

Podcast 26 – Emergency Descent

Hello everyone and welcome to another 737 Talk. We promised a while back that when we had enough of the systems covered, we'd start to look at non normals so here we are today looking at our first one. It's one that can often be a bit rushed in the simulator and brings with it communication difficulties as well as potentially significant physical impairments should this happen for real. What is it? I won't make you hold your breath any longer, sorry terrible joke, it's the emergency descent.

Decompressions are put into three categories; explosive, rapid and gradual. The difference between the explosive and rapid decompression is the explosive decompression will happen in a time between 0.1 and 0.5 seconds with the rapid somewhere above that threshold. The more important difference for us is that the Explosive carries with it a high risk of lung trauma whereas that risk is significantly decreased with the rapid definition.

The causes of this type of decompression could be structural, an outflow valve malfunction or even an open door.

You would recognise this by some or all of these factors. A possible very loud bang to start along with the visuals of fog forming in the aircraft. You would be in physiological discomfort and the indications on your cabin altitude panel would confirm the issue. You would also have the cabin altitude warning lights illuminating, if installed, and the cabin altitude horn sounding if you could hear it over, what may well be, very loud ambient noise.

A gradual decompression may not sound like too difficult a situation but we all of course remember what happened with the Helios flight, if not, perhaps that will be a future podcast. This led to the introduction of the cabin altitude warning lights on the forward instrument panels on all recently delivered 737's as well as many aircraft being retrofitted.

There have been reports of alerts caused by improperly configured engine bleeds and air conditioning pack switches, usually following a no engine bleed take off. There have also been incidences of crews delaying their response to the cabin altitude warning alert due to confusing it with the take-off config warning horn.

To counter the threat of incorrect switch positions we have the after take-off scan and after take-off checks and this highlights the reason for vigilance when performing them.

The confusion between the take-off config warning horn and the cabin altitude horn on aircraft without the cabin altitude warning lights can be resolved with the knowledge that the take-off config warning horn is only armed when on the ground. If the horn is active in flight, it indicates cabin altitude has reached 10,000ft.

Try and remember the location of the altitude horn cutout on the cabin altitude panel on the overhead. When you've identified your problem and got your masks on it would be a good idea to push this to get rid of another stressor stopping the very loud audio noise infringing on your senses and further draining capacity.

Other reasons behind a gradual decompression could be worn door seals, an outflow valve malfunction, perhaps a toilet flush valve jammed open or even fuselage damage through damage by a ground vehicle that perhaps hasn't been reported.

Physiologically this one can be dangerous if it goes unnoticed as it can be insipid. Euphoria is likely to set in, with tingling sensations to the extremities as well as the lips starting to take on a bluish tint.

Your instruments will of course alert you to the problem with that horn sounding at 10,000 as well as the cabin altitude red lights if installed. A glance at that cabin altitude panel would confirm the picture for you.

Do you remember the Time of Useful Consciousness times at the flight levels representative to our operating theatre? At FL300 we are looking at 1-3mins, FL350 30-60seconds and FL400 15-20 seconds but don't be fooled by the length here as they are dependent on a number of factors.

Firstly, the physical condition of the individual. I'm afraid if you're out of shape you can significantly reduce these times so maybe think about that 2nd onboard desert a bit more next time.

Secondly, if you are engaged in any physical activity such as moving around the cabin you can also take time off.

Thirdly the type of decompression has a significant effect on these times. If it is explosive, you can halve them. Have a quick think about what that would mean up at FL400 together with the startle effect. You need to get that oxygen on as soon as you can.

If you've had a gradual decompression, you may well get the call in for the memory items and then don your masks. It may not happen like this in the real world with an explosive decompression as the noise levels and startle will hinder communications to the point where you will be operating in a split flight deck. In this case you would just get your masks on independently and then start communications from there.

Some airlines require the captain to be PF for this manoeuvre whereas others leave it as whoever was PF before the event remains PF. For simplicities sake here we'll discuss it with a view that the captain was PF before the event and so will remain so during. Please check your own company SOPs.

Something that is often done with memory items is to just learn them verbatim without thinking about how you will be doing them. Whilst it's good to have them in your head it's better to fully understand how you will action them and who will be doing what.

We'll start with a look at the memory items for Cabin Altitude warning or Rapid Depressurisation. Item 1 and 2 are good examples of those items that need thinking about before the event, remember those? 1 is Don Oxygen masks and set regulators to 100% and 2 Establish crew communications. But how will you don your oxygen mask? By this think about

the physical actions, do you wear glasses? What will you do with your headset? We suggest putting your headset around the back of your neck making it easy to find once the mask is on. A great thing to do here is to ask your instructor next time you're in the sim if they'd mind you getting the Oxygen masks out and have a proper look at them. Even when you have 1,000's of hours on type there's nothing quite like a getting your hands on the equipment to get more comfortable with its use, especially something that you will need to operate under a highly stressful situation.

A note about those masks. N or normal supplies an air/oxygen mix on demand, 100% supplies 100% O2 on demand. When the cabin altitude is above 27,000ft the system will automatically supply 100% O2 under positive pressure. Emergency will supply that positive pressure at all times and is to be used to protect against smoke and harmful vapours as well as to potentially clear the face mask if it has misted up. Be aware that communications will become more difficult with this mode on.

Also, something to be aware of with the masks is what you need to do when stowing them. You need to close that left panel door and push the press to test and reset switch to turn the oxygen supply off and disable the mask microphone which will then enable the boom mic. Don't forget to then flick your switch on the ACP back to boom if there is one on that particular aircraft.

In regard to item 2, this is a little check I always do before a flight. Does the aircraft have an automatic mic switch over or will I need to toggle a switch on the ACP to establish communications? Also, remember not to leave your intercom on when you've finished communicating. We've all been there and done it or had it done to us, and your colleagues Darth Vader style breathing can be very distracting when you are trying to get on with your drills.

Items 3 and 4 are in the responsibility of the PM and are also worth having a little think about. 3 is putting the pressurisation mode selector to MAN and 4 operating the outflow valve switch. Imagine you are in an environment full of loud noise and possibly even fog. Which way do you toggle that outflow valve switch? Well, here's our technique. After you've switched the system to manual move your hand up and onto the toggle switch. Now this switch is located right over on the first officers' side of the forward overhead so if you move it toward the captain, it's IN to the aircraft so you are trying to bring air IN to the aircraft that has escaped.

This of course, in the situation we are looking at, will be to no avail and so the PM will then put the passenger signs on as well as the guarded Pax Oxy switch on the aft overhead.

Now you will move on to the memory items of the emergency descent checklist.

Use your company SOP call to announce the decent to the PM as well as the cabin crew. PM will then advise ATC and get an area QNH. You are now into your area of responsibility drills, but we'd suggest PM monitoring that PF has started that descent before continuing their own actions.

So how will PF start this descent. The FCTM recommends the turn first if you are to do one. Here you need to be aware of a few things. Different Airspace will have its own regulations including certain European regions having it written in their AIPs that an emergency descent should be done on cleared track, areas like the north Atlantic also have specific contingency procedures to follow. Try to get a working knowledge of this but you must also apply some airmanship here looking for traffic below you. You may well get some help too if PM has informed ATC, they will probably vector you to keep you clear. We're not going in to escape routes here as that is very company specific, but an awareness of Terrain below is also critical.

So, you've pushed heading select and perhaps taken your turn, now to get the descent under way. We recommend a first sweep of the MCP winding that altitude window down to an arbitrary figure then pressing LVL CHG. This will of course open your speed window and here you have the decision as to whether to increase speed or not. Remember, if structural integrity is in doubt, you should limit speed to current airspeed or less.

That decision made it is now time to ensure the thrust levers are closed (remember your autothrottle and AP are engaged as recommended) and smoothly extend your speedbrake.

Now back up to that MCP to fine tune your selections. Look at that traffic below you, have ATC given you a heading? If necessary, adjust the heading for what is required. Next set 10,000ft or minimum safe altitude, whichever is higher and then finally come across and adjust speed. Here is where perhaps you may even need to reduce speed if structural issues are apparent. If you don't believe structural issues to be a problem, then you are looking for Mmo or Vmo.

Boeing also gives you the option of the landing gear to give a more desirable descent rate should airspeed have to be limited. We would say to use caution in making that decision without knowing about structural integrity and if you do decide to lower the gear make sure to adhere to placard speeds.

Having ensured PF has the descent under way PM can now do their memory items ensuring the passenger signs are on and the engine start switches are in continuous.

Our recommendation here is that while your hand is up there switch those fixed lights on to give maximum visibility to others and when your hand drops down take it the transponder and set 7700 to warn controllers of lower airspace you have an emergency. This is not part of the memory items but shows good airmanship and SA.

Here is a personal technique I picked up from a TRE and has stayed with me just to ensure the items as PM are done. I say MAY DAY MAY DAY MAY DAY to myself when I am PM, pointing to each panel where an action should have been done and double-checking switches are where they should now be. The first MAY DAY I look at the aft overhead for the passenger oxygen switch, the second the forward overhead and a check of seat belts, engine start switches and fixed landing lights and the 3rd May day down to the transponder.

This is purely a recommendation you can have a go out to see if it works for you.

Having established yourself in the descent and completed your ANC, Aviate – the aircraft is flying safely under control, Navigate – your turn or not to turn is decided, and Communicate – you are talking to each other, the cabin crew have been alerted and you are in two way comms with ATC, you are now into the QRH starting with the first warning “cabin altitude warning or rapid depressurisation”.

This will then lead you into the Emergency Descent QRH which should also be completed.

When you are descending at speeds near to Mmo/Vmo as you may well be here you may encounter short term airspeed increases above these limits possibly due to wind and temperature changes. These are deemed acceptable for this manoeuvre and the autopilot should adjust pitch to correct. Do not disengage the AP unless its operation is clearly unacceptable. These exceedances will of course have to be logged post flight.

What is your lowest safest altitude? According to the FCTM its MEA, MORA or any other altitude based on terrain clearance, or other appropriate criteria. Let's quickly define these, MEA or Minimum Enroute Altitude is the greatest of MOCA, which is Minimum Obstacle clearance altitude and provides 1000ft clearance where terrain rises to 3000ft, 1500ft clearance where terrain is between 3 and 5000ft and 2000ft clearance in areas where terrain is greater than 5,000ft, and either the minimum altitude that complies with airspace structure or the minimum altitude that provides adequate reception of relevant nav aids and ATS communication coverage.

MORA is designed by your chart provider and gives obstacle clearance 10nm either side of the route centre line of 1,000ft if the highest point is below 5,000ft and 2,000ft clearance if the highest point is above 5,000ft. Grid MORA gives these clearances within the sections outlined by lat long lines.

Something to bear in mind with these minimum flight altitudes or MFAs is factors that could affect them such as QNH below ISA should be corrected by adding 30ft to the MFA for each hPa, for each 2.5°C below ISA you're looking at a 1% increase in MFA and strong winds will also have a large effect. Winds in excess of 50kts over high ground above 8,000ft will increase your MFA by 2,000ft. So, be aware of your depressurisation MFA when flying over high ground in winter where pressure and temperature is likely to be low and winds strong.

At 2,000ft to level off you can start to bring that speed back towards either LRC of 300kts or perhaps even 250kts if there are plenty of options around you. Once you have a positive decreasing speed trend on the PFD you can start to slowly stow that speedbrake keeping an eye on any trends back toward Vmo.

We thought we'd mention the manually flown technique for this procedure too, as you may have to take those automatics out for whatever reason but please remember the recommended way to fly this manoeuvre is with the automatics engaged.

You will disconnect the autothrottle and retard the thrust levers manually when under manual flight. Then smoothly extend the speedbrake, disengage the autopilot and smoothly lower the nose to initial descent attitude of approximately 10°.

If you are going to turn on your initial entry, in this case by asking your PM to set the MCP for you in the same order as for the automatic flight, just make sure that when you extend those speedbrakes you maintain at least minimum manoeuvre speed. Good clear communications between you will be vital as the PMs workload has increased with setting the MCP as instructed while they are also thinking about their own memory items.

About 10 kts before reaching target speed slowly raise the pitch attitude to maintain target speed and trim. Smooth pitch changes are required in the case of inadvertent speed exceedances.

When approaching level, you will smoothly adjust pitch attitude to reduce rate of descent and as you get that speed trend arrow showing a sustained speed decrease you can look to start smoothly and cautiously stowing the speedbrakes. Remember they are your thrust levers so as your desired speed is reached you will need to set thrust accordingly and anticipate the trim changes that will have on the aircraft.

You've now won slightly less than half the battle as once you've levelled off you now need to assess the aircraft condition, that of your crew and passengers and how much time you have in relation to fuel to get the aircraft safely back on the ground.

Be aware that you are flying at low altitude where weather and terrain are nearly always factors and use that company decision making tool to come up with a plan as a crew.

One last thing to mention here is your descent planning from your new altitude. Remember that your aircraft rate of descent now equals your cabin rate of descent so to prevent further discomfort a figure of between 500 and 700fpm should be considered which is obviously slower than we are used to so needs to be thought about in your planning.

So, in summary, think back to those Times of useful consciousness and the factors involved and remember how important it is to don those masks in an expeditious but controlled manner. Once the mask is on take a deep breath to settle yourself and then start your actions first making sure the aircraft is safely under control.

Good communication is vital here and is made all the more difficult by what could be a very noisy and uncomfortable environment. Be prepared for a split flight deck and possible hand signals but make sure to give yourself a fighting chance by at least cancelling that altitude warning horn. It's something I've seen missed regularly in the simulator. Make sure to switch to mask on the acp if you don't have the automatic switchover and a checking of understanding on important communications is a useful tool to use.

Memory items must be ingrained into your psyche and remember to have a think not only about what they are but also about how you would action them in the event of having to do this manoeuvre for real.

It's important to keep your situational awareness up when in long and boring cruises. Mini briefs on MSA's and atmospheric conditions effecting MFA's as well as weather nearby will

help you as a crew to remain at a high level throughout the flight operation. Some people use circles or lines around waypoints where high ground begins and ends which is another good tool aiding crew SA.

Once you have completed those memory items and are established in your descent you will get in to the QRH. The Cabin altitude warning or rapid depressurisation checklist should be called for first leading you into the Emergency descent checklist. Be thorough and methodical and maintain your checklist discipline.

You've done the hard work of the manoeuvre in getting yourself to the 2,000ft to level off point and now you need a little anticipation. You will slow to LRC speed or perhaps 250kts if in the vicinity of a suitable aerodrome so select this speed and make sure to get that speed decreasing away from Vmo before smoothly stowing those speed brakes. If you rush the stowing of the brakes, you may well find yourself inadvertently in an overspeed situation. If you've flown the procedure manually now is also a good time as PF to remind yourself it is manual thrust, perhaps even a call to your PF as PM stating this would be sensible too.

Having completed the manoeuvre, you now have multiple considerations as to how to bring the flight to a safe outcome. Your own physical condition as well as the state of your crew and passengers will need to be assessed along with the state of the aircraft and its systems and the fuel on board. You will now need to get into that decision making model and decide on the next safest course of action.

There it is our first foray into non normals. We hope it's been useful for you and please feel free to contact us through the b737talk.com website with any suggestions for future non normal coverage.

Now, we have a new feature to the podcast we hope you'll enjoy where each episode we'll ask 10 technical questions, some related to the subject and others random as well as maybe some general too. We will be adding a tab to the b737talk.com website where you'll be able to find confirmation of the answers, I'm sure you already knew. So here we go with the tongue twisting Talks Tech Ten...

Intro music etc

Q1: What is the maximum cabin differential pressure for takeoff and landing?

Q2: Which stages of the compressor does engine bleed air come from?

Q3: How are the bleed air valves activated and operated?

Q4: If you have a DUAL BLEED light illuminated what is your maximum engine thrust?

Q5: Where is water tank pressurisation supplied from

Q6: Which lights will illuminate with a leak in the APU bleed air duct, located in the keel beam?

Q7: In single pack operations with the pack selected to AUTO when will the pack be in High Flow?

Q8: When will the AUTO FAIL light illuminate

Q9: What is the maximum takeoff and landing Altitude?

Q10: What is the minimum number of satellites required for a GPS to obtain a 3-dimensional fix?

Outro

So, there we go, the first of many! I'm sure this will have brought out some discussion points so feel free to continue the talk with us over on our social media channels or try the linkedin group [b737training.org](https://www.linkedin.com/groups/1217737) where there are over 1000 737 pilots, engineers, TRIs and TREs with 10's of 1,000s of hours experience on the Jet ready to discuss anything 737 related. For now though, from Mark and I, fly well and be safe.