Applying take-off thrust on unsuitable pavement surface may have hidden dangers

Most flight crews are well aware of the danger jet blast can pose to people and equipment. However, few are aware of the risks associated with applying high thrust while the aircraft is standing on or near pavement surfaces not normally used for take-off or engine run-up.

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IF one were to ask pilots and air traffic controllers what precautions should be taken when increasing engine thrust during ground operations, they would almost certainly reply that the area behind the aircraft must be free of personnel and objects. But is it sufficient to ensure that the jet blast zone is clear? Very few of us would think about the risk associated with the type of surface on which the aircraft is standing. And yet, forgetting this detail can lead to extreme consequences.

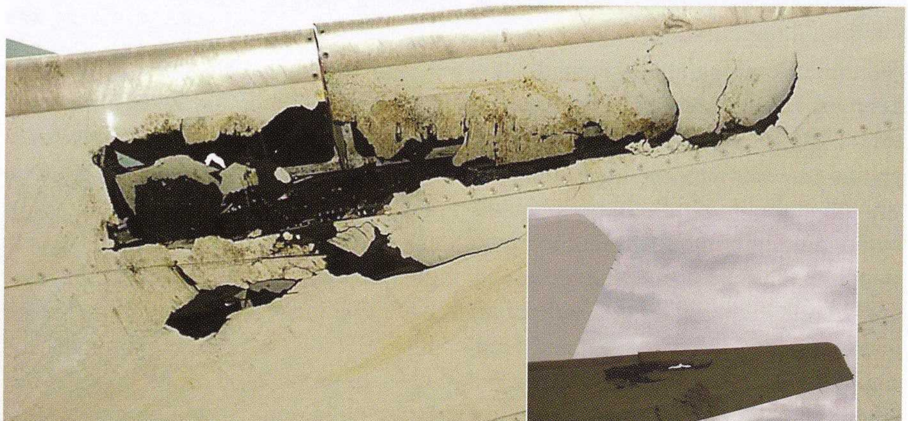
On the morning of 7 February 1991, a thin layer of snow covered the Nîmes Garons Airport (LFTW), France. The crew of an A320 was taxiing for take-off. After taking into account the contamination of the runway, the crew decided to start the take-off roll from a point as close to the end of the runway as possible. Take-off and initial climb proceeded normally up to approximately 2,000 feet above the ground, when the entire aircraft began to shake violently for two or three seconds. At the time, no explanation could be found for what had happened since the aircraft seemed to resume flying normally. However, on returning to the parking area, the crew discovered that the horizontal stabilizers had suffered considerable damage from ground debris that had been dislodged by jet blast.

Without realizing it because of the thin layer of snow, the crew had aligned the aircraft on the stopway. The surface of this portion of the runway was not able to resist the blast from a jet engine applying take-off thrust. When the engines reached take-off thrust, entire sections of asphalt, each weighing tens of kilograms, were ripped up and blown away. Even more serious, a number of smaller chunks weighing several kilograms each were dislodged and projected at high speed into the horizontal stabilizer, ripping out pieces of composite material that were later found on the overrun area. During acceleration on climb out and prior to retracting the flaps, the weakened stabilizer began vibrating and more than a metre snapped off each end. (Despite the loss of half of the elevator on either side, the aircraft's fly-by-wire control system limited the consequences on piloting to a minimum.)

Eleven years later, in 2002, the crew of a different aircraft type operated by another airline was taxiing up the runway of an airport in Europe. It was nighttime, with rain and poor visibility. On reaching the end of the runway, the crew completed the turn-around and aligned the aircraft so that the entire runway was available for the take-off because of the rain and limited length. Several seconds after applying take-off thrust and accelerating down the runway, an alarm for low hydraulics level (HYD LOW LEVEL) appeared, and the take-off was aborted. After returning to the parking area and shutting down the engines, the crew discovered — as with the Nîmes incident — that chunks of asphalt had been ripped up and projected against the stabilizer at very high speed. It was determined that take-off thrust had been applied while the aircraft was standing on the stopway and the asphalt surface had disintegrated.

In this case, the energy of the impact was such that the chunks perforated the stabilizer and ripped off a hydraulic line in the process, thereby triggering the alarm when acceleration began.

The two events described above may seem to be rare and isolated, but they do occur from time to time and are likely to



Example of a stabilizer severely damaged by surface debris which had been dislodged by jet blast.

reoccur unless operating personnel are aware of such scenarios. They are similar to incidents that have occurred during engine run-ups for maintenance purposes; all such incidents have included severe damage to the aircraft's horizontal stabilizer. The common denominator in these events is applying elevated thrust above a pavement surface that could not withstand the aerodynamic effect of jet engine blast. (Among other known examples of incidents involving damaged tail units are a Boeing 747 during take-off from Hong Kong in 1985 and run-up mishaps involving an A320 at Milan Linate Airport in 1995 and a Boeing 767 in Yaoundé, Cameroon, in 2001.)

An example of a fatal accident arising from loss of control caused by a piece of asphalt trapped in an aircraft elevator (New York JFK International Airport, September 1970) was summarized by the U.S. National Transportation Safety Board (NTSB) as follows: Approximately 1,500 feet after starting its take-off, the DC-8-63F aircraft rotated to a nose-high attitude. After a take-off roll of 2,800 feet, the aircraft became airborne and continued to rotate slowly to an attitude of approximately 60 to 90 degrees above the horizontal at an altitude estimated to have been between 300 and 500 feet above the ground. The aircraft rolled about 20 degrees to the right, rolled back to the left to an approximate vertical angle of bank, and fell to the ground in that attitude. The aircraft was destroyed by impact and post-impact fire.

The NTSB determined that the probable cause of the 1970 accident was a loss of pitch control caused by the entrapment of a pointed, asphalt-covered object between the leading edge of the right elevator and the spar web access door in the aft part of the right horizontal stabilizer. "The restriction to elevator movement ... was not detected by the crew in time to reject the take-off successfully."

As highlighted by this fatal accident, the risk associated with the scenarios described here is loss of control after take-off. The following lessons can be drawn from various events involving severe damage to the elevators or the stabilizer:

- Flight crews, airport managers and air traffic controllers should be aware of these scenarios and be conscious of the risks associated with applying thrust or performing a run-up beyond the runway ends (i.e. on blast pads or stopways).
- Operational procedures of airlines and airports and directives applied by air traffic control (ATC) must state explicitly that applying thrust for take-off, or run-up, must always be performed on an appropriate surface.

Finally, although the danger from jet blast to personnel or objects located behind the aircraft is generally well known, the same cannot be said of that associated with the projection of chunks of surface debris against a stabilizer located far above the engine exhaust. Indeed, it is easy to underestimate or be unaware of this risk. In order to avoid confusion, the reasons for taking these precautions need to be clearly detailed in the aircraft operator's procedures. □

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JET BLAST HAZARDS IN THE AIRPORT ENVIRONMENT

THE BOEING COMPANY

Exhaust blast from jet engines can pose hazards in airport environments. Operators and airport authorities must carefully consider these hazards and the resulting potential for injury and damage.

When modern jet engines are operated at high thrust levels, the exhaust blast can exceed 325 knots immediately aft of the engine exhaust nozzle. This exhaust flow extends in a rapidly expanding cone, with portions of the flow contacting and extending along the pavement surface. Exhaust velocity components are attenuated with increasing distance from the engine nozzle, but an airflow of 260 knots can still be present at the empennage, and significant hazards to people and equipment will persist hundreds of feet beyond this area. At full power, the exhaust blast speed can typically be 130 knots at 200 feet beyond the aeroplane.

One approach to relating these values to airport operations is to consider the hurricane intensity scale used by the U.S. National Oceanic and Atmospheric Administration (NOAA). At the extreme end of the intensity scale is a Category 5 hurricane, with winds greater than 135 knots. With such a hurricane, residential and industrial structures would experience roof failure, and lower strength structures would completely collapse. Mobile homes, utility buildings and objects such as trees would be extensively damaged or destroyed. At take-off thrust levels, a jet engine blast can easily exceed the sustained winds associated with a Category 5 hurricane.

High engine thrust during maintenance activity can also cause considerable damage to aircraft and other property. An example of this problem occurred after an aircraft arrived at its final destination with a log entry concerning anomalous engine operation. Subsequent evaluation resulted in replacement of an engine control component followed by an engine test and trim run to verify proper engine operation. The aircraft was positioned on an asphalt pad adjacent to a taxiway, with the paved surface extending from the wing tips aft to the empennage. During the high-power portion of the test run, a 20-by-20-foot piece of the asphalt immediately aft of the engine detached and was lifted from the pad surface. This four-inch thick piece of asphalt entered the core area of the left engine exhaust blast, where it shattered into numerous smaller pieces. These were driven aft at substantial velocity, striking the aft fuselage and left outboard portion of the horizontal tail. The maintenance crew was alerted to the ramp disintegration and terminated the engine run. Subsequent inspection found that the outboard four feet of the left horizontal stabilizer was missing, as was the entire left elevator.

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