OBSERVE, AND THINK OUTSIDE THE BOX

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California is generally a warm and sunny place. But it had rained for days. On January 28, 2008, the rain stopped in the early afternoon. It was still cool at +12°C, but the air blew dry and a light wind at 10 kts removed all residual moisture from the runway. The commander of VP-CRC, a Bombardier Global Express, arrived at Van Nuys airport for a scheduled departure into the night at around 2200 hours. At 2240 hours he took off bound for London Luton on a private flight with one passenger.

The night flight went on well. The commander touched down the next day at 0808 hours UTC. During the subsequent landing roll, one main landing gear tire suffered a slide-through failure.

FAILURE Landing at Van Nuys, a main landing gear tire of the Global Express suffered a slide-trough failure.

Crew and passenger remained unharmed. But the aircraft suffered substantial damage. The left inboard main gear tire had burst resulting from a locked wheel. The flap drive shaft and two hydraulic pipes fractured. Impact damage from flailing sections of the tire also damaged a wiring loom and localized elements of the wing structure. Thus, the flight control system was extensively damaged. A similar failure in a touch-and-go scenario might have resulted in a much less benign outcome.

Frozen Brakes

It seems counterintuitive at first glance that frozen brakes had been the cause for the tire burst in Luton.

The take-off happened in dry weather on a dry runway. And yet, one of the brakes froze once the cold air at high altitude cold soaked the brake assembly.

VP-CRC had been parked on the Tarmac for four days. It had rained a lot in Van Nuys during this period. It was only during the last 8 hours before departure that the weather dried up.

This rainfall had wetted the carbon brakes of which both the rotors and stators are porous and slightly absorbent. To mitigate the risk of frozen brakes, the manufacturer's training material recommended to heat the brake assemblies during taxi by applying the brakes. However, such guidance was not contained in the approved aircraft documentation and it did not specify brake temperature limitations.

As it is common practice in business jet operations to reduce wear and tear of the brakes by avoiding brake applications as far as possible, the pilot of this flight did not dry the brakes sufficiently before take-off. On many smaller airports this would also be hard to accomplish as the distance to taxi to the runway might not be sufficiently long to allow such brake application.

Certificated Tire Failure Mode

The tire in question was of the cross-ply type, sometimes known as Bias ply type.

Slide-through events and lateral cutting by debris are at the origin of tire failures in which the tire ruptures. Tire ruptures on take-off can be induced by lateral cutting by debris on the runway such as in the tragic accident of Concorde flight 4590 on July 25, 2000.

Partial or complete separation of large sections of total carcass thickness and substantial portions of the tire sidewall then detach. The flailing section inflicts great damage.

EASA and FAA had certificated this type of tire based on much lower speeds than the speeds encountered by our incident aircraft.

Having analyses the serious incident discussed in this Safety Sense and the Concorde accident, the UK AAIB concluded that EASA certification rules did not suffice to prepare for such catastrophic tire rupture and recommended a review of such certification rules.

Understanding the System

Type certification rules and pilot type training aim to achieve the highest level of safety possible. They root in assumptions regarding what can go wrong and what actions are best suited to handle the failure. Aircraft certification rules will never encompass all possible failure modes and pilot training will never include all actions to deal with all possible failures. The probability of a failure as well as the severity of such a failure determine if it is incorporated in the certification requirements and in the pilot training syllabus for a particular aircraft type.

Therefore real life situations can occur which are outside of the scope of both aircraft type certification as well as the pilot training syllabus.

Pilot training aims to optimize the learning effect versus the time required. To deeply understand aircraft systems, the relationship between such systems and the environment and to know about the operational consequences and practice them, exceeds the time available for formal training.

The UK AAIB suggested in the wake of the incident discussed here that crew should be made aware of the vulnerability of carbon brakes to freezing in flight following exposure to moisture on the ground. It should be emphasized that saturated carbon brakes dry very slowly even in warm, low humidity conditions.

Depending on weather conditions and the specific geometry of wing, the wing will not shield the brake assemblies from moisture. Aircraft parked outdoors for several days are particularly vulnerable to this effect.

The Cost of Safety, The Benefits of Safety

Carbon brakes are much lighter than steel brakes and allow considerable weight savings for aircraft manufacturers. They can absorb more energy than steel brakes and are therefore more effective at decelerating the aircraft.

To limit wear and tear on carbon brakes pilots should avoid to 'ride the brakes'. One single, firm brake application causes less wear than numerous light applications. Reducing maintenance costs on brakes by avoiding to apply them is of course good practice.

But as with any rule of thumb, it must be used wisely and in consideration of the full context.

When weather conditions might wet the brakes, pilots should dry them prior to take-off. By doing so, they avoid the cost of losing more than just a brake.

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ROUTINE
Pilots should avoid applying numerous light impulses on brakes. One firm application causes less wear and tear.