

MU-2 magazine

APRIL • 2016 • 10th edition

a publication of Turbine Aircraft Services, Inc.



what's inside:

LOSS OF CONTROL

On the NTSB "Most Wanted" list.

OWNER / OPERATOR SPOTLIGHT

Gary Palmer

PAINTING YOUR PLANE?

The importance of balancing the flight controls after painting.

SORRELLS' SIDESLIPS

PROP: A short history and glimpse of the future.

HOW TO USE ANGLE OF ATTACK (AOA)

A follow up article.

STARTER-GENERATOR OVERHAUL

www.mu-2aircraft.com





The Mitsubishi MU-2, one of Japan's most successful aircraft, is a high-wing, twin engine turboprop with a pressurized cabin. Work on the MU-2 began in 1956. Designed as a light twin turboprop transport suitable for a variety of civil and military roles, the MU-2 first flew on September 14, 1963. More than 700 MU-2 aircraft were built before the aircraft went out of production in 1986. Presently, nearly 300 MU-2 aircraft remain in operation with the majority of the fleet registered in the U.S.

Turbine Aircraft Services, Inc. (TAS) is under contract to Mitsubishi Heavy Industries America, Inc. (MHIA) to assist with the support of the MU-2. TAS distributes MHIA-issued publications and serves as liaison between MHIA and MHIA's contracted Service Centers, Vendors and Training Agencies.

COVER PHOTO:

Ken Sutton,
Owner

Photo by Jan Glenn during
PROP photo shoot.



Notice: Although this publication will provide you with useful information regarding the operation of your airplane, it is not and cannot be a substitute for your compliance with all applicable requirements from the appropriate airworthiness authorities.

Turbine Aircraft Services, Inc. • 4550 Jimmy Doolittle Dr. • Addison, Texas 75001
Tel 972-248-3108 • Fax 972-248-3321 • www.turbineair.com

Editorial by Pat Cannon

Well, here we are in the middle of the PROP seminar season. By now, the Dallas seminar has been completed, and the PROP team will be leaving for Tucson in a few days, then on to Cincinnati. This issue of the MU-2 Magazine is being distributed a week early to accommodate the PROP schedule. Since this issue was written and completed sometime before PROP started, we don't have any PROP stats for you. However, Ralph Sorrells has written a piece on the history of this great event. In looking back at the numbers, it becomes clear that PROP has had a significant impact on safety.

This month, we feature Gary Palmer as our Owner/Operator Spotlight and once again, our editor and writer have done an excellent job in giving you insight into his background and his reasons for choosing the MU-2 as his favorite mode of air transportation.

Since loss of control has been big on the FAA's agenda these days, Rick Wheldon has brought us in touch with all the elements of this justified concern.

Ron Renz brings us AOA Part II in preparation for the imminent release of this great system to the MU-2 community. Now you have everything you ever wanted to know about angle of attack.

We have welcomed Sean Roberts back to PROP again this year and as a follow on to Joe Megna's article about maintenance after paint, Sean will discuss the balancing of the flight control surfaces after paint as an essential part of that process.

Lastly, but certainly not least, Joe Megna discusses starter generator overhauls to give you a better knowledge of the whys and wherefores of maintaining this important piece of equipment.



Pat Cannon is President of Turbine Aircraft Services. He is an FAA Designated Pilot Examiner, former MU-2 Demo Pilot, and Safety Expert.



mt-propeller

New MT-Propeller STC for Mitsubishi MU-2B-Series

- Best vibration damping characteristics
- Bonded on nickel alloy leading edge
- Enhanced take-off distance
- Enhanced climb performance
- Unlimited blade life
- FOD repairable blades
- Cooler ITTs during engine start up
- Significant inside and outside noise reductions
- Unbeatable esthetic ramp appeal!
- Less weight than the original propellers (1591RPM Version)



EASA STC No: 10043855
FAA STC No: SA03315NY

The Winner's Propeller!

- 60 Service Centers worldwide
- More than 200 STCs worldwide
- 30 certified propeller models
- more than 30 years of production
- More than 65.000 blades in service
- 110 Million Fleet hours on MT-Propellers
- more than 16.000 MT-Propeller systems flying
- No active AD's on any MT-Propeller
- Best weight to price ratio in the industry

Airport Straubing-Wallmühle
94348 Atting / Germany
Phone: +49 (0) 9429 9409-0
Fax: +49 (0) 9429 8432
sales@mt-propeller.com



www.mt-propeller.com



Loss of

by Rick Wheldon

CONTROL

For several years, the National Transportation Safety Board (NTSB) has identified “Loss of Control” in General Aviation as one of the highest concerns on their “Most Wanted” list. NTSB statistics indicate that, over a ten year period, 40% of all fixed wing GA fatal accidents occurred when pilots lost control of their aircraft. Compared to other causes, Loss of Control was far and away the most likely cause of an accident in General Aviation.

It has been nearly 10 years since the introduction of Special Federal Aviation Regulation (SFAR) 108. There have been only 2 fatal MU-2 accidents since then, but both of these fell into the loss of control/failure to maintain airspeed column, and one of them involved an engine not running.

What would these “loss of control” accidents have in common? Loss of control is generally a euphemism for stall or stall/spin. Stall occurs for one reason only – the wing exceeds its critical angle of attack, or, more conventionally, the airplane is too slow considering its weight, attitude, G loading, and, to a lesser extent, altitude. Spins develop when an aircraft is stalled in unbalanced flight. Therefore, the ability to maintain control should be to simply maintain an adequate airspeed and keep the aircraft in balanced flight. Why do pilots have so much trouble following this simple prescription?

When approaching a stall at low altitude, one’s mindset makes it difficult to lower the nose to reduce the angle of attack. Yet history has shown, time and time again,



Rick Wheldon is Vice President of Turbine Aircraft Services. He is an Aeronautical Engineer, and is a former U.S. Navy aviator and MU-2 Demo Pilot.

that doing just that will vastly improve the likelihood of recovery or, if recovery is not possible, survival, because the airplane remains under control, wings level, at low energy. I am reminded of a non-fatal MU-2 accident in Scottsdale, Arizona in 1996. The accident airplane was unable to climb after an engine failure, likely due to being overweight for the takeoff conditions. What the pilot did right was recognize his inability to climb, lower the nose, and land on an off-airport street. While the airplane was destroyed, the pilot survived. He did not allow his airspeed to deteriorate, he did not enter a stall/spin, and he flew the airplane to the ground under control. He made a timely and positive decision that he needed to land off-airport, and once the decision was made, he executed it. However, there were accidents in the past where proper decisions were not made, and the aircraft occupants paid the ultimate price with a stall/spin.

There are some characteristics of twin engine airplanes that should be reviewed here. First, when operating on a single engine at low speeds and with the operating engine at full power, small changes in airspeed result in large changes in yaw. Consequently, maintaining the ball near the center becomes more difficult if you have allowed your airspeed to decay, even slightly. The solution? Keep your airspeed stable at Airplane Flight Manual (AFM) prescribed values or slightly higher. This will reduce your workload considerably and, unless the wing is contaminated, it will also eliminate the likelihood of a stall. Airspeeds from the AFM and checklist have been flight tested to provide an adequate margin over stall. Review these speeds as part of your takeoff and approach planning, and don't go below them. Also, know your V_x and V_y speeds (which are on your checklist.)

Second, directional control is only a problem when the operating engine is at full power. If you are unable to maintain directional control, ensure you are banked slightly into the operating engine and, if this fails to correct the problem, reduce power on that operating engine. Do not allow the aircraft to slow further, as you are probably close to stall. It is better to accept a descent rather than loss of control.

Third, it is possible to load your aircraft so that it will not climb in the event of an engine failure. This will generally be due to some combination of high weight, altitude and temperature, but can also be caused by engines that do not perform to their "book" values. Many pilots will progress to stall/spin when they find themselves unable to climb. Fortunately, this can also be dealt with. In 2006, Mitsubishi Heavy Industries America, Inc. added charts to the Pilot's Operating

Manual and checklists which provide single engine climb rates at various weight, altitude, temperature and flap combinations. Thus, our typical prudent MU-2 pilot can load his airplane to ensure his ability to climb after takeoff. He can use the same chart for reference when approaching a high/hot airport for landing. Engine performance can be dealt with by referring to the power assurance charts in the AFM and checklists.

Fourth, single engine performance will be best with minimum drag. Drag reduction is achieved first by retracting the gear and landing lights, and feathering the propeller. Initially, flaps should remain at their current position until clear of terrain, at which time a level acceleration should be accomplished and the flaps retracted on schedule. Any rotation of the propeller or any propeller blade angle less than feather blade angle will produce some extra drag. For the MU-2, that means that the Negative Torque Sensing (NTS) system is a stopgap measure, basically allowing the pilot time to feather the propeller with the condition lever in order to eliminate the remaining drag. In my experience, gear drag, nominally, can reduce climb rates by 600 feet per minute and the landing lights can reduce climb rates by another 50 fpm. My habit pattern is, when I raise the gear, the landing lights come in at the same time.

Lastly, loss of control can also result from sudden power addition at very low airspeeds, even with both engines running. Especially when slow, a rapid power addition will cause the nose to rise, and, if uncorrected, the wing to stall. If power is added without proper pitch and rudder inputs, a spin can develop. On approach, while a pilot is looking for the runway, he might be surprised when the stick shaker activates while his scan is outside. With the airplane just a few hundred feet above the runway, if he rapidly adds power without rudder, the airplane nose could pitch up with a consequent stall or spin. Rather than a rapid power addition, a better action would be for the pilot to follow the current FAA's Commercial Pilot Practical Test Standard which calls for the pilot to lower the nose, accelerate, then slowly add power. He will probably still avoid ground contact while maintaining control. Seldom are more than a few hundred feet of altitude lost during this type of stall recovery.

In summary, all "Loss of control" or "Failure to maintain airspeed" accidents share two things in common – in each, the airplane got slow, and the airplane was flyable. Perhaps there is a third common factor – that the pilot was not properly prepared. We owe it to ourselves and to our passengers to be well prepared so that these needless accidents never happen to us.



Peeling Back the Layers

by Kimberly Fish

Featuring Gary Palmer, J.F. Palmer and Sons Produce, Inc.

Picture early morning light washing over acres of onion fields growing in the flat, sandy soil of Mexico. An irrigation system pulses water sprays over green stalks attached to big bulbs of sweet 1015s (a tasty yellow-bulb onion favored by cooks.) And banking off to the north is an MU-2 Solitaire flying into Tampico International Airport to scout the fields for harvest. This scene is repeated multiple times during the growing season as Gary Palmer, co-owner of J.F. Palmer and Sons Produce, sweeps in to monitor the conditions of a crop he'll eventually warehouse and ship to markets all across the southern United States. Gary oversees an extensive series of details getting fresh onions into the hands of consumers.

One might expect a pick-up truck to be the vehicle of choice for someone associated with the farming industry, but so much of Gary's day-to-day operations require

him to be in various locations across the Southwest and Mexico that a rugged airplane that can hit serious air speed is essential for him being able to network with farmers in the morning and be back at his home by nightfall. Since 2003, his plane of choice has been a Mitsubishi twin-engine turboprop. He started with the longer model with larger hauling capacity as he was moving employees between Texas, New Mexico, Arizona, and North Dakota, but as his business model changed, so did his airplane. The shorter Solitaire helps him make the deadlines and appointments critical to the fresh food market; peeling away some of the time constraints that might befall someone whose transportation was limited to highways and commercial air travel.

Aviation has been an integral part of Gary's family business since 1981. Licensed in 1979, the Palmers first rented planes then began purchasing Pipers,



Beechcraft, and Aerostars before committing to an MU-2 Marquise in 2003. Gary takes aviation safety seriously and does his due diligence in research; so when he was considering moving from the Duke to the MU-2 he decided to commit 20 hours to a ground school so that he could be as knowledgeable as possible before he decided to purchase. Reliability was a key feature in the plane he wanted to fly, and spending the 20-hour sessions with Reece Howell convinced Gary that not only was the MU-2 the solution to his search, but that the myths that had long been associated with the airplane were... a lot of hot air. Howell didn't just tell Gary that the aircraft was safe and reliable; he put him in the cockpit and took him into the air to prove it. In a series of "what have you heard" scenarios, Howell proved that the rumors about engines and airframes were not a function of how the MU-2 was built, but rather how the pilot is trained to fly. Seeing how the airplane was engineered, its rugged airframe, and the fact that it's the only "U" (for utilitarian) category plane in general aviation were convincing facts for Gary. In the years since, he has discovered that his initial impressions were solid. Even now, when other pilots ask Gary about safety and performance features, he has a list of examples to allay their concerns and delights in validating the twin-engine, turboprop at every opportunity.

Because reliability is critical with his weekly aviation needs, the MU-2 has never disappointed him. Ever. He's seen other pilots have their flight plans scrubbed because of maintenance issues, but his experience is the opposite. He credits much of that enviable track record to the 100-hour inspection requirements, the experts at Carolina Turbine Support in Aiken, SC and Intercontinental Jet Service in Tulsa, OK (Authorized Mitsubishi MU-2 Service Centers), and the flexibility of updating technology systems within the airplane. As a

CAA member, the speed and strength of the Solitaire enables him to frequent almost exclusively CAA-affiliated FBOs. Networking is an intrinsic layer to Gary's line of work, but he enjoys the camaraderie of fellow MU-2 pilots to be one of his favorite byproducts from being an owner/operator.

Participating in the Fly-In this fall in Aiken, SC was a treat for someone who already had spent thousands of hours in the air. As Gary is also an advocate for safety training, and trains semi-annually at SimCom in Orlando, FL, he enjoyed the sessions with experts and the mixers with other pilots. Much like the stories between farmers and their crop yields, pilots of MU-2s have an endless supply of tales and adventure too. No one understands that more than other MU-2 pilots. With the PROP safety seminar in Dallas already on Gary's schedule, he's looking forward to networking, technique training, and technology updates in a format that is easy to digest. Plus, he admits it's comforting to know that so many pilots take their training and safety issues seriously. That gives a pilot confidence in the air. With the longevity of the MU-2 proving itself over and over again, having well trained pilots with honorable flight logs dismisses a lot of the myths that still hover from the airplane's past.

While the rest of the country is considering locations for Spring Break, Gary Palmer is at his busiest with the onion harvest production. Knowing that he can rely on his MU-2 Solitaire to get him to meetings, appointments and harvest scouting and still be back home at the end of the day gives peace of mind. The skill and his training associated with this mode of business travel gives him pleasure. His airplane is an essential asset to his business and his business is essential to consumers. The MU-2 is an integral part of the recipe for his success.

Painting Your Plane? Rebalance it too.

by Sean Roberts

Painting your personal aircraft makes the aircraft look as good as new. However, unless the paint shop really knows how to paint and balance the flight controls after repainting, you could be unpleasantly surprised on the first flight after aircraft painting.

- **UNBALANCED FLIGHT CONTROL**
- **HARD/FIRM LANDING**

At touch down, since the center of gravity of the flight control is aft of the pivot point, the control surface will move the trailing edge down, resulting in an increase in lift on the horizontal tail, thereby resulting in a nose down pitching moment.

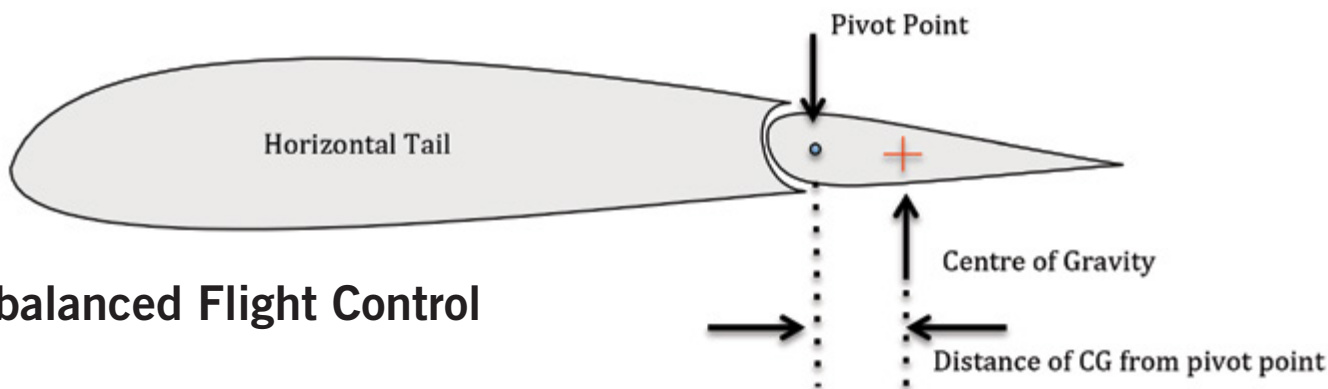
The nose gear will hit hard then bounce back. With the pilot in the loop, he will pull back on the yoke, resulting in longitudinal porpoising and possible damage to the nose gear. Longitudinal porpoising due to the nose gear

compressing and expanding, combined with the pilot in the control loop is difficult to control. If you ever get in that situation, the best solution is to go around. Going around will prevent damage to the nose gear and allow the pilot time to relax and plan a 3 degree approach and a soft touchdown on the main wheels only.

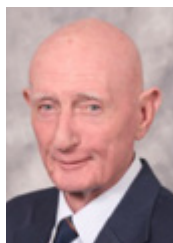
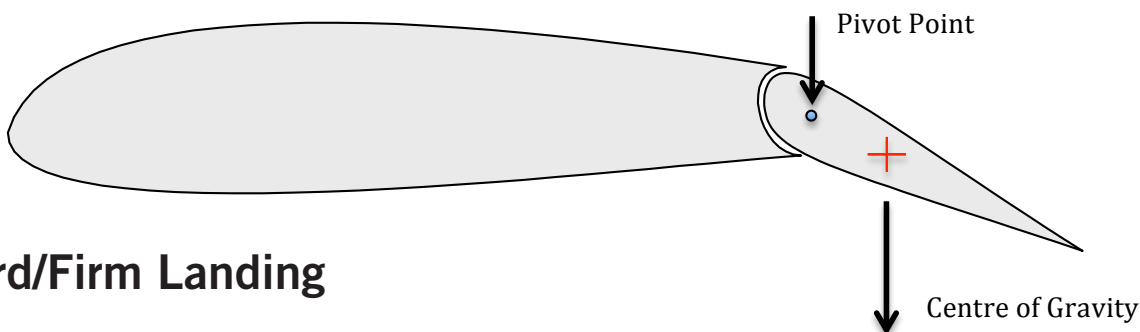
• FLUTTER

Your maintenance manual is usually very specific about how to balance your controls. One of the possible unintended consequences of not rebalancing your control surface after either painting or performing a repair on the control surface is flutter. This does not mean by any means that flutter will definitely occur if you don't rebalance your control surface. But if you change the mass balance of a control surface, its flutter frequency may not be the same as it was originally and you may find yourself in flutter at a much lower speed and much different frequency. This has happened to me in several test programs. One case was where maintenance was not performed following a service bulletin put out by the manufacturer. This particular aircraft suffered tail flutter at 120 Kts. The aircraft was slowed down and recovered but the results could have been catastrophic.

Unbalanced Flight Control



Hard/Firm Landing



Sean Roberts was born in Ireland and learned to fly while he was apprenticed at Short Bros. & Harland Aircraft Co. He soloed in 4.5 hours. He has a BS in Aeronautical Engineering, a graduate degree in Aeronautical Engineering, and was a Fulbright Research Scholar at Mississippi State University. He is the founder of Flight Research, Inc. and also is the founder and director at the National Test Pilot School. He has participated as a test pilot for numerous FAA STC projects and is the author of more than 50 publications in professional journals.

Maintenance Matters

At your Authorized Mitsubishi MU-2 Service Center

There Is A Difference



- Highly trained, factory service personnel
- On-site MU-2 Ambassadors and Technical Representatives
- Detailed aircraft status reporting
- Highest standards including FAA Certified Repair Station
- In-house MU-2 parts inventory, specialized tooling, technical publications
- Rated #1 in AIN Product Support Survey
- Meets liability insurance standards
- In-depth pre-purchase knowledge and support
- Minimal aircraft downtime, rapid deployment
- Maintained to the highest factory standards
- In-house overhaul/repair capability

Domestic Service Centers



Tulsa, OK • (800) 349-6827
www.ijetservice.com



Green Bay, WI • (800) 382-0250
www.jetairgroup.com



Aiken, SC • (888) 222-7969
www.cts-mu2.com



Vienna, OH • (800) 837-4964
www.winner-aviation.com



SAAB

Nykoping, Sweden • 46-155-77100
www.saabgroup.com



Goiania, Brazil • 55-62-3096-7000
www.voeseite.com.br



Professional Aircraft
Maintenance Inc.
Bakersfield, CA • (661) 302-5151

PROP:

A SHORT HISTORY AND GLIMPSE OF THE FUTURE

As many of you know, a Special Certification Review (SCR) was conducted by the FAA in the early 1980s, resulting in the FAA determining that the MU-2 was properly certified. "No Common Thread" was found for any of the accidents that had occurred. But Mitsubishi Aircraft International, Inc. (MAI) and later Mitsubishi Heavy Industries America, Inc. (MHIA), consistently being proactive when flight safety is an issue, looked back to the 1982 time frame when MAI initiated a program called Pilot's Review of Proficiency or PROP. While not a training program, it was offered free of charge to MU-2 Owners and Operators and was credited with improving MU-2 flight safety. Learjet had previously developed Checklist '81 to do a program similar to PROP with similar results.

PROP IS REBORN...

In the mid-1990's we asked, "Would a resurrection of PROP be effective again in improving flight safety if the program was reborn?" In 1994 PROP was resurrected and again made available free of charge to all MU-2 Owners and Operators, and it was hugely accepted. The answer to the question above was an emphatic...YES. Pat Cannon, who was a key participant in the 1982 version of PROP, again became the key presenter for the new version of PROP. "Things were certainly different between PROP 1982 and PROP 1994", said Pat. "In the early years our state of the art was using a slide show and some overhead projection. But it worked, and it was quite effective in improving flight safety." Yes, things are certainly different today in the way we do our PROP presentations. Newer computers, projectors and software have to be utilized to keep up with the rapidly evolving technology in the area of media presentations. "Heck...we used bulky hand held video cameras to do our in-flight shots" Pat laughed. "Today, we have high resolution cameras stuck practically anywhere we want them (on and in the airplane). We can get some pretty dramatic shots that way." Several other original equipment

manufacturers (OEMs) have solicited the advice of Mr. Cannon to try to come up with a program similar to MHIA's PROP program.

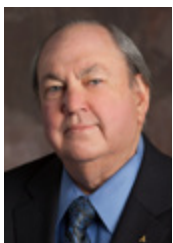
At the end of PROP 2016, PROP will have been presented 69 times, not only in the U.S. but in 5 foreign countries as well. All-in-all, based on the number of registrations for PROP 2016, over 5000 attendees of this biennial event will have been recorded. "There is only one person who has attended all 69 PROP Programs and that person is me", Pat declared.

I have been asked, "Why does PROP improve flight safety?", and I can only speculate on an answer. I believe PROP effectively establishes a catalyst composed of MU-2 Owners and Operators who interact to discuss the cause of accidents, the error chain leading to an accident, decision making, maintenance issues, and training. No one expects to have an accident, but when a person is faced with having to make a go or a no-go decision perhaps they question, "Is this a link in the error chain? Do I have to make this trip today? Is all of my equipment working properly? Am I subjecting myself to get-home-itis?" These are all subjects discussed at PROP. Of course PROP, along with Special Federal Aviation Regulation 108 and safety improvements initiated by MHIA, has been instrumental in improving flight safety for our MU-2 drivers to the point that the MU-2 has earned the distinction of one of the safest turboprops flying.

...AND STILL GOING STRONG

It is commendable that MHIA and its parent company, Mitsubishi Heavy Industries, Ltd. (MHI) have continued to support our MU-2 Owners and Operators with PROP for the past 20+ years. MHIA's General Manager, Kensuke (Ken) Takeuchi has already committed to PROP 2018 and work has begun on it. "While you will see some changes in the 2018 PROP Program, we intend to keep the content fresh and exciting as you have come to expect over the years", Ken said. "The main change will be that MHIA will pick up the reins long held by Turbine Aircraft Services (TAS), to promote and present PROP in 2018, but you will see many of the same faces that you've seen over the years. We'll have quite a challenge following in the footsteps of TAS, but with their assistance in the future, we believe we can provide an interesting and informative PROP series". Ken continued, "And you can expect to see some innovations that MHIA believes will be well received by the MU-2 Owners and Operators and which are designed to add some new spice. We're excited about the future of PROP and the MU-2 airplanes."

Keep 'em Flying Safely.



Ralph Sorrells is Deputy General Manager of Mitsubishi Heavy Industries America.



Dear MU-2 Magazine Reader,

My name is Richard Shine, and I am the CEO and Chief Pilot of Manitoba Corporation, a family-owned metal recycling company founded by my grandfather in 1916, and based in Lancaster, NY. Like many of you, my business would not exist today without my Mitsubishi MU-2. It has allowed us to go outside our region and generate the product we need to stay in business. We're able to make quick trips, see the right people, and yet be back to mind the store. And for nearly

20 years, our NBAA Membership has been indispensable in that process, ensuring we use our aircraft as safely, efficiently and cost-effectively as possible to achieve success for our company.

I believe so strongly in NBAA, in fact, that in 2008 I joined the Board of Directors and am now a past chairman. I am committed to ensuring that the many small and mid-sized companies in NBAA's Membership continue to have a strong voice on the Board.

I have often been asked, "As an MU-2 operator, why do you belong to NBAA?" And my answer is always the same: If you use your airplane for business – no matter how large or small the plane or the company – NBAA has resources to help you succeed. In fact, there are a number of Member benefits designed *specifically* for owner/operators, single pilots and anyone using a light business aircraft (LBA). Here are just a few I think you will find particularly useful:

- **LBA Flight Operations Manual** – provides guidance on topics such as safety management systems (SMS), standard operating procedures, qualifications and training, and includes a risk assessment tool designed specifically for LBA operators.
- **Operations Service Group and NBAA's Website** – gives you access to expert help on *any* issue you face. Whether it's a question on taxes, regulatory changes, personal use of your aircraft or any number of topics, you can research and find the information on www.nbaa.org, or simply call or email one of the on-staff industry experts in NBAA's Operations Service Group Help Desk, and they will have the answers you need.
- **Reimbursement of Flight Expenses for Owner Pilots Handbook** – a comprehensive reference guide to help you gain the maximum Federal reimbursement cost benefit from your airplane.
- **Frontline Advocacy** – NBAA represents the interests of *every* company using an airplane for business, working hard to fight onerous proposals – which could have a devastating impact on your business and your bottom line. Adding your voice to NBAA's will greatly strengthen the Association's work in Washington, and help protect the future of this industry.

I would like to extend a special offer of \$189 first-year dues to all of my fellow MU-2 Magazine readers. Simply join online at www.nbaa.org/join/MU2 and enter Promotional Code: **MU2MAG** when prompted in the payment section. I look forward to welcoming you as a fellow Member.

Sincerely,

Richard Shine
CEO and Chief Pilot, Manitoba Corporation
Past Chairman, NBAA Board of Directors

HOW TO USE ANGLE OF ATTACK (AOA)

A follow up to the article "Why Fly Angle of Attack?" that appeared in the January 2016 issue of MU-2 Magazine.

by Ron Renz



THE IMPORTANT PREMISE FROM MY LAST ARTICLE ON AOA BEARS REPEATING...

Angle of Attack (AOA) systems increase safety by indicating and alerting the pilot when entering a critical phase of flight which might result in **LOSS OF CONTROL** due to a stall or spin unless immediate and appropriate action is taken. An AOA system does this by increasing pilot awareness of the **MARGIN FROM STALL**.

Also repeated here is the most important graphic from that article. The Lift Coefficient vs AOA graph (Figure 1) provides important details about the airplane flight characteristics which an AOA indication system provides to the pilot.

So how does one make the best use of that information? Comments made in this article are general in nature, but the details refer directly to the AOA system that has been developed for the MU-2B.

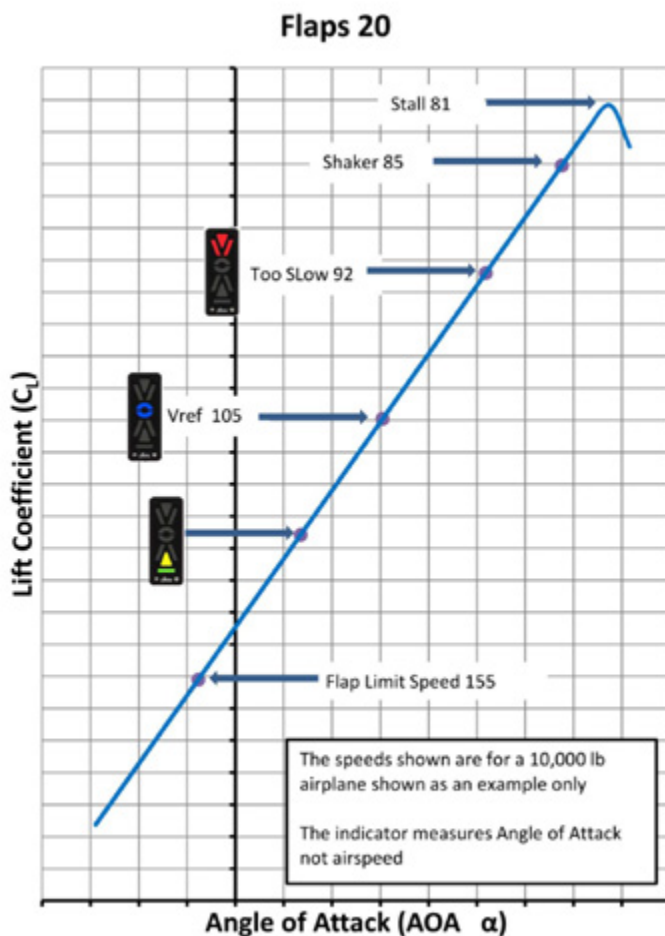


Figure 1 Lift Coefficient vs AOA



Ron Renz is a member of the MHIA engineering support team for the MU-2B, with degrees in both Aerospace and Mechanical Engineering. Ron carries an ATP certificate, is an A&P with Inspection Authorization, and has served as both a flight test engineer and a flight test pilot. Ron has worked on STC programs, new aircraft programs and has developed specialized techniques for simulator data gathering during flight test programs.

Normal Operations:

Let's start with normal operations. Use the AOA indicator's blue donut to verify V_{Ref} , i.e. use it as a cross check for the Checklist-specified speed. (V_{Ref} will be used in this article to describe the recommended threshold crossing speed from the FAA Accepted Checklist tabular data.)

If a large difference exists between AOA indication and the checklist V_{Ref} , verify the gross weight and recheck your V_{Ref} calculation from the checklist. If the weight/ V_{Ref} calculation is not causing the discrepancy, then you must disregard the AOA indicator, because the FAA has determined that the AOA system is a secondary instrument only and the airspeed indicator is primary. As always, for gusty crosswind conditions, add $\frac{1}{2}$ the steady stated wind plus all of the gust, but not to exceed 10 knots to your V_{Ref} airspeed. This is about 3 to 4 AOA segments. Therefore, in the worst case crosswind adjustment, fly the segments shown as $V_{Ref} + 9$ or $V_{Ref} + 12$ knots (Figure 2.)

Now, fly the speed just verified with the AOA indicator using the airspeed indicator as the primary reference, especially during IFR approaches, since the Glideslope and Localizer indications are on the instrument panel near the airspeed indicator. The big benefit here is that the pilot now knows the margin from stall at the current weight and configuration. Refer to Figure 1, the Lift Coefficient vs AOA graph. This shows that at V_{Ref} , there is a comfortable margin from stall. This knowledge

provides confidence in the numbers rather than arbitrarily adding 5 knots for the wife, 5 knots for the kids, and 5 knots just for good measure. At minimums, begin the transition outside; keep AOA in your peripheral vision with the goal that by 50 feet above touchdown, you will be at the target speed and AOA. At 50 feet, start a normal deceleration and be aware that, at touchdown or just before touchdown, you may hear the "TOO SLOW" message. If you train yourself to fly this way, you will automatically become a more precise pilot, become much more in tune with the airplane, and enhance your ability to fly according to the numbers. This will help reduce wear and tear on the airplane, tires and brakes, and provide comfort that landing distances will be achieved reliably.

In the pattern, keep the AOA indicator in the scan. AOA will help in maintaining proper stall margin, especially when turning. In a turn, the load the wing must carry increases, and in order to maintain altitude, AOA must increase and the margin above stall must decrease. However, even with stall margins slightly decreased during level, circling turns, margins should still be more than adequate, and above the blue donut, if proper profile airspeeds are maintained. Of course, anticipate adding small amounts of power during level turns to maintain proper airspeed as per the SFAR profiles. Use the AOA indicator as a guide to help determine how much power to add during the turn. Note that airspeeds called for in the SFAR 108 profiles

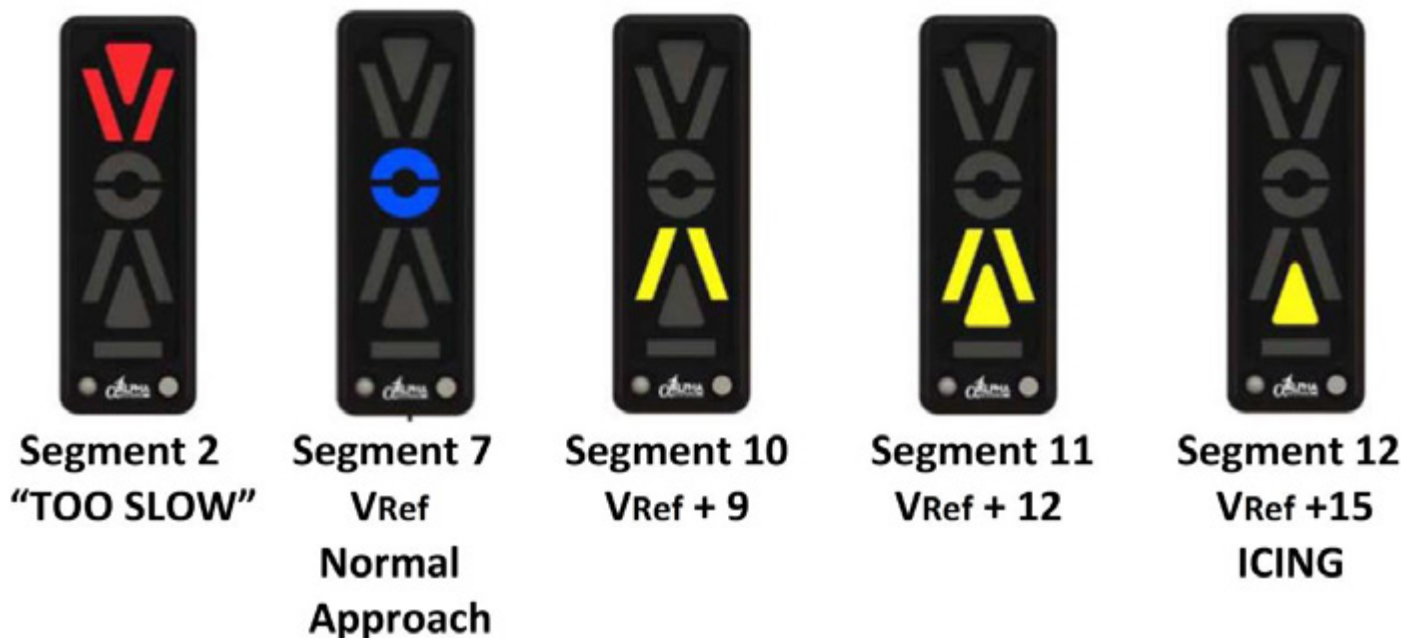


Figure 2 Selected AOA Segments

provide adequate margins above stall as long as bank angles do not exceed 30 degrees.

On descent to landing, AOA can help fly a precise glide path. Use AOA to help control the pitch angle and airspeed, and use power to control descent rate. Remember the mnemonic that your instructor used during IFR training? “Pitch controls airspeed, power controls rate of descent.” This really means pitch controls AOA, and now you know why this is important. As you learn to use AOA, remember to point the nose in the direction the AOA arrow indicates. For example, when slow, the shapes of the AOA indications point in a downward direction. Therefore, proper response is to push the nose down. Conversely, when fast, the AOA arrows point up, telling you to raise your nose. AOA is an intuitive indicator.

As the airplane accelerates on takeoff, keep the AOA indicator in your peripheral vision and plan to accelerate past the Blue Donut into the yellow range as the airplane climbs away from the runway.

Non Normal Operations, the Real Safety Benefit:

Where the AOA will most likely have the most marked safety benefit is the circling IFR approach. Imagine you’ve just shot a great minimums approach, and now you need to circle. Where is your attention focused? Often, you’re outside the cockpit keeping the runway environment in sight. Then, out of the corner of your eye the AOA display transitions to the red chevrons. You notice this. If you are circling to the right, AOA will be in your direct vision, and if circling to the left, AOA will still be in your peripheral vision. Red chevrons should bring you back to the cockpit instrument panel and alert you to the threat of low airspeed and possible low altitude, thus providing time for you to correct the situation while there is still plenty of margin from stall. If you don’t notice the display, the next indication will be the voice alert “TOO SLOW” in your headset. Tests conducted on the M-2 show that there is ample margin at the voice alert to correct the situation if prompt action is taken. Abandoning the landing, and executing a missed approach may be the safest action to take.

Let’s assume that an engine failure occurs shortly after liftoff. With runway remaining, the pilot can focus outside and execute an emergency landing, while keeping the AOA indication in his peripheral vision and keeping the airplane flying with adequate stall margin during this critical maneuver. If there is not enough

runway remaining, while transitioning to single engine climb, if the speed deteriorates, the AOA indicator can help in several ways. If the airspeed or AOA deteriorates away from best climb toward stall, the red chevrons will be the first indication, alerting the pilot to take action. Lowering the nose to increase airspeed is the appropriate response. If the red chevrons are not noticed, the next indication would be the voice alert “TOO SLOW,” bringing attention to what is now a critical problem. At the “TOO SLOW” alert, the airplane is at or near the minimum control airspeed and well below V_{YSE} , requiring immediate action to rectify the situation. Lower the nose and reduce drag prior to potential loss of control. Feather the engine when time permits. Check gear position and landing lights. Leave flaps in their takeoff position until clear of obstacles, at which point accelerate and retract flaps on schedule. Once rectified, the climb can continue.

During a missed approach or go around, either multi engine or single engine, a potential loss of control is again lurking nearby. AOA can again help alert the pilot if loss of control is imminent. The scenario is virtually identical to the engine failure on takeoff, except that if flaps are at 40 for landing, immediately select 20 and establish a climb attitude.

These are just three potential scenarios where the AOA system may mean the difference between loss of control and a non-event. In each, information is available to alert the pilot of a potential loss of control in the form of a visual indication in his field of view, and, possibly, a voice alert of “TOO SLOW” in his headset. The response is always the same - focus back to the cockpit instruments, lower the nose, reduce drag, add power (as appropriate) and maintain control of the airplane.

Icing:

Icing will change the Lift Coefficient to AOA characteristics. A wing covered with ice will require a higher AOA to provide the same lift, and the stall angle of attack will be reduced compared to a clean wing. The MU-2B Checklist says: “When landing with any ice accumulation on the wing, increase the computed V_{Ref} by 15 knots.” This quantifies what happens to the wing lift characteristics for the MU-2B. Use AOA segment 12 shown in Figure 2 when determining the proper speed to use for the approach. On the MU-2B installation, AOA probe heat is provided whenever the right hand pitot heat is turned on. Like all airplane systems, this needs to be verified functional before relying on it in icing conditions.

Other:

There will be an AOA for best climb, both V_x and V_y . Testing conducted for the MU-2B AOA system did not determine these data points. Each pilot can determine the AOA for V_x and V_y , but they will be among the higher yellow segments.

Conclusion:

AOA can provide a substantial safety advantage when used by a trained pilot, providing ample warning of deteriorating flight situations. The FAA has determined that adding AOA as a supplemental system can significantly reduce loss of control mishaps.

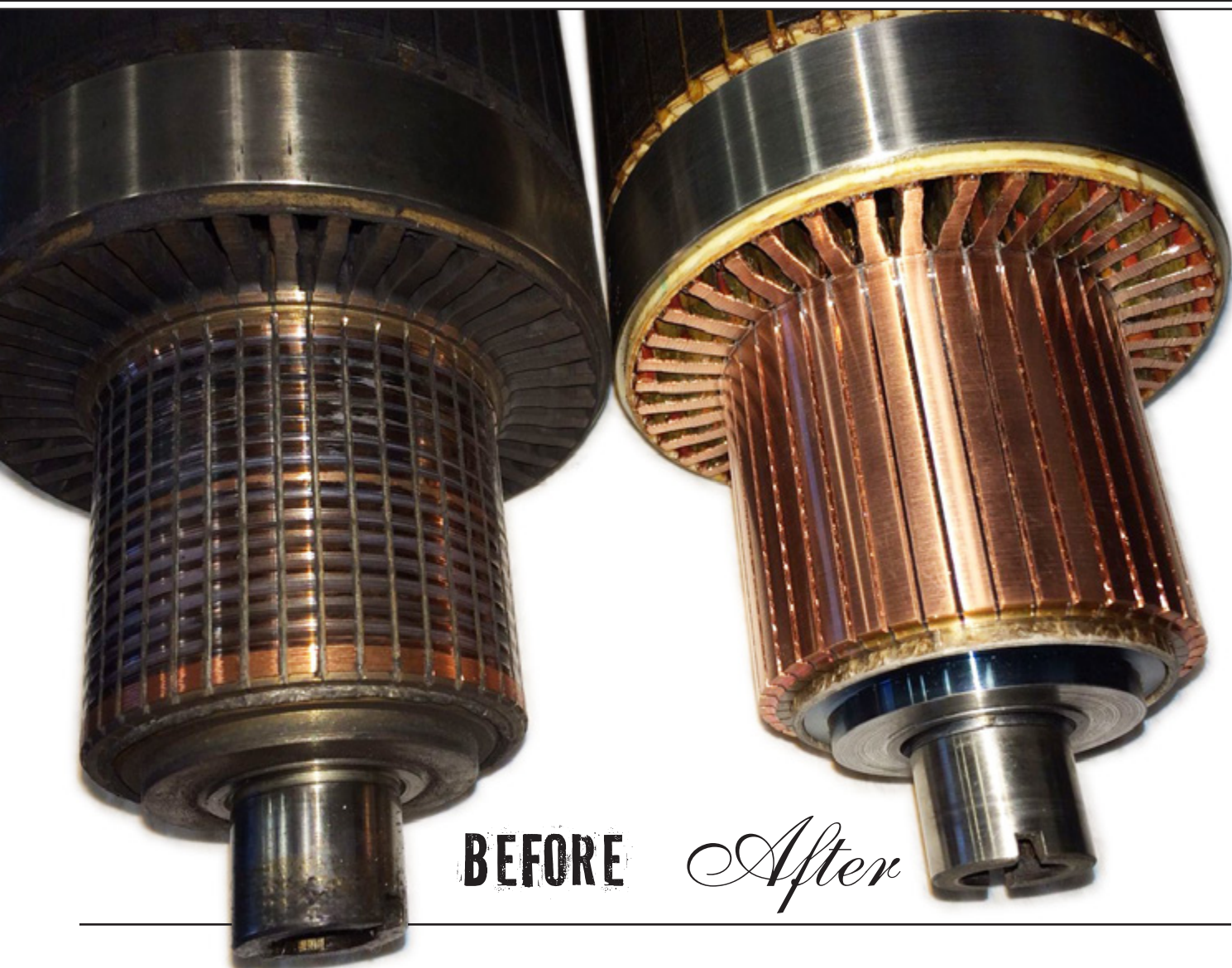


IMPORTANT POINTS TO REMEMBER:

Keep the AOA indicator in your peripheral vision to monitor lift reserve, especially during head-out-of-cockpit flying.

**If below Blue Donut, it is time to do something.
Actions to take are:**

- Decrease bank and/or lower nose
- Increase airspeed
- Increase power as required in a coordinated manner
- Be aware that if the airplane is turning, all these actions will result in the turn radius increasing. If you are in the landing pattern, is the airplane too close to the runway?
- If on approach to a runway you may need to consider a go around.
- Execute a go around if a stable adequate airspeed or reasonable bank angle cannot be maintained.
- At voice alert “TOO SLOW,” immediately reduce bank angle and/or lower nose and, after accelerating, add power.
- If on approach, go around?
- The “TOO SLOW” aural warning will typically sound prior to the stick shaker, so earlier warning of an impending stall is provided.



Starter-Generator Overhaul

by Joe Megna

The starter-generator has a tough job to perform. It must produce no load speeds of 3,500 to 4,500 rpm and produce up to 300 amps during the entire operating cycle of the engine. In addition, it is expected to last nearly 1,000 hours of operation before recommended overhaul.



Joe Megna served in the US Navy working on carrier-based aircraft in Southeast Asia. Joe started with Jet Air Corp. in Green Bay, WI in 1978 working on MU-2 aircraft and left Jet Air Corp. as General Manager in July, 2015. Joe is now the Product Support Manager for Mitsubishi Heavy Industries America in Addison, TX.

This author is a former General Manager and Director of Maintenance at Jet Air Group in Green Bay, WI. Jet Air Group has been an overhaul facility for starter-generators since the late 1990's, and is also a business jet/ turbo prop and general aviation maintenance facility and an Authorized Mitsubishi MU-2 Service Center. Starter-generators, even though the overhaul intervals are 1,000 hours, seldom make a thousand hours due to brush wear. The brushes average, depending on what model starter-generator they're used on, somewhere in the neighborhood of 400 hours – higher if it's turning a free-spooling turbine such as the Pratt & Whitney PT6, less if it's turning the Honeywell 331 engine, driving the prop, gearbox, and accessories. The TPE-331 is much harder on the brushes and on the starter.

The starting cycle is where most of the wear and stress is placed upon the starter. And it's here where technicians and operators should adhere strictly to manufacturer's start and cooling cycles.

THE OVERHAUL PROCESS

The primary starter-generator that Jet Air Group overhauls is Safran Power, formally Lucas Aerospace, BF Goodrich or, long ago, the Lear Siegler. The models used on MU-2 aircraft are the 23046-007 and 007M along with the 23046-028, which are used on the later models with dual heated windshields.

Basically, when JetAir receives a starter-generator for overhaul and/or repair, they make sure all components are there and observe the general condition for warranty claims. They completely tear down the unit and inspect the air inlet and fan, the brushes, holder and tension springs, drive shaft, damper hub and friction ring. Then they'll look at the stator subassembly and the RPM pick-up (if applicable.) The unit is cleaned, inspected, and tested. The armature commutator is then cut, undercut and Hi-potted for shorts or grounds. They then balance the armature. The elimination of vibration is critical to the longevity of the Starter Generator.

Once they're done reassembling the starter, they complete run sheets designed by the manufacturer to ensure the starter-generator meets all output data.

A typical starter-generator run-in requires a variable speed test stand capable of driving the starter-generator at speeds of 6,000 to 12,000 rpm at rated load, and 13,000 rpm at no load. It also needs to be equipped with suitable instrumentation to measure torque, speed,

voltage, current and temperature, and the power supply must have a capacity of not less than 700 amperes at 10 volts. Additionally, the ambient temperature must be controllable, and a means for providing cooling air must be provided.

Essentially, the technicians try to simulate conditions of the starter-generator when it's in the aircraft inflight, where a cooling duct is attached and ram air provides cooling. They also perform tests with the ducting detached and allow the unit to self-cool. This simulates idling conditions where the aircraft is not being provided with ram air and has to pump air with its own fan.

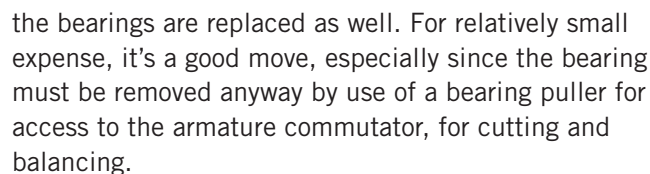
Another area where there's a lot of wear and tear is in the starter drives. This inspection requirement is in the MU-2 Maintenance Requirements Manual. On the engine side, Honeywell went to a Torlon® insert that doesn't require lubrication. If there is excessive wear on inspection, just replace the insert. On Pre-Service Bulletin (non-Torlon) engines, technicians might have to replace the entire starter drive gear, which could entail disassembly of the gearbox if problems occur with the removal of the starter gear. On the starter-generator side of Pre-Service Bulletin engines, the drive shaft would also typically require replacement, generally due the fact that it's a metal to metal drive with only a small amount of grease to protect the gear-shaft connection, and both the shaft and the gear wear at about the same rate.

The armature and field are the "heart" of the starter-generator and the most costly parts. If the armature is replaced either due to undersize of the commutator or winding failure, it will be re-balanced as part of the overhaul process. In most cases one can expect to get about 4 overhauls on the armature, depending on how much material requires removal.

REPLACING BRUSHES THE RIGHT WAY

There are many facilities that don't have the resources to disassemble the unit to replace the brushes. They just replace the brushes on the aircraft. If this works (or even starts,) you'll be reducing the life of the armature. By this short cut, the brushes will not seat 100% and will cause arcing of the armature commutator. This will reduce the life of the unit, and also the proper output voltages and amperage may not be reached.

The starter-generator uses two bearings in the unit to support the armature, which is spinning at a speed in excess of 12,000 rpm. At that speed, they take a lot of abuse. Every time Jet Air's customers need brushes,



The following is a list of typical acceptance run tests that are performed before an overhauled starter-generator is returned to service:

The generator is operated at 7200 rpm, 30 volts, 200 amps, and the field current and voltage are measured to determine field resistance.

(varies between models)

The unit is operated at 12,000 rpm, 30 volts, and 300 amps until stabilized. Once the temperature is stabilized the output voltage must fall within specified limits. This is the normal speed and maximum output that the starter-generator runs on the aircraft. Before taking any measurements, technicians must stabilize the temperature of the starter-generator. This usually takes about 20 minutes of operation. At this point there

is allowed no more than a 2°F rise for each five-minute period of time. Also, they have to ensure

Finally, while the starter-generator is still hot from the above tests, the technicians will conduct a Hi-pot to Ground test of 250 volts AC, 60 Hz for one minute. There cannot be a breakdown of insulation between circuits and the frame.

One of the last tests they do during the overhaul process is the No-load starter test. After installing a 1.25 ohm resistor into the system, they then apply 24 volts and operate the starter portion of the unit. The speed shall be not lower than 3500 RPM.

While there are other tests that must be followed in the overhaul process, the above are a general overview of the process.

The starter-generator has to operate in a hot or cold environment along with carbon dust, grease and oil. These conditions only suggest that extra care should be given to the unit.

Look to Turbine Aircraft Marketing... For Aircraft Parts and Engines Including Hard to Find or Overhauled Parts for your MU-2

Think Turbine Aircraft Marketing

- Genuine Quality OEM Parts and Engines with Full Traceability
- New Surplus Parts Save You Money and Our Fast Exchange on Overhauled Rotables In Stock Saves You Time



At Turbine Aircraft Marketing we deliver results with our:

- Hard to Find Parts Locator Service
- Purchase of Your Surplus Inventory
- Consignment Inventory Management

- Quality time-continued parts with full traceability
- Cost effective new surplus parts and "as removed" parts
- Extensive overhauled/exchange rotatables inventory available
- Hartzell 3- and 4-blade hubs
- TPE331 -1 through -10 series engines
- Brokerage service for hard to find parts
- Surplus inventory purchases
- Consignment inventory management services provided by a product support staff continually recognized as the best in their field



Turbine Aircraft Marketing is your Aircraft Parts and Engines Specialist.

We can assist with any issue involving airframe, instruments, components, avionics and engines.



We also offer:

- Engine purchasing and sales
- Aircraft sales, acquisition and management
- Parts and Engines for Diamond / Beechjet
- Buyer/seller consulting



Turbine Aircraft Marketing, Inc.

Talk to one of our professionals today:



Rick Forbes
(972) 248-3108, x302
Cell: (214) 649-2290
rforbes@turbineair.com



David Finley
(972) 248-3108, x213
Cell: (214) 649-2288
dfinley@turbineair.com



Thelma Pence
(972) 248-3108, x305
Cell: (214) 649-2291
tpence@turbineair.com