AIRSPEEDS
& THE MU-2

by Rick Wheldon

We all learned early in our piloting days that the number on your airspeed indicator does not really tell you how fast you are going through the air. Instead, the airspeed indicator is merely a differential pressure gauge, measuring the difference between ram air pressure (related to speed and measured through the pitot tube) and static air pressure. The pitot static system then delivers an indication of that difference to a needle on the face of the airspeed indicator. This simple concept though, masks the many corrections that must be made to determine your actual velocity through the air.
Why am I addressing this most basic fact to our MU-2 community of experienced pilots? Hopefully, that should be apparent by the end of this article.

Let's start with a general review of the various airspeeds and how they relate to one another. First, there's the number we read on the face of the airspeed indicator, which we call indicated airspeed (IAS). Every instrument has its own error (on the card from the instrument shop when sending the instrument in for "calibration"). Correcting for the instrument error yields actual indicated airspeed (IAS). However, airspeed indication systems are also subject to errors due to the positioning of the pitot tube and, more likely, the static ports on the airframe.

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When an airplane is certified, a long pitot static boom or trailing cone is typically installed on the test aircraft to determine free stream pitot and static pressures well away from the aircraft without any interference from the airframe. Comparing the free stream data with the data measured through the aircraft's permanent pitot static system for the full range of angles of attack allows the engineers to determine a "position error" for the aircraft system. This error typically varies with airspeed and possibly configuration. Correcting indicated airspeed for this position error yields calibrated airspeed (CAS.) Once CAS is determined, the next correction is for compressibility. Even the MU-2 at cruise conditions can encounter compressibility effects. This is due to air compressed inside the pitot tube, which has the effect of falsely inflating the pressure inside the tube as extra air molecules are packed inside. This in turn causes the airspeed indicator to read higher than the actual airspeed. Engineers can correct for compressibility, and CAS corrected for compressibility is known as equivalent airspeed (EAS.) For a late model MU-2 at high speed cruise, the compressibility correction is seldom over 3 knots, though. Finally, while the airplane aerodynamics respond to EAS, pilots are most interested in true airspeed. Therefore, there is a final correction applied for density altitude. Since the airspeed indicators are customarily calibrated for a standard day at sea level, any variance from those conditions will cause an error in the airspeed indication as compared to the actual speed that the airplane is moving through the air. This makes sense because, to get the same pressures inside a pitot tube in less dense air, you would need to go faster through that air. So, EAS is corrected for air density (temperature and altitude) to determine true airspeed (TAS), which is the actual speed of the aircraft through the air mass.

So now, let's look at our MU-2. When the MU-2 was certified in the 1960s, the standards of the day called for the presentation of airspeeds to the pilot in terms of CAS. If you look at your AFM and checklist, you'll see takeoff and approach airspeeds presented that way. But are those speeds the actual speeds you should fly? The answer is not really, because the airspeed indicator in front is displaying... indicated airspeed! So you, the pilot, will need to be making that correction. Attached below are several IAS/CAS correction charts from various MU-2 models. Note that they are all different.

Figure 1 is the Solitaire Correction Table. Look at the corrections for approach speeds. For a typical threshold speed of 100 to 110 knots, the IAS should be 4 knots slower than the published CAS. If you have been landing your Solitaire without making the correction and using the uncorrected CAS speeds in the checklist as your target, you have been carrying an extra 4 knots, which is slightly over 8% extra energy. Over the lifetime of an airframe, 8% extra energy on all landings will correspond to greater tire wear with more stress on the landing gear and airframe.

Figure 1. MU-2B-40 Solitaire Airspeed Correction Table

△K = Correction (KNOTS) KCAS = KIAS + △K

CONFIG.	KIAS								
GEAR UP OR DWN	70	80	90	100	110	120	140	160	180
FLAPS UP OR DWN	+7	+6	+5	+4	+4	+3	+2	+1	+1

Now let's look at Figure 2, which is the same table for another short body airplane, a K Model equipped with heated static ports. Notice that the numbers are quite different than those for the Solitaire. Also note that corrections vary by flap configuration. At the 100-110 knots threshold speeds for flaps 20, the corrections will be only 1 knot. This effectively means that, for this K Model, unlike the Solitaire, corrections to the published CAS are minimal during final approach.

There is one other interesting feature seen in the K model table. At high speeds with flaps up, there is a considerable correction, up to 7 knots, that is not seen

Figure 2. MU-2B-25 K Model Airspeed Correction Table (Heated Static)

△K= Correction (KNOTS) KCAS=KIAS +△K

CONFIG.	KIAS											
	95	100	110	120	130	140	160	180	200	220	240	260
FLAPS UP	-	-	-	-2	-2	-3	-3	-4	-5	-6	-7	-7
FLAPS 5°	-	-	-	-1	-1	-2	-	-	-	-	-	-
FLAPS 20°	-	-	+1	0	0	-1	-	-	-	-	-	-
FLAPS 40°	+3	+2	+1	-1	-2	-3	-	-	-	-	-	-

in the Solitaire tables. Effectively, the CAS is lower than the IAS by 7 knots. Years ago, when -10 engines were first installed in MU-2 K Models and speeds increased, I heard some pretty impressive claims for TAS with the K model, as much as 335 KTAS at the best speed altitudes. Looking into it, I found that the pilot/salesman had not applied the IAS/CAS correction. Had that 7 knot correction been applied, the TAS would have been about 10 knots slower – still impressive, but slightly overstating the actual performance.

Why might there be a difference in the airspeed correction tables? Obviously, long body vs. short body geometry would cause different position errors, but see also the static ports in Figure 3. The Solitaire on the left, like other short models with heated static ports, has a small block positioned behind the heated port, while the long body Marquise in the center, also with a heated static port, does not. Unheated static ports like the J model on the right have a much smaller profile. Many early models of the MU-2 were originally delivered without heated static ports. These models may now have either heated or unheated static ports installed depending on whether Service Recommendation 064 has been complied with. In the AFM for each model, there may be different airspeed correction tables for unheated and heated static ports. Make sure you use the proper one for the airplane you are flying.

Figure 3. MU-2B Static Ports

As a last exercise, let's look at the Marquise Correction Table (Figure 4) and the G Model Correction Table (Figure 5.) The Marquise never requires more than 2 knots correction in the normal airspeed range. Therefore, the CAS numbers presented in the checklist are basically close enough to be usable as IAS for the

Figure 4. MU-2B-60 Marquise Airspeed Correction Table)

ΔK = Correction (KNOTS) KCAS = KIAS +ΔK

CONFIG.	KIAS								
GEAR UP OR DWN	70	80	90	100	110	120	140	160	180
FLAPS UP OR DWN	+4	+3	+2	+2	+2	+1	+1	0	0

Figure 5. MU-2B-30 G Model Airspeed Correction Table (Heated Static)

KCAS=KIAS + ΔVi

CONFIG.	K I A S											
	90	100	110	120	130	140	160	180	200	220	240	260
FLAPS UP	-	-	-	-	-2	-2	-2	-2	-3	-4	-6	-8
FLAPS 5°	-	-3	-2	-2	-1	-1	-	-	-	-	-	-
FLAPS 20°	-	-5	-3	-1	-	-	-	-	-	-	-	-
FLAPS 40°	-4	-4	-4	-4	-4	-4	-	-	-	-	-	-

entire normal flight envelope. The G Model requires about a 3 knot correction at typical approach speeds for flaps 20. But… there is a difference here also! Note that for the Marquise, the correction is positive; therefore, 109 KCAS = 107 KIAS. For the G Model, the correction is negative; therefore, 109 KCAS = 112 KIAS.
At the same weight, the target indicated threshold airspeed for these 2 long body models might be 5 knots different!

For those of you intending to install the new Angle of Attack system in your airplane, rest assured that the AOA was calibrated taking into account the CAS/IAS corrections, so an on speed indication on the AOA should accurately reflect the proper speed (and Angle of Attack) on approach.

To summarize, because of the CAS corrections, which can be as high as 4 knots on approach, a quick look at the airspeed correction table for your model might be in order. If you see a 3 or 4 knot correction, knowing that your checklist airspeed is presented in CAS, make the small adjustment to reduce or increase your indicated airspeed and more precisely cross the threshold on target. This will lead to consistently better landings. Be sure to also check your instrument error card from the last airspeed instrument calibration and also correct for that when comparing approach speeds to the AOA indication.