JETSETS

Icing induced loss of control

Three incidents highlight this problem on Turboprop aircraft

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Avoid severe icing

A report on fan blade icing and how to stay clear of it

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Spotlight>

More info: see page 06

Recent aviation articles discussing smoke/ fumes occurrences and the emergency procedures for cabin high altitude warning have highlighted a reluctance from certain crews to don their masks and goggles. We ask the question…why?

Don't eat into your margins

How to cope with wet runways and hydroplaning

Above: wet runways can affect braking

An incident

In 2005 an Embraer 145 overshot runway 27L at Hanover Airport. According to the German Federal Bureau of Aircraft Accident Investigation Report EX006-0/05 which can be read in full on their web site (http://www.bfu-web.de):

The weather forecast indicated thunderstorms and heavy showers of rain. The initial ATIS indicated a wind of 150/5 kt and a visibility of 8 km in light rain. The weather deteriorated during the approach, and at the time of landing the wind was 100/5 kt (a 3 kt tailwind) with a visibility of 2000 m in heavy rain. The runway was wet and showed patches of standing water. Approximately 15 minutes after the occurrence the braking coefficients for the first third of the runway were between 0.4 and 0.7 and for the remainder of the runway were between 0.6 and 0.7 (good); however, it had stopped raining by this time, and so these coefficients were not considered by the Investigation to be relevant to the accident.

A Boeing 737 that landed prior to the Embraer subsequently reported to the Investigation that the braking action was medium – but this was not reported at the time to ATC. According to crew statements the aircraft crossed the threshold at 140 kt (Vref 131 kt) and touched down in the touchdown zone. The FDR showed a threshold crossing height of 62 feet as as opposed to the correct 50 feet. The crew did not experience any significant deceleration of the aircraft even

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BAE SYSTEMS

Welcome>

JEt and **T**urboprop **S**upport, **E**ngineering,**T**raining and **S**afety.

Welcome to the autumn (for those of us in the northern hemisphere) issue of JETSETS. Here in Scotland summer seems to have passed us by and so, with winter nearly upon us, we look at some of the issues that face you, both in the air and on the ground. Although the articles are slanted towards either jet or turbo prop, I would like to think that there are lessons for all of us in each article.

Please also take the time to look on our web site (www.regional-services.com) for a copy of Think Ice! 2007 it is well worth reading if you've not seen it before, and even if you've read it there are a few good reminders for the coming winter season.

Recent incidents (not only on our fleets) have shown that there is a marked reluctance among flight deck crews to don oxygen masks in the face of smoke or cabin high altitude warnings, and this is discussed more fully in a later article.

For the jet operators there is an article on fan blade icing, and a discussion on hydroplaning which is pertinent to all aircraft.

For the turboprops there is an article on Icing Induced loss of Control.

Although not covered by articles in this JETSETS, I would like to discuss 2 further safety issues.

One of our turboprop operators recently had an incident during which a wheels-up approach was carried out, and the bottom of the fuselage and one prop were damaged. The captain, who was PF, had called for the undercarriage, but had not checked the undercarriage indicators after calling for its selection because this check was not required by his company's SOPs. The philosophy behind our checklists is based on the assumption that vital checks are carried out as challenge and response, and that both crew members confirm the correct result of the action. What are your company SOPs? I personally always cross check such selections during the flight. I look at the gear, flaps and engines on short finals to assure myself that they are in the correct positions for landing, and also check flaps etc., prior to increasing power on take-off.

Another turboprop operator suffered a control restriction during the climb out which is likely to have been caused by ice, and there were four jet incidents over one weekend that were put down to hail, after the aircraft had been de-iced, causing elevator problems. Reading the incident reports, I was reminded of an incident during which a cabin crew member was injured when the controls suddenly freed after the crew had applied a force to the control column. Everyone and everything should be secured before making any vigorous attempts to free any jammed control as it may free suddenly leading to an abrupt change in the aircraft's attitude. If the jam persists, remember that the secondary effects of the controls might help you to fly the aircraft. Thrust can be used to change the pitch attitude, and rudder can provide roll control. The trim might still provide some control if the elevator is jammed. Always make any inputs small initially until the effect is understood, and do not chase airspeed altitude or attitude as large movements could result in pilot induced oscillations.
I hope that you find this issue interesting, and would welcome any feedback. I would specially welcome any contributions from any of you.

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How to cope with wet runways and hydroplaning

FROM PAGE 01

though the ground spoilers had automatically deployed after touchdown.

Both pilots attempted to brake, and shortly before the aircraft overshot the runway the pilot in command activated the parking brake which is also the emergency brake. This resulted in deactivation of the anti-skid system, the wheels locked up and the ground spoilers retracted (because the wheels had locked). The aircraft came to a rest about 160 m beyond the end of the runway, and suffered only minor damage.

Eyewitnesses stated that the aircraft touched down about 1000 m after the threshold, and this was later refined from FDR data to 849 m. All four tyres showed traces of rubber reversion hydroplaning (Figure 1), and had left about 400 m long bright traces on the runway which were definitely caused by rubber reversion hydroplaning (runway marks left following rubber reversion hydroplaning look like they might originate from steam blasting (Figure 2)). Furthermore, melted away rubber was found on the runway (Figure 3).

The Investigation concluded that based on the slow deceleration after touchdown it was highly likely that dynamic aquaplaning occurred in the middle portion of the runway followed by rubber reversion hydroplaning which occurred when the emergency brake was activated, the anti-skid deactivated and the tyres locked. The aircraft technical log did not show any irregularities regarding the brakes or tyres, and the tyres were inflated correctly.

The worst case RLW calculation, which the Investigation thought most likely to apply to this landing, gave a stopping distance with 150 m runway remaining – there was a longer runway available but the crew chose 27L because of construction work on a taxiway and the shorter distance to the terminal.

Lessons that can be learnt

I would like to use this incident to illustrate 2 lessons: firstly the factors leading to an overrun, and secondly to discuss hydroplaning.

Lesson 1 - The overrun

The last issue of JETSETS also covered overruns and we found that all overruns had more than one contributory factor. From my reading of the report this overrun is no different in that there were several factors as listed below:

Above: figure 1 - marks of rubber reversion hydroplaning on the tyre

Above: figure - marks of hydroplaning on the runway

Above: figure 3 - rubber dumped from tyre

Above: an Embraer 145 similar to the aircraft that suffered an runway overshoot

1. Landed slightly long. The ideal touchdown point is 300 m from the threshold - in this instance the touchdown was at 849 m. This shortened the LDA.

2. Landed slightly fast - but only by a few knots.

3. Runway condition. The runway was wet, or even flooded, but it is not clear whether the crew were aware of this. The crew were not informed of the runway condition by ATC.

4. Wind. There was a slight tailwind.

5. Incorrect braking technique. The Aircraft Operation Manual Part B included: When hydroplaning occurs, it causes a substantial loss of tire friction and wheel spin-up may not occur.

- The approach must be flown with the target of minimising the landing distance.
- The approach must be stabilized, and landing on centre line in the touchdown zone.
- The touchdown should be firm to penetrate the contaminating fluid film, and ensure wheel spin-up and spoiler activation.
- Immediately after touchdown, check the ground spoiler automatic deployment when thrust levers are reduced to IDLE.
- Lower the nose wheel positively, with forward pressure to assist traction and directional stability.
- **Apply brakes with moderate-to -firm pressure, smoothly and symmetrically, and let the anti-skid do its job.**
- **If no braking action is felt, hydroplaning is probably occurring. Do not apply Emergency/Parking brake, as it will cause the spoilers to close and cut the anti-skid protection. Maintain runway centre line and keep braking until airplane is decelerated.**

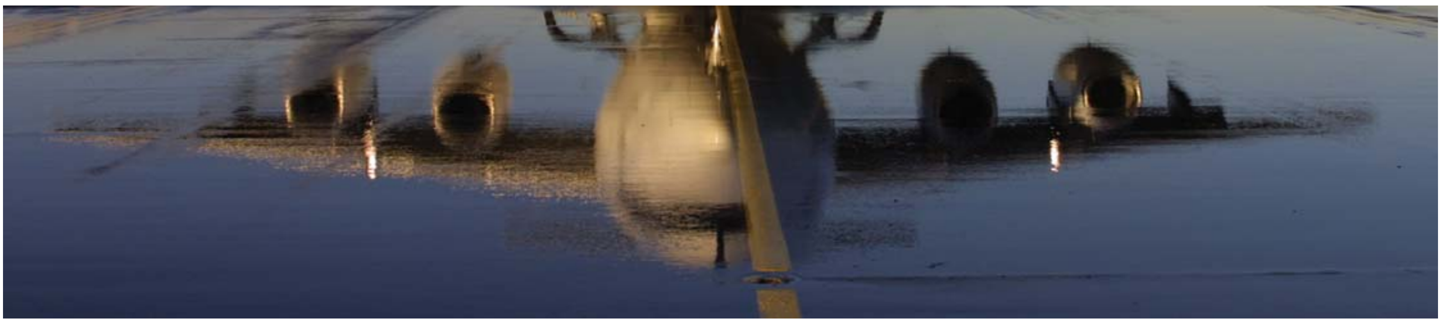
The crew do not appear to have followed some of the above advice. BAE Systems have received reports of incidents occuring to BAe 146/ Avro RJ aircraft where the anti-skid system was not given a chance to adapt to the conditions because yellow, green and then emergency yellow were selected in quick succession. This does not allow the adaptive feature of the anti-skid to operate correctly. You should note from the above that locked wheels provide very little stopping assistance!

As can be seen, there were at least five contributing factors. This incident may have been inevitable because the LDR following the long touchdown might have been insufficient, but if the other factors had not been present it is possible that an overrun would not have occurred. As stated at the end of the JETSETS article in the previous issue dated February 2008:

Don't eat into your margins, and if in doubt go around.

Lesson 2 - Hydroplaning

The other lesson from this accident has to do with hydroplaning. Control of your aircraft on the ground depends on the contact between the tyres and the surface, and on the friction provided by that surface. Whilst the above accident



Above: wet runway contamination can cause hydroplaning

Conclusion

I hope that this article has provided some food for thought. Our northern winter will soon be here with wet weather and we will be faced with conditions similar, and worse to those described above. Of course other areas in the world suffer similar conditions in monsoons and heavy rain. I can do no better than reiterate the advice given in the previous issue:

- A good landing starts with a good approach.
- Think before accepting a downwind component.
- Land in the right place at the right speed.
- If in doubt go around.
- Trust the systems and brake for effect, not comfort.

Don't eat into your margins

highlighted the braking problems caused by hydroplaning, directional control can be equally affected, especially in strong crosswinds before the rudder becomes fully effective. As a tyre rolls along the runway it is constantly squeezing water from the tread. This squeezing action generates pressure within the water that can lift part of the tyre off the runway and reduce the amount of friction that the tyre can develop. This squeezing action is called hydroplaning. Please note that icy runways are a totally separate issue.

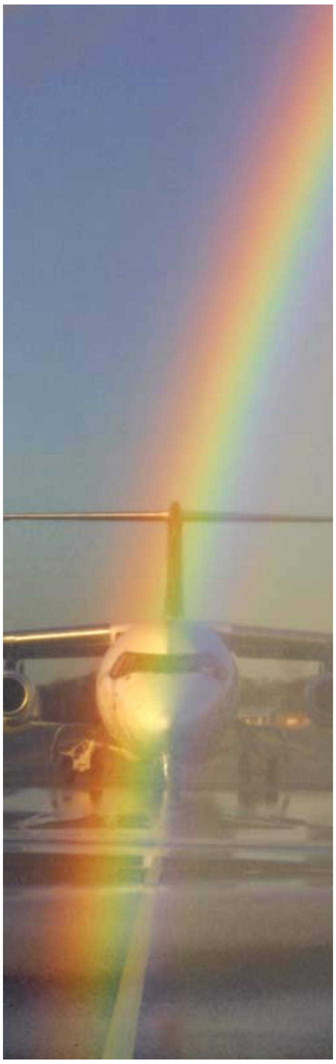
Three basic modes of hydroplaning have been identified: dynamic, viscous and reverted rubber.

Dynamic hydroplaning, which is also called aquaplaning, is related to speed and tyre pressure. High speed and low tyre pressure are the worst combination, giving the lowest aquaplaning speeds. During total dynamic hydroplaning the tyre lifts off the surface and rides on a wedge of water like a water ski. You have probably experienced this when driving through large puddles on the road, and felt the steering lighten. Dynamic hydroplaning will occur at speeds above 9 times the square root of your tyre pressure (in pounds per square inch). For instance the 146/RJ with tyres at 155 psi would hydroplane at speeds above 112 kt, the ATP (86 psi) above 84 kt, and the Jetstream 41 (100 psi) above 90 kt When dynamic hydroplaning occurs it may lift the wheel off the runway and prevent spin up or, if anti-skid is not being used, cause the wheel to stop spinning. Once started the hydroplaning could continue to much lower speeds.

Viscous hydroplaning occurs on all wet runways and describes the normal slipperiness or lubricating action of the water. Viscous hydroplaning reduces the friction, but not to such an extent the spin up on touch down is prevented. The most positive way to prevent viscous hydroplaning is to provide texture to the surface – hence grooved runways.

Reverted rubber hydroplaning is similar to viscous hydroplaning in that it occurs with a thin film of water and a smooth runway surface. It often follows dynamic or viscous hydroplaning where the wheels are locked. The locked wheel creates enough heat to vaporise the underlying water film thus forming a cushion of steam that eliminates tyre to surface contact, and begins to revert the rubber, on a portion of the tyre, back to its uncured state. Once started, reverted rubber hydroplaning will persist down to very low speeds – virtually until the aircraft comes to a stop. During the skid there is no steering ability. Indications of reverted rubber hydroplaning are distinctive white marks on the runway, and a patch of reverted rubber similar to the uncured state on the tyre. It is also likely that melted away rubber will be found on the runway.

The increase in stopping distance as a result of hydroplaning is impossible to predict accurately, but it has been estimated to increase it by as much as 700%. The reduced braking action on a wet runway may prevent the aircraft from decelerating normally with the anti-skid system operational. But the anti-skid system will provide optimum braking – switching it off will most likely lead to wheel lock up and burst tyres.



Report

From the European Regions Airline Association Air Safety Work Group Safety Targeted Awareness Report 009 V1 - November 2007: The following incident was reported by a CRJ crew on an early morning winter flight.

While holding in VMC we were cleared to descend to FL 150 and were IMC. Shortly after entering the clouds aircraft icing began to develop rapidly, being clearly visible at the wiper blade posts and cockpit window frames. Engine vibration was felt immediately. As we expected a 40 minute hold we asked to climb to VMC, but initially we were only cleared to FL160. Shortly after, the engine vibration increased rapidly, and after a few moments

Above: Canadair Regional Jet (CRJ)

Fan blade icing

ice particles separated from engine No 1, audible all over the aircraft. A more urgent request for climb was successful but at the same time there was a loud noise, the aircraft was vibrating heavily and the VIB indication for No 1 engine showed exceedance. We reduced thrust on No 1 to idle and decided to request priority. Vibrations also started on No 2 and were increasing. We were both convinced that the vibrations were caused by fan blade icing and not by damage, so we decided to leave No 1 engine running at idle thrust instead of shutting it down. During the approach the vibrations reduced and the instruments showed normal values. We then increased thrust on the engine, but the VIB indication went up into the 'yellow' range. On short final the ice seemed to have dissipated and we were able to use both engines in a normal way.

The ground report showed a surface temperature at the time of -1 deg C in light snow. The crew reported that the aircraft wing/cowl ant-ice had been switched on long before entering cloud. With the first sign of vibrations the crew also noticed significant elevator pulsing (4-5 cm fore and aft). There was no mechanical damage or fan imbalance on the engines, and the incident was put down to fan blade icing.

Flying in severe icing is to be avoided where ever possible. When encountering such conditions steps must immediately be made to move out of that environment

Engine fan blade icing

- First symptoms of icing can be detected by observing ice build-up on small objects like wiper blade posts.
- Sudden icing of the window frames is a sign of severe icing.
- Engine fan blade icing is often announced with engine vibrations.
- Due to ice shedding, the vibrations may be accompanied by sharp metallic noise as ice impacts the inside of the nacelle.
- Check the procedure for a an ENG VIBN caption
- In icing conditions, increase fan RPM in order to shed the ice. A higher fan speed reduces the risk of blade icing.
- Fan blade icing directly reduces the aerodynamic effectivity of the fan rotor, leading to significant performance degradation although the gas generator is at full thrust.
- Clean fan blades are less likely to pick up ice.

Why the reluctancy?

The use of oxygen masks in the event of smoke or pressurisation failure

Reading back numbers of the UK CAA Flight Operations Department Communications - I know, I should get out more! - I came across a communication that discussed smoke/fumes occurrences and the emergency procedures for cabin high altitude warning. These articles struck me as timely because recently we have had a couple of incidents during which the crew seemed reluctant to don their masks and goggles.

Reviewing the reports has made me ask: **why are crew so reluctant to don a mask?**

In one recent smoke/fumes incident the crew even had a therapeutic bottle and mask brought up for them to use if they felt any worse in spite of never having used the cockpit supply. There are two occasions where it would be prudent, and possibly even essential for life preservation, to use oxygen, and they are discussed in this article. You have two sources of oxygen available: there are therapeutic sets located round the aircraft for use by one and all and, much more readily to hand, there are the mask and goggles beside your seat for your exclusive use. I would like to discuss the use of the latter in the event of smoke or pressurisation failure.

We all need oxygen to survive.

I am sure that we all remember, however vaguely, the reasons for needing supplemental oxygen at height, but I will cover them again briefly. The atmosphere contains 21% oxygen, 78% nitrogen and some trace elements. We all need oxygen to live, and the amount that we get at sea level is adequate for us. As the atmospheric pressure reduces with altitude the proportion of gases remains fairly constant, but the amount of oxygen that we can take in with each breath reduces markedly with decreasing pressure. The amount of oxygen in the air is usually given by the partial pressure of the gas. At a pressure of 1000hPa there will be 210 hPa of oxygen (21% of 1000). At 500 hPa (equivalent to about 20,000ft) there will only be 105 hPa of oxygen and at 300 hPa (equivalent to about 30,000ft) there will only be 63 hPa. So as you can see there will not be enough oxygen to keep us going at the higher altitudes (your aircraft oxygen system should be able to supply enough gas to maintain a partial pressure of around 122 hPa). Figure 1 gives times of useful consciousness, and is covered in more depth later. Do remember that the symptoms of hyperventilation, or over breathing, which is usually associated with intense stress or anxiety, can be very similar to those of hypoxia.

Above: Embraer 145

Smoke/fumes

The QRH instructs you to put on the oxygen mask (with oxygen set to 100% - you do check that 100% is set on the first flight of the day don't you?) and goggles as part of the memory actions. This first action is to ensure that incapacitation does not occur although some manufacturers do allow some drills before going onto oxygen. The basic premise is that the crew are not best placed to diagnose the contaminant/source of the smoke, and the safety of the aircraft must be paramount and so the safest option has been chosen. Once on 100% oxygen the crew are protected from breathing any impurities, and should find that their performance is not impaired. Wearing the masks is less comfortable, and the mics are noisy. However, many pilots in the military get used to wearing a mask for every flight whereas for you it will only be for the remainder of the current flight. The smoke goggles also provide important protection as some contaminants can cause heavy eye watering leading to difficulties in seeing out of the cockpit, and so if separate goggles are provided they must also be donned. Having donned the masks and goggles there will be no cue as to whether to remove them before coming to a safe halt, and so they should be worn for the remainder of the flight. Don't be tempted to take them off if the smoke seems to have disappeared as there may still be some contaminant in the cockpit.

As we go to press a recent UK Air Accident Investigation Branch Bulletin 04/2008 (http://www.aaib.dft.gov.uk) contains a 'smoke' incident that occurred to an Embraer 145 during a scheduled operation. The first

Above: smoke in the cabin, first priority is to ensure against crew incapacitation officer was PF. Shortly after take-off a warning sounded, the captain's displays went blank, and smoke appeared from the left side of his seat. The flight deck crew described this as a 'smoke haze' and they smelt an 'acrid burning smell'. A return to the departure airfield was initiated and the captain ascertained from the cabin crew that there was a strong smell at the front of the passenger cabin. The captain told the first officer that he was happy to continue without masks as there was only a little smell of smoke, and the first officer concurred. At no time during the incident did the crew put on their oxygen masks, instruct the cabin crew to put on their oxygen masks, deploy the passenger oxygen masks or refer to the QRH. The QRH contained memory actions which included donning masks, and donning the goggles. The captain commented that he did not put his oxygen mask on as there was only a small amount of smoke. After the smoke cleared, and having discussed it with the first officer, he did not want to put his oxygen mask on as he was concentrating on monitoring the first officer, thought it might 'hamper things', and did not want to cause undue concern to the passengers in the event of doing an announcement with the mask on.

I leave you to draw your own conclusions from this.

Cabin high altitude warnings

There have been some well publicised accidents that have been caused by lack of pressurisation (and therefore inadequate oxygen) at altitude. Two that spring to mind are Payne Stewart and the Boeing 737 operated by Helios. You may recall that the professional golfer Payne Stewart was killed, along with 5 others, when his chartered Learjet crashed. Speculation centred on the possibility that the accident might have followed a decompression early in the flight with all onboard becoming incapacitated. Pilots of military aircraft who followed the Learjet after the crew stopped responding to ATC and climbed above their assigned altitude of 39,000 feet said that the aircraft's windows were covered with ice, and there was no sign of flight control movement. The Helios accident was a result of continuing to climb unpressurised to an altitude above which life could be supported without supplemental oxygen. Apparently the flight crew did not don their oxygen masks.

Can't happen to us? We've had a couple of reports recently where the packs were not selected ON and the aircraft continued the climb until the crew received a warning to indicate that they were not pressurised.

Not all of us are able to experience hypoxia at first hand in a pressure chamber or for real (many might not want to!), and so we have to make do with reading books or ground training. Those of us who have been in a chamber will remember how insidious the onset of unconsciousness was. Mostly we were given a simple task such as writing down a multiplication table or writing our name; when I went through a chamber run, and my oxygen was switched off, I felt all was OK till I woke up when the oxygen had been restored and looked at my pitiful attempt to complete the table and my scribbled writing. The most important lesson from this exercise that I learnt was: I was not competent to judge my condition. For this reason the first action on getting a cabin high altitude warning must be to don your oxygen mask.

Altitude ft AMSL	Time
15,000	Indefinite
18,000	20 to 30 minutes
22,000	10 minutes
25,000	3 to 5 minutes
28,000	2.5 to 3 minutes
30,000	1 to 2 minutes
35,000	0.5 to 1 minute
40,000	15 to 20 seconds
43,000	9 to 12 seconds

Above: figure 1 - time of useful consciousness

Above: Boeing 737

The table opposite (copied from Wikipedia, but there are many similar tables published) gives indications of times of useful consciousness without oxygen:

This table was probably calculated on a young fit person sitting down. Someone walking about would have less time (cabin crew?), and other factors such as stress, fitness, smoking and fatigue will also affect the time available to you. Certainly some published tables give less time at the heights above 22,000 feet.

How long will it take you to don your mask? For our turbo props there is a bit of leeway because they cruise at lower levels, but for the jets time may be of the essence. Tests have shown that pilots often take up to 15 seconds to don a mask. If you go unconscious you will probably regain consciousness within 30 seconds of oxygen being restored – but someone will need to be around to put your mask on for you. This should be your first action, you must not delay putting the mask on because the cabin altitude is only about 20,000 feet (as has happened) since you might not get a second chance!

Once you've got your masks on the aircraft must be descended to a level where the rest of the crew and passengers can breathe normally – this is usually 10,000ft or MSA if higher. The emergency descent configuration given in your QRH should ensure that the descent can be made in less than 4 minutes.

Conclusion

I hope that this article has given you something to think about, and may help to save your life in the event you suffer a problem. These events are rare, and preparation and education can help us to reduce the possibility of them becoming more than an incident. I would be very interested in any feedback from you giving indications as to whether you feel crews are reluctant to don masks, and if so giving an indication of the problems - e-mail address at the front of this issue.

Ice - beware of the pitfalls

Icing induced loss of control experienced by turboprop powered aircraft

Lessons learnt

Most crews associate ice with use of the engine de or anti-ice system and looking out to try and gauge when their wings have acquired enough ice to warrant the use of the boots. Unfortunately some icing encounters have also led to the loss of control - which has not always been regained. The following discussion covers three incidents and tries to draw some lessons.

Incident 1

The Australian Transport Safety Bureau (www.atsb.gov.au) report that the SAAB 340 crew commenced descent to MDA with a low power setting, and reported that the visibility alternated between visual and instrument flight conditions. During the descent the engine anti-ice was on but not the propeller de-ice, nor had the airframe boot de-ice system been activated. The flight crew noted ice accretion on the windshield wiper but not on the wing. At MDA the autopilot captured the altitude and, as the airspeed was reducing due to a low power setting, commanded the trim to progressively raise the nose of the aircraft to maintain altitude. PF commanded the autopilot to turn right to begin tracking downwind. At about this time PNF noticed that the airspeed was decreasing and called 'speed'. As PF applied power to compensate for the decreasing airspeed, the aircraft rolled to the left and pitched down without warning. During the recovery from the steep pitch and bank angles, the aircraft rolled to the right and descended to 112 feet AGL. PF regained control of the aircraft and carried out an uneventful landing. The aircraft's aerodynamic stall warning system did not activate during the initial roll to the left, but the autopilot disconnected during the subsequent roll to the right due to activation of the stall warning. The investigation determined that, following altitude capture by the autopilot, the airspeed continued to decrease, and the aircraft stalled. The stall occurred prior to the stall warning operating. The investigation found that it was possible for the aircraft to stall prior to activation of the stall warning system if ice had accumulated on the wings.

Above: a Saab 340 similar to the aircraft involved in an icing incident in Australia

Incident 2

Less lucky were the crew and passengers on board an ATR over Roselawn Indiana USA as recorded by the Aviation Safety Network (http://aviation-safety.net). The aircraft had been in the hold for over 30 minutes, and early on the crew had selected flap 15 to reduce the nose up attitude of the aircraft for passenger comfort. The aircraft was cleared to descend and the power was reduced to flight idle. The autopilot was engaged and the aircraft was descending in a 15 degree right turn. The flap overspeed warning sounded and so the flaps were selected to zero; the AOA increased and the ailerons began deflecting to a right wing down position. About half a second later the ailerons deflected rapidly and the autopilot disconnected. The aircraft rolled rapidly to the right and the pitch attitude and AOA started to decrease. Within several seconds of the initial aileron input the AOA was 3.5 degrees, the ailerons were nearly neutral and the aircraft attitude was 77 degrees right wing down. The airplane began to roll to the left towards a wings level attitude and the elevator began moving in a nose up direction. Following several unsuccessful attempts by the crew to correct the airplane's attitude the airplane impacted in a soya field killing all on board. The NTSB found that the probable cause was loss of control attributed to a sudden, unexpected aileron hinge moment reversal that occurred after a ridge of ice accreted beyond the de ice boots while the aircraft was in the holding pattern.

Above: ice accretion on windshield indicates severe icing conditions

Incident 3

The 1992 UK Air Accident Investigation Board report stated that an ATP crew were en-route to the Channel Islands, and the aircraft entered cloud about 3000 feet below cruise height. The crew observed sleet and rain in the cloud although the only indication of airframe ice was a thin layer of what the crew described as rime ice on the leading edges of the wing, and 3/8 of an inch of rime ice on the windscreen wiper blade. The engine and propeller ice protection system had been switched on from take-off. About 1000 feet before level off the aircraft speed reduced and the rate of climb fell at times to zero. The commander requested a lower level, but was not immediately cleared to descend due to other traffic. The aircraft was being flown by the autopilot in the heading mode with the **attitude being controlled by the autopilot pitch wheel**. The aircraft began to experience vibration which rapidly increased in severity. Both pilots had experienced propeller icing and the associated vibration, but on this occasion they thought it to be more severe. Shortly after the onset of the vibration the left wing dropped and the aircraft began to descend. The aircraft initially pitched down approximately 15 degrees and began a rolling oscillation. The commander disengaged the autopilot and felt that the aircraft was slow to respond to aileron control inputs and large bank angles were reached, particularly to the left where a single peak 68 degrees of bank was recorded. The aircraft descended below the cloud and at about that time the vibration subsided. As the commander stabilized the roll, the aircraft pitch, which had oscillated back toward zero following the initial nose drop rapidly increased to 10 degrees nose up under the influence of aft elevator trim which had been applied by the autopilot at the onset of the incident. The crew reported that at no time were they aware of a warning from the stick shaker.

Above: an ATR 42 aircraft suffered loss of control due to an unexpected aileron hinge moment reversal due to accreted ice

Three turbo-prop upset accidents/ incidents out of many, and all seemingly caused by small accumulations of ice. Loss of control has many definitions, but for the purposes of this article loss of control will be assumed to be when an aircraft ceases to respond in the correct sense to a control input. For instance if the aircraft starts to roll left and does not roll right in response to right roll input then loss of control has occurred. This is specially true in pitch where, following a stall, it may not be possible to raise the nose, and the aircraft can stabilise in a rapid descent. In the above incidents all the aircraft rolled initially; two were subsequently recovered but one was not. The most likely explanation is that in two instances the angle of attack (AOA) was reduced below that of the stall and control was regained whereas in the third instance it was not. Conventional stall training emphasises that the recovery should be made with minimum loss of height, and this minimum height loss is emphasised by some authorities.

Simulator training usually requires response to the first indication of stall by applying power and maintaining the pitch attitude so as to lose little or no height. Thus the aircraft accelerates level to a higher speed and lower AOA. Upsets usually occur in IMC and the recovery has to be made from an unusual attitude. An ice related stall will most likely have occurred at a lower than normal AOA, higher than normal airspeed with no stall warning. The only warning is the above defined loss of control.

Digging in the far recesses of your minds you may recall the Standard Stall Recovery that was trained by your first instructor. It goes something like this:

Simultaneously
- Control column centrally forward until the buffet stops and:
- Apply full power.
- Roll wings level.
- Recover to level/climbing flight.

Note that the forward movement is 'until the buffet stops'. In other words don't keep pushing till you are pointed straight down! This is the source of the minimum height loss recovery training since in an incipient stall the buffet stops almost immediately the control column is moved forward and the aircraft can then be climbed.

The most important action is the first one – you are unstalling the aerodynamic surfaces. We are not blessed as are many military aircraft with AOA gauges – if we were then stall recovery would be simpler. Our only option is to move the control column forward to lower the nose, apply full power to accelerate and then climb.

Note that with autopilot engaged these cues may be masked; this is why it is suggested that you hand fly in heavy ice encounters – specially if there is an airspeed loss due to ice accretion.


Above: an ATP was involved in an incident whilst en-route to the Channel Islands

Additionally, the autopilot might trim as ice is accumulated, then disengage suddenly when it reaches its trim force limits, and so apply a sudden and substantial control input. This unexpected control input can also occur when the pilot disengages the autopilot even if it has not quite reached its limits.

Recovery from an ice related stall should be possible if:

- At the first sign of stall (activation of stall warning device, uncommanded roll, buffet or other aerodynamic cues).
- Apply nose down pitch control.
- Apply full power.
- Initially try and stop further roll.
- When roll control regained roll wings level and recover to a climb.
- Monitor the airspeed to ensure it does not increase too much.
- If the nose cannot be lowered, selecting the first flap angle may help - don't forget the flap airspeed limitation during the recovery.

In most cases the nose will drop due to the stall, but this drop will usually not reduce the AOA enough, and further forward movement of the pitch control will be required. This pitch down may well feel uncomfortable, and it is also important not to bury the nose too deep.

There are other considerations. Ice will probably also affect the props, and so there may not be as much power as usual, and ice will increase drag (although the drag at Roselawn was only calculated to have increased by 5 – 10%) .

Following the ATP incident it was found that the Cl max reduced from 1.6 to 0.9, and the stall speed increased from about 110 knots to 140 knots.

Having covered wing stalls we're not quite home and dry as the tailplane can also give rise to problems. A tailplane stall occurs when the maximum AOA for the tailplane is exceeded and it stalls. Normally the tailplane creates a down force to balance the nose down pitching moment of the wing and, under normal conditions without any ice accreted, the forces on the elevator are roughly equal and produce no hinge moment. With ice accreted on the tailplane flow separation can occur on the lower surface causing it to stall. This reduces the amount of down force produced by the tailplane and can lead to a nose down pitch. The flow separation will also result in a change in the elevator force by causing a change in the relative pressure distribution over the upper and lower surfaces with the lower surfaces sensing a lower force. This can lead to stick lightening, or even forward movement of the control column. This forward force can be quite high, and the pull force needed to apply up elevator can be even higher. So in the worst case of a tailplane stall the aircraft will pitch rapidly nose down and the control column will move rapidly and strongly towards the instrument panel. Recovery from this is the reverse of a wing stall – pull back on the control column. Selection of the flap up to the next setting is also likely to assist the recovery. The tendency towards tailplane stall is exacerbated by speed and flap angle. A tailplane stall is most likely to occur at high flap angles and at speeds around Vfe. This is because extending the flaps increases the down wash angle from the wing and thus the tailplane AOA. For any flap angle the AOA on the tailplane gets nearer the stall as speed is increased. Therefore at higher flap angles the wing stall margin is increased but the tailplane margin is reduced as airspeed is increased. On some aircraft, the HS 748 for instance, the tailplane stall occurs at lower speeds nearer Vref.

From the above it is apparent that those operating turbo props in ice need to be aware of the pitfalls. However, jets are not immune, and jet pilots should know that ice may well have an effect on the stall characteristics of their aircraft.

ABBREVIATIONS

AGL	Above Ground Level
AOA	Angle Of Attack
AMSL	Above Mean Sea Level
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
CAA	Civil Aviation Authority
CL	Co-efficient of Lift
cm	centimetre(s)
CRJ	Canadair Regional Jet
CWP	Central Warning Panel
ECS	Environmental Control System
FDR	Flight Data Recorder
FL	Flight Level
hPa	hectoPascals
IMC	Instrument Meteorological Conditions
Km	kilometre
Kt	knot
LDA	Landing Distance Available
LDR	Landing Distance Required
m	meter(s)
MSA	Minimum Safe Altitude
NTSB	National Transport Safety Board (USA)
PF	Pilot Flying
PNF	Pilot Not Flying (now Pilot Monitoring (PM))
psi	pounds per square inch
QRH	Quick Reference Handbook
RLW	Regulated Landing Weight
RPM	Revolutions Per Minute
SOP	Standard Operating Procedure
Vfe	Flap limiting speed
VIB	Vibration warning caption
VMC	Visual Meteorological Conditions
Vref	Landing Reference Speed at threshold

Interesting accidents and incidents

The UK AAIB has recently published the following reports which can be read on their web site (www.aaib.gov.uk/bulletins):

Formal Report 3/2008 reports on the Jetstream 32 wheels up approach that I commented on in the editorial; Formal Report 6/2008 reports on an HS 748 which landed in poor weather on Guernsey, and overran the runway.

The June 2008 Bulletin covers a fumes incident that occurred during a 146/300 positioning flight. There was an unusual smell and both flight crew felt unwell. The fumes were confirmed to come from a chemical in the forward toilet, and the August 2008 Bulletin reports on a tailstrike that occurred to an RJ/100 at London City. The strike caused significant damage to the rear fuselage

Among the recent incidents that have been reported to us are the following:

BAe 146/Avro RJ

- An RJ burst all 4 tyres on landing during a proving flight into a short runway. BAE Systems are currently assisting the Authority in the investigation.
- An RJ lost a nose wheel on take-off and landed safely. The loss was identified as a bearing failure. The aircraft landed safely.
- A 146 turned off runway and skidded off taxiway. Left main undercarriage collapsed. There were no injuries, and this incident is under investigation with BAE Systems assisting the Investigators.
- A 146 was carrying out an approach to a runway where snow clearing had been carried out. During the flare to land the aircraft started diverging to the left of the runway centre line, and it landed on the uncleared left hand side of the runway. Shortly after touchdown the nose landing gear collapsed. Under Investigation by the local Authorities, and BAE Systems are assisting the Investigators.

Jetsteam 31/32

- A Jetstream 32 overran on a slippery runway with no injuries. This incident has raised questions as to when to select full flap. To avoid destabilising the approach we recommend that the aircraft should be fully configured and stable by 1000 feet IMC and 500 feet VMC. Contrary advice in the Crew Manuals will be amended in due course.

- A Jetstream 31 landed short following an approach in turbulent conditions. This led to the collapse of both main undercarriage legs and the aircraft departed from the runway. There were no injuries.
- A passenger attempted to hijack a Jetstream 32 in New Zealand. Both crew were stabbed, but landed the aircraft safely.

Jetstream 41

- A Jetstream 41 called MAYDAY and diverted with control problems. The aircraft landed safely. This incident is the subject of an UK AAIB Investigation. BAE Systems are assisting this investigation.

ATP

- An ATP suffered an inverter failure with no CWP warning. During the flight, problems were encountered with the number 2 IAS and servo altimeter indications, and the number 2 auto-pilot. During the cruise, other faults occurred and the crew diagnosed an inverter fault. On checking the inverter output the number 2 inverter indicated a low voltage although no fault/failure was indicated. The inverter failure checklist was actioned with the result that all systems were restored with only an amber XMON legend displayed on the number 2 PFD and the EFIS caption was illuminated. BAE Systems are investigating this incident.
- An ATP suffered torque fluctuations of 20% which reduced slightly when the power lever was retarded. Selection of the ECS to OFF had no effect and, as the fluctuations increased, the engine was shut down. A connector to the EEC was found to be heavily contaminated. This connector was cleaned, and this rectified the fault..
- There have been 5 ATP power interrupts. These were characterised by the torque falling to (usually to 0) over a period of 1 to 3 seconds followed by a recovery between 2 and 19 seconds later. In one case the event was over in 2 seconds and in all other cases the propeller RPM maintained at its preset value of 80% or 82.5%. Ice ingestion is thought to be the cause, and BAE Systems are asking all ATP Operators to ensure that there are no large steps between adjoining panels in the intake.

JETSNIPS

A light hearted look at the aviation industry

Learn from the mistakes of others, you will not have enough time to make them all yourself.

There are 3 rules for making a perfect landing; unfortunately no one can remember what they are.

As a pilot you can do anything you want in flight. As long as its right…and we'll let you know if its right after you've landed.

Always keep your words short and sweet as you may have to eat them.

Many years ago, when I was learning to sail, the instructor asked me 'when should you reef the sails?' As I searched for an answer, and was about to guess, he said 'the first time you think about it'.

Basic flying rule; try and stay in the middle of the air, and do not go near to the edges of it. The edges can be recognised by the appearance of ground, buildings, trees, sea and interstellar space. It is much more difficult to fly there storing dead batteries.

Heard on the PA

"Ladies and Gentlemen... Welcome to London... at this time in the flight we ask for volunteers to clean the toilets. If you want to help... all you have to do is stand up before the fasten your seatbelt sign has been switched off."

"As you leave the aircraft please make sure to gather all of your belongings. Anything left behind will be distributed evenly among the cabin crew. Please do not leave any children or spouses."

"Dad, why are there always two pilots?"
"One has to prevent the other from doing stupid things."
"Which one is doing the stupid things?"

"And during the take-off I may fail one of the power units"

Cartoons: Derek Paul, Graphics and Media, Prestwick

High flight

Oh, I have slipped the surly bonds of earth (1),
And danced (2) the skies on laughter silvered wings;
Sunward I've climbed (3), and joined the tumbling mirth (4)
Of sun-split clouds (5) and done a hundred things (6)
You have not dreamed of –
Wheeled and soared and swung (7)
High in the sunlit silence (8).
Hov'ring there (9)
I've chased the shouting wind (10) along and flung
My eager craft through footless halls of air (11).
Up, up the long delirious (12), burning blue
I've topped the wind-swept heights (13) with easy grace,
Where never lark, or even eagle (14) flew;
And, while with silent, lifting mind I've trod
The high untrespassed sanctity of space (15),
Put out my hand (16), and touched the face of God.
(from John Gillespie Magee Jr., "High Flight")

NAA SUPPLEMENT to "High Flight"

1. Flight crews must insure that all surly bonds have been slipped entirely before aircraft taxi or flight is attempted.
2. During periods of severe sky dancing, flight crew and passengers must keep seatbelts fastened. Flight crew should wear shoulder harnesses if provided.
3. Sunward climbs must not exceed the maximum permitted aircraft ceiling.
4. Passenger aircraft are prohibited from joining the tumbling mirth.
5. Pilots flying through sun-split clouds must comply with all applicable visual and instrument flight rules.
6. Do not perform these hundred things in front of Flight Operations Inspectors.
7. Wheeling, soaring, and swinging will not be accomplished simultaneously except by pilots in the flight simulator or in their own aircraft on their own time.
8. Be advised that sunlit silence will occur only when a major engine malfunction has occurred.
9. "Hov'ring there" will constitute a highly reliable signal that a flight emergency is imminent.
10. Forecasts of shouting winds are available from the local meteorological office. Encounters with unexpected shouting winds should be reported by pilots.
11. Pilots flinging eager craft through footless halls of air are reminded that they alone are responsible for maintaining separation from other eager craft.
12. Should any crew member or passenger experience delirium while in the burning blue, submit an irregularity report upon flight termination.
13. Wind swept heights will be topped by a minimum of 1,000 feet to prevent massive airsickness-bag use.
14. Aircraft engine ingestion of, or impact with, larks or eagles should be reported to the Authority and the appropriate aircraft maintenance facility.
15. Air Traffic Control (ATC) must issue all special clearances for treading the high untresspassed sanctity of space.
16. Pilots and passengers are reminded that opening doors or windows in order to touch the face of god may result in the loss of cabin pressure.

FACT FILE REGIONAL AIRCRAFT IS RESPONSIBLE FOR THE WORLDWIDE SUPPORT OF APPROXIMATELY 900 AIRCRAFT