Windshear: Why pilots learn to respect the weather

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The events at Dallas/Fort Worth International Airport on 2 August 1985 played an integral role in how pilots learn to respect the weather. Right from the very start of flying school, understanding how the clouds, wind and rain affect the performance of your aircraft is key to becoming a safe pilot.

On that fateful day, from descending at a controllable 1,000 feet per minute (a normal approach will be around 700 feet per minute), the aircraft then began to descend at 1,800 feet per minute, the airspeed reducing suddenly to 130 knots. As the engines had been at idle power, it took six long seconds for the full power to come into effect. This quickly brought the speed back up to a safe level and reduced the rate of descent. After that, it began to descend at a sickening 3,000 feet per minute. When just 300 feet above the ground, this descent rate had increased to 5,000 feet per minute. Despite the best efforts of the pilots to fly the aircraft back up into the air, they hit the ground around one mile short of the runway.

Of the 163 people on board, 136 lost their lives that evening.

Windshear — the invisible killer

What the captain had realised, tragically too late, was that the aircraft had entered windshear conditions. Simply put, windshear is when the wind changes rapidly in a short distance and it comes in two forms: vertical shear and horizontal shear.

Vertical shear is the change in wind strength the aircraft experiences as it climbs or descends. Horizontal shear is the change in wind strength the aircraft experiences as it moves forwards through the air. To understand why windshear is a serious threat to the safety of a flight, we need to know what impact the wind has on an aircraft.

Contrary to popular belief, it is not the engines that make aircraft fly, it is the wings. The engines merely provide the forward acceleration.

A wing works by air flowing over its surface. When the airflow reaches a certain speed, the wing starts to provide lift. When the lift generated is greater than the weight, the aircraft climbs into the air. The engines merely provide the driving force to create that airflow over the wing. As a result, the strength and direction (velocity) of the wind is of great importance to aircraft at all stages of flight, particularly during takeoff and landing.

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Microbursts

Windshear was just one part of dangerous conditions encountered by the crew of Flight 191 that August day. What *caused* the windshear was a phenomena known as a "microburst".

Microbursts happen when a cooled, heavier column of air in a thunderstorm sinks rapidly. As the column of air falls out the bottom of the cloud, it brings rain, and often hail, with it. As this "rain bomb" hits the ground, it sends out violent winds in all directions. It's like when you turn on the kitchen tap — water hits the sink and sprays out in all directions.

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This can even be seen from smaller storm clouds. Have you ever been outside when you experienced a sudden increase in wind, just a few minutes before it started pouring with rain? This is known as a gust front and comes from heavy rain falling from a cloud.

If that sudden gust of wind is strong enough, as can easily be the case from bigger storms, the change in wind speed can be enough to cause windshear.

A lesson to be learned

So, as we put together the pieces of a microburst event, we can start to see what happened to Flight 191.

Unbeknownst to the crew, due to the limitations of 1980s weather radar, they were about to fly under a massive storm cell where a heavy column of wet air was just about to fall out of the bottom. As the microburst occurred, the wind pushed out from the falling rain caused a sudden increase of air over the wings of the aircraft, increasing the airspeed.

To counter this, the first officer reduced the engine power. Yet, as the aircraft entered the downdraft beneath the cloud, the captain realised what was going on, hence his instruction to push the thrust levers all the way forwards.

The aircraft exited the downdraft and, for a moment, everything stabilised. Until the real danger came.

With the engine power now back at normal, the aircraft entered the wind on other side of the storm. This time, instead of increasing the airflow over the wings, the addition of a strong tailwind decreased the airflow. The aircraft got so slow that it started to lose lift.

The pilots applied maximum power again but it was too late. The down drafts from the storm took away any remaining hope of climbing back up into the air and slammed the aircraft into the ground.

How do pilots deal with windshear?

One thing the aviation industry is good at is learning from past events and trying its best to ensure that they don't happen again. The 1985 crash in Dallas was a defining moment in how we handle windshear events.

Crew training

At the time, even though crews were aware of the threat of windshear and microbursts, the training given in how to deal with them was limited to theoretical training. No practical training in the simulator was given. In addition to this, the training focused on how pilots should cope with the situation once in it, instead of how to escape from it. Or, even better, how to not get into the situation in the first place.

Nowadays, pilots are trained how to recognise the signs of potential windshear and microburst activity and how best not to end up in a windshear scenario. If a thunderstorm is sitting on the approach to a runway, pilots will usually opt to enter a holding pattern and wait the 10 to 15 minutes it will take for the storm to pass through.

However, should there be no perceptible signs of potential windshear, we have another tool at our disposal. The weather radar.

Aircraft weather radar

The weather radar on the Lockheed L-1011 aircraft was primarily designed for avoiding weather en route. As the aircraft neared the ground, the pictured painted on the pilots' screens became less and less useful. This was because the radar was only good at detecting moisture. As there is no moisture in wind, it was unable to detect the dangerous winds coming out of the storm.

As weather radar technology improved, pilots were presented with not only a better depiction of weather closer to the ground, but also the ability to detect windshear ahead, even before encountering it. The weather radar system in today's aircraft, such as the Boeing 787 Dreamliner which I fly, are so advanced that they give us greater protection from windshear than ever before.

Predictive windshear

As the radar scans the sky ahead of the aircraft, it is able to detect significant changes in the wind velocity. If windshear is detected ahead, an aural caution of “MONITOR RADAR DISPLAY!” is presented to the pilots, along with a display on their screens showing where the windshear has been predicted. This is know as predictive windshear.

Pilots can use this display to manoeuvre the aircraft to stay clear of the cone area depicted on their screens.

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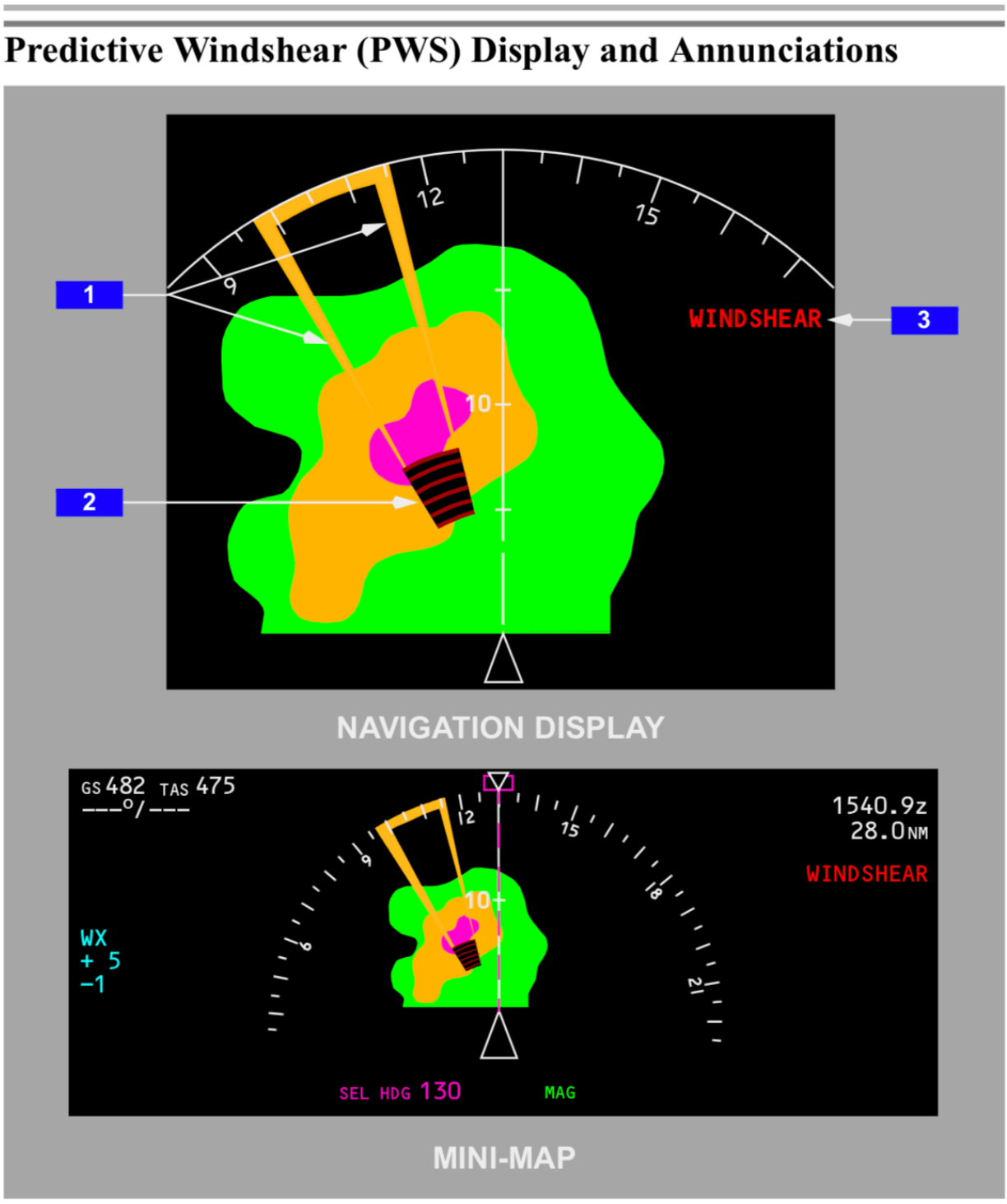

The predictive windshear display on the 787 Dreamliner. (Image courtesy of Boeing)

Reactive windshear

If windshear is actually detected, depending on the stage of flight, pilots will respond in different ways.

On the takeoff run, a warning of “WINDSHEAR AHEAD!” would result in a rejected takeoff. It’s much safer to stay on the ground rather than get airborne into a windshear scenario.

Once in the air, on activation of this warning, pilots would carry out the “Windshear Escape Manoeuvre”. In essence, this requires them to immediately apply full power and pitch the nose up, climbing away from the ground as quickly as possible.

If on the approach, like in the case of Flight 191, there is also a predictive warning, “GO-AROUND, WINDSHEAR AHEAD!” This is the warning which could have saved Flight 191. Should the same scenario happen today, the predictive windshear system will alert the pilots to the impending situation.

Before they even get to the point of encountering the windshear, the crew will perform a go-around — putting the power on and climbing back up to safety.

Ground-based radar

In addition to the radar systems on board the aircraft, most airports which are at high risk from windshear have their own ground-based radar systems. Terminal Doppler Weather Radar detects the movement of water droplets and other airborne particles.

As these elements are blown by the wind, the Doppler radar picks this up and informs ATC of windshear conditions close to the ground. This information is then passed on to the pilots who can then asses whether it’s safe to land or if it’s preferable to hold off making an approach until the weather improves.

Bottom line

A good pilot will never underestimate the weather, especially when there are thunderstorms in the vicinity of an airport. Fortunately, these days we have a wealth of technology available to help us understand the weather around as thoroughly as possible.

Windshear is a threat which should never be taken lightly. Avoiding the situation in the first place is alway the best option, even if this means causing a delay to the flight. However, should we find ourselves in windshear conditions, the training we undertake in the simulator every six months ensures that we deal with the situation safely.

By learning from the misfortune of those who have gone before us, we strive to continually improve flight safety for those who we carry “in the back”.

Featured photo by ViktorCap/Getty Images

Charlie Page Charlie Page is an airline pilot flying the Boeing 787 Dreamliner. Each Saturday he gives you a 'behind the cockpit door' insight to life in the flight deck.