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Winter Operations

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MU-2

SERVICE NEWS

MITSUBISHI HEAVY INDUSTRIES, LTD.
NAGOYA AEROSPACE SYSTEMS WORKS
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MODELS AFFECTED: All MU-2B Airplanes

Winter operations present unique challenges for flight planning, maintenance, and maneuvers, especially on approach and landing phases of flight. Mitsubishi Heavy Industries America, Inc. (MHIA) would like to remind all MU-2 owners and operators that careful preparation and prudent decision making are essential to safely overcome these various challenges.

Contaminated Runway Conditions

Contaminated runways always have negative impacts on airplane controllability on the ground. Selection of a landing airport is one of the most important decisions a pilot has to make. This is especially true during the winter when runway conditions may not be the usual "dry, hard surface" associated with performance charts in the Airplane Flight Manual. Pilots know instinctively that when a runway is wet or covered in packed snow or ice, wheel brakes may not be effective in stopping any airplane. This is due to the reduction of friction between the tires and the runway surface. This reduction of tire to runway friction could result in a loss of the ability of the airplane to react to side forces needed to control natural weathervane tendency in a cross wind, rudder inputs, or asymmetric propeller reverse. If the available runway at the preferred destination is shorter than 8,000 feet or is narrow, a prudent pilot needs to consider the impact of a contaminated runway's limitations on safe operation and factor in the availability of a suitable alternative airport.

For example, the friction coefficient between rubber and dry concrete is ~0.8. If the concrete is wet the coefficient reduces to ~0.25 or zero depending on hydroplaning. On hard packed snow or ice friction coefficients around 0.05 would be typical. This reduction in friction coefficient has a direct influence on both stopping distance and resistance to side forces trying to slide the airplane to the downwind side of the runway. Often, on contaminated runways, aerodynamic drag and propeller reverse are the only stopping forces available to the pilot.

This negative impact on airplane controllability may also be challenging during takeoff, especially in the event of an engine failure or a need to abort the takeoff.

Engine Rigging / Beta Transition

Another factor that is under the control of MU-2 pilots and essential to safe operations on wet or icy runways is engine rigging and adjustment. If the transition to Beta from the flight mode is uneven, a multi-engine airplane might naturally swerve. It is also common for pilots to carry extra airspeed during an approach in wet or icy conditions, which will result in a faster touchdown speed and further aggravate any swerving tendency. While the airplane might have been controllable under dry conditions, the added factor of an icy or a wet runway might be enough to cause a runway excursion. Fortunately, engines can be rigged and adjusted to evenly transition to ground idle, then reverse. However, the process is complex and best performed by a mechanic with appropriate training and extensive experience on your airplane. MHIA has appointed Service Centers with the experience to properly rig and adjust your airplane. Be prepared to fly several test flights after your engines have been adjusted in order to verify that the engines are transitioning to Beta evenly.

Landing Precautions

When approaching a runway that may be contaminated it may be useful to borrow a trick from floatplane pilots and do a reconnaissance flyby to assess winds, most favorable runway, surface condition and other important details before committing to a landing. Of course, if arriving at night at an uncontrolled airport, a flyby reconnaissance might not be feasible. That, by itself, might be a red flag. Arriving at the destination of choice is one of the great advantages of general aviation. However, poor decision making resulting in a runway excursion can spoil your whole day. Landing at an alternate airport may be the best decision for the existing conditions.

As a Pilot-in-Command, you must ask yourself the following questions(s) before planning any flight: Is another airport available with better conditions? Can the trip be postponed until the runway clears?

Conclusion

Thoughtful planning can make winter flying safe and allow you to reap all the benefits general aviation can offer.

Further Reading

Attached are previously published articles that address winter operations for MU-2 pilots: (1) Winter Flying and (2) Transitioning to Beta During Landing by Mr. Rick Wheldon. MHIA also suggests MU-2 owners and operators refer to MHI Service News No. 139 (A2PC), No. 093/30-014 (A10SW), "Cold Weather Operations", dated December 20, 2001.

If you have any questions on this matter, please contact MHIA at the following contact information:

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MU-2 Operations

Winter Flying | by Rick Wheldon

As the winter months approach, a review of winter flying practices is useful so that the unique conditions found during the winter months need not detract from the safe operation of your aircraft. Winter flight has always presented challenges – the key to successfully navigating these challenges is to understand the effects of snow, ice, low ceilings, cold temperatures, and other environment factors on your aircraft and to take steps to mitigate them.

Mitsubishi Heavy Industries, Ltd. (MHI) has issued a number of documents that offer guidance on winter operations. Service News 139 and 093/30-014 was distributed in 2001, and described how one Canadian operator "winterized" his fleet of MU-2 aircraft to optimize reliability. Since lubrication is such an essential ingredient to the dependable operation of the MU-2, especially with the landing gear and flap systems, the Service News offered tips on lubrication techniques, which ensured that the various systems operated in their intended manner. Often, because of the extreme cold, the operator would lubricate at more frequent intervals than was required by the Maintenance Requirements Manual, and would use specific techniques which would thoroughly and evenly distribute fresh grease over the entire range of travel of the various jackscrews and torque tubes. Operators in northern climates would benefit from a review of this Service News.

Rubber components may become brittle in extreme cold conditions, so it would be wise for any operator to carefully inspect hoses, clamps, hydraulic fittings and seals for leaks or deterioration prior to the winter onset and regularly during winter. Suspect components should be replaced. Also, although control cable tensions are normally checked every 600 hours or 3 years, extreme cold could affect tensions, and a recheck might be warranted at winter onset. Finally, it wouldn't hurt to drain the static system to ensure that there has been no water buildup.

Preflight inspections are especially important during the winter, and a natural human tendency is to hurry through the preflight because of the extreme cold conditions. In fact, more time should be spent on the winter preflight than would be required in more moderate conditions. One technique to counteract the tendency to give short shrift to the winter preflight is to dress as if you were going to be marooned outdoors. This, of course, has the additional benefit of ensuring that you are dressed for emergencies which might, in fact, maroon you. For example, one non-MU-2 operator had a landing incident which disabled his aircraft at the end of the runway in a heavy snowstorm at a non-towered airport. Heavy clothing was necessary just to walk from the aircraft to the FBO.

Batteries and engine oil can both disable any aircraft which has been left outdoors for extended periods. Batteries lose cranking power, and engine oil becomes extremely thick, both of which may act to prevent the starting of an engine. Battery blankets and engine pre-heaters are one solution – heated hangars are better. Some operators remove the batteries and store them indoors.

Condensation of water in the fuel tanks is more likely during the cold winter months. However, since water is more soluble in jet fuel than in avgas, draining the sumps in a turbine powered aircraft is best accomplished only after that airplane has been motionless for several hours, so that the water has had ample time to separate from the jet fuel. Otherwise, any water suspended in the jet fuel may not be apparent. Obviously, it is wise to ensure that any fuel added is clean and filtered. Many operators store their aircraft with the tanks full to minimize condensation.

Check for mud, slush, or other frozen accumulations in wheel wells and on brakes and gear. Also, strictly adhere to the clean aircraft concept. Even a thin layer of ice, frost or snow sticking to the wing or airframe can have catastrophic effects. The most effective means

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of detecting airframe ice are your hands and eyes. Frost may form when the fuel has cold soaked and the ambient air is humid and cool. Dry snow may be removed with a broom or brush, but frozen snow, ice or frost should be removed with an appropriate deicing fluid, or a hangar "warm-up." Caution should be taken upon removing the aircraft from a heated hanger. The skin of the aircraft should be allowed to cool prior to moving the aircraft into falling snow conditions. The snow, when it falls onto a warm aircraft skin, will melt and then re-freeze within a few minutes to form contamination on the surface that cannot be easily removed.

Not often recognized is the fact that water or blowing snow can collect in hidden cracks or crevices and then freeze. Reports have been received of ice forming in the spoiler wells of MU-2 aircraft which restrict the free movement of the spoilers. This ice will not be visible with a cursory inspection of the top of the wings. Fortunately, ice in the spoiler wells will be detected by the normal control checks during taxi out. Other areas where water/ice may accumulate include pitot tubes, heater ports, fuel vents, and elevator and trim tab controls and hinges.

TPE-331 engines should be operated on the ground with the engine heat ON in icing conditions (10°C or below with visible moisture for all engines except for the TPE331-25AA or AB). Ensure that the oil filter bypass valve bypass indicator is not popped. Perform a thorough preflight inspection of all anti-ice and de-ice systems per the Airplane Flight Manual prior to taxi. To preflight the wing de-ice boots, an outside observer must be positioned so that boot inflation on all boots can be verified after engine start. A thorough safety brief should be conducted between the observer and the pilot prior to engine start, since the engines are running during the check.

Winter taxi operations present unique challenges, primarily due to ice, winds, low visibilities, or a combination of all three. Do not taxi through small snowdrifts since there may be ice underneath. Braking action may be poor or nil, so keep taxi speeds to a crawl. Expect the airplane to slide sideways in a crosswind. One operator recommends keeping a cloth handy for de-misting the inside of windows while taxiing. When starting in extreme cold conditions, allow the gyros to spin up for a few minutes to heat the bearing mechanisms. Premature movement can wear the bearings at a higher than normal rate.

Aircraft takeoff performance is seriously compromised if there is snow, slush, or wet mud on the runway. Do not expect the aircraft to perform according to "book" specifications in these conditions, since the MU-2 has no data for takeoff with degraded runway conditions. For takeoffs in icing conditions, always turn the IGNITION switch to CONT (continuous) or ON.

Once you are airborne, keep

in mind that the most likely range for airframe icing is 0°C to -10°C. Ice seldom will form at temperatures below -20°C. Ice is most always encountered within a 3000 foot altitude range or less, so a small altitude change made early will pay great dividends in avoiding icing. It is worthwhile to note the freezing level during the preflight brief. Will terrain obstruct a descent to below the freezing level? If so, your only option may be to climb. In that case, do you have enough power reserve to climb through the icing range to colder temperatures above, while maintaining minimum airspeed in icing conditions? These questions should be answered before takeoff.

Operators should exercise caution during extreme cold operations since their altimeters may read higher than the actual aircraft altitude by several hundred feet. Canadian and Alaskan operators routinely make corrections to their minimum descent altitudes based on tabular cold temperature data.

Blowing snow or ice fog are two weather phenomena which may occur suddenly and unexpectedly. Both occur very close to the ground, usually within 50 feet or so, and a prudent pilot should keep alternate landing sites available. Blowing snow can be anticipated if rising winds are forecast with loose snow present, while ice fog is usually found on calm days near urban areas with temperatures below -30°F.

When approaching an airfield for landing, often it is wise to circle the runway, looking for snow banks, poorly marked runways, or other obstacles. Note the winds, and try to determine the runway condition, if possible. While the MU-2 is regarded as a good airplane for slick runway operations, any airplane landing on glaze ice is in a precarious situation, and it might be prudent to continue on to an alternate with a runway in better condition. Glaze ice, or "black ice" may not be readily apparent.

If any ice remains on the airframe prior to landing, increase the landing airspeed by at least 15 knots. Note that this will increase touchdown speeds on a potentially slippery runway, so care must be taken to maintain directional control. Use ground idle, then reverse thrust and light braking so as not to lock the wheels. Do not attempt to "grease" the landing. A firm touchdown will provide minimum stopping distance. As in the takeoff scenario, be aware that there are no data for landing distances on contaminated runways, so the need for extra margins must be anticipated.

Finally, once back on the ground, don't forget to install pitot and engine covers, control locks, and, if parking outside, tie-downs, or make arrangements for hangar storage.

Winter operations present unique challenges. Careful preparation is essential to safely overcoming these various challenges. While some element of risk is inherent in winter operations, it is entirely manageable for a well prepared pilot. Never forget that, if you are uncomfortable with any of these risk factors, the prudent decision may be a decision not to go in the first place.

AAOG

Black Ice (from Wikipedia)

Black ice, also known as "glare ice" or "clear ice", typically refers to a thin coating of glazed ice on a runway or taxiway (or roadway). While not truly black, it is transparent, allowing the usually-black asphalt runway to be seen through it, hence the term. It is unusually slick compared to other forms of runway ice.

It is usually deposited by extremely cold rain droplets, mist, or fog. The process of freezing is slowed down due to latent heat given off in sublimation, allowing the rain droplets to flow and merge together on the surface forming a film before freezing into clear ice.

Nevertheless, because it contains relatively little entrapped air in the form of bubbles, black ice is transparent, and thus, very difficult to see (as compared to snow, frozen slush, rime ice, or other typical forms of ice on runways). In addition, it often has a matte appearance rather than the expected gloss; and often is interleaved with wet pavement, which is identical in appearance. For this reason, it is especially hazardous, because it is both hard to see and extremely slick.

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Transitioning to Beta During Landing

by Rick Wheldon

Over the years, there has been much confusion over what is happening to the MU-2 engine and propeller as the airplane flares and slows during landing. Propeller "loads" increase, flight idle fuel flows, propeller governors, prop pitch controls and underspeed fuel governors interact, etc. etc. Frankly, it's confusing. Let's look at the complex interactions as you touch down and transition from the prop governing mode to Beta mode.

First, let's try to understand what a "load" on the propeller is. Load can be understood as the resistance to rotation of the propeller. Like drag to a wing, propeller load acts opposite to the direction of motion, except that, since the propeller blade is spinning, load is acting opposite to the direction of spin. Engine power works against load, and when the propeller speed is steady, the power and the load are equal and opposite. On a wing, angle of attack is measured in relation to flight path, and drag relates to the relationship of AOA and flight path. With a propeller, though, flight path of the blade section is a little more complicated. Primarily, the flight path of the blade through the air is the vector sum of the rotational velocity of the propeller and the forward velocity of the airplane (*Fig.1*).

To better understand load, let's look at an engine during start. Since the forward velocity is zero, to minimize load and make it easier to start the engine, the start blade angle is set near zero, producing no forward or reverse thrust (equivalent to zero angle of attack on a wing.) The only "load" on the propeller is caused by air friction resisting rotation of the propeller blades. The propeller just "slices" through the air as cleanly as possible (*Fig 2*). Any blade angle either higher or lower than zero would increase the load and the amount of work required to start the engine (*Fig. 3*). Imagine the huge work load if we attempted to start a feathered propeller with the blades positioned perpendicular to the direction of rotation. I would imagine that it is hard on the starter!

Now, let's look at an engine inflight, at flight idle. Remember, the intent at flight idle is to have zero thrust at landing. Regarding the flight path of the propeller blade, we still have a rotational component, but we also have a forward velocity component. Because of this forward velocity, then, we need some positive blade angle where the "bite" of the propeller again "slices" through the air as clean as possible, with minimum rotational resistance (*Fig.4*). The propulsion engineers, when they designed our airplanes, calculated that the flight idle blade angles at approach speeds would minimize the load (zero thrust from the propeller) at about 12 degrees. Any blade angles higher or lower than 12 degrees would increase the load (*Fig. 5*).

OK, what have we got? At zero airspeed, minimum load is at zero degrees blade angle. At approach speed, minimum load is at 12 degrees, so we've determined that the blade angle for zero thrust, minimum load varies with airspeed. But . . . what will the load be if we maintain a <u>constant</u> 12 degree blade angle while the airplane slows during the flare and touchdown? If you said that the load will increase, you got it right! That's exactly what the TPE-331 is designed to do.

Now, at flight idle in the flare, with an increasing load, but also with a constant flight idle blade angle controlled by the prop pitch control, what might we expect to see? As the load increases with constant fuel flow, the propeller rpm will decrease, similar to a fixed pitch propeller on roll out after touchdown. As the propeller rpm decreases, several more things occur. The propeller governor senses underspeed and increases pressure to the propeller dome. The Beta light illuminates. As the rpm drops, the underspeed governor assumes control of the fuel scheduling. You have just transitioned into Beta, and now, as you retard the power levers behind flight idle, you are controlling the blade angles hydraulically with the power lever through the prop pitch control. As the power lever is retarded below flight idle, load will increase further as reverse thrust is obtained, but fuel will only be scheduled high enough to maintain the underspeed governor setting.

How does this affect you, the pilot? If you want to make consistently good landings, it is important for both engines to make the transition from the propeller governing mode to the Beta mode evenly. Otherwise, when transitioning into Beta, one engine will provide reverse thrust earlier than the other, the aircraft will swerve, and, in your efforts to correct for the swerve with rudder and spoiler, you'll "wobble" on the runway. Although perfectly safe, the wobble is embarrassing, but maintenance can correct uneven reversing.

First, note that uneven reversing will be more pronounced at higher touchdown speeds. Use AFM published landing speeds, and remember that those speeds are based the 50 foot threshold crossing height, so touchdown should be at something less than the published landing speed.

If you find that your airplane wobbles on landing, ensure that you have the power levers together as you cross over the flight idle gate after touchdown. Looking forward, determine which way the nose swerves initially. Have a copilot note if the Beta lights illuminate together. Once you have determined the direction of the swerve, on subsequent landings try placing the opposite power lever slightly behind as you select ground idle.

You can check your flight idle flats (the area of power lever movement which maintains the flight idle blade angles and fuel flows constant near flight idle) on the ground by placing masking tape on the throttle quadrant. With the condition lever forward, advance the power lever for one engine very slowly from flight idle. Initially, the fuel flow will remain steady, but after a short distance of travel, the fuel flow will begin to rise. Mark that power lever position on the masking tape. Do this again with the other engine. Your marks should be even. If uneven, maintenance can adjust the relationship of the flats. They can also check and adjust flight idle blade angles, which obviously should be even and within specs.

Finally, uneven flight idle fuel flows could be a factor. Perform the flight idle check, paying particular attention to the flight idle readings. Five pounds difference in flight idle, while allowable within specifications, might still cause uneven reversing.

It's a complicated process shifting from flight to ground modes, but engines can be adjusted to work together at touchdown. Plan on several maintenance test flights to accomplish this. If you invest the time and effort in rigging and adjusting your engines properly, you'll find the experience of flying your MU-2 well can be one of the most rewarding in aviation. **AAOG**

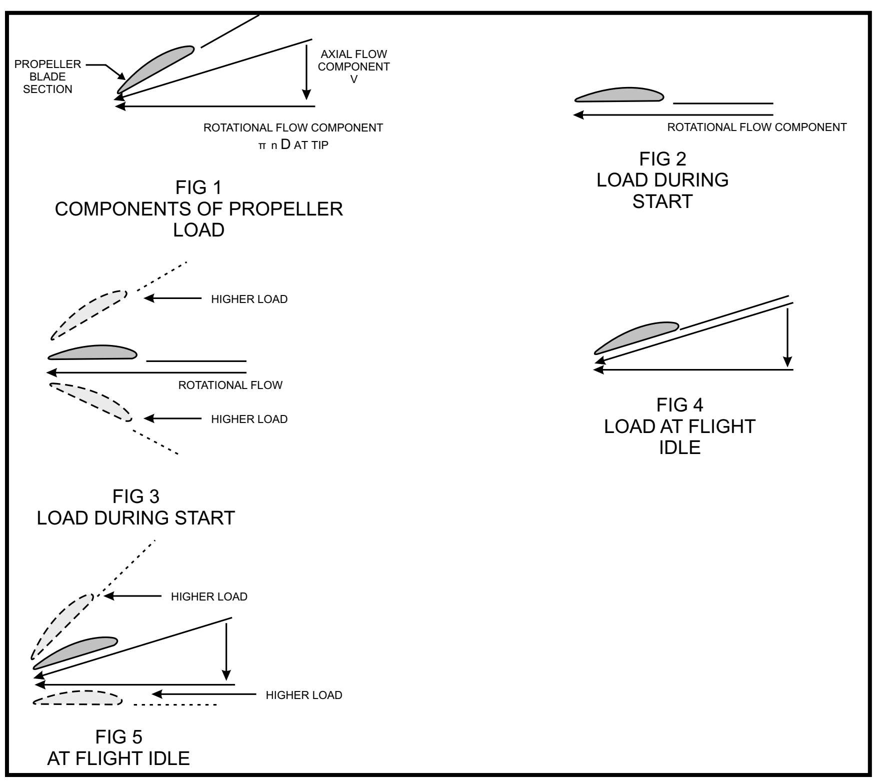

FIG 1 COMPONENTS OF PROPELLER LOAD

FIG 2 LOAD DURING START

FIG 3 LOAD DURING START

FIG 4 LOAD AT FLIGHT IDLE

FIG 5 AT FLIGHT IDLE