Podcast 24 – Hot weather operations

Hi and welcome to another episode of the 737 Talk with me Mark and my co-host Ian. Today we're looking at a subject that probably doesn't get quite as much press as its antithesis cold weather operations. That's right we're looking at hot weather operations. A lot of us will hopefully be flying people to their summer holiday destinations soon and one of the reasons people pick our destinations is to be gently toasted by the surrounding climate. So how will this affect our aircraft and also potentially our approach path into those destinations?

As we all know our performance and charts take reference ISA, or International Standard atmosphere, which as we are all aware will never be exactly right for actual conditions. The further we get away from that 15°C (59F) at sea level at 1013.2 hpa (29.92inches) with a lapse rate of 2°C per 1000ft the more we have to think about problems that may arise for us in operating and that goes for temperatures above as well as below.

Not only do we need to think about the aircraft performance, but we'll also be looking at different approach gradients, reduced brake efficiency and of course passenger discomfort what could get to be a dangerously hot cabin if not handled properly. Inoperative APUs when going into a particularly hot airfield need careful thought and I can certainly think of a couple of times when headlines have been made from such events.

Let's think back first to our ATPL days and the term air density. Put simply air density is the absolute pressure divided by the specific gas constant times the absolute temperature… Ok maybe I'll try that again. Air density is, in essence, the number of air molecules that are contained in a specific space. Now, the warmer these molecules become the more energy they have and therefore they bounce off each other and you will find less of them inhabiting that specific space and you'll have less air density.

Other things that affect air density are humidity and pressure. Our 737 will perform to specific levels given a specific air density. So, as we now know if we are operating in an atmosphere that is warmer than ISA our aircraft will perform the same as if it were operating in less dense air so our density altitude could be a lot higher than our pressure altitude which is set upon standard pressure. Density altitude is pressure altitude corrected for non-standard temperature. To calculate pressure altitude simply set your altimeter to 1013.2hpa or 29.92 inches.

As a rule of thumb for every 3°C increase in temperature we are looking at a decrease in air density of approximately 1%. For those who want to get really scientific the air density of 15°C air is approximately 1.225kg/m3 compared to air at 40°C being 1.127kg/m3. To those of us who that means next to nothing it basically means that if the airfield was at sea level our aircraft would perform as if it was at approximately 3000ft pressure altitude.

A simpler equation, and I'm certainly all for that, to calculate density altitude is to add 120ft for each 1°C you are above standard temperature to your pressure altitude. So if your pressure altitude was sea level and the outside air temperature was 40°C then you would be 25°C above the standard temperature. 25 x 120 is 3000ft bringing us back to the that same answer we just went through.

Our engine Thrust capability depends on the amount of air molecules we can force through and accelerate thus moving us in our desired direction of travel. As Ian has mentioned if the environment we are operating in is warmer than ISA then we are going to experience less dense air meaning getting those required molecules will become more difficult. In other words, our performance will suffer meaning we'll require not only an increased take off distance, but we'll also experience a decrease in climb performance and thus obstacle clearance capability. This could mean further Take off weight reductions are necessary due to being climb weight limited.

The effects of the decreased density reducing thrust, lift generation and giving a higher ground speed for a given IAS give us that increased take-off roll and we also then need to bear in mind our maximum tyre rotation speed limits. This is because at very high-density altitudes true airspeed may be as much as 20kts or higher above the IAS.

Engine components themselves have maximum operating temperatures and cooling ability is significantly affected by hot temperatures. On the 737 we have the EECs to protect us against exceeding these limits but in doing so they will limit engine power.

A lot of us will be operating the 737 on pretty tight turn around schedules. A limiting factor on this could be brake cooling times. This is particularly apparent when operating into a hot environment with perhaps limiting landing distance available where we have applied a high level of braking on arrival. This could be coupled with a long taxi out where brake applications are necessary and a heavy aircraft which could all together cause significant wear and heating of the brakes causing problems with their overall effectiveness. A look at the QRH PI section under the Advisory information section will give you some tables for recommended brake cooling schedules. Visiting these in the cruise or the crewroom beforehand will give you a good heads up on what to expect. For those of us lucky enough to have the digital brake read outs then of course these will help you in determining your turn around.

You will also find some useful guidance in the supplementary procedures in the adverse weather section under hot weather operation. Here you will find guidance when packs should be run, how best to cool the cabin, use of APU bleed air on the ground and some tips on dealing with those hot brakes including the recommendation to put the gear down early on approach.

Higher temperatures at altitude will affect our ability to attain our optimum altitudes for fuel burn due to performance capability. This will mean we may be looking at a fuel burn in excess of what has been planned which is something to again be mindful of at the planning stage.

Something that isn't often talked about during hot weather ops is the effect on the approach gradient should you be using a non ILS approach. We use corrected altitudes in accordance with our company procedures for cold weather operations as this keeps us safe due to our true altitude being below our indicated. It is not practised to correct for hot weather altitude corrections as they don't tend to produce effects to the extent of cold weather and are in the safe sense, but it is something to perhaps have a think about when you are operating into hot weather environments, so the result doesn't take you by surprise.

Using an altitude conversion app which we must state is not approved but just gives us some idea of the true altitude for this example, if we were flying into a sea level airport where the temperature was 40 degrees Celsius on the ground and our platform altitude was 3,000ft then flying this indicated altitude would give us a true starting altitude of approximately 3,250ft. The error decreases as you get closer to the ground but just be aware of the picture this may give as you continue happily down the approach keeping to the charted altitudes and then perhaps come visual above the PAPI's and having to adjust your flight path from there. You will also find that to keep to those charted altitudes your approach gradient will be higher than charted.

One last thing to mention here is the effect on your single engine climb ability in the event of a go around. Especially if you've had to turn back or divert early on and are heavy. A quick look at the performance inflight section of the QRH in the Engine Inop gear down landing rate of climb available at Flap 15 shows that at a TAT of 40 degrees C and at 0ft pressure altitude you will have 160fpm available to you. This is based on 60T and will need to be decreased by 120fpm per 5T over this weight. Food for thought with what is required from a standard missed approach gradient of 2.5% and the reason to check your approved landing performance tables or software. Those figures were gear down too and more reinforcement on the importance of getting that gear up in the event of a single engine Go Around.

In summary. Remember the effects that hot temperatures have on air density bringing with it the associated performance issues in all flight phases. Weather effects that can come with hot temperatures include thermally induced turbulence, convective storms and possibly significantly reduced visibility due to haze.

The overheat of system equipment as well as the cabin itself can be difficult to stop and a look through the supplementary procedures will certainly help with this. Something we haven't mentioned is care should also be taken on the walk around with metal surfaces that have become hot enough to burn skin prevalent.

Careful planning needs to take place to mitigate the threat of hot weather including a look at take-off, landing, climb and potentially cruise performance. In all circumstances, performance calculations must take density altitude into consideration when calculating max take-off weight, climb gradients, the go around approach climb gradient and also stopping distance.

When on the ground think about brake usage, use of chocks on the turn around and best strategies for cabin and equipment cooling.

Thanks for listening today and we hope this one has provoked some thinking round the subject with the summer months where we operate approaching fast and hopefully, we'll all see an upturn in aviation after the covid pandemic has affected us all so much. If you'd like to continue the talk head over to our social media sites on fb, Instagram and twitter all @B737 talk or visit our website for more content B737talk.com where you can also download the scripts to the podcasts for anyone who struggles with our accents. Until next time fly well and be safe.