Podcast 25 Anti-Ice & Rain

Hello everyone, and welcome back to a short technical discussion on the Ice and rain protection systems that the 737NG has. We'll start off by chatting about what systems there are and how they work - incorporate the indications in the flight deck, and then a brief talk at the end on Boeing's recommendations for using the systems and how and when to do so.

So, let's start with discussing what systems the aircraft has to protect against ice/rain. The engine cowls can be fed with hot air, supplied upstream from the PRSOV – to heat the cowls and prevent ice build up there, which could disrupt the laminar air flow into the engine, and thus eventually risking stalls/surges or worse. This hot air is then ducted out and discharged at the bottom of the engine through a vent on the bottom of the cowl lip.

Each engine Anti ice valve is controlled independently and actioned with a switch in the flight-deck. There are 2 lights for each engine. The first is the blue COWL VALVE OPEN light – which can illuminate bright or dim. In keeping with Boeing switch philosophy, bright blue indicates that the valve is in transit, or a switch/valve disagreement and dim means the valve is open and the switch is ON. If it is off, the valve is closed. Above this blue light, is an amber light, COWL ANTI_ICE. This light, if illuminated, indicates an overpressure in the duct downstream of the engine cowl anti ice valve. There is a non normal checklist for this. If the switches are turned on, as well as the blue COWL VALVE LIGHT on the overhead, you will also get 'TAI', (thermal anti-ice on the N1 indication on the engine display on the Upper display.

The other anti-ice system, is the Wing Anti Ice. This system uses hot air from the bleed air ducts and heats the 3 inboard leading-edge slats by ducting the hot air into leading edge spray tubes and then into the slat cavities and thus heats up the slat with an aim to prevent or minimise ice accretion. The hot air is then exhausted through holes on the bottom of the slat. The ducting will move, and thus can provide hot air to the slats, regardless of what position they are in. There is one switch to control both sides, located next to the Engine thermal anti ice switches. However, each side has its own blue indication light, showing L/R VALVE OPEN. Again, if bright blue, the valve is in transit or in disagreement with the switch position, and if in dim – the anti ice control valve is open, with the switch on. If there is no blue light, the valve is closed, and the switch is off.

There is overheat protection on the ground only, which will automatically close the WAI shutoff valve when the temperature reaches 125 deg c. When this happens, the only indication will be a bright blue L/R VALVE open.
If the WAI is used at all in flight, the stick shaker logic is altered and set for icing conditions for the rest of the flight – regardless of subsequent wing anti ice switch position.

They are the 2 hot air anti ice systems, and now we'll look at some electrical heating systems. If you remember, there are three windows/windshields on each side of the flight deck. A forward window, and 2 side windows. These can be electrically heated and controlled by switching the flight deck. On all variants the front window, L1/R1 is heated, being the main

window you will be looking out of the majority of the time. Some 737 variants will heat the 2 side windows, 2 and 3, wheres some only heat and control window number 2.

Flight deck windows 1 and 2 consist of glass panes laminated to each side of a vinyl core. Flight deck windows 3 consists of two acrylic panes separated by an air space (for unheated windows) or two glass panes laminated to each side of a vinyl core for heated windows.
A conductive coating on the outer glass pane of window numbers 1 and 2 permits electrical heating to prevent ice build–up and fogging. If a window 3 is heated, there will be a thermal switch (a black 'puck' about the size of a 10p piece) present on the inside bottom edge of the window. A conductive coating on the inner glass pane of windows 3 permits electrical heating to prevent fogging.

Temperature controllers maintain windows 1 and 2 at the correct temperature to ensure maximum strength of the windows in the event of bird impact.

There is a bus bar at the top and bottom of the window which current runs through, and via a conductive coating to the whole window, ensures that the window is protected from fogging and ice build up. Boeing didn't hold back when the chap responsible for buying in the switches clearly bought a load too many – and the forward and side windows, on each side are switched independently. There is also a bonus switch in the middle which is a window heat test switch – which is spring loaded to neutral, and can simulate an overheat condition, to check overheat warnings, or by pressing it down provides a complete power confidence check. This power test verifies operation of the window heat system and its use is covered in the supplementary procedures, which in practise you may need during those hot summer turn arounds. Above each main switch are usually 2 lights, a Green ON light, and above that an AMBER OVERHEAT light. The green on light, as the name suggests is illuminated if electrical heat is applied to the selected window. It is extinguished when:

- The switch is Off
- An Overheat is detected
- A system failure has occurred or
  System is at the correct temperature.

On some variants or fits, this GREEN ON light may be substituted by an AMBER OFF light instead. This works the other way and is illuminated if the switch is off – as the normal position in flight is ON.

Both variants however will have the AMBER OVERHEAT indication. This comes on if an overheat condition is detected.

The other systems that have electrical heating are the probes.

All probes on the left/right are electrically heated using current from respective AC transfer bus 1 or 2. As well as the normal probes, the L and R elevator feel pitot probes are heated in the same way. Static ports are not heated.

There are 2 switches, having an ON and AUTO selection – for each side of the aircraft and each transfer bus. When ON, power is supplied to the related system side. When in AUTO, power is automatically supplied to both sides when either engine is running.
There are a number of AMBER lights for each side, and these will illuminate AMBER if the related probe is not heated.

When on standby power, to conserve power, only the CAPT pitot is heated, and none of the probe heat lights will illuminate and do not indicate system status.

Finally, the other ice/rain system the 737 has, are the two independent windshield wipers. The selectors are on the forward overhead panel and have 4 positions. PARK, INT, LOW and HIGH. The normal position is PARK and turns off the motors and stows the wiper blades. INT will intermittently run the blades every 7 seconds. LOW and HIGH are self-explanatory. It is worth highlighting that Windshield scratching will occur if the windshield wipers are operated on a dry windshield.

Now we'll take a quick look at Boeing's recommended use of the Anti-ice and rain protection systems.

On the ground, Engine anti-ice must be selected ON immediately after both engines are started and remain on during all ground operations when icing conditions exist or are anticipated. However, it is recommended not to use engine anti-ice when OAT is above 10°C.

Use wing anti-ice during all ground operations between engine start and takeoff when icing conditions exist or are anticipated, unless the airplane is, or will be protected by the application of Type II or Type IV fluid in compliance with an approved ground de-icing program.

It is worth highlighting that the use of wing anti-ice should not be used as an alternative for ground de-icing/anti-icing. Close inspection is still needed to ensure that no frost, snow or ice is adhering to the wing, leading edge devices, stabilizer, control surfaces or other critical airplane components at takeoff.
Again, wing anti-ice is not to be used when the OAT is above 10°C.

A good look at the adverse weather section of the supplementary procedures before operating under these conditions is worthwhile.

In flight operations.

Engine anti-ice must be ON during all flight operations when icing conditions exist or are anticipated, except during climb and cruise when the temperature is below -40°C SAT. Engine anti-ice must be ON before, and during descent in all icing conditions, including temperatures below -40°C SAT.

When operating in areas of possible icing, activate engine anti-ice **before** entering icing conditions.
When should we use Wing anti ice?

Ice accumulation on the flight deck window frames, windshield centre post, or on the windshield wiper arm may be used as an indication of structural icing conditions and the need to turn on wing anti-ice.

In flight, the wing anti-ice system may be used as a de-icer or as an anti-icer. The primary method is to use it as a de-icer by allowing ice to accumulate before turning wing anti-ice on. This procedure provides the cleanest airfoil surface, the least possible runback ice formation, and the least thrust and fuel penalty. Normally it is not necessary to shed ice periodically unless extended flight through icing conditions is necessary (holding).
The secondary method is to use wing anti-ice before ice accumulation. Operate the wing anti-ice system as an anti-icer only during extended operations in moderate or severe icing conditions, such as holding.

A few notes of caution here: Wing anti-ice should not be used when TAT is above 10°C.
Also, the Use of wing anti-ice above approximately FL350 may cause bleed trip off and possible loss of cabin pressure. Operators may have specific SOPs regarding this, so check the aircraft flying manual.

And finally, Prolonged operation in icing conditions with the leading edge and trailing edge flaps extended is not recommended.

Thankfully Boeing don't provide any guidance as to when to use the windshield wipers, hopefully relying on the fact that pilots would know that if it is raining, the wipers would help clear the windows…, without having to read it in a manual.

So, there it is, a shorter, more succinct podcast than usual – to highlight and refresh the adverse weather systems this great aircraft has to help us out.
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