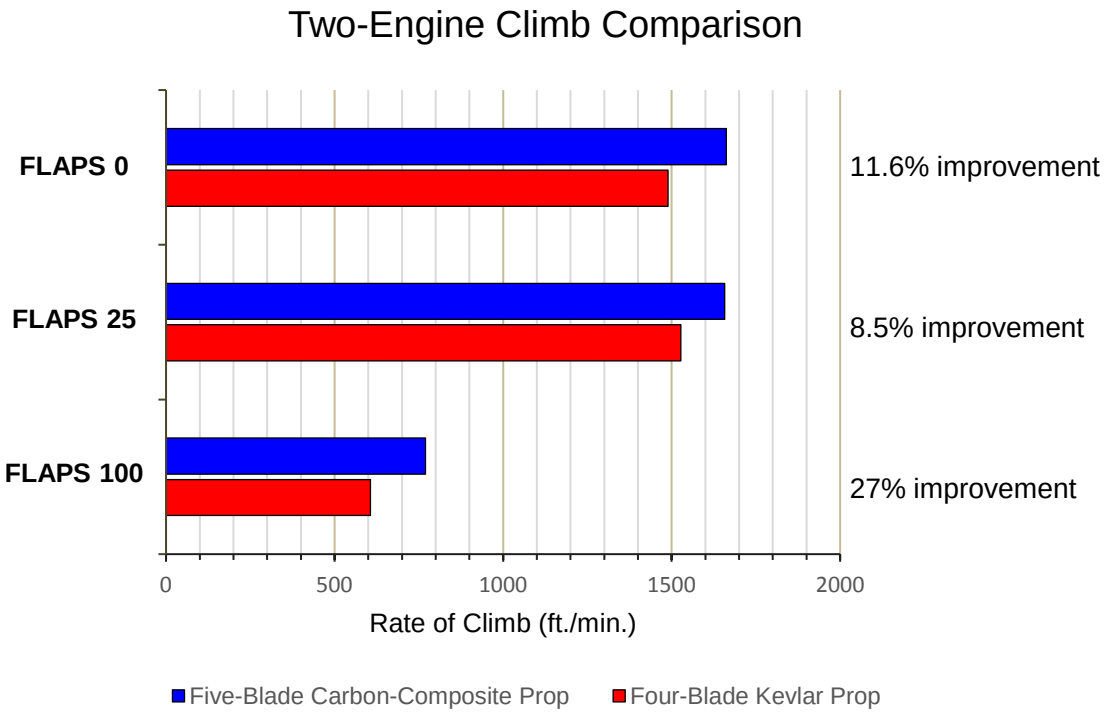
1 A performance chart was developed for the Final Segment Climb Gradient that shows an 8-50% improvement in climb gradient when compared to the Hartzell Kevlar propeller, depending on the weight, altitude, and temperature, with the greatest percentage of improvement seen in high and hot conditions.

2 A performance chart was developed for the Second Segment Climb Gradient that shows a 5-25% improvement in climb gradient when compared to the Hartzell Kevlar propeller, depending on the weight, altitude, and temperature, with the greatest percentage of improvement seen in high and hot conditions.

3 A performance chart was developed for the Single Engine Approach Climb Gradient that shows a 10-40% improvement in climb gradient when compared to the Hartzell Kevlar propeller, depending on the weight, altitude, and temperature, with the greatest percentage of improvement seen in high and hot conditions.

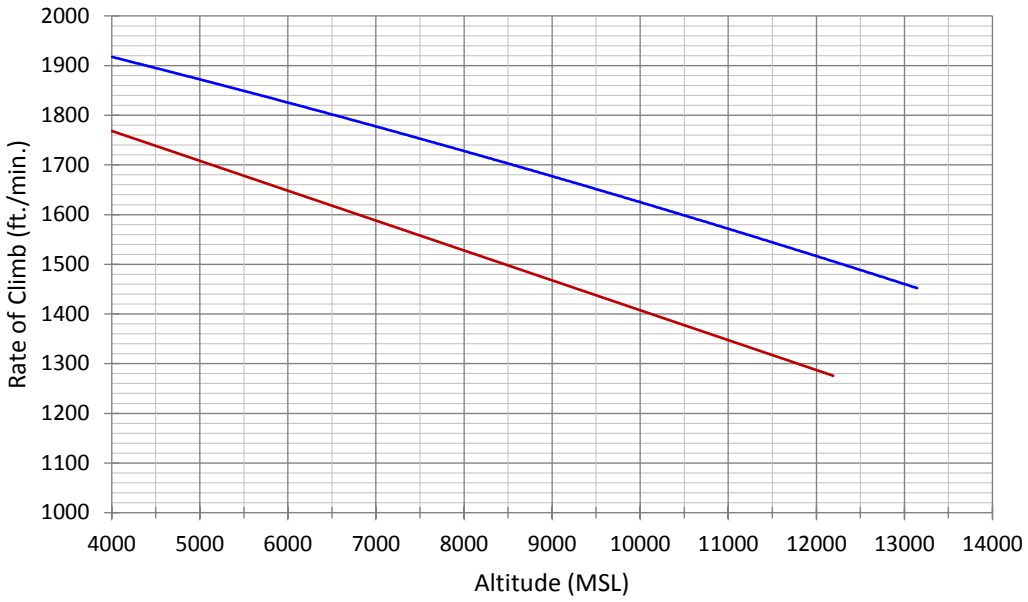
Two- Engine Climb Performance

Performance gains from 8.5% to 27% were determined in the two-engine operating condition. The greatest improvement (27%) was seen in the balked landing/landing climb condition, which was evaluated at/above the maximum landing weight on hot (30°C - 35°C) days.

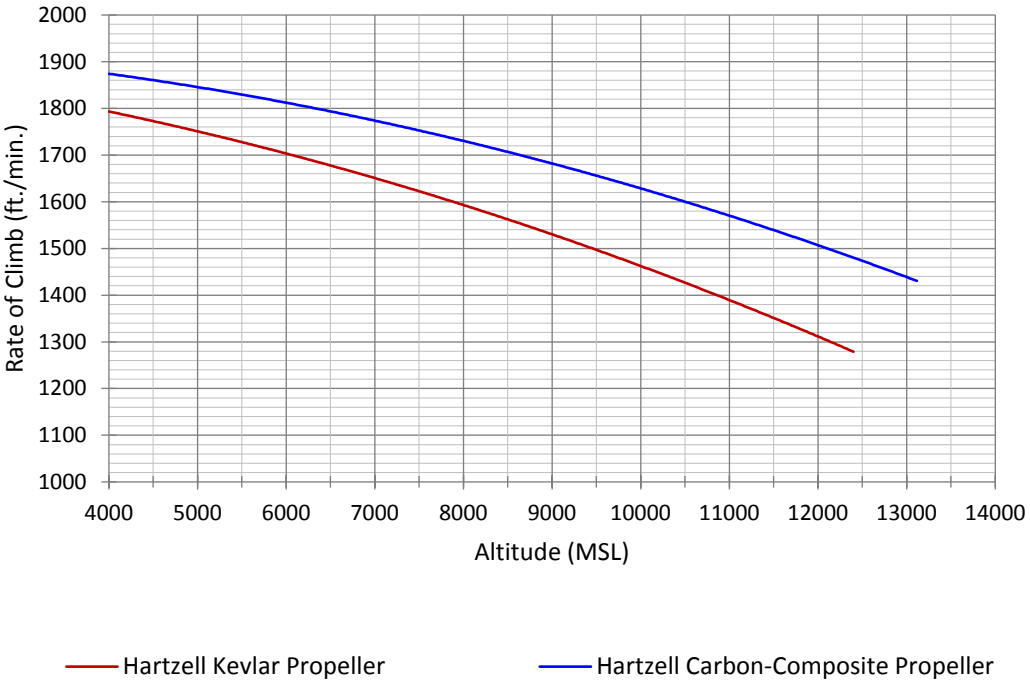


Climb performance with Flaps 0 showed an average improvement of 11.6%. The average improvement in climb performance with Flaps 25 was 8.5%. This testing was performed with the airplane loaded at medium weight.

Climb Performance - FLAPS 0, 105 KTS.

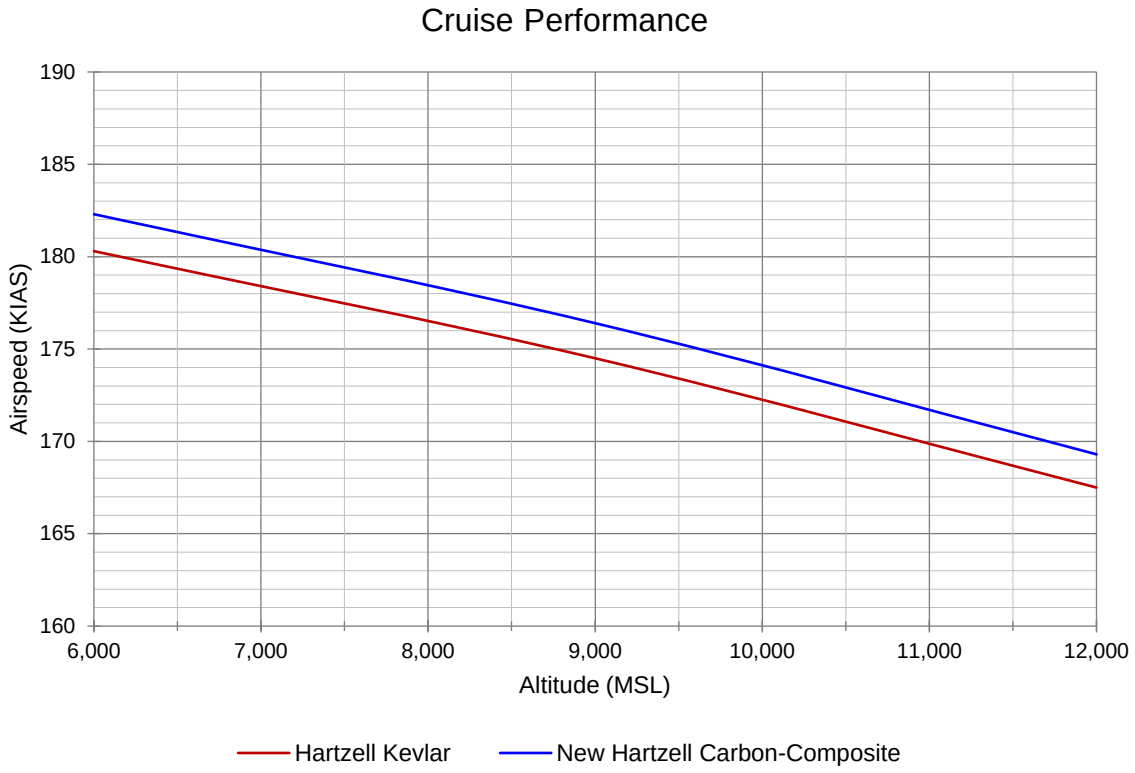


Climb Performance - FLAPS 25, 105 KTS.



Cruise Performance

A 2-3 KT increase in airspeed with the new propeller was observed when tested at 6000, 9000, and 12000 ft. MSL. This testing was performed with the same torque and EGT values for both the new propellers and the Hartzell Kevlar propellers.



Ordering the New Propellers

The new propeller set can be order either directly through Texas Turbine Conversions or through Airbus Defense and Space. Texas Turbine Conversions can be contacted at (972) 382-2500. Propeller pricing is available through these companies. A deposit of $10,000 per propeller set and $5000 per spare propeller is required with each order. The lead time is estimated by Hartzell to be 12-14 weeks, although Hartzell is attempting to keep at least 1 set on the shelf for prompt delivery. Orders will be filled in the order in which deposits are received.

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PROPELLER DATA SHEET

Model Numbers

Aircraft	C.A.S.A. C-212-CC, CD, CE, CF, DF
Engine	TPE-331-10, -10R
Propeller	HC-E5N-5KL/JNC10905B
Spinner	106528P
Blade	JNC10905B
Hub	HC-E5N-5KL
Control System	5

Configuration

Number of Blades	5	
Propeller Diameter	112.0 inches	284.5 CM
Spinner Diameter	19.8 inches	50.3 CM
Spinner Length	25.4 inches	64.5 CM
Hub Material	Aluminum	
Spinner Material	Aluminum	

Blade Data

Activity Factor / Blade	116
Design Lift Coefficient (CL_i)	0.654
Blade Material	Carbon Composite

Weights and Moments

Basic Propeller	173.0 pounds	78.47 Kg	☐ Measured
Spacer	pounds	Kg	☐ Measured
Mounting Hardware	pounds	Kg	☐ Measured
Spinner	11.2 pounds	5.08 Kg	☐ Measured
De-Ice	6.2 pounds	2.81 Kg	☐ Measured
Total Weight	190.4 pounds	86.36 Kg	☑ Measured
Polar Moment of Inertia	11.57 slugs x ft ^{2}	15.687 Kg x M ^{2}	☑ Measured
Distance from Blade Center to Mounting Flange (CG location)	3.660 inches	9.30 CM	

Restrictions / Placards

Stabilized ground operation is prohibited below 1034 (65%) RPM.

Oil weight approx 2.5 lbf at reverse, 0.25 lbf at feather

NOTE 1: OPERATING RESTRICTION INFORMATION MUST BE COMMUNICATED TO ALL OPERATORS IN THE FLIGHT AND MAINTENANCE MANUALS, AND ALSO IDENTIFIED ON INSTRUMENT OR PANEL MARKINGS WHERE APPROPRIATE.
NOTE 2: Unless otherwise noted, all data are analytically estimated at nominal dimension.

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